

Mathematics

7



With the blessings of :
Our Parents

Mathematics (Part-7)

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Based on:

- National Education Policy 2020
- NCF 2022
- Activity Based Format
- Innovative Approach
- Learning with fun

Preface

Mathematics, a well arranged series of Mathematics strictly confirms to the vision of National Curriculum Framework 2022 and also meets the requirement of the NCERT latest syllabus. It is an activity-based maths textbook created to give the students a National Education Policy 2020-based interactive learning foundation in mathematics while also fostering the holistic development of learners through critical thinking and creativity.

These traits will aid the students in better understanding the fundamental ideas through play. Core educational ideas are the foundation of this textbook. The goal is to encourage youngsters to look beyond the theoretical side of arithmetic and to learn about practical applications.

The book's design emphasises effectiveness and logical progression. Through teaching and interactive learning, N EP 2020 seeks to enhance higher order thinking.

The purpose of this book's design and presentation is to reinforce mathematical concepts through the use of simple games. This book includes enough questions in accordance with the NEP 2020 criteria.

Salient Features of the series:

Learning Objectives: Learning objective shows the right path of learning to the teacher as well as students. It determines the direction of learning for effective and quality learning outcomes.

Warm-Up: It aids pupils in remembering lessons learnt in previous years and lets them ready for new concepts. Also, allows learners to process and explore mathematical concepts while applying, extending, and analysing information within their own unique range of understanding.

Teacher's note: A "Teacher's Note» is a set of instructions laid out for the teachers to follow in the classroom in order to make class interactive and discussion based.

Quick Tip: It offers suggestions on how to quickly solve the questions.

Facts To know: The inclusion of it gives the learner plenty of chances to investigate the information regarding the topics ..

Think Wisely: These questions have been included to encourage learners to think, analyse and apply.

Mental Maths: The main goal of teaching Mental Maths to the learners is to focus on improving their arithmetic abilities through memory, practice and number manipulation.

Maths Lab Activities: These are provided with the intention of making maths learning efficient, engaging, pleasant, and intellectually stimulating.

This series of Mathematics books from class 1-8 contains sufficient questions for practice on each topic.

I am very appreciative of the entire staff and the management for working so hard to get this book into such a wonderful arrangement.

The books are always open to suggestions and enhancements.

Author

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1

Knowing the Numbers

Recall what we have learnt in previous class about integers. We studied that integers comprise of **whole numbers** and **negative numbers**. We also learnt about the representation of integers on the number line, their comparative values, absolute value of an integer, addition and subtraction of integers. Let's briefly revise the main points again.



Integers

A combined set of negative numbers and whole numbers i.e., $\{\dots\dots -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, \dots\dots\}$.

[In this set, all the natural numbers are **positive integers** and others are **negative integers** except '0'. 0 (zero) is neither positive nor negative.]

Absolute Value of an Integer

The absolute value of an integer is the magnitude of the numerical value of an integer regardless of its sign (direction). It is denoted by the symbol ' $|$ '. The absolute value of an integer is always positive or 0 (zero).

Example : $|-5| = 5$
 $|-6 + 4| = |-2| = 2$
 $|7 - 3 - 4| = |0| = 0$

Also, the corresponding positive and negative integers have the same absolute value.

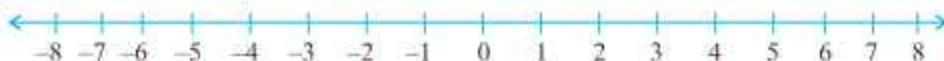
Example : $|25| = 25$ and $|-25| = 25$



Ordering of Integers

Integers and whole numbers obey the same rule in their ordering when represented on a number line, i.e. an integer represented to the right of any integer is greater than that integer and vice-versa.

Examples : $8 > 6, 5 > 3, 3 > 1, -1 > -3, -3 > -5, -7 > -8$



1. For every positive integer placed to the right of zero, there is a negative integer to the left of zero placed at the same distance from zero.
2. Zero is greater than every negative integer and less than every positive integer.
3. Every positive integer is greater than every negative integer.



Facts to Know

- The beginning of integers dates back to Babylonia around 4000 years back.
- The first evidence of the use of negative integers had been found in China around 300 BC.



Addition and Subtraction of Integers

1. When two integers with the same sign (either positive or negative) are added, their absolute values are added and the common sign is assigned to their sum.



$$(+75) + (+25) = 100$$

$$(-35) + (-15) = -50$$

2. When two integers with different signs are added, first the difference of their absolute values is found and it carries the sign of the integer having greater absolute value.

$$(+30) + (-12) = 18$$

$$(-30) + (+12) = -18$$

$$(+12) + (-30) = -18$$

$$(-12) + (+30) = 18$$

3. When we have to subtract two integers, we change the integer to be subtracted into its corresponding opposite integer and then the two integers are simply added.

$$(+18) - (+13) = (+18) + (-13) = 5$$

$$(-18) - (-13) = (-18) + (+13) = -5$$

$$(+13) - (+18) = (+13) + (-18) = -5$$

$$(-13) - (-18) = (-13) + (+18) = 5$$

$$(+18) - (-13) = (+18) + (+13) = 31$$

$$(-18) - (+13) = (-18) + (-13) = -31$$

$$(+13) - (-18) = (+13) + (+18) = 31$$

$$(-13) - (+18) = (-13) + (-18) = -31$$

Example 1 : Add the following :

(a) (-30) and (-15)

(b) (-6) and 18

(c) 4 and (-12)

(d) (-52) and 25

Solution : (a) (-30) and (-15)

$$= (-30) + (-15)$$

$$= -45$$

(b) (-6) and 18

$$= (-6) + 18$$

$$= 12$$

(c) 4 and (-12)

$$= 4 + (-12)$$

$$= -8$$

(d) (-52) and 25

$$= (-52) + 25$$

$$= (-27)$$

Example 2 : Subtract the following :

(a) $(-8) - (-8)$

(b) $17 - (-33)$

(c) $(-21) - (-8)$

(d) $20 - (-14)$

Solution : (a) $(-8) - (-8)$

$$= -8 + 8 = 0$$

(b) $17 - (-33)$

$$= 17 + 33 = 50$$

(c) $(-21) - (-8)$

$$= -21 + 8$$

$$= -13$$

(d) $20 - (-14)$

$$= 20 + 14$$

$$= 34$$



Exercise 1.1

1. Arrange the following integers in ascending order :

(a) $-28, 7, 1, 3, -7, -12, -1$

(b) $11, -4, 8, 3, -5, 1, 6$

2. Arrange the following integers in descending order :

(a) $-12, 15, 6, -14, -10, 3, -7, 9$

(b) $-16, 14, 2, 6, -8, -10, 0, 8, 13$

3. Write the absolute value of the following :

(a) $|-27 + 68|$

(b) $|21 - 18|$

(c) $|-83 + 0|$

(d) $|72 - 99|$

4. Add the following :

(a) $33 + (-17)$

(b) $-180 + 212$

(c) $0 + (-919)$

(d) $(-815) + (-913)$

5. Subtract the following :

(a) $-32 - (-48)$

(b) $(-45) - (+92)$

(c) $-8 - (-15)$

(d) $165 - (-319)$

6. Which value is higher ?

(a) -4°C or 7°C

(b) 0°F or -4°F

(c) -17°C or -14°C

(d) 44°F or 0°F

7. Complete the following sequences :

(a) $-15, -12, -9, -6, -3, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}$

(b) $45, 51, 57, 63, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}$

8. Write the opposites of the following integers :

(a) -15 +17

(b) -220 -110

(c) -11 +227

(d) 0 +1

(e) -1000 +1

(f) -99 -88





Multiplication of Integers

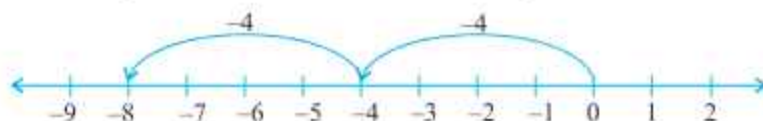
In previous classes, we have learnt that multiplication is nothing but repeated addition. Therefore, we can find the product of any two integers using repeated addition method.

Example : $(+4) \times (+2) = (+4) \times 2 = (+4) + (+4) = 8$
 $(-4) \times (+2) = (-4) \times 2 = (-4) + (-4) = -8$

On the number line, $(+4) \times (+2)$ means moving to the right of zero 2 times in steps of 4.



Similarly, $(-4) \times (+2)$ means moving to the left of zero 2 times in steps of 4.



Multiplication of Two Negative Numbers

Observe the following patterns :

$$\begin{aligned} (-5) \times 4 &= (-20) \\ (-5) \times 3 &= (-15) \\ (-5) \times 2 &= (-10) \\ (-5) \times 1 &= (-5) \\ (-5) \times 0 &= 0 \end{aligned}$$

Here, we observe that when the multiplier is decreased by 1, the product increases by 5. Using this fact, we can proceed like this:

$$\begin{aligned} (-5) \times (-1) &= 5 \\ (-5) \times (-2) &= 10 \\ (-5) \times (-3) &= 15 \\ (-5) \times (-4) &= 20 \end{aligned}$$

From the above given examples, we conclude that the product of two integers is the product of their absolute values and their signs are as follows :

- (i) The product of two positive integers carries positive sign.
 $(+9) \times (+8) = 72$
 $(+12) \times (+7) = 84$
- (ii) The product of two negative integers carries positive sign.
 $(-15) \times (-6) = 90$
 $(-9) \times (-8) = 72$
- (iii) The product of two integers with opposite signs carries negative sign.
 $(-17) \times (+4) = -68$
 $(-7) \times (+13) = -91$



Facts to Know

- For multiplying integers we use the following rules :
 - (i) Product of two positive integers is positive (i.e. $++=+$)
 - (ii) Product of two integers with opposite sign is negative (i.e. $+ \times - = -$ or $- \times + = -$)
 - (iii) Product of two negative integers is positive (i.e. $- \times - = +$)

Example 3 : Find the product of the following :

(a) $(-13) \times 9$ (b) $(-15) \times (-15)$ (c) $(+17) \times 5$ (d) $(+6) \times (-19)$

Solution : (a) $(-13) \times 9 = -117$ (minus $\times$ plus = minus)
 (b) $(-15) \times (-15) = 225$ (minus $\times$ minus = plus)
 (c) $(+17) \times 5 = 85$ (plus $\times$ plus = plus)
 (d) $(+6) \times (-19) = -114$ (plus $\times$ minus = minus)

Example 4 : Find the value of the following :

(a) $(-12 + 7) \times 5$ (b) $(-2) \times (-4) \times 4$ (c) $(-4 - 5) \times (-5)$ (d) $(-6 + 11) \times (-2 + 3)$

Solution : (a) $(-12 + 7) \times 5$
 $= (-5) \times 5$
 $= -25$ [$- \times + = -$]

(b) $(-2) \times (-4) \times 4$
 first we multiply -2 and -4
 $(-2) \times (-4) = 8$ [$- \times - = +$]
 Now, multiply
 $8 \times 4 = 32$

(c) $(-4 - 5) \times (-5)$
 $= (-9) \times (-5)$
 $= 45$ [$- \times - = +$]

(d) $(-6 + 11) \times (-2 + 3)$
 $= 5 \times 1$
 $= 5$ [$+ \times + = +$]



Division of Integers

It is well known that **division** is the inverse operation of **multiplication**. When we write $8 \times 4 = 32$, we can say $32 \div 4 = 8$ and $32 \div 8 = 4$. It means, for each multiplication statement there are two division statements.

So, when $(-7) \times 8 = -56$, then

$(-56) \div (-7) = 8$ and $(-56) \div 8 = -7$

Also, when $(-4) \times (-7) = 28$, then

$28 \div (-7) = -4$ and $28 \div (-4) = -7$

Some more examples :

$(-5) \times 8 = (-40)$ So, $(-40) \div (-5) = 8$ and $(-40) \div 8 = (-5)$

$(-14) \times (-3) = 42$ So, $42 \div (-14) = -3$ and $42 \div (-3) = (-14)$

$(-6) \times 8 = (-48)$ So, $(-48) \div (-6) = 8$ and $(-48) \div 8 = (-6)$

$4 \times (-17) = (-68)$ So $(-68) \div 4 = -17$ and $(-68) \div (-17) = 4$

From the above examples, we can draw the following conclusions :

- When dividend and the divisor have the same sign (either both positive or both negative), the quotient carries a positive sign.
- When dividend and divisor have different signs (one positive and other negative), the quotient carries a negative sign.



Facts to Know

For dividing integers we use the following rules:

(i) $- \div - = +$

(ii) $+ \div + = +$

(iii) $- \div + = -$

(iv) $+ \div - = -$

Example 5 : Determine the quotient for the following :

(a) $(-76) \div (-19)$ (b) $75 \div (-15)$ (c) $(-69) \div 23$ (d) $(-48) \div (-4)$





Solution : (a) $(-76) \div (-19)$

$$= \frac{-76}{-19} = 4 \quad [\therefore - \div - = +]$$

(c) $(-69) \div 23$

$$= \frac{-69}{23} = (-3) \quad [\therefore - \div + = -]$$

(b) $75 \div (-15)$

$$= \frac{75}{-15} = (-5) \quad [\therefore + \div - = -]$$

(d) $(-48) \div (-4)$

$$= \frac{-48}{-4} = 12 \quad [\therefore - \div - = +]$$

Example 6 : Find the integer which gives (-54) when multiplied by (-6) .

Solution : Let the unknown integer be x ,

According to the question,

$$x \times (-6) = (-54)$$

$$\Rightarrow x = \frac{-54}{-6} = 9 \quad [- \div - = +]$$



Exercise 1.2

1. Multiply the following :

(a) 21 and 0

(b) (-12) and (-12)

(c) (-192) and 0

(d) (-11) and (-12)

(e) (-7) and 11

(f) $(-24) \times 5$

2. Find the product of each of the following :

(a) $16 \times (-5)$

(b) $(-6) \times (-3) \times (-3)$

(c) $5 \times 4 \times 3 \times 2 \times 0$

(d) $(-15) \times (-6)$

(e) $(-10) \times (-9) \times 5 \times 4$

(f) $(-10) \times (-10) \times 10$

(g) $(-2) \times (-5) \times (-6) \times 0$

(h) $2 \times 3 \times 4 \times (-5) \times (-5)$

3. Fill in the boxes for the following :

(a) $(-12) \times (-2) \times (-4) = \square$

(b) $(-2) \times (-2) \times 2 \times 2 = \square$

(c) $80 \div (-8) = \square$

(d) $\square \div (-25) = (-3)$

(e) $(-24) \div \square = (-6)$

(f) $123 \div \square = (-41)$

(g) $66 \div \square = (-11)$

(h) $84 \div (-12) = \square$

(i) $[(-2) \times \square] \div 6 = -1$

(j) $(-5) \times (-2) \times 10 = \square$

4. Determine the quotient for each of the following :

(a) $(-20) \div (-1)$

(b) $(-72) \div 6$

(c) $(-26) \div 13$

(d) $36 \div (-3)$

(e) $(-126) \div 6$

(f) $(-111) \div (-3)$

(g) $(-117) \div (-13)$

(h) $(-14) \div (-14)$

(i) $(-81) \div 9$

(j) $(-100) \div (-10)$

5. Simplify and find the absolute value of the following :

(a) $|(-5 + 6 - 5) \times (-3)|$

(b) $|(-18) \div 3|$

(c) $|{(-8) - (-4)} \div (-2)|$

(d) $|(-5) \times (-5) \times (-2) \times 2|$

6. Find the integer which gives (-51) when it is multiplied by (-17) .

7. Find the quotient when divisor and dividend are (-4) and (-48) respectively.

8. An integer when divided by -7 gives 12. Find the integer.





Properties of Integers

Properties of Addition

Closure Property : If a and b are two integers, then $a + b$ will always be an integer.

Examples : $(-7) + (-8) = -15$

$$(-2) + 4 = 2$$

$$18 + (-12) = 6$$

$$(-16) + (-12) = -28$$

Commutative Property : If a and b are two integers, then their sum remains the same, irrespective of the order, i.e. $a + b = b + a$

Examples : $(-12) + (-16) = (-16) + (-12) = (-28)$

$$(-5) + 47 = 47 + (-5) = 42$$

$$10 + (-65) = (-65) + 10 = (-55)$$

$$(-17) + (-18) = (-18) + (-17) = -35$$

Associative Property : If a , b and c are three integers, then $a + (b + c) = (a + b) + c$. While adding these integers it is not necessary to add it in a particular order of their occurrence. We can do it by grouping them as per our convenience.

Examples : $[(-8) + 7] + (-15) = (-8) + [7 + (-15)]$

$$\Rightarrow (-1) + (-15) = (-8) + (-8)$$

$$\Rightarrow (-16) = (-16)$$

Let's see another example :

$$[(-7) + (-8)] + (-11) = (-7) + [(-8) + (-11)]$$

$$\Rightarrow (-15) + (-11) = (-7) + (-19)$$

$$\Rightarrow (-26) = (-26)$$

Additive Identity : If 0 (zero) is added to any integer, its value remains same. Thus, for an integer ' a ', $a + 0 = 0 + a = a$

Examples : $(-29) + 0 = (-29)$

$$0 + (-35) = (-35)$$

Additive Inverse : The sum of an integer and its opposite is always zero. If ' a ' is an integer, then $(-a)$ is its opposite and vice versa such that $a + (-a) = 0 = (-a) + a$

Examples : $29 + (-29) = 0 = (-29) + 29$

$$(-18) + 18 = 0 = 18 + (-18)$$

$$(-95) + 95 = 0 = 95 + (-95)$$

In the above given examples, the integers of each pair, i.e. $(29, -29)$, $(18, -18)$ and $(95, -95)$ are additive inverse of each other.

Property of 1 : If 1 is added to any integers, it gives its successor.

Examples : $11 + 1 = 12$

So, 12 is the successor of 11.

Also,

$$(-7) + 1 = (-6) \text{ So, } -6 \text{ is the successor of } (-7).$$





Properties of Subtraction

Closure Property : If a and b are two integers, then $a - b$ will always be an integer.

Examples : $(-4) - (-8) = 4$
 $(-8) - 12 = (-20)$
 $4 - 11 = (-7)$
 $(-17) - (-14) = (-3)$

Commutative Property : If a and b are two integers, then, $a - b \neq b - a$. It means commutative property is not applicable for the subtraction of integers.

Examples : $(-7) - (-4) = (-3)$ but $(-4) - (-7) = 3$
 $11 - (-17) = 28$ but $(-17) - 11 = (-28)$
 $(-4) - 18 = (-22)$ but $18 - (-4) = 22$

Associative Property : If a , b and c are three integers, then $(a - b) - c \neq a - (b - c)$. It means associative property is not applicable for the subtraction of integers.

Examples : $[(-2) - 4] - (-7) \neq (-2) - [4 - (-7)]$
 $\Rightarrow (-6) - (-7) \neq (-2) - 11$
 $\Rightarrow 1 \neq -13$

Property of Zero : If 0 (zero) is subtracted from any integer, its value remains same. Thus, for an integer ' a ', $a - 0 = a$

Examples : $(-32) - 0 = (-32)$
 $(-75) - 0 = (-75)$
 $99 - 0 = 99$

Property of 1 : If 1 is subtracted from any integer, it gives its predecessor.

Examples : $(-23) - 1 = (-24)$
 $83 - 1 = 82$
 $(-87) - 1 = (-88)$

In the above given examples, the integers (-24) , 82 and (-88) are predecessors of (-23) , 83 and (-87) respectively.

Properties of Multiplication

Closure Property : If a and b are two integers, then $a \times b$ will always be an integer.

Examples : $(-7) \times (-8) = 56$
 $(-8) \times 4 = (-32)$
 $7 \times (-3) = (-21)$
 $11 \times 12 = 132$

Commutative Property : If a and b are two integers, then their multiples remains the same, irrespective of the order, i.e. $a \times b = b \times a$

Examples : $(-7) \times (-12) = 84 = (-12) \times (-7)$
 $4 \times (-9) = (-36) = (-9) \times 4$
 $(-13) \times 6 = (-78) = 6 \times (-13)$
 $17 \times 5 = 85 = 5 \times 17$

Associative Property : If a , b and c are three integers, then $a \times (b \times c) = (a \times b) \times c$. While multiplying these integers it is not necessary to multiply it as a particular order of their occurrence. We can do it by grouping them as per our convenience.





Examples : $[(-5) \times 6] \times (-7) = (-5) \times [6 \times (-7)]$
 $(-30) \times (-7) = (-5) \times (-42)$
 $\Rightarrow 210 = 210$

Let's see another example :

$[(-12) \times (-5)] \times (-2) = (-12) \times [(-5) \times (-2)]$
 $\Rightarrow 60 \times (-2) = (-12) \times 10$
 $\Rightarrow -120 = -120$

Multiplicative Identity : If 1 is multiplied to any integer, its value remains same. Thus, for an integer 'a'

$$a \times 1 = 1 \times a = a$$

Examples : $(-87) \times 1 = 1 \times (-87) = (-87)$
 $43 \times 1 = 1 \times 43 = 43$
 $(-27) \times 1 = 1 \times (-27) = (-27)$

Multiplicative Inverse : The multiple of an integer and its multiplicative inverse is always 1. If 'a' is an integer, then $(\frac{1}{a})$ is its multiplicative inverse and vice-versa such that

$$a \times \frac{1}{a} = 1 = \frac{1}{a} \times a$$

Examples : $(-15) \times \frac{1}{(-15)} = 1 = \frac{1}{(-15)} \times (-15)$
 $(-43) \times \frac{1}{(-43)} = 1 = \frac{1}{(-43)} \times (-43)$

Distributive Property : If a, b and c are three integers, then

$$a \times (b + c) = (a \times b) + (a \times c)$$

It means multiplication distributes over addition.

Examples : $(-7) \times [4 + (-8)] = [(-7) \times 4] + [(-7) \times (-8)]$
 $\Rightarrow (-7) \times (-4) = -28 + 56$
 $\Rightarrow 28 = 28$



Facts to Know

- 1 and -1 are the only two integers whose respective multiplicative inverse remains same.

Properties of Division

Closure Property : If a and b are two integers, thus $a \div b$ will not always be an integer.

Examples : $(-2) \div 5 = -0.4$
 $2 \div 3 = 0.\bar{6}$
 $(-4) \div 0 = \text{not defined}$
 $(-7) \div (-28) = 0.25$

Commutative Property : If a and b are two integers, then $a \div b \neq b \div a$. It means commutative property is not applicable for the division of integer.

Examples : $(-4) \div (8) \neq 8 \div (-4)$
 $\Rightarrow -0.5 \neq -2$



Let's see another example:

$$(-12) \div (-4) \neq (-4) \div (-12)$$

$$\Rightarrow 3 \neq 0.\bar{3}$$

Associative Property : If a , b and c are three integers, then $(a \div b) \div c \neq a \div (b \div c)$. It means associative property is not applicable for the division of integers.

Examples : $[(-16) \div 4] \div (-2) \neq (-16) \div [4 \div (-2)]$

$$\Rightarrow (-4) \div (-2) \neq (-16) \div (-2)$$

$$\Rightarrow 2 \neq 8$$

Let's see another example:

$$[(-24) \div (-4)] \div 6 \neq (-24) \div [(-4) \div 6]$$

$$\Rightarrow 6 \div 6 \neq (-24) \div \left(\frac{-4}{6}\right)$$

$$\Rightarrow 1 \neq 36$$

Property of 1 : If we divide any integer by 1, it gives the same integer as quotient. For any integer ' a ', $a \div 1 = a$

Examples : $(-29) \div 1 = (-29)$

$$(-75) \div 1 = (-75)$$

Property of 0 (zero) : If we divide zero by any integer, the result is always zero. For any integer ' a ',

$$0 \div a = 0$$

Example : $0 \div -92 = 0$

$$0 \div 345 = 0$$

$$0 \div 645 = 0$$



Facts to Know

- Zero divided by an integer is always zero.
- Any integer divided by zero is not defined.

Example 7 : Sum of two integers is (-73) . If one of the integers is 46, find the other integer. Also verify the answer.

Solution : Let the required integer be ' x '

According to the question,

$$x + 46 = (-73)$$

$$\Rightarrow x = (-73) - 46$$

$$\Rightarrow x = -119$$

Hence, the required integer is (-119)

Verification :

$$-119 + 46 = -73$$

$$\Rightarrow -73 = -73$$

Example 8 : Subtract the sum of (-75) and (-47) from the multiple of (-8) and (-12) .

Solution : Sum of (-75) and (-47)

$$= (-75) + (-47)$$

$$= -122$$



Multiple of (-8) and (-12)

$$= (-8) \times (-12) = 96$$

$$\therefore \text{The required difference} = 96 - (-122) = 218$$

Example 9 : Subtract the sum of 16, 14 and (-7) from the sum of 7, 19 and the additive inverse of 16.

Solution : Sum of 16, 14 and (-7)

$$= 16 + 14 + (-7) = 23$$

Additive inverse of 16 is (-16) ,

Sum of 7, 19 and (-16)

$$= 7 + 19 + (-16) = 10$$

$$\therefore \text{The required difference} = 10 - 23 = (-13)$$

Example 10 : In a quiz competition, Rahul scored 70, (-20) and 40, whereas Saurav scored 50, 0 and 20 in three successive rounds. Who won the quiz competition and by what margin?

Solution : Rahul's total score $= 70 + (-20) + 40 = 90$

$$\text{Saurav's total score} = 50 + 0 + 20 = 70$$

Rahul's score is 90 and Saurav's score is 70.

So, Rahul won by the margin of $90 - 70 = 20$.

Example 11 : Evaluate the following using distributive property :

(a) $(-6) \times 97$

(b) $(-7) \times 1002$

Solution : (a) $(-6) \times 97 = (-6) \times (100 - 3)$

$$= [(-6) \times 100] - [(-6) \times 3] \text{ (by distributive property)}$$

$$= (-600) - (-18)$$

$$= (-600) + 18 = (-582)$$

(b) $(-7) \times 1002 = (-7) \times (1000 + 2)$

$$= [(-7) \times 1000] + [(-7) \times 2]$$

$$= (-7000) + (-14) = (-7014)$$

Example 12 : A submarine descends into sea water at the rate of 12 km per minute. What will be its position after 15 minutes?

Solution : Since the submarine is going down, so the distance covered by it will be represented by negative integer.

$$\text{Change in position of the submarine in one minutes} = (-12) \text{ km}$$

$$\text{Position of the submarine after 15 minutes} = (-12) \times 15 = (-180) \text{ km}$$

It means, after 15 minutes the submarine will be 180 km below the surface of sea water.

Example 13 : A room heater starts raising the temperature at the rate of 2°C per minute. Ankit feels comfortable at 34°C . In how much time will Ankit be happy? [If current temperature is 0°C]

Solution : Times taken by room heater to reach at $34^\circ\text{C} = \frac{34}{2} = 17 \text{ min}$

Hence, after 17 minutes the temperature of the room will reach at 34°C that will make Ankit happy.





Exercise 1.3

1. Fill in the blanks :

(a) $20 \div \square = -1$

(b) $\square \div 25 = -1$

(c) $\square \div 6 = 0$

(d) $13 - (-13) = \square$

(e) $(-17) \times \square = 16 \times (-17)$

(f) $(-243) \times 0 =$

(g) $(-5) \times \frac{1}{\square} = 1$

(h) $(-10) \times [(-5) + 7] = [(-10) \times \square] + [(\square) \times 7]$

(i) $\square \times [3 + (-4)] = [(-8) \times 3] + [(-8) \times \square]$

(j) $[10 \times \square] \times (-6) = 10 \times [(-5) \times (-6)]$

2. Write T for True and F for False for the following statements :

(a) $(-5) \times 7 = -35$

(b) $(-5) \times (-4) \times 2 = 5 \times 2 \times (-4)$

(c) $(-4) - (-8) = -12$

(d) $(-18) \times 0 = -18$

(e) $(-8) \times (-14) \times 0 = 0$

(f) $(-12) \div 4 = 4 \div (-12)$

3. Calculate the following using suitable arrangements:

(a) $(127 \times 8) + (127 \times 12)$

(b) 105×7

(c) $(-125) + (-75) + 188 + (-38) + 25$

4. Prove the validity of the following using property of multiplication:

(a) $[57 \times (-127)] + [(-23) \times 57]$

(b) $(-8) \times [(-12) + (-16)]$

(c) $[(-21) \times [(-5) + (-7)]]$

(d) $[(-105) \times 91] + [5 \times 91]$

5. Evaluate the following using distributive property:

(a) 18×102

(b) $(-5) \times 1003$

(c) 89×14

(d) $(-37) \times 97$

6. An integer divided by (-13) gives 9. Find the integer.

7. Find an integer which when multiplied with (-8) gives 72.

8. Tanya throws a stone 52 m vertically up in the air which later settled on the bottom of a lake 60 m deep. Find the total distance covered by stone.

Points to Remember

- ❖ Integers are the combined sets of negative numbers and whole numbers.
- ❖ The absolute value of an integer is the right magnitude of the value of an integer regardless of its sign.
- ❖ On a number line, every integer to the right of zero is greater than the integers to its left and vice versa.
- ❖ 0 is neither negative nor positive.
- ❖ Addition of integers follow closure, commutative and associative property i.e.,
 - (a) The value of sum of two integers a and b is integer.
 - (b) $a + b = b + a$
 - (c) $(a + b) + c = a + (b + c)$
- ❖ Subtraction of integers follow only closure property. The value of subtraction of two integers a and b is integer.
- ❖ Multiplication of integers follow closure, commutative and associative property i.e.,
 - (a) The product of two integers a and b is integer.
 - (b) $a \times b = b \times a$
 - (c) $(a \times b) \times c = a \times (b \times c)$
- ❖ Integers follow distributive property, i.e. for any three integers a, b and c,

$$a \times (b + c) = (a \times b) + (a \times c)$$
- ❖ For division of integers
 - (a) The quotient carries a positive sign when dividend and divisor have same sign (either positive or negative).
 - (b) The quotient carries a negative signs when dividend and divisor have different signs (one positive and other negative).
- ❖ For any integer 'a',
 - (a) $a \div 0$ is not defined
 - (b) $0 \div a = 0$ and
 - (c) $a \div 1 = a$



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options :

(a) Which of the following is correct ?

(i) $a \div 0 = 0$

☐

(ii) $0 \div a = \text{not defined}$

☐

(iii) $0 \div a = 0$

☐

(iv) $1 \div a = a$

☐

(b) The smallest positive integer is :

(i) 0

☐

(ii) 1

☐

(iii) 99

☐

(iv) 1000

☐

(c) The additive inverse of (-7) is :

(i) $\frac{1}{7}$

☐

(ii) $-\frac{1}{7}$

☐

(iii) 7

☐

(iv) None of these

☐

(d) The multiplicative inverse of $7x$ is :

(i) $\frac{1}{7x}$

☐

(ii) $\frac{7}{x}$

☐

(iii) $\frac{7x}{1}$

☐

(iv) $(-7x)$

☐

(e) Which of the following relation is correct ?

(i) $(-24) \div (-4) = (-6)$

☐

(ii) $(-72) \div 8 = (-9)$

☐

(iii) $20 \div (-10) = 2$

☐

(iv) $(-30) \div (-3) = -27$

☐

(f) What is the value of expression:

$\{(-15) + 4 + (-7)\} \div \{(-3) - 9 + 18\}$

(i) 2

☐

(ii) -3

☐

(iii) 4

☐

(iv) 6

☐

(g) The expression $103 \times (-35)$ can be re-written as which of the following expression ?

(i) $10300 - 105$

☐

(ii) $-10300 + 105$

☐

(iii) $3500 + 105$

☐

(iv) $-3500 - 105$

☐

2. Find the product of the following :

(a) $(-13) \times (-11)$

(b) $(-4) \times 16$

(c) $(-6) \times (-15)$

(d) $(-125) \times 8$

3. Find the quotient :

(a) $(-64) \div (-16)$

(b) $(-84) \div 4$

(c) $0 \div (-7)$

(d) $168 \div (-8)$

(e) $(-216) \div (-6)$

(f) $120 \div (-15)$

4. Simplify :

(a) $\{(-80) \div 16\} \times (-2) + 6$

(b)

$\{[(-3) - (-4)] \times \{(-6) + (-8)\}\}$

(c) $\{(-7) \times (-5) \times (-6)\} \div (-15)$

(d)

$[24 \div \{(-6 + 18) - 6\}]$

5. Find the product using suitable properties as:

(a) $(-17) \times 29$

(b) $(-51) \times 13$

(c) $\{(-47) \times 21\} + (-47)$

(d) $\{(-24) \times 37\} + \{(-24) + 13\}$

(e) $(99 \times 17) + (17 \times 101)$

(f) $(-12) \times 25 \times 6 \times (-4)$

6. A monkey is trying to reach at the top of vertical slippery pole 25 m high. In one jump he goes up by 3 m but slips by 1 m. In how many moves he will reach at the top?

7. Rinku gets ₹ 1500 as pocket money per month. He spends ₹ 750 eating outside and ₹ 300 as donation to a charity organisation. Find out Rinku's saving at the end of the year.



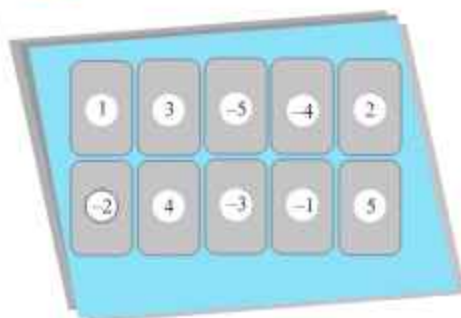
Every floor of a 20 storey building is 5 m high. If a lift moves 2 metres every second, how long will it take to move from 3rd floor to 15th floor.



Objective

Materials Required

- To comprehend the operation of multiplication through a game.
- 10 square-shaped one coloured cards with integers from -5 to 5 mentioned on it, square paper sketch pens and different coloured counters.



- Procedure :** The game is to be played ideally among 2 to 4 players.
- Step 1 :** Take a white coloured chart paper. Cut it in squared shape.
Take a chart paper and draw a 9×9 grid on it using sketch pen.

32	33	34	35	36	37	38	39	40
31	30	29	28	27	26	25	24	23
14	15	16	17	18	19	20	21	22
13	12	11	10	9	8	7	6	5
-4	-3	-2	-1	0	1	2	3	4
-5	-6	-7	-8	-9	-10	-11	-12	-13
-22	-21	-20	-19	-18	-17	-16	-15	-14
-23	-24	-25	-26	-27	-28	-29	-30	-31
-40	-39	-38	-37	-36	-35	-34	-33	-32

- Step 2 :** Write the integers starting from -40 to 40 as shown.
- Step 3 :** Keep the counters at 0. [Each player will play with only counter].
- Step 4 :** Rules to be followed:
Each player will choose two cards from the pack of 10 cards randomly. (Integers hidden on other side)
The player has to multiply the integers shown on the card. For example, the appearing numbers are (-4) and 5 . So, $(-4) \times 5 = (-20)$. The player will put his counter at (-20) on the board.
- Step 5 :** Now its turn of the next player sitting next to the first player.
- Step 6 :** If the product is positive, the counter will move towards 40. If the product is negative it will move towards (-40) .
- Step 7 :** Each player gets another chance to choose two cards after the completion of the first round.
- Step 8 :** The player whose counter crosses 40 first is the winner.



When one starts learning Mathematics, he first starts with counting numbers, i.e., 1, 2, 3, 4, 5, 6 (Natural Numbers). Then he learns about 0 and numbers beyond 1 (Whole Numbers). Knowing about the negatives of natural numbers he learns about integers. Suppose one has to find out a part of a whole or a part of a set of objects, he may or may not get the desired result. Therefore, we need to extend the set of whole numbers so as to make the division of whole always possible. This new set of numbers is termed as the set of **rational numbers**. Here, rational number is any number that can be written as a **ratio of two integers**. It means a number is rational, if it can be written as a fraction where both numerator and denominator are integers.

The word 'rational' originates from the word 'ratio' because rational numbers are the ones that can be written in ratio form, $\frac{p}{q}$ where p and q are integers and $q \neq 0$.

Before knowing more about rational numbers, let's refresh the basics of number system.

Natural numbers : The counting numbers are called natural numbers. Thus, 1, 2, 3, 4, 5 are natural numbers.

Whole Numbers : All natural numbers including 0 (zero) are called whole numbers. Thus, 0, 1, 2, 3..... are whole numbers.

We also learnt these properties related with whole numbers:

(a) The sum of two whole numbers is always a whole number.

Example : $0 + 8 = 8$

$$17 + 25 = 42$$

$$29 + 97 = 126$$

(b) The product of two whole numbers is always a whole number.

Example : $0 \times 17 = 0$

$$8 \times 15 = 120$$

$$7 \times 19 = 133$$

(c) The difference of two whole numbers is not always a whole number.

Example : $57 - 30 = 27$

$$0 - 68 = (-68) \text{ (Not a whole number)}$$

$$75 - 87 = (-12) \text{ (Not a whole number)}$$

(d) The division of two whole numbers does not always give a whole number as quotient.

Example : $12 \div 3 = 4$

$$14 \div 6 = 2.\bar{3} \text{ (Not a whole number)}$$

$$49 \div 7 = 7$$

Division of integers by zero is not defined.

$$\text{i.e. } 7 \div 0 = 0$$

$$(-6) \div 0 = 0$$

Integers : The whole numbers with the negatives of natural numbers are called Integer.

Thus, -4, -3, -2, -1, 0, 1, 2, 3, 4, are all integers.

We learnt from above that subtraction of whole numbers may give us integers.

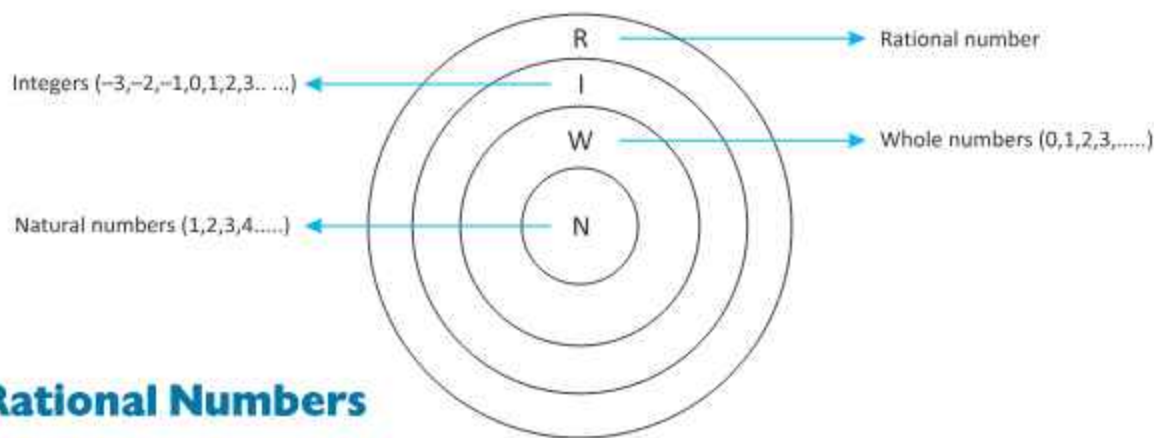
Also, if you recall the previous chapter, while dealing with properties of integers, we saw that the division of one integer by another integer may or may not be an integer.

Example : $24 \div 8 = 3$

$$(-72) \div 18 = (-4)$$

$$(-5) \div 15 = \frac{-1}{3} \text{ [Not an integer]}$$

$$(-3) \div (-18) = \frac{1}{6} \text{ [Not an integer]}$$



Rational Numbers

Therefore, we need to extend our number system in which negative and positive fractions must be included. This new system of numbers is known as rational number system.

A number that can be represented in the form of $\frac{p}{q}$, where p and q are integers and $q \neq 0$, is called a rational number. The denominator of a fraction cannot be 0 (zero) because division of any number by zero is not defined.

Examples : (a) $\frac{-6}{11}$ is a rational number as both (-6) and 11 are integers and denominator (11) is not equal to 0.

(b) $\frac{-3}{8}$ is a rational number as both (-3) and 8 are integers and denominator (8) is not equal to zero.

(c) 15 is a rational number as $15 = \frac{15}{1}$.

Both 15 and 1 are integers and the denominator (1) is not equal to 0 (zero).

From the above, we can conclude that rational numbers include both **integers** and **fractions**.



Facts to Know

- If both the numerator and denominator of a rational number are either both positive or both negative, it is a positive rational number.



Types of Rational Numbers

There are two types of rational numbers:

(a) **Positive Rational Numbers**

(b) **Negative Rational Numbers**

(a) **Positive Rational Numbers :** A rational number is positive, if its numerator and denominator are either both positive or both negative.

Example : $\frac{2}{7}, \frac{8}{19}, \frac{23}{5}, \frac{0}{4}, \frac{7}{9}$ are positive rational integers

Also, $\frac{-7}{-18}, \frac{-2}{-9}, \frac{-13}{-77}, \frac{-1}{-6}$ are positive rational numbers, because $\frac{-7}{-18} = \frac{7}{18}, \frac{-2}{-9} = \frac{2}{9}, \frac{-13}{-77} = \frac{13}{77}$ and $\frac{-1}{-6} = \frac{1}{6}$

(b) **Negative Rational Numbers** : A rational number is negative, if either its numerator or denominator is negative.

Example : $\frac{-3}{7}, \frac{3}{-17}, \frac{18}{-29}, \frac{-37}{39}$ are negative rational numbers because

$$\frac{-3}{7} = \left(-\frac{3}{7}\right), \frac{3}{-17} = \left(-\frac{3}{17}\right), \frac{18}{-29} = \left(-\frac{18}{29}\right), \frac{-37}{39} = \left(-\frac{37}{39}\right)$$



Facts to Know

- A rational number $\frac{p}{q}$ is a fraction only when p and q are whole numbers and $q \neq 0$.
- All fractions are rational numbers but a rational number is not always a fraction.
- Negative fractions are also called negative rational numbers.
- All counting numbers (Natural numbers), whole numbers and integers are rational numbers.



Rational Numbers on a Number Line

We already know how to represent fractions, integers, whole numbers and natural numbers on number line. Let's learn to denote rational numbers on a number line.

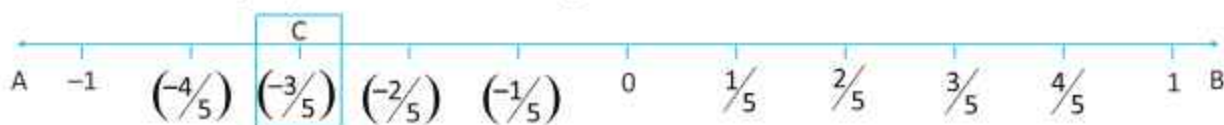


When we move from left to right on the number line, the number increases, whereas, if we move from right to left, the number decreases as shown in the given figure.

To represent a rational number on a number line, each unit length is divided into equal parts of the denominator of a rational number. Then one can easily mark the required rational number on line.

Example 1 : Represent $\frac{-3}{5}$ on a number line.

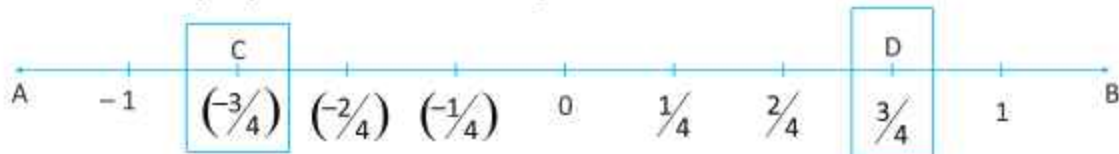
Solution : Here, the denominator of the rational number is 5. So we divide each unit length on the number line AB into 5 equal parts as shown in the figure.



The numerator to be denoted, is (-3) , so counting 3 parts to the left of zero on the number line, mark it as point C. Point 'C' represents $\left(\frac{-3}{5}\right)$.

Example 2 : Represent $\left(\frac{-3}{4}\right)$ and $\frac{3}{4}$ on a number line.

Solution : Here, the denominator of the rational number is 4. So we divide each unit length on the number line AB into 4 equal parts as shown in the figure.



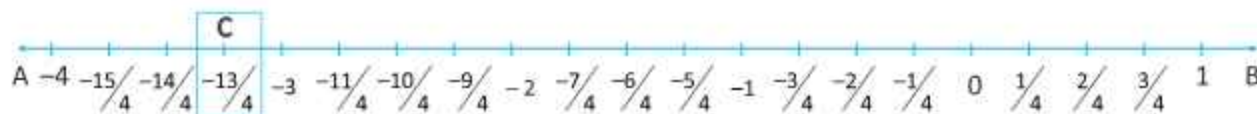
The numerators to be denoted are (-3) and 3. So counting 3 parts to the left of zero on the number line, mark it as point 'C' and counting 3 parts to the right of zero on the number line, mark it as point D. Point C and D represents $\left(\frac{-3}{4}\right)$ and $\frac{3}{4}$ respectively.



Example 3 : Represent $\frac{-13}{4}$ on a number line.

Solution : $\frac{-13}{4} = -3\frac{1}{4} = -3 + \left(\frac{-1}{4}\right)$

Here, the denominator of the rational number is 4. So we divide each unit length on the number line AB into 4 equal parts as shown in the figure.



Since the numerator to be denoted is -13 , so count 13 parts to the left of zero on the number line and mark it as point 'C'. Point 'C' represents $\left(\frac{-13}{4}\right)$.



Standard Form of a Rational Number

A rational number is said to be in the standard form if its denominator is a positive integer and the numerator and the denominator are co-primes i.e., have no common factor other than 1.

Example : $-\frac{2}{7}, \frac{17}{47}, \frac{8}{19}$ and $-\frac{17}{6}$ are the rational numbers in standard form.

Example 4 : Reduce the following in the standard form :

(a) $\frac{-4}{26}$

(b) $\frac{24}{-16}$

Solution : (a) The denominator of $\left(\frac{-4}{26}\right)$ is positive. To express it in standard form, first find the HCF of 4 and 26, which is 2. Now denominator is positive.

now
$$\frac{-4}{26} = \frac{(-4) \div 2}{26 \div 2}$$

$$= \frac{-2}{13}$$

So, the standard form of $\left(\frac{-4}{26}\right)$ is $\left(\frac{-2}{13}\right)$.

(b) The denominator of $\left(\frac{24}{-16}\right)$ is negative. To make it positive, multiply both numerator and denominator by (-1) , we get

$$\frac{(24) \times (-1)}{(-16) \times (-1)} = \frac{-24}{16}$$

Now find the HCF of 24 and 16, which is 8. Divide both numerator and denominator by 8, we get

$$\frac{(-24) \div 8}{16 \div 8} = \frac{-3}{2}$$

So, the standard form of $\left(\frac{24}{-16}\right)$ is $\left(\frac{-3}{2}\right)$.



Absolute Value of a Rational Number

The absolute value of a rational number is its positive numerical value, irrespective of the sign of numerator and denominator, i.e., $\left|\frac{p}{q}\right| = \frac{p}{q}$, $\left|\frac{-p}{q}\right| = \frac{p}{q}$, $\left|\frac{p}{-q}\right| = \frac{p}{q}$ and $\left|\frac{-p}{-q}\right| = \frac{p}{q}$

Example :

(a) $\left|\frac{-7}{-6}\right| = \frac{7}{6}$ (b) $\left|\frac{-17}{18}\right| = \frac{17}{18}$

(c) $\left|\frac{27}{8}\right| = \frac{27}{8}$ (d) $\left|\frac{6}{-13}\right| = \frac{6}{13}$



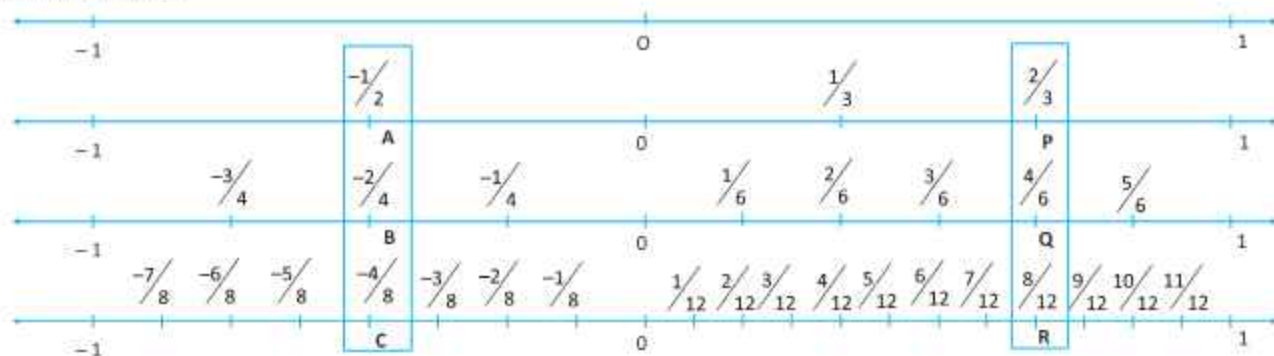
Facts to Know

- The absolute value of rational number, when represented on a number line, is taken as its distance from zero (irrespective of the direction) and it is represented as $\frac{p}{q}$.
- A positive rational number is always greater than a negative rational number.



Equivalent Rational Numbers

Let's understand the concept of equivalent rational numbers through number lines. Draw the number lines as shown in the figure.



One can observe that points P, Q and R representing $\frac{2}{3}$, $\frac{4}{6}$ and $\frac{8}{12}$ respectively are equidistant from point O that represents (0) zero on the number line. In other words, the same point corresponds to these rational numbers. We can say rational numbers $\frac{2}{3}$, $\frac{4}{6}$ and $\frac{8}{12}$ are equivalent. Similarly points A, B and C, representing $\left(\frac{-1}{2}\right)$, $\left(\frac{-2}{4}\right)$, $\left(\frac{-4}{8}\right)$ and respectively are equidistant from point O that represents 0 on the number line. Hence, these are equivalent,

i.e., $\frac{-1}{2} = \frac{-2}{4} = \frac{-4}{8}$

Thus, rational numbers which can be represented by the same point on a number line are called equivalent rational numbers.

Let $\frac{a}{b}$ and $\frac{c}{d}$ be two rational numbers:

(a) If $\frac{a}{b} = \frac{c}{d}$ or $ad = bc$, they are equivalent rational numbers.



(b) If $\frac{a}{b} > \frac{c}{d}$, then $ad > cd$

(c) If $\frac{a}{b} < \frac{c}{d}$, then $ad < cd$

Equivalent rational numbers can be obtained by multiplying or dividing both the numerator and the denominator of the given rational number by the same non-zero integer.

Example : (a) $\frac{-7}{8} = \frac{-7 \times 2}{8 \times 2} = \frac{-14}{16}$
 $\frac{-7}{8} = \frac{-7 \times (-5)}{8 \times (-5)} = \frac{35}{-40}$

(b) $\frac{13}{18} = \frac{13 \times 3}{18 \times 3} = \frac{39}{54}$
 $\frac{13}{18} = \frac{13 \times (-2)}{18 \times (-2)} = \frac{-26}{-36} = \frac{26}{36}$

(c) $\frac{3}{-13} = \frac{3 \times (-3)}{-13 \times (-3)} = \frac{-9}{39}$
 $\frac{3}{-13} = \frac{3 \times 6}{-13 \times 6} = \frac{18}{-78}$

Example 5 : Show that rational numbers $\frac{3}{5}$ and $\frac{18}{30}$ are equivalent.

Solution : We know that for two rational numbers $\frac{a}{b}$ and $\frac{c}{d}$ to be equivalent $ad = bc$.

Let $\frac{a}{b} = \frac{3}{5}$ and $\frac{c}{d} = \frac{18}{30}$

$ad = 3 \times 30 = 90$ and $bc = 5 \times 18 = 90$

Since $ad = bc = 90$, So $\frac{3}{5}$ and $\frac{18}{30}$ are equivalent.

Example 6 : Write four equivalent rational numbers of $\frac{6}{11}$.

Solution : $\frac{6}{11} = \frac{6 \times 2}{11 \times 2} = \frac{12}{22}$, $\frac{6}{11} = \frac{6 \times 3}{11 \times 3} = \frac{18}{33}$
 $\frac{6}{11} = \frac{6 \times 4}{11 \times 4} = \frac{24}{44}$, $\frac{6}{11} = \frac{6 \times 5}{11 \times 5} = \frac{30}{55}$

So, four equivalent rational numbers of $\frac{6}{11}$ are $\frac{12}{22}$, $\frac{18}{33}$, $\frac{24}{44}$ and $\frac{30}{55}$.

Example 7 : Express $\frac{-17}{15}$ as a rational number with numerator 85.

Solution : To express $\frac{-17}{15}$ as a rational number with numerator 85 which when multiplied by (-17) , gives 85.

Since $85 \div 17 = 5$, so multiply both the numerator and denominator by (-5) as $(-17) \times (-5) = 85$.

$\frac{-17}{15} = \frac{(-17) \times (-5)}{15 \times (-5)} = \frac{85}{-75}$ So, $\frac{-17}{15} = \frac{85}{-75}$



Comparison of Rational Numbers

Have a look at the number line representing rational numbers as shown in the figure.



From the figure, we learn that

$-\frac{6}{6} < -\frac{5}{6} < -\frac{4}{6} < -\frac{3}{6} < -\frac{2}{6} < -\frac{1}{6} < 0 < \frac{1}{6} < \frac{2}{6} < \frac{3}{6} < \frac{4}{6} < \frac{5}{6} < \frac{6}{6}$ (ascending order)

and $\frac{6}{6} > \frac{5}{6} > \frac{4}{6} > \frac{3}{6} > \frac{2}{6} > \frac{1}{6} > 0 > -\frac{1}{6} > -\frac{2}{6} > -\frac{3}{6} > -\frac{4}{6} > -\frac{5}{6} > -\frac{6}{6}$ (descending order)

The above mentioned rational numbers have same denominator. Therefore, by comparing the numerators we find out which is greater or smaller.

Example : $\frac{-4}{6} > \frac{-5}{6}$ (Since $-4 > -5$)

$\frac{-2}{6} < \frac{5}{6}$ (Since $-2 < 5$)

Other than this, all other rules for the comparison of integers and fractions are applicable to rational numbers also.

- (i) All positive rational numbers are greater than 0.
- (ii) All positive rational numbers are greater than all negative rational numbers.
- (ii) All negative numbers are smaller than 0.

Example : $\frac{-3}{17} < \frac{-1}{17}$ [Since $(-3) < (-1)$]

and $\frac{3}{7} < \frac{18}{7}$ [Since $3 < 18$]

When the rational numbers have different denominators we change them as rational numbers with the same denominator and then compare. We will learn it through examples.

Example 8 : Arrange the following in descending order :

(a) $\frac{1}{12}, \frac{3}{12}, \frac{6}{12}, \frac{5}{12}, \frac{13}{12}$ (b) $\frac{-4}{13}, \frac{4}{13}, \frac{-1}{13}, \frac{12}{13}$

Solution : (a) Since the denominator of the given rational numbers is same i.e. 12, we write their numerators in descending order.

Here, $13 > 6 > 5 > 3 > 1$

So, $\frac{13}{12} > \frac{6}{12} > \frac{5}{12} > \frac{3}{12} > \frac{1}{12}$

(b) Since the denominator of the given rational numbers is same, i.e. 13, so, we write their numerators in descending order:

Here, $12 > 4 > -1 > -4$

So, $\frac{12}{13} > \frac{4}{13} > \frac{-1}{13} > \frac{-4}{13}$

Example 9 : Which is greater: $\frac{5}{6}$ or $\frac{7}{9}$?

Solution : Since the denominators of the given rational numbers are different, we change them as rational numbers with the same denominator and then compare.

$$\frac{5}{6} = \frac{5 \times 3}{6 \times 3} = \frac{15}{18}, \quad \frac{7}{9} = \frac{7 \times 2}{9 \times 2} = \frac{14}{18}$$

$$\frac{15}{18} \boxed{?} \frac{14}{18}$$

Since $15 > 14$ So, $\frac{15}{18} > \frac{14}{18}$ or, $\frac{5}{6} > \frac{7}{9}$



Facts to Know

- We can also use the following relations to compare two rational numbers :

(i) If $\frac{a}{b} > \frac{c}{d} = ad > bc$ (ii) If $\frac{a}{b} < \frac{c}{d} = ad < bc$





Exercise 2.1

1. Which of the following is not a rational number ?

$$\frac{-2}{7}, \frac{4}{-13}, 1, \frac{2}{9}, 0, \frac{0}{7}, \frac{6}{0}, \frac{7}{5}$$

2. Convert the following rational numbers into integers:

$$\frac{-4}{-1}, \frac{-42}{14}, \frac{-36}{-18}, \frac{7}{-1}$$

3. Identify the positive rational numbers from the following :

$$(a) \frac{-3}{-4} \quad (b) \frac{6}{8} \quad (c) \frac{-8}{7} \quad (d) \frac{9}{-14} \quad (e) \frac{-8}{-14} \quad (f) \frac{-1}{7} \quad (g) \frac{2}{-6} \quad (h) \frac{-277}{643}$$

4. Write any five positive and five negative rational numbers.

5. Represent the following on a number line:

$$(a) \frac{-3}{4} \quad (b) \frac{-5}{3} \quad (c) \frac{3}{5}, \frac{1}{5}, \frac{7}{5}, \frac{4}{5} \quad (d) \frac{-7}{8}, \frac{-5}{8}, \frac{-3}{8}, \frac{1}{8}, \frac{3}{8}$$

6. Express the following in standard form :

$$(a) \frac{85}{280} \quad (b) \frac{27}{243} \quad (c) \frac{-12}{156} \quad (d) \frac{70}{357}$$

7. Write four equivalent rational numbers for the following:

$$(a) \frac{-3}{7} \quad (b) \frac{2}{3} \quad (c) \frac{-11}{7} \quad (d) \frac{6}{11}$$

8. Find the value of x in the following:

$$(a) \frac{x}{-9} = \frac{15}{12} \quad (b) \frac{-3}{4} = \frac{18}{x} \quad (c) \frac{4}{7} = \frac{-12}{x} \quad (d) \frac{-2}{5} = \frac{-8}{x} \quad (e) \frac{27}{15} = \frac{x}{24}$$

9. Observe the given patterns carefully and write the next two rational numbers for the following :

$$(a) \frac{7}{11}, \frac{5}{13}, \frac{3}{15}, \frac{1}{17}, \frac{-1}{19}, \underline{\quad}, \underline{\quad} \quad (b) \frac{5}{7}, \frac{7}{14}, \frac{9}{21}, \frac{11}{28}, \underline{\quad}, \underline{\quad}$$

$$(c) \frac{1}{2}, \frac{2}{4}, \frac{3}{6}, \frac{4}{8}, \underline{\quad}, \underline{\quad} \quad (d) \frac{-3}{7}, \frac{-4}{7}, \frac{-5}{7}, \frac{-6}{7}, \underline{\quad}, \underline{\quad}$$

10. Arrange the following rational numbers in ascending order :

$$(a) \frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{1}{5}, \frac{1}{6} \quad (b) \frac{-2}{7}, \frac{4}{4}, \frac{6}{7}, \frac{-3}{7}, \frac{-4}{7}$$

11. Arrange the following rational numbers in descending order:

$$(a) \frac{-2}{3}, \frac{4}{3}, \frac{2}{3}, \frac{-1}{3}, \frac{1}{3}, \frac{7}{3}, \frac{-7}{3} \quad (b) \frac{1}{3}, \frac{6}{3}, \frac{7}{3}, \frac{-13}{3}, \frac{-14}{3}, \frac{2}{3} \quad (c) \frac{-1}{2}, \frac{-3}{4}, \frac{4}{3}, \frac{2}{6}, \frac{2}{5} \quad (d) \frac{-7}{5}, \frac{-2}{5}, \frac{2}{5}, \frac{7}{10}, \frac{-6}{5}$$

12. Which of the two given rational numbers is smaller ?

$$(a) \frac{-3}{7}, \frac{-4}{9} \quad (b) \frac{14}{27}, \frac{7}{9} \quad (c) \frac{-6}{17}, \frac{-8}{15} \quad (d) \frac{-4}{7}, \frac{-3}{4}$$



Addition of Rational Numbers

For addition of rational numbers, we should follow these steps:

- Express each rational number with positive denominator.
- If the denominators are same, add their numerator and divide it by common denominator.
- If the denominators are different, express them as equivalent rational numbers with same denominator. Now add the numerators and divide it by the common denominator of the equivalent rational numbers.
- If required, change the result into standard form.

Example 10 : Add the following:

$$(a) \frac{-8}{19} + \frac{-2}{57}$$

$$(b) \frac{-18}{29} + \left(\frac{-4}{29}\right)$$

Solution : (a) $\frac{-8}{19} + \frac{-2}{57} = \frac{-8 \times 3 + (-2) \times 1}{57}$
 $= \frac{-24 + (-2)}{57} = \frac{-26}{57}$ [LCM of 19 and 57 is 57]

(b) $\frac{-18}{29} + \frac{-4}{29} = \frac{-18 + (-4)}{29}$
 $= \frac{-18 - 4}{29} = \frac{-22}{29}$

Example 11 : Add the following:

$$(a) \frac{-17}{4} \text{ and } \frac{-37}{8}$$

$$(b) \frac{-4}{9} \text{ and } \frac{-7}{27}$$

Solutions : (a) $\frac{-17}{4} + \left(\frac{-37}{8}\right)$
 $= \frac{-17 \times 2}{4 \times 2} + \left(\frac{-37}{8}\right)$ (8 is a multiple of 4)
 $= \frac{-34}{8} + \left(\frac{-37}{8}\right)$
 $= \frac{-34 - 37}{8} = \frac{-71}{8}$

(b) $\frac{-4}{9} + \left(\frac{-7}{27}\right)$
 $= \frac{-4 \times 3}{9 \times 3} + \left(\frac{-7}{27}\right)$ (27 is a multiple of 9)
 $= \frac{-12}{27} + \left(\frac{-7}{27}\right)$
 $= \frac{-12 - 7}{27} = \frac{-19}{27}$

Example 12 : Solve the following:

$$(a) \frac{2}{3} + \frac{4}{5} + \frac{3}{4}$$

$$(b) \frac{-3}{4} + \frac{7}{10} + \left(\frac{-5}{12}\right)$$

Solution : (a) $\frac{2}{3} + \frac{4}{5} + \frac{3}{4} = \frac{2 \times 20}{3 \times 20} + \frac{4 \times 12}{5 \times 12} + \frac{3 \times 15}{4 \times 15}$
 [LCM of 3, 5 and 4 = 60]
 $= \frac{40}{60} + \frac{48}{60} + \frac{45}{60}$
 $= \frac{40 + 48 + 45}{60} = \frac{133}{60}$

(b) $\frac{-3}{4} = \frac{-3 \times 15}{4 \times 15} = \frac{-45}{60}$
 $\frac{7}{10} = \frac{7 \times 6}{10 \times 6} = \frac{42}{60}$
 $\frac{-5}{12} = \frac{-5 \times 5}{12 \times 5} = \frac{-25}{60}$
 [LCM of 4, 10 and 12 = 60]
 Now, $\frac{-3}{4} + \frac{7}{10} + \left(\frac{-5}{12}\right) = \frac{-45}{60} + \frac{42}{60} + \left(\frac{-25}{60}\right)$
 $= \frac{-45 + 42 - 25}{60} = \frac{-28}{60} = \frac{-7}{15}$





Subtraction of Rational Numbers

We know that subtraction is the inverse process of addition. We can subtract a rational numbers from another by adding its additive inverse to it. Let $\frac{p}{q}$ and $\frac{r}{s}$ be two rational numbers. To subtract $\frac{r}{s}$ from $\frac{p}{q}$ we add additive inverse of $\frac{r}{s}$ to $\frac{p}{q}$.

$$\text{Thus, } \frac{p}{q} - \frac{r}{s} = \frac{p}{q} + \left(\frac{-r}{s} \right)$$

Example 13 : Subtract $\frac{-7}{8}$ from $\frac{5}{7}$.

Solution : The additive inverse of $\frac{-7}{8} = -\left(\frac{-7}{8}\right) = \frac{7}{8}$

Now, we have to add additive inverse of $\frac{-7}{8}$ to $\frac{5}{7}$

$$\begin{aligned} \frac{5}{7} - \left(\frac{-7}{8} \right) &= \frac{5}{7} + \frac{7}{8} \\ &= \frac{(5 \times 8) + (7 \times 7)}{56} \\ &= \frac{40 + 49}{56} \\ &= \frac{89}{56} \end{aligned}$$

Example 14 : Subtract $\frac{5}{7}$ from $\frac{18}{7}$.

Solutions : $\frac{18}{7} - \frac{5}{7}$

$$\begin{aligned} \frac{18}{7} - \frac{5}{7} &= \frac{18}{7} + \left(\frac{-5}{7} \right) \\ &= \frac{18 + (-5)}{7} \\ &= \frac{13}{7} \end{aligned}$$



Facts to Know

- There are infinite rational numbers between two consecutive rational numbers.



Multiplication of Rational Numbers

Let's learn multiplication of rational numbers $\left(\frac{4}{5} \times \frac{1}{5}\right)$ with the help of a diagram.

The shaded part ABFE shows $\frac{1}{5}$ of ABCD

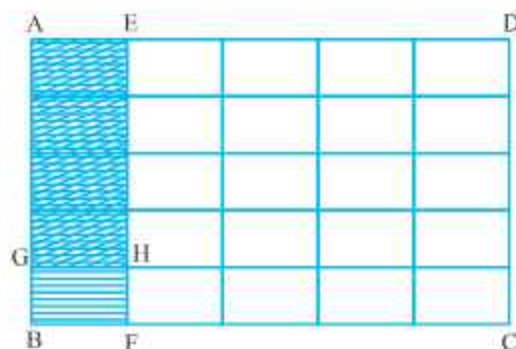
The double-shaded part AGHE shows $\frac{4}{5}$ out of $\frac{1}{5}$.

From the given figure, it is clear that the double-shaded part shows $\frac{4}{25}$

$$\text{So, } \frac{4}{5} \text{ of } \frac{1}{5} = \frac{4}{25}$$

$$\text{or } \frac{4}{5} \times \frac{1}{5} = \frac{4}{25}$$

$$\text{Also, we observe that } \frac{4}{5} \times \frac{1}{5} = \frac{4 \times 1}{5 \times 5}$$



Hence, it can be concluded that the product of two rational numbers is a rational number whose numerator is the product of numerators of the denominators. If $\frac{p}{q}$, $\frac{r}{s}$ and $\frac{t}{u}$ are three rational numbers, then

$$\frac{p}{q} \times \frac{r}{s} \times \frac{t}{u} = \frac{p \times r \times t}{q \times s \times u} = \frac{\text{Product of numerators}}{\text{Product of denominators}}$$

Example 15 : Find the product of $\frac{-12}{17}$ and $\frac{8}{5}$.

$$\begin{aligned} \text{Solution : } \frac{-12}{17} \times \frac{8}{5} &= \frac{(-12) \times 8}{17 \times 5} \\ &= \frac{-96}{85} \end{aligned}$$

Example 16 : Find the product of $\frac{2}{3}$, $\frac{-4}{5}$, $\frac{6}{7}$ and $\frac{-3}{4}$.

$$\text{Solution : } \frac{2}{3} \times \left(\frac{-4}{5}\right) \times \frac{6}{7} \times \left(\frac{-3}{4}\right) = \frac{2 \times (-4) \times 6 \times (-3)}{3 \times 5 \times 7 \times 4} = \frac{12}{35}$$



Division of Rational Numbers

It is known to us that division is the inverse of multiplication i.e., if p and q two integers, then $p \div q = p \times \frac{1}{q}$. Here we multiply the dividend by the multiplicative inverse of the divisor. The same rule is applied for division of rational numbers.

If $\frac{a}{b}$ and $\frac{c}{d}$ are two rational numbers, then $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$ $\left[\frac{c}{d} \neq 0\right]$

Example 17 : Divide $\frac{-8}{9}$ by $\frac{12}{13}$.

$$\begin{aligned} \text{Solution : } \frac{-8}{9} \div \frac{12}{13} &= \frac{-8}{9} \times \frac{13}{12} \left[\text{Multiplicative inverse of } \frac{12}{13} \text{ is } \frac{13}{12} \right] \\ &= \frac{-8 \times 13}{9 \times 12} = \frac{-26}{27} \end{aligned}$$



Facts to Know

- The sum of a rational number and its additive inverse is 0 (zero).
- The product of a rational number and its reciprocal is always 1.



Example 18 :

Divide $\frac{-3}{7}$ by $\frac{3}{5}$.

Solution :

$$\begin{aligned}\frac{-3}{7} \div \frac{3}{5} &= \frac{-3}{7} \times \frac{5}{3} \quad \left[\text{Multiplicative inverse of } \frac{3}{5} \text{ is } \frac{5}{3} \right] \\ &= \frac{(-3) \times 5}{7 \times 3} \\ &= \frac{-5}{7}\end{aligned}$$



Exercise 2.2

1. Solve the following:

(a) $\frac{3}{5} + \frac{6}{5} + \frac{8}{5}$

(b) $\frac{-5}{6} + \left(\frac{-3}{7}\right)$

(c) $\frac{4}{7} + \left(\frac{-2}{6}\right) + \left(\frac{-2}{3}\right)$

(d) $\frac{-3}{11} + \left(\frac{-4}{11}\right)$

(e) $\frac{5}{7} + \frac{4}{21} + \left(\frac{-3}{14}\right)$

(f) $\frac{-3}{4} + \left(\frac{-4}{5}\right) + \left(\frac{-6}{7}\right) + \left(\frac{-7}{8}\right)$

2. Add the following:

(a) $\frac{3}{4}, \frac{5}{6}$ and $\frac{-2}{3}$

(b) $\frac{-8}{7}$ and $\frac{-4}{7}$

(c) $\frac{13}{15}$ and $\frac{-7}{25}$

(d) $\frac{1}{3}$ and $\frac{-3}{4}$

(e) $\frac{5}{6}$ and $\frac{-6}{7}$

(f) $\frac{-7}{15}$ and $\frac{12}{5}$

3. Subtract the following:

(a) 14 from $\frac{-7}{8}$

(b) $\frac{-4}{5}$ from $\frac{-7}{12}$

(c) $\frac{4}{5}$ from $\frac{-4}{7}$

(d) $\frac{5}{7}$ from $\frac{7}{5}$

(e) $\frac{-3}{8}$ from $\frac{-7}{8}$

(f) $\frac{-5}{8}$ from $\frac{-11}{12}$

4. Find the product of the following:

(a) $\frac{4}{5} \times \left(\frac{-15}{21}\right) \times \frac{14}{25}$

(b) $\frac{-7}{8} \times \left(\frac{-5}{6}\right)$

(c) $\frac{-3}{4} \times \left(\frac{-5}{6}\right) \times \left(\frac{-7}{8}\right)$

(d) $\frac{-5}{7} \times \left(\frac{-8}{15}\right) \times \left(\frac{21}{16}\right)$

(e) $\frac{4}{7} \times \left(\frac{-3}{5}\right) \times \frac{14}{24}$

(f) $\frac{-11}{5} \times \left(\frac{-15}{22}\right) \times \frac{3}{5}$

5. Simplify the following:

(a) $\left\{\frac{4}{7} \times \frac{21}{16}\right\} \div \frac{7}{8}$

(b) $\frac{-5}{8} + \frac{6}{7} - \frac{2}{3}$

(c) $\frac{-3}{4} \times \left[\frac{3}{5} - \frac{2}{3}\right]$

(d) $\frac{-7}{4} \times \left[\frac{-7}{8} + \frac{9}{16}\right]$

(e) $\frac{-3}{5} - \frac{(-4)}{15} + \frac{-7}{10}$

6. The sum of two rational numbers is $\frac{-3}{7}$. If one of them is $\frac{2}{3}$, find the other number.

7. What should be added to $\left(\frac{-3}{4} + \frac{5}{7}\right)$ to get $\frac{-6}{14}$.

8. Find the product of $\frac{-3}{8}$ and the reciprocal of $\frac{15}{16}$.



Rational Numbers as Decimals

We can express a rational number into a decimal either by the long division method or by writing an equivalent rational number with the denominator as power of 10, and then write the equivalent rational number as a decimal.

Example 19 : Express $\frac{7}{4}$ as a decimal number by writing an equivalent rational number with denominator as power of 10.

Solution : $\frac{7}{4} = \frac{7 \times 25}{4 \times 25} = \frac{175}{100} = 1.75$
 $\therefore \frac{7}{4} = 1.75$

Example 20 : Express $\frac{3}{25}$ as a decimal number by using long division method.

Solution : $\frac{3}{25} = 3 \div 25$

$$\begin{array}{r} 25 \overline{) 3.0} \quad (0.12 \\ \underline{-25} \\ 50 \\ \underline{-50} \\ 0 \end{array}$$

 $\therefore \frac{3}{25} = 0.12$



Terminating and Non-Terminating Decimals

When a rational number is converted into decimals by division method, any one of the following two conditions will arise:

- (a) The division process comes to an end after some steps, as there is no remainder left at certain point of time. Such decimals are called terminating decimals.

Example : $\frac{1}{2} = 0.5$, $\frac{-3}{8} = -0.375$ etc.

- (b) The division process goes on indefinitely as there may be a remainder at each step. Such decimals are called non-terminating decimals.

Example : $\frac{1}{3} = 0.333....$

$$\begin{array}{r} 0.333.... \\ 3 \overline{) 10} \\ \underline{-9} \\ 10 \\ \underline{-9} \\ 10 \\ \underline{-9} \\ 1 \end{array}$$

The rational number in which the division process does not come to an end and keeps repeating, is called non-terminating repeating decimal. To represent such decimals, we put a bar sign (—) above the repeating part. So, $\frac{1}{3} = 0.333... = 0.\overline{3}$.



Example 21 : Express the following rational numbers as decimals using the division method. Do write whether these represent terminating or non-terminating decimals.

(a) $\frac{5}{6}$

(b) $\frac{2}{7}$

(c) $\frac{5}{8}$

Solution :

(a) $\frac{5}{6} = 5 \div 6$

$$\begin{array}{r} 6 \overline{) 5.0000} \quad (0.8333 \\ \underline{-48} \\ 20 \\ \underline{-18} \\ 20 \\ \underline{-18} \\ 20 \\ \underline{-18} \\ 2 \end{array}$$

$\therefore \frac{5}{6} = 0.8333 \dots = 0.8\bar{3}$

Thus, $\frac{5}{6} = 0.8\bar{3}$ represent non-terminating decimals.

(c) $\frac{5}{8} = 5 \div 8$

$$\begin{array}{r} 8 \overline{) 5.000} \quad (0.625 \\ \underline{-48} \\ 20 \\ \underline{-16} \\ 40 \\ \underline{-40} \\ 0 \end{array}$$

$\therefore \frac{5}{8} = 0.625$

Thus, $\frac{5}{8} = 0.625$ represents terminating decimals.

(b) $\frac{2}{7} = 2 \div 7$

$$\begin{array}{r} 7 \overline{) 2.00000000} \quad (0.28571428 \\ \underline{-14} \\ 60 \\ \underline{-56} \\ 40 \\ \underline{-35} \\ 50 \\ \underline{-49} \\ 10 \\ \underline{-7} \\ 30 \\ \underline{-28} \\ 20 \\ \underline{-14} \\ 60 \\ \underline{-56} \\ 4 \end{array}$$

$\therefore \frac{2}{7} = 0.28571428 \dots = 0.2\bar{85714}$

Thus $\frac{2}{7} = 0.2\bar{85714}$ represents non-terminating decimals.

It is to note that non-terminating non-repeating decimals can not be converted into rational number. Such type of numbers are called irrational numbers.



Facts to Know

- Every rational number can be converted into either a terminating decimal or non-terminating repeating decimal.
- Such decimals which are non-terminating and have no repeating parts are called irrational numbers.

Rule to Find Terminating or Non-terminating Repeating Decimals

Rule for Terminating Decimals : If a rational number is in its lowest term and its denominator has no multiple other than 2 or 5 or both.

Example : $\frac{1}{4}$, $\frac{3}{25}$ and $\frac{1}{250}$ represent terminating decimals.

Rule for Non-terminating Repeating Decimals : If a rational number is in its lowest term and its denominator has a prime factor other than 2 and 5.





Example : $\frac{3}{7}, \frac{5}{6}$ and $\frac{7}{15}$ are examples of non-terminating repeating decimals.

Example 22 : Without actual division, determine which of the following rational numbers have a terminating decimal representation:

(a) $\frac{7}{225}$

(b) $\frac{3}{16}$

(c) $\frac{9}{75}$

Solution : (a) In $\frac{7}{225}$ the denominator is 225.

We have, $225 = 5 \times 5 \times 3 \times 3$

Thus, 225 has 3 as a prime number that is other than 2 and 5.

Hence, $\frac{7}{225}$ must have a non-terminating decimal representation.

(b) In $\frac{3}{16}$ the denominator is 16.

We have, $16 = 2 \times 2 \times 2 \times 2$

Thus, 16 has 2 as the only prime factor.

Hence, $\frac{3}{16}$ must have a terminating decimal representation.

(c) In $\frac{9}{75}$ the denominator is 75.

We have, $75 = 5 \times 5 \times 3$

Thus, 75 has 3 as a prime number that is other than 2 and 5.

Hence, $\frac{9}{75}$ must have a non-terminating decimal representation.

Conversion of Non-terminating Repeating Decimals into Rational Numbers

There are two types of decimal representation of non-terminating repeating decimals:

- (i) **Pure Repeating or Recurring Decimal :** A decimal presentation in which all the digits after the decimal point are repeated.

Example : 0.67, 0.7 and 0.123 are recurring decimals.

- (ii) **Mixed Repeating or Recurring Decimal :** A decimal presentation in which at least one digit after the decimal point is non-repeating.

Example : $1.23\overline{45}$, $4.23\overline{5}$ and $1.01\overline{25}$ are mixed recurring decimals.

Let's learn conversion of non-terminating repeating decimals into rational numbers through examples.

Example 23 : Convert the following decimals in the form of $\frac{p}{q}$:

(a) $0.\overline{8}$

(b) $0.\overline{87}$

(c) $7.\overline{23}$

(d) $0.72\overline{3}$

Solution : (a) Let $x = 0.\overline{8} \dots\dots\dots$ (i)

Here, only one digit in decimal part is repeated, we multiply it by 10, we get,

$$10x = 8.\overline{8} \dots\dots \text{ (ii)}$$

Subtracting (i) from (ii), we get,

$$10x - x = 8.\overline{8} - 0.\overline{8}$$

$$\Rightarrow 9x = 8$$

$$\Rightarrow x = \frac{8}{9}$$



(b) Let $x = 0.\overline{87} \dots\dots(i)$

Here, only two digits in decimal part is repeated, we multiply it by 100, we get,

$$100x = 87.\overline{87} \dots\dots(ii)$$

Subtracting (i) from (ii), we get,

$$\Rightarrow 99x = 87$$

$$\Rightarrow x = \frac{87}{99}$$

(c) Let $x = 7.\overline{23} \dots\dots(i)$

Here, only two digits in decimal part is repeated, we multiply it by 100, we get,

$$100x = 723.\overline{23} \dots\dots(ii)$$

Subtracting (i) from (ii) we get,

$$100x - x = 723.\overline{23} - 7.\overline{23}$$

$$\Rightarrow 99x = 716$$

$$\Rightarrow x = \frac{716}{99}$$

(d) Let $x = 0.7\overline{23}$

Here, we have 3 digits in the decimal part, out of which only one is repeating.

First we multiply it by 100 so that only the repeating decimal is left on the right side of the decimal point.

$$\therefore 100x = 72.\overline{3} \dots\dots(i)$$

Now, only one digit is repeating, so we again multiply it by 10, we get

$$1000x = 723.\overline{3} \dots\dots(ii)$$

Subtracting (i) from (ii), we get,

$$1000x - 100x = 723.\overline{3} - 72.\overline{3}$$

$$\Rightarrow 900x = 651$$

$$\Rightarrow x = \frac{651}{900}$$

Short-cut Method of Converting a Non-terminating Decimal into Rational Numbers:

To convert a recurring decimals into $\frac{p}{q}$ form, write repeated figure only once in the numerator and take as many nines in the denominator as the number of repeated digits

Example : $0.\overline{37} = \frac{37}{99}$ and $0.\overline{123} = \frac{123}{999}$

To convert a mixed recurring decimal into $\frac{p}{q}$ form, its numerator is obtained by removing the decimal point and bar and then subtract the non-repeating number. The denominator will carry as many nines as the number of digits in the repeating part followed by as many zero as the numbers of digits in the non-repeating part after decimal point.

Example : $0.2\overline{37} = \frac{237 - 2}{990} = \frac{235}{990}$

Example 24 : Evaluate the following using short-cut method:

(a) $3.\overline{67} + 4.\overline{58}$ (b) $2.\overline{353} - 1.\overline{125}$

Solution : (a) $3.\overline{67} + 4.\overline{58} = (3 + 4) + (0.\overline{67} + 0.\overline{58})$

$$= 7 + \left(\frac{67}{99} + \frac{58}{99} \right)$$

$$\begin{aligned}
 &= 7 + \frac{125}{99} \\
 &= 7 + 1\frac{26}{99} \\
 &= 8\frac{26}{99}
 \end{aligned}$$

$$\begin{aligned}
 \text{(b)} \quad &2.\overline{353} - 1.\overline{125} \\
 &= (2 + 0.\overline{353}) - (1 + 0.\overline{125}) \\
 &= \left(2 + \frac{353-3}{990}\right) - \left(1 + \frac{125-1}{990}\right) \\
 &= 2 + \frac{350}{990} - 1 - \frac{124}{990} \\
 &= (2-1) + \left(\frac{350}{990} - \frac{124}{990}\right) \\
 &= 1 + \frac{350-124}{990} \\
 &= 1 + \frac{226}{990} \\
 &= 1\frac{113}{495}
 \end{aligned}$$



Exercise 2.3

1. Convert the following into decimals by writing an equivalent rational number with denominator as power of 10:

(a) $\frac{13}{5}$

(b) $\frac{-7}{25}$

(c) $\frac{3}{125}$

(d) $\frac{-7}{40}$

2. Without actual division state whether the following rational numbers represent terminating or non-terminating decimals:

(a) $\frac{5}{18}$

(b) $\frac{17}{8}$

(c) $\frac{-23}{75}$

(d) $\frac{27}{64}$

(e) $\frac{-7}{25}$

(f) $\frac{12}{29}$

(g) $\frac{8}{125}$

(h) $\frac{-19}{20}$

3. Convert the following rational numbers into decimal numbers:

(a) $\frac{2}{15}$

(b) $\frac{3}{7}$

(c) $\frac{7}{8}$

(d) $\frac{17}{25}$

(e) $\frac{12}{24}$

(f) $\frac{13}{4}$

(g) $\frac{125}{8}$

(h) $\frac{12}{25}$

4. Convert the following decimals into rational numbers:

(a) 1.25

(b) 7.025

(c) $3.\overline{7}$

(d) $2.\overline{345}$

(e) $0.\overline{23}$

(f) $3.\overline{356}$

(g) $0.\overline{78}$

(h) $1.\overline{023}$



5. Find the value of the following :

(a) $2.\overline{3} + 3.\overline{4}$

(b) $3.\overline{34} + 6.\overline{78}$

(c) $1.\overline{235} - 0.\overline{785}$

(d) $18.\overline{63} - 7.\overline{683}$

6. If $\frac{x}{y} = 2.\overline{36} + 1.\overline{73}$, find $\frac{x}{y}$.

7. If $\frac{x}{y} = 1.\overline{356} - 1.\overline{067}$, find the least value of x and y.

8. Which of the following decimals can be expressed as rational numbers ?

(a) 0.3333

(b) 0.127272727.....

(c) 3.4010010001.....

(d) 13.35735735

(e) 2.0010020003.....

(f) 7.125125.....

Points to Remember

- A rational number can be expressed in the form of $\frac{p}{q}$, where p and q are integers and $q \neq 0$.
- All fractions are rational numbers but all rational numbers are not fractions.
- All counting numbers, whole numbers and integers are rational numbers.
- All rational numbers can be represented on a numbers line.
- The absolute value of a rational number is equal to its positive numeric value.
- For two rational numbers $\frac{a}{b}$ and $\frac{c}{d}$:
 - (i) $\frac{a}{b} = \frac{c}{d} \Rightarrow ad = bc$ (Equivalent)
 - (ii) $\frac{a}{b} > \frac{c}{d} \Rightarrow ad > bc$
 - (iii) $\frac{a}{b} < \frac{c}{d} \Rightarrow ad < bc$
- A rational number is in standard form if the HCF of its numerator and denominator is 1.
- For two rational numbers $\frac{a}{b}$ and $\frac{c}{d}$, $\frac{a}{b} + \frac{c}{d} = 0$ then $\frac{c}{d}$ is called the additive inverse of $\frac{a}{b}$ and vice versa.
- The product of a rational number and its reciprocal is always 1.
- A rational number can be converted into decimal either by long division method or by writing an equivalent rational number with the denominator as power of 10.
- Rational numbers can be expressed either as terminating or non-terminating repeating decimals.
- Decimals which are non-terminating and non-repeating are called irrational numbers.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options :

(a) Only rational number whose absolute value is 0, is :

(i) 0

☐ (ii) -1

☐ (iii) +1

☐ (iv) -9

☐

(b) Additive inverse of $\frac{-17}{14}$ is :

(i) $\frac{14}{17}$

☐ (ii) $\frac{17}{14}$

☐ (iii) $\frac{17}{-14}$

☐ (iv) $\frac{-14}{-17}$

☐

(c) Only rational number which is neither positive nor negative is :

(i) 0

☐ (ii) 1

☐ (iii) 100

☐ (iv) None of these

☐

(d) The largest rational numbers is :

(i) 2^n

☐ (ii) 10^n

☐ (iii) $\left(\frac{p}{q}\right)^n$

☐ (iv) non determinable

☐

(e) Multiplicative inverse of $-\frac{7}{18}$ is :

(i) $\frac{18}{7}$

☐ (ii) $\frac{18}{-7}$

☐ (iii) $\frac{7}{18}$

☐ (iv) $-\frac{7}{-18}$

(f) $-\frac{312}{169}$ in the standard form is :

(i) $\frac{24}{14}$

☐ (ii) $\frac{27}{13}$

☐ (iii) $\frac{24}{13}$

☐ (iv) $\frac{29}{17}$

(g) If $-\frac{x}{6} = \frac{42}{-36}$, then the value of x is:

(i) 7

☐ (ii) -7

☐ (iii) 14

☐ (iv) -14

(h) The example of irrational number is :

(i) $\frac{2}{5}$

☐ (ii) $\frac{3}{7}$

☐ (iii) $\frac{7}{100}$

☐ (iv) 0.1234564325624....

2. Represent the following on the numbers line:

(a) $-\frac{5}{3}$

(b) $-\frac{3}{4}$

(c) $-\frac{2}{5}$ and $\frac{2}{5}$

(d) $-\frac{3}{5}$ and $\frac{3}{5}$

3. Convert the following rational numbers in standard form:

(a) $\frac{-65}{225}$

(b) $\frac{161}{343}$

(c) $\frac{-125}{1000}$

(d) $\frac{55}{3250}$

4. Find the absolute value of the following rational numbers:

(a) $-\frac{3}{4} + \frac{3}{7} - \frac{6}{8}$

(b) $\frac{5}{9} + \left(\frac{-6}{24}\right)$

(c) $-\frac{2}{3} - \frac{3}{5}$

(d) $3 - \frac{4}{5}$

5. In each of the following pairs of rational numbers, which is greater ?

(a) $\frac{3}{4}, \frac{5}{7}$

(b) $-\frac{7}{3}, -\frac{5}{3}$

(c) $\frac{5}{11}$ and $-\frac{3}{-7}$

(d) $-\frac{2}{3}, \frac{3}{4}$

6. Arrange the following rational numbers in ascending order:

(a) $\frac{2}{3}, \frac{3}{4}, \frac{5}{8}, \frac{-7}{8}, \frac{-5}{6}$

(b) $-\frac{5}{14}, \frac{3}{10}, \frac{-3}{7}, \frac{-6}{35}$

(c) $-\frac{2}{3}, \frac{-5}{6}, \frac{2}{3}, \frac{5}{6}, \frac{-1}{3}, \frac{1}{3}$

(d) $-2, \frac{-1}{2}, \frac{1}{2}, 0, 2, \frac{-3}{5}, \frac{3}{5}$

7. Simplify:

(a) $-\frac{3}{7} + \left(\frac{-4}{7}\right) + \left(\frac{-6}{7}\right)$

(b) $\frac{3}{5} + \left(\frac{-4}{14}\right) + \left(\frac{-2}{5}\right) + \frac{6}{15}$

(c) $-\frac{6}{17} + \frac{5}{51}$

(d) $-\frac{1}{2} - \frac{2}{3} - \frac{3}{4} - \frac{5}{6}$

8. Solve:

(a) $\frac{-7}{17} - 0$

(b) $-\frac{12}{13} - \left(\frac{-15}{26}\right)$

(c) $-\frac{8}{26} - \left(\frac{24}{26}\right)$

(d) $\frac{9}{13} - \left(\frac{-4}{13}\right)$

9. Simplify:

(a) $-\frac{3}{8} \times \frac{16}{15} \times \left(\frac{-24}{75}\right) \times \frac{20}{12}$

(b) $-\frac{6}{5} \times \left(\frac{-4}{7}\right) \times \left(\frac{21}{-12}\right) \times \left(\frac{-3}{-4}\right)$

10. Divide the sum of $\frac{7}{8}$ and $-\frac{3}{4}$ by the product of $-\frac{2}{3}$ and $-\frac{3}{4}$.

11. What rational number should we multiply to $-\frac{5}{6}$ to get the product 24 ?

12. If $x = \frac{-3}{4}$ and $y = \frac{-2}{3}$, find the value of $3x - 4y$.

13. Find the value of x for the following :

(a) $\frac{-6}{7} + x = \frac{-7}{8}$

(b) $\frac{2}{5} \div x = \frac{-3}{7}$

(c) $x - \left(\frac{-5}{7}\right) = \frac{7}{5}$

14. Convert the following rational numbers into decimals:

(a) $\frac{2}{5}$

(b) $\frac{6}{7}$

(c) $\frac{3}{50}$

(d) $\frac{5}{12}$

15. Convert the following decimals into rational numbers:

(a) 0.025

(b) 3.15

(c) $25.\bar{5}$

(d) $0.3\bar{7}9$

16. Simplify of the following:

(a) $4.2\bar{3} + 3.\bar{7}9$

(b) $2.\bar{3}7 - 3.\bar{2}5 + 1.\bar{2}3$

(c) $0.\bar{7}8 + 0.\bar{6}7$

(d) $3.7\bar{8}6 + 37.\bar{8}6$

17. If $\frac{p}{q} = 3.\bar{7} + 7.\bar{3}$, find $\frac{p}{q}$.

18. Evaluate the following:

(a) $2.\bar{3} \times 1.\bar{2}$

(b) $1.2\bar{5} \div 0.\bar{5}$

HOTS

There are 100 students in a school. Each student is required to participate in an extracurricular activity. The choices are art, cricket, basketball and swimming. $\frac{3}{10}$ of students are in art, $\frac{1}{10}$ are in cricket and 17 play basketball. How many students are going to participate in swimming?



Objective

Materials Required

Procedure

: To multiply two rational numbers by folding circular paper.

: Circular paper strip and sketch pen.

: Let us find the product of two rational numbers, say $\frac{2}{4}$ and $\frac{1}{2}$.
Take circular paper strip and follow these steps :

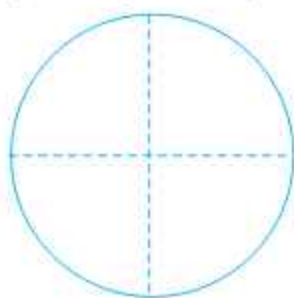
Step 1 : Fold the circular strip into two halves



Step 2 : Fold the strip again.



Step 3 : Unfold the strip and you will get the shape like this.



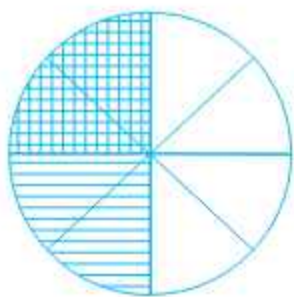
Step 4 : Shade two parts with horizontal lines and fold the rest unshaded part.



Step 5 : Now, fold the strip horizontally to divide the strip into two parts and shade it with vertical lines in one out of two parts.



Step 6 : Unfold the strip. You will find that 2 out of 8 parts are double shaded. This illustrates that the double shaded region represents $\frac{2}{8}$ of the whole strip.



Conclusion : $\frac{2}{4} \times \frac{1}{2} = \frac{2}{8}$





Multiplication of Fractions

Multiplying a Fraction by Whole Number

To multiply a fraction by whole number, we should remember:

$$\text{Fraction} \times \text{Whole Number} = \frac{\text{Numerator of the fraction} \times \text{Whole number}}{\text{Denominator of the fraction}}$$

We know that multiplication is a repeated addition.

For example, $2 \times \frac{3}{7} = \frac{3}{7} + \frac{3}{7} = \frac{6}{7}$

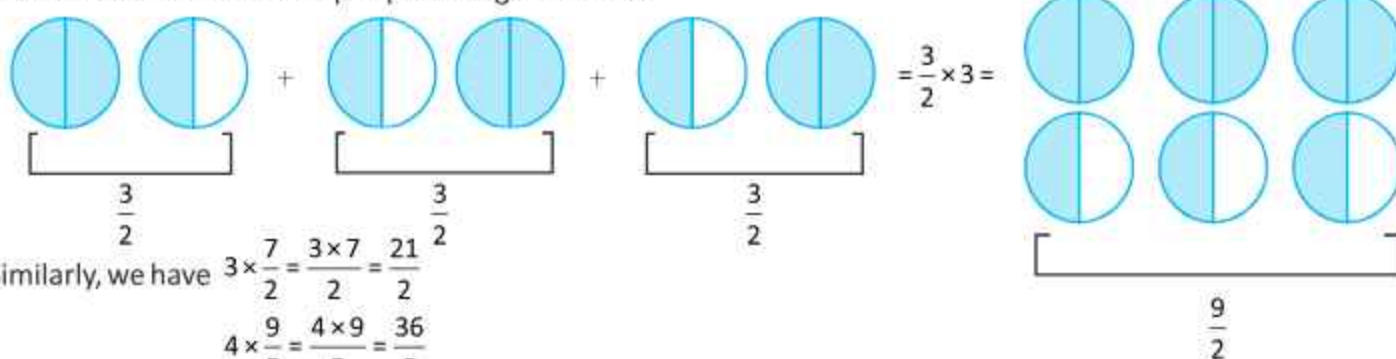
Here, $\frac{3}{7}$ is added two times, so that we get $\frac{6}{7}$.

In this case, we have multiplied proper fraction $\frac{3}{7}$ with whole number 2.

Suppose, we multiply improper fraction $\frac{3}{2}$ with whole number 3. We get

$$\frac{3}{2} \times 3 = \frac{3}{2} + \frac{3}{2} + \frac{3}{2} = \frac{3+3+3}{2} = \frac{9}{2}$$

Let us denote it with the help of pictures given below.



Similarly, we have $3 \times \frac{7}{2} = \frac{3 \times 7}{2} = \frac{21}{2}$

$$4 \times \frac{9}{5} = \frac{4 \times 9}{5} = \frac{36}{5}$$

$$7 \times \frac{8}{3} = \frac{7 \times 8}{3} = \frac{56}{3}$$

If we want to multiply a mixed fraction with a whole number we first convert mixed fraction into an improper fraction, then multiply.

For example: $3\frac{3}{4} \times 5 = \frac{15}{4} \times 5 = \frac{75}{4} = 18\frac{3}{4}$

$$2\frac{7}{5} \times 3 = \frac{17}{5} \times 3 = \frac{51}{5} = 10\frac{1}{5}$$

$$3\frac{1}{4} \times 5 = \frac{13}{4} \times 5 = \frac{65}{4} = 16\frac{1}{4}$$

Multiplication of a Fraction by a Fraction

What do you understand by $\frac{1}{2}$ of $\frac{1}{4}$? It means $\frac{1}{2} \times \frac{1}{4}$.



Let us use square as 1 unit. Now, we divide it into 4 equal parts with the help of horizontal lines as shown here. One part is shaded to show $\frac{1}{4}$

Again, we divide into two equal halves (parts) and shade the one half as shown here.

It shows $\frac{1}{2}$ of $\frac{1}{4} = \frac{1 \times 1}{2 \times 4} = \frac{1}{8}$

It means that dark shaded portion is $\frac{1}{8}$ part of square.

Therefore, multiplication of two fractions can be written as:

$$\text{Product of two fractions} = \frac{\text{Product of numerators}}{\text{Product of denominators}}$$

Multiplication of more than two Fractions

While multiplying three or more fractions, we convert each and every mixed fraction, if they are, into improper fraction. After that, we multiply numerators of all the improper fractions with each others. We also multiply the denominators of all the fractions with each other.

Finally, we divide the product of numerators by the product of denominators.

We must reduce the fraction so obtained into the lowest form and express the answer as a mixed fraction, if the answer in an improper fraction.

Example 5 : Simplify $2\frac{3}{3} \times \frac{2}{7} \times 11\frac{1}{6} \times 48\frac{2}{2}$

Solution :

$$\begin{aligned} & 2\frac{3}{3} \times \frac{2}{7} \times 11\frac{1}{6} \times 48\frac{2}{2} \\ &= \frac{9}{3} \times \frac{2}{7} \times \frac{67}{6} \times \frac{98}{2} \\ &= 67 \times 7 = 469 \end{aligned}$$



Facts to Know

- Product of a fraction does not change if the order is changed.
- Product of a fraction with 1 is the fraction itself.
- Product of a fraction with zero (0) is always zero (0).

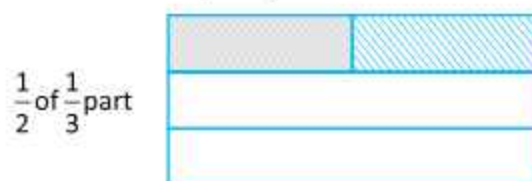
Fraction as an Operator "of"

Suppose, we express 1 as a rectangle. Now, we divide it into three equal parts as shown in the figure.

Shade one part and represent it as $\frac{1}{3}$.



Now, we divide $\frac{1}{3}$ into two equal halves. Thus, $\frac{1}{2}$ of $\frac{1}{3}$ is represented by the darker shade as shown in the figure.



It means $\frac{1}{2}$ of $\frac{1}{3} = \frac{1}{2} \times \frac{1}{3} = \frac{1 \times 1}{2 \times 3} = \frac{1}{6}$

Hence, we observe that "of" represents multiplication only.

Reciprocal of a Fraction

To get the reciprocal of a fraction, just turn fraction upside down. In other words, swap over the Numerator and Denominator.

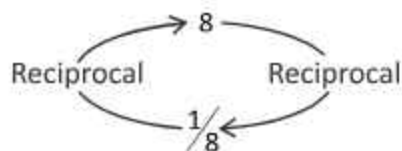
Examples :

Fraction	Reciprocal
$\frac{3}{8}$	$\frac{8}{3}$
$\frac{5}{6}$	$\frac{6}{5}$
$\frac{1}{3}$	$\frac{3}{1} = 3$
$\frac{19}{17}$	$\frac{17}{19}$

Every non-zero fraction when multiplied by its reciprocal (or multiplicative inverse), gives 1.

Examples : $\frac{99}{78} \times \frac{78}{99} = 1$, $\frac{2}{3} \times \frac{3}{2} = 1$, and so on.

If you take the reciprocal of a reciprocal you end up back where you started.



Facts to Know

- The word "Reciprocal" comes from the Latin word *reciprocus* meaning *returning*.

If a number is greater than 1, then its reciprocal is less than 1.

For example : 2 is greater than 1 but its reciprocal $\frac{1}{2}$ is less than 1.

If a number is less than 1 (i.e., between 0 and 1), then its reciprocal is greater than 1.

For example : $\frac{1}{2}$ is less than 1 but its reciprocal is greater than 1.

Example 6 : Find the reciprocal of each of the following :

(a) $\frac{5}{7}$

(b) $2\frac{1}{3}$

(c) 3

(d) $\frac{6}{11}$

Solution : (a) Reciprocal of $\frac{5}{7}$ is $\frac{7}{5}$.

(b) Reciprocal of $2\frac{1}{3}$ or $\frac{7}{3}$ is $\frac{3}{7}$.

(c) Reciprocal of 3 is $\frac{1}{3}$.

(d) Reciprocal of $\frac{6}{11}$ is $\frac{11}{6}$.

Exercise 3.1

1. Find the product of the following :

(a) $5 \times \frac{7}{11}$

(b) $2 \times \frac{19}{4}$

(c) $6 \times \frac{7}{5}$

(d) $15 \times \frac{2}{5}$

(e) $\frac{8}{9} \times 7$

(f) $\frac{64}{9} \times 3$

2. Find the product of the following :

(a) $\frac{27}{9} \times \frac{7}{2}$

(b) $\frac{6}{11} \times \frac{21}{7}$

(c) $\frac{5}{3} \times \frac{7}{2}$

(d) $5\frac{2}{3} \times \frac{3}{2}$

(e) $7\frac{1}{9} \times 3\frac{2}{16}$

(f) $\frac{8}{45} \times \frac{7}{9}$

3. Find the value of the following :

(a) $\frac{5}{9} \times 1\frac{2}{3} \times 3\frac{3}{5}$

(b) $\frac{2}{3} \times \frac{3}{4} \times \frac{4}{5}$

(c) $\frac{1}{4} \times \frac{8}{9} \times \frac{3}{4}$

(d) $\frac{1}{7} \times \frac{3}{5} \times \frac{4}{19} \times \frac{17}{3}$

4. The cost of 1 m of ribbon is ₹ $67\frac{1}{2}$. Find the cost of $1\frac{1}{3}$ m of ribbon.

5. Avinash walks $7\frac{1}{2}$ km in 4 hours. How much distance will be covered by him in 12 hours?

6. A cow grazes for 2 hours in a field and gives $2\frac{1}{2}$ litres of milk. Find the quantity of milk given by cow if it grazes for 6 hours.



Division of Fractions

Division of a Fractions by Whole Number

To divide a fraction by whole number, we multiply the bottom number of fraction by whole number.

or

Fraction $\div$ Whole number = Fraction $\times$ Reciprocal of the whole number

Example 7 : Does $\frac{1}{2} \div 3$ equal $\frac{1}{6}$?

Solution : We look at the pizzas below. . .

When half of pizza is divided into 3 equal parts, each person gets one sixth of a whole pizza, i.e., $\frac{1}{2 \times 3} = \frac{1}{6}$

A Half :



Divided by 3 :



Answer: $\frac{1}{6}$

Similarly, $\frac{2}{5} \div 4$ gives $\frac{2}{5 \times 4} = \frac{2}{20}$ or $\frac{1}{10}$

Division of a Fractions by another Fraction

We multiply first fraction by reciprocal of second fraction.

So, First fraction $\div$ Second fraction = First fraction $\times$ Reciprocal of second fraction.



Hence, $\frac{3}{4} \div \frac{1}{4} = \frac{3}{4} \times \frac{4}{1} = \frac{3 \times 4}{4 \times 1} = \frac{12}{4} = 3$

and $\frac{24}{3} \div \frac{6}{2} = \frac{24}{3} \times \frac{2}{6} = \frac{24 \times 2}{3 \times 6} = \frac{48}{18} = \frac{8}{3} = 2\frac{2}{3}$

In divisions having mixed numbers, convert the mixed numbers into improper fractions and then solve.

For example : $3\frac{7}{5} \div \frac{3}{2} = \frac{22}{5} \div \frac{3}{2} = \frac{22}{5} \times \frac{2}{3} = \frac{22 \times 2}{5 \times 3} = \frac{44}{15}$

$1\frac{1}{2} \div \frac{6}{4} = \frac{3}{2} \times \frac{4}{6} = \frac{3 \times 4}{2 \times 6} = \frac{12}{12} = 1$

Division of a Whole Number by a Fraction

To perform this, we multiply whole number by the reciprocal of fraction.

Example 8 : Divide the following :

(a) $15 \div \frac{3}{5}$

(b) $8 \div \frac{7}{4}$

(c) $5 \div 3\frac{4}{7}$

Solution : (a) $15 \div \frac{3}{5} = \frac{15}{1} \div \frac{3}{5} = \frac{15}{1} \times \frac{5}{3} = \frac{15 \times 5}{1 \times 3} = \frac{75}{3} = 25$

(b) $8 \div \frac{7}{4} = \frac{8}{1} \div \frac{7}{4} = \frac{8}{1} \times \frac{4}{7} = \frac{8 \times 4}{1 \times 7} = \frac{32}{7}$

(c) $5 \div 3\frac{4}{7} = \frac{5}{1} \div \frac{25}{7} = \frac{5}{1} \times \frac{7}{25} = \frac{35}{25} = \frac{7}{5}$

Example 9 : Mohanty cuts 21 m long cloth into pieces of $3\frac{1}{2}$ m length each. How many pieces of the cloth did he get ?

Solution : Length of the cloth = 21 m

Length of each piece = $3\frac{1}{2}$ m

So, number of pieces = $21 \div 3\frac{1}{2}$

$= 21 \div \frac{7}{2}$

$= \frac{21 \times 2}{7} = \frac{42}{7} = 6$

Hence, Mohanty got 6 pieces of cloth.



Exercise 3.2

1. Find the value of the following:

(a) $\frac{3}{5} \div \frac{1}{2}$

(b) $2\frac{1}{2} \div \frac{3}{5}$

(c) $5\frac{1}{6} \div \frac{7}{2}$

(d) $\frac{13}{6} \div \frac{11}{3}$

2. Divide the following:

(a) $\frac{2}{9} \div 3$

(b) $\frac{1}{2} \div 5$

(c) $\frac{3}{11} \div 4$

(d) $4\frac{3}{7} \div 7$

3. Divide the following:

(a) $11 \div \frac{3}{4}$

(b) $100 \div \frac{3}{10}$

(c) $5 \div 3\frac{4}{7}$

(d) $14 \div \frac{5}{6}$

4. The product of two numbers is $14\frac{1}{2}$. If one number is $4\frac{5}{7}$, find the other number.
5. The cost of a pen is ₹ $12\frac{3}{4}$. How many pens can be purchased for ₹ 204?
6. One box can hold $7\frac{1}{4}$ kg of Rajma dal. How many kilogram of Rajam dal can 18 such boxes hold?
7. The price of 11 footballs is ₹ $536\frac{1}{4}$. Find the price of 1 football.
8. $\frac{1}{4}$ liter of mustard oil costs is ₹ $27\frac{1}{2}$. How much would $8\frac{3}{5}$ liters of mustard oil cost?

Points to Remember

- A fraction is a part of whole.
- A fraction has two part - Numerator and Denominator.
- It can be written as :

$$\text{Fraction} = \frac{\text{Numerator}}{\text{Denominator}}$$
- Fraction can be classified into Proper fraction, Improper fraction, Mixed fraction, Unit fraction, Like fractions, Unlike fraction etc.
- Equivalent fractions are fractions that have same values as that of fraction.
- To multiply a fraction by a whole number, we first multiply numerator of fraction with whole number, then divide it by the denominator of the fraction.
- To multiply a mixed fraction with a whole number, we first convert it into an improper fraction, then multiply.
- Multiplication of two fractions can be written as :

$$\text{Product of two fractions} = \frac{\text{Product of Numerator}}{\text{Product of Denominator}}$$

- Product of a fraction with zero (0) is always zero (0).
- Reciprocal of a fraction means swap over the Numerator and Denominator.
- To divide a fraction by whole number, we multiply the bottom number of fraction by the whole number.
- To perform division by a fraction, we multiply fraction by the reciprocal of second fraction.
- To divide whole number by a fraction, we multiply whole number by the reciprocal of fraction.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options :

(a) Which one of the following is a proper fraction?

(i) $\frac{15}{11}$

☐

(ii) $\frac{17}{14}$

☐

(iii) $\frac{6}{10}$

☐

(iv) $\frac{15}{7}$

☐

(b) Which one of the following is a unit fraction?

(i) $\frac{17}{7}$

☐

(ii) $\frac{50}{17}$

☐

(iii) $\frac{1}{18}$

☐

(iv) $\frac{5}{14}$

☐


(c) What is the final output of $\frac{2}{7} + \frac{6}{11} + \frac{5}{7}$?

(i) $\frac{117}{66}$

☐ (ii) $\frac{119}{15}$

☐ (iii) $\frac{109}{7}$

☐ (iv) $\frac{119}{77}$

(d) What is the product of $2\frac{2}{3}$ and 6 ?

(i) 17

☐ (ii) 22

(iii) 16

☐ (iv) 15

(e) Shikha reads $8\frac{1}{2}$ page of a book in one hour. How many pages will she read in $2\frac{1}{2}$ hours?

(i) $17\frac{13}{4}$

☐ (ii) $18\frac{13}{4}$

☐ (iii) $12\frac{13}{4}$

☐ (iv) $17\frac{15}{7}$

(f) On simplifying $\frac{7}{5} \div \left(\frac{3}{2} \times \frac{1}{8}\right)$, we get

(i) $\frac{115}{12}$

☐ (ii) $\frac{112}{15}$

☐ (iii) $\frac{66}{15}$

☐ (iv) $\frac{109}{11}$

(g) If we add $2\frac{1}{4}$ and $3\frac{1}{4}$, we get

(i) $\frac{31}{2}$

☐ (ii) $\frac{11}{2}$

(iii) $\frac{15}{4}$

☐ (iv) $\frac{19}{7}$

(h) $\frac{78}{14}$ is same as

(i) $5\frac{8}{14}$

☐ (ii) $6\frac{8}{14}$

(iii) $4\frac{8}{13}$

☐ (iv) None of these

2. By what number should we multiply $8\frac{3}{4}$ to get $26\frac{2}{8}$?

3. The cost of $7\frac{3}{4}$ kg of Jaggery is ₹ $201\frac{1}{2}$. At what price per kg Jaggery will be sold?

4. Kanchan covers $2\frac{1}{2}$ km in 1 hour. How much distance she covers in 6 hours?

5. The cost of $2\frac{1}{3}$ kg of tomatoes is ₹ 70. How much will $4\frac{2}{3}$ kg tomatoes cost?

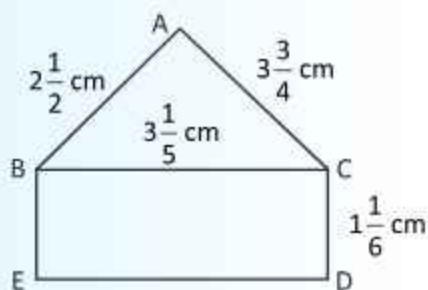
6. $\frac{32}{3}$ litres cold drink is kept for distribution among 8 children. How much cold drink would one child get?

7. There are 56 students in a class. Suppose $\frac{7}{8}$ of them are boys. Find out the number of girls in the class.

8. To publish a monthly school magazine, ₹ $2\frac{1}{5}$ are collected from each student. If the amount collected is ₹ $512\frac{3}{5}$, find the number of students who contributed for this cause.

9. Kiran travelled $26\frac{4}{5}$ km by train, $18\frac{3}{5}$ km by bus and $3\frac{3}{5}$ km by cycle. Find the total distance travelled by her.

Find the perimeters of $\triangle ABC$ and rectangle BCDE of the given figure. Whose perimeter is greater and by how much?



Lab Activity

Objective

: To multiply two fractions.

Materials Required

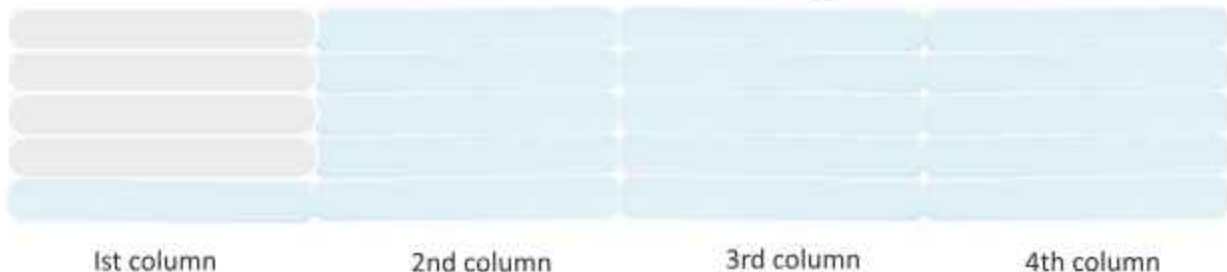
: 20 small sized broad ice-cream sticks, glue, A4 size paper, green sketch pen.

Procedure :

Step 1 : Take an A4 size paper horizontally.

Step 2 : Paste small sized broad ice-cream sticks on A4 sized paper with the help of glue. Look at the structure.

Step 3 : The first column is made up of horizontally pasted sticks shows $\frac{1}{4}$ of total structure.



Step 4 : Shade the top four sticks with green sketch pen.

These shaded sticks show $\frac{4}{5}$ of $\frac{1}{4}$ structure.

Conclusion : So, you can observe that $\frac{4}{5}$ of $\frac{1}{4}$ shows $\frac{4}{20}$ th part of the complete structure i.e., $\frac{4}{5} \times \frac{1}{4} = \frac{4}{20}$.



Decimals

Decimals belong to the category of numbers that consist of a whole number and a fractional part, with the two components separated by a decimal point.

Examples: 18.64, 8.2, 0.223, etc.

The numbers having equal digits in the fractional part (part after the decimal point) are the Like decimals.

Unlike decimals are the numbers having unequal digits in the fractional part.

Addition and Subtraction of Decimals

To add or subtract decimal numbers, both numbers should have equal digits after the decimal point i.e. they should be like decimals.

To convert unlike decimal to like decimal, add zeros in the fractional part.

Examples: $18 + 1.568 = 18.000 + 01.568 = 19.568$
 $45.012 + 7.86432 = 45.01200 + 07.86432 = 52.87632$
 $12.09 - 1.8903 = 12.0900 - 01.8903 = 10.1997$



Multiplication of Decimal Fractions

Multiplication of a Decimals by 10, 100, 1000, ...

When we multiply a decimal by 10, the decimal point moves one place to the right and when we multiply a decimal by 100, the decimal point moves two places to the right. Similarly, when we multiply a decimal by 1000, the decimal point moves three places to the right.

Example 1 : Multiply the following :

(a) 9.47×1000 (b) 94.234×100 (c) 78.25×10

Solution : (a) $9.47 \times 1000 = 9470$ (The decimal point shifts three places to the right)
 (b) $94.234 \times 100 = 9423.4$ (The decimal point shifts two places to the right)
 (c) $78.25 \times 10 = 782.5$ (The decimal point shifts one place to the right)

Example 2 : The cost of 1 kg packet of detergent cake is ₹ 52.75. What will be the cost of 100 packets, if each packet weighs 1 kg?

Solutions : It is very clear that we have to multiply 52.75 by 100 to find out the cost of 100 packets
 Therefore, ₹ $52.75 \times 100 = ₹ 5275$

Multiplication of a Decimal by a Whole Numbers

To multiply a decimal number by a whole numbers :

- ❖ Ignore the decimal point and multiply the digits.
- ❖ Place the decimal point in the answer so that it has the same number of decimal places as that of number (decimal numbers)

Example 3 : Calculate 39.98×7

Solution :

39.98	2 decimal places in the number
× 7	
279.86	2 decimal places in the answer

Do not forget to place the decimal point two places from the right-hand end of the answer.

Example 4 : Calculate 0.0005×8

Solution :

$$\begin{array}{r} 0.0005 \\ \times 8 \\ \hline 0.0040 \end{array} \quad \text{or } 0.004$$

Example 5 : Calculate 47.4×45

Solution :

$$\begin{array}{r} 47.4 \\ \times 45 \\ \hline 2370 \\ 1896 \times \\ \hline 2133.0 \end{array}$$



Facts to Know

- Any trailing zeros in the decimal places can be omitted.

Multiplication of a Decimal Number by Another Decimal Number

To multiply the two decimals :

- ❖ Ignore the decimal points and multiply the digits.
- ❖ Place a decimal point in the answer so that it has the same number of decimal places as the sum of decimal places in the given numbers.

Example 6 : Calculate 0.8×0.9

Solution :

$$\begin{array}{r} 0.8 \\ \times 0.9 \\ \hline 0.72 \end{array}$$

← 1 decimal place
← 1 decimal place
← 2 decimal places in the answer

Thus, $0.8 \times 0.9 = 0.72$. In this example, we have ignored the decimal points first and multiplied 8 by 9. Then, you have placed the decimal point at 2 places of decimal from right.

Example 7 : Multiply 114.2 by 2.14

Solution :

$$\begin{array}{r} 114.2 \\ \times 2.14 \\ \hline 4568 \\ 1142 \times \\ 2284 \times \times \\ \hline 244.388 \end{array}$$



The decimal places in multiplicand $(114.2) = 1$
 and decimal places in multiplier $(2.14) = 2$
 Sum of decimal places $= 2 + 1 = 3$
 Thus, we place a decimal point after 3 places from right-hand end.

Example 8 : Multiply 18.81 by 1.11

Solution :

18.81	← 2 decimal places
<u>× 1.11</u>	← 2 decimal places
1881	
1881 ×	
<u>1881 × ×</u>	
20.8791	← 4 decimal places



Exercise 4.1

1. Multiply the following :

- | | | | |
|----------------------|-------------------------|--------------------------|------------------------|
| (a) 7.95×10 | (b) 1.45×100 | (c) 1.53×1000 | (d) 6.75×100 |
| (e) 0.55×10 | (f) 3.567×1000 | (g) 279.01×1000 | (h) 287.33×10 |

2. Find the product of the following :

- | | | | |
|------------------------|------------------------|-----------------------|-----------------------|
| (a) 0.874×401 | (b) 3.5×40 | (c) 0.96×91 | (d) 3.3×9 |
| (e) 9.28×17 | (f) 745.20×37 | (g) 532.2×49 | (h) 8.9×2.75 |

3. Find the product of the following :

- | | | | |
|-------------------------|------------------------|------------------------|-------------------------|
| (a) 0.429×33.5 | (b) 15.78×1.1 | (c) 3.05×1.29 | (d) 279.7×2.14 |
| (e) 45.7×3.36 | (f) 19.13×7.3 | (g) 0.75×1.25 | (h) 1.35×0.123 |

4. Nayan can travel at 54.67 km per hour by his car. How far can he travel in 3 hours ?

5. Find the area of a square of sides 17.90 m each. [Hint : Area of square = side $\times$ side]



Division of Decimals

When we have learnt the techniques to multiply two decimals. Now, we shall learn about division of two decimals.

Division of a Decimal by 10, 100, 1000,

We have divide a decimal by 10, 100 or 1000, the decimal point in the answer shifts accordingly to the left side by 1, 2 or 3 places respectively.

Example 9 : Divide 7578.9 by 1000

Solution : Number of zeros in the divisor (1000) is 3. So, the decimal point will move three places to the left.
 $7578.9 \div 1000 = 7.5789$

Example 10 : Divide 27.89 by 100

Solution : The decimal point will shift to 2 places to the left.
 $27.89 \div 100 = 0.2789$

Division of a Decimal by a Whole Number or a Decimal Fraction

- ❖ Move the decimal point in the **divisor** to the right until it changes into a whole number.
- ❖ Move the decimal point in the **dividend** to the right by the same number of places as the decimal point was moved to make the divisor a whole number.



- ❖ Divide the new dividend by the new divisor.
- ❖ After division, count the number of decimal places in the new dividend from right handed and place the decimal point accordingly in the quotient so obtained.

Example 11 : Calculate $4.2625 \div 0.05$

Solution : Number of decimal places in divisor is 2. We make divisor a whole number. Now, shift the decimal point 2 places to the right in the dividend. So, new dividend is 426.25.

$$\begin{array}{r}
 5 \overline{) 426.25} \quad 85.25 \\
 \underline{-40} \\
 26 \\
 \underline{-25} \\
 12 \\
 \underline{-10} \\
 25 \\
 \underline{-25} \\
 \times
 \end{array}$$

Thus, $4.2625 \div 0.05 = 85.25$

Example 12 : Divide 72.5 by 29

Solution :

$$\begin{array}{r}
 29 \overline{) 72.5} \quad 2.5 \\
 \underline{-58} \\
 145 \\
 \underline{-145} \\
 \times
 \end{array}$$

Thus, $72.5 \div 29 = 2.5$

In the above example, we counted the number of decimal placed in the new dividend and placed the decimal point accordingly in the quotient so obtained.



Exercise 4.2

1. Calculate the following :

(a) $17.28 \div 100$

(b) $9.26 \div 10$

(c) $5.685 \div 1000$

(d) $75.399 \div 1000$

2. Divide the following :

(a) $0.14 \div 0.7$

(b) $0.12 \div 1.2$

(c) $1.44 \div 0.8$

(d) $1.5813 \div 2.51$

(e) $10.9326 \div 2.74$

(f) $11.2 \div 5.6$

3. The product of two decimals is 5832.8222. If one decimal is 427.94, find the other.

4. Calculate the area of a rectangle whose breadth is 2.5 cm and length is 0.38 cm.
(Hint : Area of rectangle = length $\times$ breadth)

5. An electrician earns ₹ 75.25 per hour. If he worked 200 hours this month, how much did he earn ?



Different Units and their Conversion

We use several methods to measure quantities in our day-to-day life. We mainly use metre (or kilometre), gram (or kilogram), millilitre (or litre), paise (or rupees) etc., to make our measurement easy.

We use metric system to measure length, mass and capacity.

To convert from bigger unit to smaller unit, we multiply by 10, 100 or 1000 and to convert from smaller unit to bigger unit, we divide by 10, 100 or 1000 as the case may be.



We spell out the abbreviation as:

kg means kilogram

g means gram

km means kilometre

m means metre

kl means kilolitre

l means litre

ml means millilitre

cm means centimetre

Example 13 : Convert the following :

(a) 7 kg into grams (b) 500 cm into metres (c) 12 km into metres

(d) 3 m into centimetres (e) ₹ 36 rupees into paise

Solution : (a) $7 \text{ kg} = 7 \times 1000 \text{ g} = 7000 \text{ g}$ (Since, $1 \text{ kg} = 1000 \text{ g}$)

(b) $500 \text{ cm} = \frac{500}{100} \text{ m} = 5 \text{ m}$ (Since, $100 \text{ cm} = 1 \text{ m}$)

(c) $12 \text{ km} = 12 \times 1000 \text{ m} = 12000 \text{ m}$ (Since, $1 \text{ km} = 1000 \text{ m}$)

(d) $3 \text{ m} = 3 \times 100 \text{ cm} = 300 \text{ cm}$ (Since, $1 \text{ m} = 100 \text{ cm}$)

(e) $₹ 36 = 36 \times 100 \text{ paise} = 3600 \text{ paise}$ (Since, $₹ 1 = 100 \text{ paise}$ and ₹ is an abbreviation for Rupees)

(f) $500 \text{ paise} = ₹ \frac{500}{100} = ₹ 5$ (Since, $₹ 1 = 100 \text{ paise}$ and ₹ is an abbreviation for Rupees)

Example 14 : Convert the following :

(a) 4 km 600 m into m

(b) 6 l 500 ml into ml

Solution : (a) $4 \text{ km } 600 \text{ m} = 4 \times 1000 + 600 \text{ m}$

$$= 4000 \text{ m} + 600 \text{ m} = 4600 \text{ m}$$

(b) $6 \text{ l } 500 \text{ ml} = 6 \times 1000 \text{ ml} + 500 \text{ ml}$

$$= 6000 \text{ ml} + 500 \text{ ml} = 6500 \text{ ml}$$



Exercise 4.3

1. Fill in the blanks.

(a) 7 l = ml

(c) 3.5 kg = g

(e) 5 kl = l

(g) 7.25 ml = l

(b) 25 km = m

(d) 2900 g = kg

(f) 2945 g = kg

(h) 200 cm = m

- A bookbinder requires 1.7 m of thread to bind a book. How many such books can be binded from a bundle of thread of 44.2 m in length?
- 5590.35 kg wheat is distributed among 45 persons. How much wheat did each person get?
- 87 cartons of toys weigh 3936.75 kg. Find the weight of 100 such cartons of toys.
- The thickness of one calculator is 1.2 cm. Find the thickness of 89 calculators altogether. Also convert the unit of result so obtained into metre (m).

Points to Remember

- The word "Decimal" comes from Latin word **decima** which means **tenth part**.
- Decimals are based on 10 and contain a decimal point.
- A decimal number always represents Whole number part and Decimal part, separated by a decimal point.
- We can add and subtract like decimals; but unlike decimals can not be added and subtracted.
- Unlike decimals can be added and subtracted only after their conversion into like decimals.
- When we multiply a decimal by 10, 100, 1000, ... the decimal point shifts to 1, 2, 3, places to the right side.
- We ignore the decimal point while multiplying the decimal number with whole number, and place the decimal point in the answer so that it has same number of decimal places as that of decimal number.

- ❖ When we divide a decimal by 10, 100, 1000... the decimal point in the answer shifts accordingly to the left side by 1, 2, 3..... place respectively.
- ❖ To divide a decimal number by another decimal fraction, make the divisor a whole number, and in dividend shift the decimal point to the right by as many places as the number of decimal places in the divisor. Now, divide new dividend by the whole number.
- ❖ In our daily life, we use units such as metre, gram, millilitre and convert them into their corresponding bigger or smaller units.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options :

- (a) Which one is the value of 0.89×100 ?
- | | | |
|------------------------------------|-------------------------------------|--------------------------|
| ☐ (i) 980 | ☐ (ii) 89 | ☐ |
| ☐ (iii) 8.9 | ☐ (iv) 0.089 | ☐ |
- (b) How many grams are 37 kg 28 g ?
- | | | |
|--|---|--------------------------|
| ☐ (i) 37280 grams | ☐ (ii) 3728 grams | ☐ |
| ☐ (iii) 37028 grams | ☐ (iv) None of these | ☐ |
- (c) Which of the following is the result of $2.93 + 17.1 + 15.002$?
- | | | |
|---------------------------------------|--------------------------------------|--------------------------|
| ☐ (i) 34.023 | ☐ (ii) 37.302 | ☐ |
| ☐ (iii) 33.023 | ☐ (iv) 35.032 | ☐ |
- (d) If we multiply a decimal fraction by 1000, how many places to the right a decimal point move ?
- | | | |
|----------------------------------|---------------------------------|--------------------------|
| ☐ (i) 2 | ☐ (ii) 1 | ☐ |
| ☐ (iii) 3 | ☐ (iv) 4 | ☐ |
- (e) The sum of two decimals is 79.37. If one of them is 37.542, then the other is
- | | | |
|---------------------------------------|--------------------------------------|--------------------------|
| ☐ (i) 40.582 | ☐ (ii) 41.727 | ☐ |
| ☐ (iii) 41.828 | ☐ (iv) 40.826 | ☐ |
- (f) One set of spoon and bowl costs ₹ 36.75. How much would 15 such sets cost ?
- | | | |
|---|--|--------------------------|
| ☐ (i) ₹ 550.22 | ☐ (ii) ₹ 551.25 | ☐ |
| ☐ (iii) ₹ 505.25 | ☐ (iv) ₹ 55.125 | ☐ |
- (g) Kitty saves ₹ 34.50 per month (30 days). How much will she save for 18 days ?
- | | | |
|---------------------------------------|---------------------------------------|--------------------------|
| ☐ (i) ₹ 22.5 | ☐ (ii) ₹ 18.75 | ☐ |
| ☐ (iii) ₹ 20.7 | ☐ (iv) ₹ 22.25 | ☐ |
2. A photocopy costs ₹1.2 per sheet. If a shopkeeper makes 12000 copies, what is their cost ?
3. A fruit vendor sells 48.6 fruits every 15 minutes. How much fruits will he sell in 2 hours ?
4. Ambuj wants to buy the following items : A DVD player for ₹ 1597.50, a DVD holder for ₹ 75.25 and a personal stereo for ₹ 1090.35. How much extra money is required to purchase all these items, if he has only ₹ 1550 in his wallet ?
5. An old man gets retirement pension of ₹ 2470.50 for 6 months. How much will he get for 2 month ?
6. Find the area of a rectangle whose breadth is 4.65 m and length is 10.38 m ?
7. If 30 drums of water weigh 2176.5 kg, find the weight of 1 drum of water.



8. A household requires 2.94 liters of kerosene oil per day for cooking purpose. How much oil is used in one week.
9. If Patra earn ₹ 26866.5 per month (i.e., 30 days), how much will he earn in 9 days ?
10. A scooter driver covers 46.8 km in 1.6 liter of petrol. How much distance will it cover in one litre of petrol ?

HOME

1. If one inch = 2.54 cm, then 1 yard = metres.
2. A flagpole of 20 m casts a shadow of 5 m. If another flagpole is only 12 m high, what is the length of its shadow?

Lab Activity

Objective

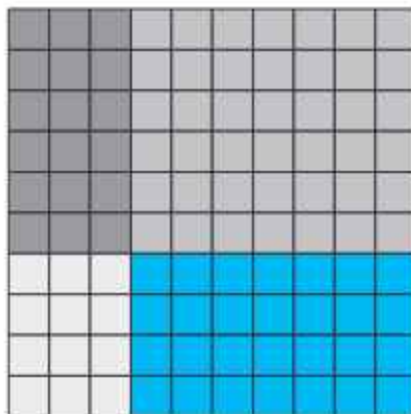
: To multiply two decimals

Materials Required

: White chart paper, scissors, black sketch pen, yellow sketch pen, green sketch pen.

Procedure :

Step 1 : Take a white coloured chart paper. Cut it in squared shape.



Step 2 : Draw grids with black sketch pen in 10 equal rows and 10 equal columns as shown above. Thus it makes 100 squares of equal length and breadth. Suppose we want to find the product of 0.6 and 0.3 i.e., 0.6×0.3

Step 3 : Shade the first 6 rows with yellow sketch colour.

Step 4 : Shade the first 3 columns with green sketch colour.

Count the boxes which are dark shaded and common in both.

You will see 18 such boxes out of 100 boxes i.e., $\frac{18}{100} = 0.18$. Hence $0.6 \times 0.3 = 0.18$

Following the similar method, you could find the product

(i) 0.7×0.2

(ii) 0.9×0.3

(iii) 0.5×0.8

and many more

In our daily life we come across many large numbers. For example, like the velocity of light is 300, 000, 000 m/s, mass of the earth is 5, 970, 000, 000, 000, 000, 000, 000 kg, the distance of Sun from the Earth is 150, 000, 000. It is difficult to read these numbers in above form. But which we write them as the velocity a light is 3×10^8 m/s, mass of the earth is 597×10^{22} kg it becomes easy to read.

We have written above the short form of large numbers using exponent. In this chapter, we shall learn about exponent and its laws.



Exponents

We use exponent to write large numbers in their short form or exponential form.

Let us see, $100,000 = 10 \times 10 \times 10 \times 10 \times 10 = 10^5$

Here 10^5 has written for $10 \times 10 \times 10 \times 10 \times 10$. In 10^5 , 10 is called the **base**, 5 is the exponent and 100, 000 is the exponential value. However the base can be any numbers also.

For example, $243 = 3 \times 3 \times 3 \times 3 \times 3$ is written as in exponential form as 3^5 . In 3^5 , 3 is base and 5 is the exponent or power. $58786 = 5 \times 10000 + 8 \times 1000 + 7 \times 100 + 8 \times 10 + 6$. We can write it as $5 \times 10^4 + 8 \times 10^3 + 7 \times 10^2 + 8 \times 10 + 6$. The base of exponential form of exponential value can be negative also. For example,

(a) $(-2) \times (-2) \times (-2) = (-2)^3 = -8$

(b) $(-2) \times (-2) \times (-2) \times (-2) = (-2)^4 = 16$

(c) $\left(-\frac{2}{5}\right) \times \left(-\frac{2}{5}\right) \times \left(-\frac{2}{5}\right) \times \left(-\frac{2}{5}\right) \times \left(-\frac{2}{5}\right) = \left(-\frac{2}{5}\right)^5 = \frac{-32}{3125}$

Let us consider for example,

$a \times a = a^2$; We read it as a raised to the power of 2.

$m \times m \times m = m^3$; We read it as m raised to the power of 3.

$a \times a \times b \times b \times b = a^2 b^3$; We read it as a raised to the power of 2 and b raised to the power of 3.

Example 1 : Express 125 as a power 05.

Solution : We write 125 as

$$125 = 5 \times 5 \times 5$$

Hence, we can say that

$$125 = 5^3.$$

Example 2 : Which one of the following is greater.

(a) 2^4 or 4^2

(b) $(-3)^4$ or $(-4)^3$

Solution : (a) We write 2^4 as

$$2^4 = 2 \times 2 \times 2 \times 2 = 16$$

and 4^2 as $4^2 = 4 \times 4 = 16$

Both numbers are equal.



- (b) We write $(-3)^4$ as
 $(-3)^4 = (-3) \times (-3) \times (-3) \times (-3) = 81$
 We write $(-4)^3$ as
 $(-4)^3 = (-4) \times (-4) \times (-4) = -64$
 It is clear that, $(-3)^4 > (-4)^3$.

Example 3 : Find the exponential value of the following :

- (a) $m^2 n^3$ (b) $n^3 m^2$ (c) $m^3 n^2$ (d) $n^2 m^3$

- Solution :** (a) $m^2 n^3 = m \times m \times n \times n \times n$
 (b) $n^3 m^2 = n \times n \times n \times m \times m$
 (c) $m^3 n^2 = m \times m \times m \times n \times n$
 (d) $n^2 m^3 = n \times n \times m \times m \times m$

Example 4 : Express the following numbers as a product of powers of prime factors :

- (a) 32 (b) 3125 (c) 729 (d) -1331

- Solution :** (a) $32 = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$
 (b) $3125 = 5 \times 5 \times 5 \times 5 \times 5 = 5^5$
 (c) $729 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$
 (d) $-1331 = (-11) \times (-11) \times (-11) = (-11)^3$

Example 5 : Express the following numbers as product of powers of prime factors :

- (a) 1800 (b) 25000

- Solution :** (a) $1800 = 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5$
 $= 2^3 \times 3^2 \times 5^2$
 (b) $25000 = 2 \times 2 \times 2 \times 5 \times 5 \times 5 \times 5 \times 5$
 $= 2^3 \times 5^5$

Example 6 : Simplify the following :

- (a) 1^{10} (b) 100^1 (c) $(-1)^5$
 (d) $5^2 \times 3^3$ (e) $(-2)^3 \times (-10)^3$

- Solution :** (a) $1^{10} = 1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 = 1$
 (b) $100^1 = 100$
 (c) $(-1)^5 = (-1) \times (-1) \times (-1) \times (-1) \times (-1)$
 $= -1$
 (d) $5^2 \times 3^3 = 5 \times 5 \times 3 \times 3 \times 3$
 $= 25 \times 27 = 675$
 (e) $(-2)^3 \times (-10)^3 = (-2) \times (-2) \times (-2) \times (-10) \times (-10) \times (-10)$
 $= (-8) \times (-1000) = 8000$

Exercise 5.1

1. Find the value of each of the following :

(a) 2^6

(b) 3^7

(c) 5^3

(d) 4^4

(e) 3^6

(f) $(-7)^3$

2. Write the base and exponent (power) of the following:

(a) $(5)^2$

(b) $(-5)^4$

(c) $(-1)^{11}$

(d) $(y)^m$

(e) m^y

(f) $(-100)^5$

3. Write the following in exponential form:

(a) $y \times y \times y$

(b) $9 \times 9 \times 9 \times 9 \times 9$

(c) $a \times a$

(d) $7 \times 7 \times 7 \times 3 \times 3$

(e) $n \times n \times n \times m \times m$

(f) $x \times x \times x \times y \times y \times z \times z$

4. Which is greater in the following pairs:

(a) 1^9 or 9^1

(b) 3^6 or 6^3

(c) 10^8 or 9^{10}

(d) $(-2)^5$ or 5^2

(e) $(-1)^{10}$ or $(10)^1$

(f) $(7)^3$ or $(3)^7$

5. Write the following numbers as a product of power of prime factor :

(a) 75

(b) 9000

(c) 625

(d) 405

(e) 3600

(f) 675

6. Simplify the following :

(a) 3×10^3

(b) 3×4^5

(c) $5^2 \times 4^4$

(d) $2^6 \times 6^2$

(e) $3^2 \times 5^2$

(f) 4×5^3

7. Simplify the following:

(a) $(-5)^2 \times (-2)$

(b) $(-1)^{10} \times (-4)^3$

(c) $(-2)^3 \times (-1)^{80}$

(d) $2^3 \times 5$

(e) $3^5 \times 5^3$

(f) $2^4 \times 4^2$



Law of Exponents

Laws of exponents are learnt through observation method. These laws are as follows.

1. **Multiplying power with the same base**

When the base of numbers are same. The exponents are to be added.

(a) Let us calculate, $3^2 \times 3^3 = (3 \times 3) \times (3 \times 3 \times 3)$
 $= 3 \times 3 \times 3 \times 3 \times 3 = 3^5 = 3^{2+3}$

Here, the base in 3^2 and 3^3 are same and the sum of exponents is $2+3=5$.

(b) $m^2 \times m^5 = (m \times m) \times (m \times m \times m \times m \times m)$
 $= m \times m \times m \times m \times m \times m \times m$
 $= m^7$ i.e., m^{2+5}

(c) $(-4)^3 \times (-4)^2 = (-4 \times -4 \times -4) \times (-4 \times -4)$
 $= (-4) \times (-4) \times (-4) \times (-4) \times (-4)$
 $= -4^5$ i.e., $(-4)^{3+2}$

Hence, $5^2 \times 5^4 = 5^{2+4}$

$6^3 \times 6^2 = 6^{3+2}$

$10^{11} \times 10^9 = 10^{11+9}$ and so on.

Therefore then, we can establish that for a non-zero integer p when q and r are whole numbers.

$p^q \times p^r = p^{q+r}$

Power of a power

Some patterns with power of a power like $(2^3)^2$, $(3^2)^4$, $(4^2)^3$, we simplify these as follows.

$$(a) \quad (2^3)^2 = 2^3 \times 2^3 = 2^{3+3} \\ = 2^6 = 2^{2 \times 3}$$

$$(b) \quad (3^2)^4 = 3^2 \times 3^2 \times 3^2 \times 3^2 = 3^{2+2+2+2} \\ = 3^8 = 3^{2 \times 4}$$

$$(c) \quad (4^2)^3 = 4^2 \times 4^2 \times 4^2 = 4^{2+2+2} \\ = 4^6 = 4^{2 \times 3}$$

From observing the above examples, we can establish the result in the form of another law as :

Law 1: If p is any integer ($p \neq 0$) and q and r are two natural number, then

$$(p^q)^r = p^{q \times r} = p^{qr}$$

Example 7 : Simplify the following as a single exponent.

$$(a) \quad (2^3)^4 \quad (b) \quad [(-20)^2]^5 \quad (c) \quad (5^2)^{30} \quad (d) \quad (3^5)^4 \quad (e) \quad (10^{10})^{10}$$

Solution :

$$(a) \quad (2^3)^4 = 2^{3 \times 4} = 2^{12}$$

$$(b) \quad [(-20)^2]^5 = (-20)^{2 \times 5} = (-20)^{10}$$

$$(c) \quad (5^2)^{30} = 5^{2 \times 30} = 5^{60}$$

$$(d) \quad (3^5)^4 = 3^{5 \times 4} = 3^{20}$$

$$(e) \quad (10^{10})^{10} = 10^{10 \times 10} = 10^{100}$$

Examples 8 : Find that which one is greater : $(2^3)^4$ or $(2^3) \times 4$

Solution : We know that $(2^3)^4 = 2^{3 \times 4} = 2^{12} = 4096$
 $(2^3) \times 4 = 2^3 \times 4 = 8 \times 4 = 32$

It is clear that $(2^3)^4 > (2^3) \times 4$

2. Dividing powers with the same base

Let us simplify $2^5 \div 2^3$

$$2^5 \div 2^3 = \frac{2 \times 2 \times 2 \times 2 \times 2}{2 \times 2 \times 2} \\ = 2^2 \text{ i.e., } 2^{5-3}$$

$$\text{Thus, } 2^5 \div 2^3 = 2^{5-3}$$

Here, the base of 2^5 and 2^3 are same. Therefore, $2^5 \div 2^3 = 2^{5-3}$.

Similarly $7^6 \div 7^5$

$$= \frac{7 \times 7 \times 7 \times 7 \times 7 \times 7}{7 \times 7 \times 7 \times 7 \times 7} = 7^1 = 7^{6-5}$$

Let m be a non-zero integer ($m \neq 0$), then find the value of $m^8 \div m^2$.

$$\text{we know that, } m^8 \div m^2 = \frac{m \times m \times m \times m \times m \times m \times m \times m}{m \times m} = m^6 \text{ i.e., } m^{8-2}$$

Now, Let us see some examples :

$$10^9 \div 10^7 = 10^{9-7} = 10^2$$

$$9^{10} \div 9^3 = 9^{10-3} = 9^7$$

$$p^8 \div p^5 = p^{8-5} = p^3$$

Law - 2: If P is any non-zero integer and q and r are whole numbers such that $q > r$.

$$\text{Then, } p^q \div p^r = \frac{p^q}{p^r} = p^{q-r}$$



Multiplying Powers with the Same Exponents

Now, we will learn to multiply the terms having some exponent but different base. For example :

$$\begin{aligned}
 \text{(a)} \quad 3^3 \times 5^3 &= (3 \times 3 \times 3) \times (5 \times 5 \times 5) \\
 &= (3 \times 5) \times (3 \times 5) \times (3 \times 5) \\
 &= 15 \times 15 \times 15 \\
 &= 15^3 \text{ i.e., } (3 \times 5)^3 \\
 \text{(b)} \quad 4^5 \times 3^5 &= (4 \times 4 \times 4 \times 4 \times 4) \times (3 \times 3 \times 3 \times 3 \times 3) \\
 &= (4 \times 3) \times (4 \times 3) \times (4 \times 3) \times (4 \times 3) \times (4 \times 3) \\
 &= 12 \times 12 \times 12 \times 12 \times 12 \\
 &= 12^5 \text{ i.e., } (4 \times 3)^5 \\
 \text{(c)} \quad m^3 \times n^3 &= (m \times m \times m) \times (n \times n \times n) \\
 &= (m \times n) \times (m \times n) \times (m \times n) \\
 &= (m \times n)^3 \text{ i.e., } (mn)^3
 \end{aligned}$$

From observing above examples we can establish the result as a law that. If p and q are two non-zero ($p \neq 0, q \neq 0$) integers and r is any whole number, then

$$p^r \times q^r = (pq)^r \quad [p \times q = pq]$$



Dividing Powers with the Same Exponents

When dividing powers having same exponents, we simplify them as following.

$$\begin{aligned}
 \text{(a)} \quad \frac{2^5}{3^5} &= \frac{2 \times 2 \times 2 \times 2 \times 2}{3 \times 3 \times 3 \times 3 \times 3} = \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \left(\frac{2}{3}\right)^5 \\
 \text{(b)} \quad \frac{4^7}{5^7} &= \frac{4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4}{5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5} = \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} = \left(\frac{4}{5}\right)^7 \\
 \text{(c)} \quad \frac{p^3}{q^3} &= \frac{p \times p \times p}{q \times q \times q} = \frac{p}{q} \times \frac{p}{q} \times \frac{p}{q} = \left(\frac{p}{q}\right)^3
 \end{aligned}$$

From observing the above examples, we establish a law that if p and q are two non-zero integers and r is a whole number, then

$$p^r \div q^r = \frac{p^r}{q^r} = \left(\frac{p}{q}\right)^r$$



Numbers with Exponent Zero

We observe some following examples in which numerator and denominator having same exponent and base. For examples.

$$\text{(a)} \quad 2^5 \div 2^5 = \frac{2 \times 2 \times 2 \times 2 \times 2}{2 \times 2 \times 2 \times 2 \times 2} = 1$$

$$\text{or, } 2^{5-5} \text{ i.e., } 2^0$$

Thus, we know that, $2^0 = 1$



Let us observe the other examples :

$$(b) \quad 5^5 \div 5^5 = 5^{5-5}$$

$$= 5^0 = 1$$

$$(c) \quad 7^4 \div 7^4 = 7^{4-4}$$

$$= 7^0 = 1$$

From observing above examples, we reach at conclusion that $p^0 = 1$ for all $p \neq 0$.

Now, summaries the above laws of exponents.

$$(a) \quad p^a \times p^r = p^{a+r}$$

$$(b) \quad (p^a)^r = (p)^{ar}$$

$$(c) \quad p^a \div p^r = p^{a-r} \text{ (where } a > r \text{)}$$

$$(d) \quad p^r \cdot q^r = (pq)^r$$

$$(e) \quad \frac{p^r}{q^r} = \left(\frac{p}{q}\right)^r$$

Example 9 : Write the following in the exponential form.

$$(a) \quad 20 \times 20 \times 20 \times 20 \times 20$$

$$(b) \quad 32 \times 81 \times 12$$

Solution : (a) We have $20 \times 20 \times 20 \times 20 \times 20 = (20)^5$

$$= (4 \times 5)^5$$

$$= 4^5 \times 5^5 = 2^{10} \times 5^5$$

$$(b) \quad \text{We have } 32 \times 81 \times 12 = (2 \times 2 \times 2 \times 2 \times 2) \times (3 \times 3 \times 3 \times 3) \times (2 \times 2 \times 3)$$

$$= (2 \times 2 \times 2 \times 2 \times 2 \times 2) (3 \times 3 \times 3 \times 3 \times 3)$$

$$= 2^7 \times 3^5$$

Example 10 : Simplify and write in the exponential form.

$$(a) \quad 4^3 \times p^3 \times 7p^4$$

$$(b) \quad [(3^2)^5 \times 15^6] \div 5^3$$

$$(c) \quad 15^5 \div 3^4$$

$$(d) \quad (3^5 \times 10^5 \times 25) \div (5^7 \times 6^5)$$

Solution : (a) $4^3 \times p^3 \times 7p^4 = 4^3 \times p^3 \times 7 \times p^4$

$$= 4^3 \times 7 \times p^3 \times p^4$$

$$= 64 \times 7 \times p^{3+4} = 7 \times 2^6 \times p^7$$

$$(b) \quad [(3^2)^5 \times 15^6] \div 5^3 = [(3^2)^5 \times (3 \times 5)^6] \div 5^3$$

$$= [3^{10} \times 3^6 \times 5^6] \div 5^3$$

$$= \frac{3^{16} \times 5^6}{5^3} = 3^{16} \times 5^3$$

$$(c) \quad 15^5 \div 3^4 = (3 \times 5)^5 \div 3^4$$

$$= \frac{3^5 \times 5^5}{3^4}$$

$$= \frac{3^5}{3^4} \times \frac{5^5}{1}$$

$$= 3^{5-4} \times 5^5 = 3^1 \times 5^5$$

$$(d) \quad (3^5 \times 10^5 \times 25) \div (5^7 \times 6^5)$$

$$= [3^5 \times (2 \times 5)^5 \times 5^2] \div [5^7 \times (2 \times 3)^5]$$

$$= [3^5 \times 2^5 \times 5^5 \times 5^2] \div [5^7 \times 2^5 \times 3^5]$$

$$= (3^5 \times 2^5 \times 5^{5+2}) \div [5^7 \times 2^5 \times 3^5]$$

$$= \frac{3^5 \times 2^5 \times 5^7}{2^5 \times 3^5 \times 5^7} = 1$$

Exercise 5.2

1. Simplify and express in exponential form :

(a) $\frac{2 \times 3^4 \times 2^5}{9 \times 4^2}$

(b) $[(5^3)^2 \times 5^4] \div 5^{14}$

(c) $\frac{9^3 \times a^5 \times b^2}{3^6 \times a^3 \times b}$

(d) $(3^0 + 4^0) \div 7^0$

(e) $\left(\frac{p^6}{p^3}\right) \times p^9$

(f) $(2^4 \times 2)^2$

(g) $\frac{5^3}{5^2 + 5}$

(h) $3^2 \times \left(\frac{p^{10}}{p^8}\right)$

2. Using law of exponents, simplify in exponential form :

(a) $5^{-2} \times 5^4 \times 5^3$

(b) $(-3)^5 \times (-3)^4$

(c) $p^4 \times p^5$

(d) $(5^3)^5$

(e) $10^{-4} \times 10^3$

(f) $(2^3)^3 \div 4^3$

(g) $m^7 \times n^7$

(h) $(3^7 \div 3^4) \times 3^2$

(i) $8^x \div 8^3$

3. Write the following as a product of prime factors in exponential form :

(a) 432×48

(b) 6000

(c) 729×81

(d) 512×300

(e) 2187×625

4. Simplify the following :

(a) $\frac{(2^8)^2 \times 5^3}{7^3 \times 4}$

(b) $\frac{6^5 \times 10^5 \times 125}{5^5 \times 3^5}$

(c) $\frac{3^7 \times 81 \times 7^3}{3^{10} \times 7^6}$

5. Justify and write true or false :

(a) $10 \times 10^9 = 10^9$

(b) $3^4 < 4^3$

(c) $7^3 \times 4^3 = 28^2$

(d) $5^1 = (5000)^0$

(e) $10^5 > 50000$

6. Find the value of x in each of the following :

(a) $2^x = 256$

(b) $2^x \div 2^5 = 2^{16}$

(c) $5^{x-7} = 5^{12}$

(d) $2^3 \times (-5)^3 = (-10)^x$



Decimal Number System

In decimal number system we write a number in the expanded form. For example,

$$579876 = 5 \times 100000 + 7 \times 10000 + 9 \times 1000 + 8 \times 100 + 7 \times 10 + 6$$

We can write the expanded form in exponential form as

$$= 5 \times 10^5 + 7 \times 10^4 + 9 \times 10^3 + 8 \times 10^2 + 7 \times 10^1 + 6 \times 10^0$$

We have written the expanded form in product 10, which is in descending order as i.e., 5, 4, 3, 2, 1, 0.



Expressing Large Number in the Standard Form

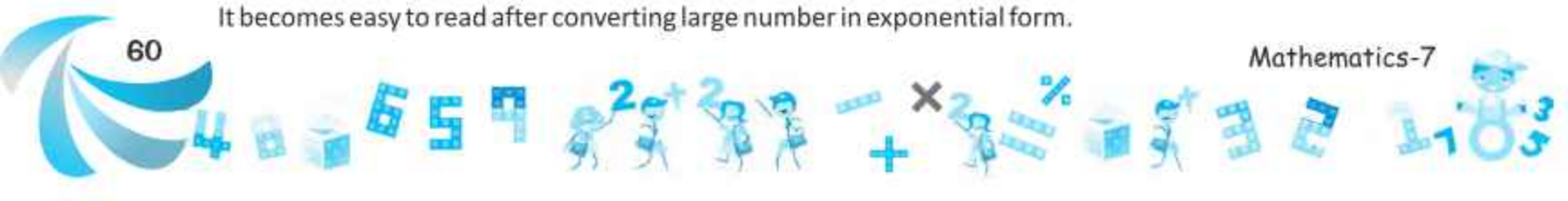
In the beginning of this chapter, we have discussed that we use exponential form of the large numbers to read them conveniently. For example, the mass of earth is 5930,000,000,000,000,000,000 kg. It is not convenient to read it. Its exponential form is given

$$= 593 \times 10^{22} \text{ kg}$$

$$= 59.3 \times 10^{23} \text{ kg}$$

$$= 5.93 \times 10^{24} \text{ kg}$$

It becomes easy to read after converting large number in exponential form.



Similarly we can convert the mass of Uranus.

$$= 86,800,000,000,000,000,000,000 \text{ kg}$$

$$= 8.68 \times 10^{25} \text{ kg.}$$

Speed of light is

$$= 300,000,000 \text{ m/s}$$

$$= 3 \times 10^8 \text{ m/s.}$$

We have expressed the numbers above in standard form. A number can be expressed as decimal number between 1 and 10.0 is called its **standard form**.



Exercise 5.3

1. Express the following numbers in the expanded form :

(a) 934657

(b) 80080807

(c) 3210312

(d) 70018

2. Write the number, their expanded term are given below.

(a) $7 \times 10^6 + 5 \times 10^3 + 3 \times 10^0$

(b) $5 \times 10^4 + 7 \times 10^3 + 8 \times 10^2 + 9 \times 10^0$

(c) $4 \times 10^5 + 3 \times 10^3 + 5 \times 10^1$

(d) $7 \times 10^4 + 6 \times 10^3 + 5 \times 10^1 + 5 \times 10^0$

3. Express the following numbers in standard form :

(a) 90000000

(b) 4156900000

(c) 590789

(d) 590658

4. Write the following in standard form :

(a) Speed of light in vacuum is 300,000,000 m.

(b) Diameter of the earth is 1,27,56,00 m.

(c) Our universe is estimated to be about 12,000,000,000 years old.

(d) The population of India was approximately 1,027,000,000 in April 2001.

(e) The distance between the earth and the moon is 384,000,000 m.

(f) Diameter of sun is 1,400,000,000 m.

Points to Remember

- ❖ In x^m , x is called the base and m is called the power or exponent or the index.
- ❖ $x^m = x \times x \times x \dots \dots m$ times, where x is a rational number and m is a positive integer.
- ❖ x^m is read as x raised to the power of m , where x is called the base and m is called the exponents or power or index.
- ❖ If x and y are rational numbers and m and n are positive integers, then,

$$x^m \times x^n = x^{m+n}$$

$$x^m \div x^n = x^{m-n}$$

$$(x^m)^n = x^{mn}$$

$$x^m \times y^m = (xy)^m$$

$$x^{-m} = \frac{1}{x^m}$$

$$x^0 = 1, \text{ where } x \neq 0$$



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options:

(a) The numbers, whose expanded form is $7 \times 10^5 + 5 \times 10^3 + 9 \times 10^0$ is

(i) 70509

☐

(ii) 705009

☐

(iii) 7005090

☐

(iv) 75090

☐

(b) The expanded form of 204305 is

(i) $2 \times 10^5 + 4 \times 10^4 + 3 \times 10^3 + 5 \times 10^1$

☐

(ii) $2 \times 10^5 + 4 \times 10^4 + 3 \times 10^2 + 5 \times 10^1$

☐

(iii) $2 \times 10^5 + 4 \times 10^3 + 3 \times 10^1 + 5 \times 10^0$

☐

(iv) $2 \times 10^5 + 4 \times 10^3 + 3 \times 10^2 + 5 \times 10^0$

☐

(c) 1.234×10^7 is the exponential form of

(i) 1234000

☐

(ii) 12340000

☐

(iii) 12340000000

☐

(iv) 0.0001234

☐

(d) If x and a are positive integers such that $x^a = 49$, then a^x equals to

(i) 49

☐

(ii) $\frac{1}{4^9}$

☐

(iii) 128

☐

(iv) 64

☐

(e) $a^x \div a^y = a^{y-x}$ when

(i) $x > 0$

☐

(ii) $y > 0$

☐

(iii) $x > y$

☐

(iv) $y > x$

☐

(f) The value of $14641 \div 11^2$ is

(i) 11

☐

(ii) 111

☐

(iii) 121

☐

(iv) 1212

☐

(g) $(4^0 + 8^0) \div 3^0$ equals to

(i) 4

☐

(ii) 2

☐

(iii) $\frac{2}{3}$

☐

(iv) $\frac{32}{3}$

☐

(h) $(x^3)^4$ when expressed as a single exponent is

(i) x^7

☐

(ii) x^{81}

☐

(iii) x^{12}

☐

(iv) $\frac{x}{12}$

☐

(i) Express $\frac{2^3 \times 9}{64 \times 27}$ in exponential form

(i) $\frac{1}{2^3 \times 3}$

☐

(ii) $\frac{3}{8}$

☐

(iii) $2^3 \times 3$

☐

(iv) $\frac{3}{2^3}$

☐

2. Find the value of each of the following:

(a) 2^8

(b) 4^5

(c) 5^3

(d) 6^6

(e) 3^5

(f) $(-7)^3$

3. Write the base and exponent (power) of the following:

(a) $(7)^7$

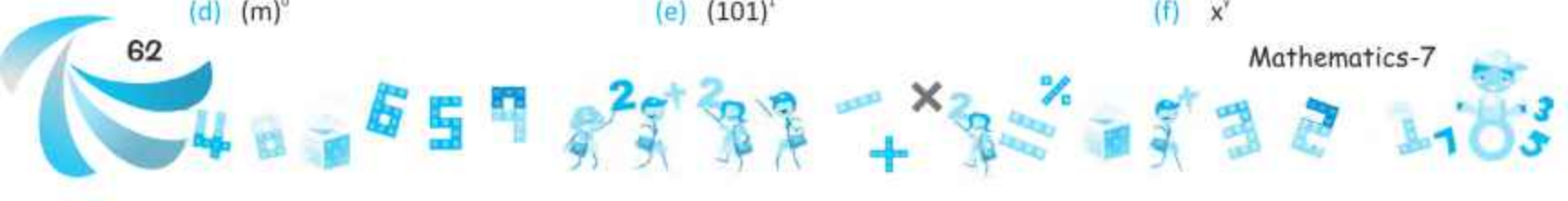
(b) $(-11)^{10}$

(c) $(xy)^5$

(d) $(m)^0$

(e) $(101)^1$

(f) x^y



4. Write following in exponential form :

- (a) $m \times m \times m$ (b) $(-1) \times (-1) \times (-1) \times (-1)$
 (c) $3 \times 3 \times 3 \times 3 \times 3$ (d) $2 \times 2 \times 2 \times m \times n$
 (e) $5 \times 5 \times 5 \times 7 \times 7$ (f) $m \times m \times m \times n \times n \times p \times p \times p$

5. Which is lesser in the following pairs:

- (a) 3^5 and 5^3 (b) 2^4 and 4^2
 (c) $(-2)^3$ and $(-3)^2$ (d) 2^7 and 7^2
 (e) 4^5 and 5^4 (f) $(-1)^4$ and $(-1)^3$

6. Write the following numbers as a product of powers of prime factor :

- (a) 540 (b) 6125 (c) 2400 (d) 648

7. Simplify the following :

- (a) 5×10^5 (b) $3^2 \times 5^2$ (c) $(-1)^{11} \times (-4)^3$
 (d) $(-4)^{20} \times (-4)^{100}$ (e) $m^2 \times m^2 \times m^3$ (f) $2^8 \div 2^{10}$

8. Using law of exponents and simplify in exponential form :

- (a) $[(2^2)^3 \times 3^5] \times 5^7$ (b) $(2^{20} \div 2^{30}) \times 2^5$
 (c) $(3^5 \times 5^5 \times 25) \div (5^3 \times 3^5)$ (d) $[(5^2)^5 \times 15^{10}] \div 5^5$

9. Justify and write true or false :

- (a) $1^0 \times 1^{10} = (-1)^3$ (b) $10^2 < 2^5$
 (c) $5^2 \times 2^5 > 2^5 \times 2^3$ (d) $11^{10} \times 11^1 > 675$

10. Find the value of y each of the following :

- (a) $3^y = 243$ (b) $5^{y+3} = 5^{3+2y} + 3 \times 5^3$
 (c) $2^y = 64$ (d) $3^y \div 3^5 = 3^9$

11. Express the following numbers in expanded form :

- (a) 507345 (b) 5000785 (c) 495781 (d) 679001

12. Write the following numbers whose expanded form are given below :

- (a) $5 \times 10^7 + 8 \times 10^5 + 3 \times 10^4 + 2 \times 10^3 + 1 \times 10^0$ (b) $4 \times 10^5 + 6 \times 10^4 + 9 \times 10^3 + 4 \times 10^0$

13. Express the following in standard form :

- (a) 7,00,00,000
 (b) 3,16,78,00,000
 (c) The earth has 1,353,000,000 cubic km of sea water.

HOOTS

If $\frac{p}{q} = \left(\frac{5}{6}\right)^2 \div \left(\frac{5}{6}\right)^2$, find the value of $\left(\frac{p}{q}\right)^2$.



Lab Activity

Objective : To understand exponents (power) by folding paper.

Materials Required : Squared paper, pencil, etc.

Procedure : Let us take exponents of 2, i.e., $2^0, 2^1, 2^2, 2^3, 2^4, \dots$. We represent the exponent by crease of folding.

Step 1 : Take the squared paper as shown in fig (i).

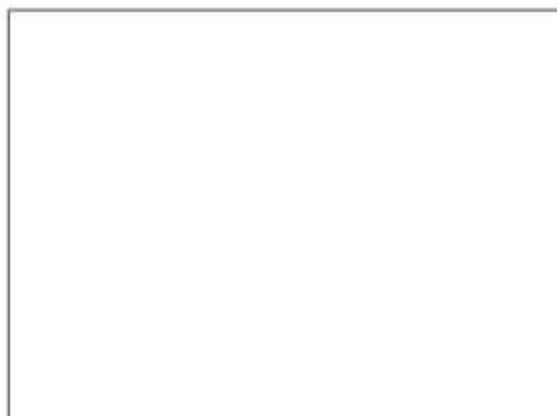


Fig. (i)

This squared paper has no fold. So, no any crease. It represents $2^0 = 1$.

Step 2 : Fold the squared paper into two halves making a vertical crease as shown in fig. (ii). Then, unfold the paper as shown in fig. (iii).

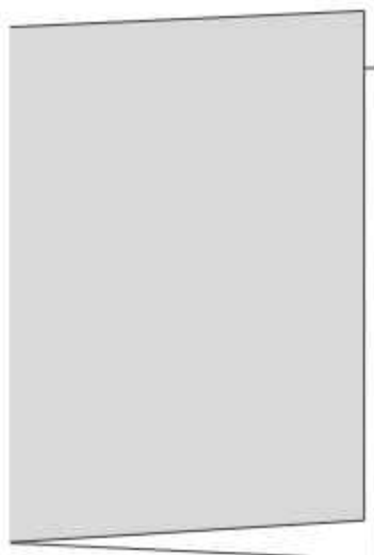


Fig. (ii)

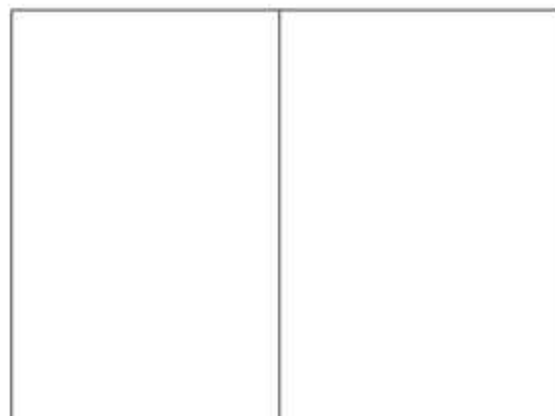


Fig. (iii)

The squared paper has one fold. So, one crease. It represents $2^1 = 2$.

Step 3 : Now, fold the squared paper into two halves making a horizontal crease as shown in fig. (iv)

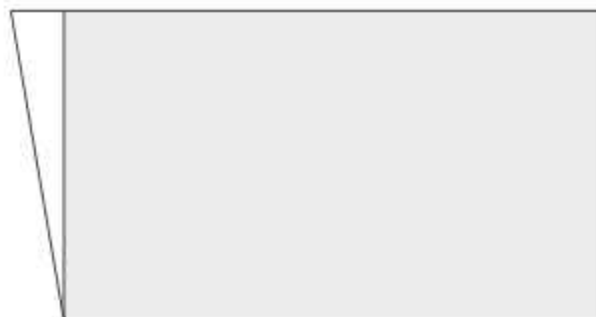


Fig. (iv)





Fig. (v)

The squared paper now has two folds as shown in fig. (v). So, two crease. It represents $2^2 = 4$.

Step 4: In the same manner, make horizontal creases with the help of three folds and vertical creases with the help of four folds as shown in fig. (vi) and fig. (vii) respectively.



Fig. (vi)

In Fig. (vi), number of folds or crease = 3; Number of parts = 8. So, $2^3 = 8$.

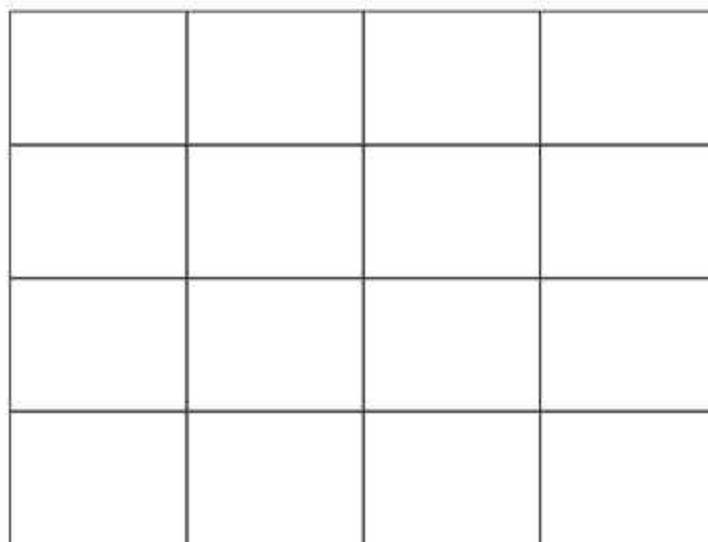


Fig. (vii)

In fig. (vii), number of fold or crease = 4;

Number of parts = 16

So, $2^4 = 16$

Conclusion: We can understand the exponents or powers as

$$2^0 = 1$$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$4^2 = 16 \text{ and so on.}$$

Revision Test Paper-I

(Based on Chapters 1 to 5)

A. Multiple Choice Questions (MCQs).

Tick (✓) the correct option.

- By how much does -4 exceed -11 ?
 (i) -7 ☐ (ii) 7 ☐ (iii) -15 ☐ (iv) -11 ? ☐
- The product of two integers with opposite sign will carry
 (i) $-$ sign ☐ (ii) $+$ sign ☐ (iii) any of these ☐ (iv) the sign of greater number ☐
- The ascending order of $\frac{3}{4}$, $\frac{2}{3}$ and $\frac{1}{2}$ is
 (i) $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}$ ☐ (ii) $\frac{1}{2}, \frac{3}{4}, \frac{2}{3}$ ☐ (iii) $\frac{2}{3}, \frac{3}{4}, \frac{1}{2}$ ☐ (iv) $\frac{3}{4}, \frac{1}{2}, \frac{2}{3}$ ☐
- The fraction equivalent to $\frac{39}{91}$ is
 (i) $\frac{7}{13}$ ☐ (ii) $\frac{13}{7}$ ☐ (iii) $\frac{3}{7}$ ☐ (iv) $\frac{7}{17}$ ☐
- If $\frac{a}{b} > \frac{c}{d}$, then
 (i) $ab > cd$ ☐ (ii) $cd > ab$ ☐ (iii) $ad > bc$ ☐ (iv) $ad < bc$ ☐
- The sum of two rational numbers is 7. If one of the numbers is $\frac{24}{5}$, then the other number is
 (i) $\frac{16}{5}$ ☐ (ii) $\frac{-16}{5}$ ☐ (iii) $\frac{11}{5}$ ☐ (iv) $\frac{-11}{5}$ ☐
- The value of $2 \times 0.2 \times 0.02 \times 0.002$ is equal to
 (i) 16 ☐ (ii) 0.00016 ☐ (iii) 0.016 ☐ (iv) 0.000016 ☐
- 12.015 km is equal to
 (i) 12 km 1500 m ☐ (ii) 12 km 150 m ☐ (iii) 12 km 15 cm ☐ (iv) 12 km 15 m ☐
- $\left(\frac{-5}{7}\right)^{-1}$ is equal to
 (i) $\frac{-5}{7}$ ☐ (ii) $\frac{-7}{5}$ ☐ (iii) $\frac{5}{7}$ ☐ (iv) $\frac{7}{5}$ ☐
- $5^x \times 5^y \div 5^z$ is equal to
 (i) 5^{x+y-z} ☐ (ii) 5^{xy+yz} ☐ (iii) 5^{x+y-z} ☐ (iv) $\frac{5^{x+y}}{5^{-z}}$ ☐

B. Fill in the blanks of the following :

- The sum of two numbers is 5. If one number is $\frac{2}{3}$, then other number is _____.
- To divide a fraction by another fraction, we multiply the dividend by the _____ of divisor.
- A rational number is said to be in its _____ form, if the HCF of its numerator and denominator is 1.
- The standard unit of measuring capacity is _____.
- Zero divided by an integer is always _____.



6. _____ fraction is a combination of whole number and proper fraction.
7. The word 'decimal' comes from Latin word _____ which means tenth part.
8. _____ fraction has numerator less than denominator.
9. Decimals which are non-terminating and non-repeating are called _____.
10. _____ are combined sets of negative numbers and whole numbers.

C. Write 'T' for true statement and 'F' for false statement :

1. Subtraction of 1 from any integer gives its successor. 
2. The set of all fractions is called the set of rational numbers, and is represented by the symbol Q. 
3. A rational number can only be expressed as the terminating decimal. 
4. 21.5×5.4 is same as 0.54×215 . 
5. $(5^3)^4 = 5^7$ 
6. 15 is a rational number. 
7. $\frac{3}{8} + \left(\frac{-7}{8}\right) = -\frac{3}{2}$ 
8. $5 \div 3\frac{4}{7}$ is equal to $\frac{5}{7}$. 
9. When we multiply a decimal by 10, 100, 1000 the decimal points shifts to 2,3,4 places to the right side. 
10. $(3^5 \times 10^5 \times 25) \div (5^7 \times 6^5) = 1$ 



In Class VI, we have learnt about the basic concepts on algebraic expression. A symbol having a fixed numeric value is called a **constant** and a symbol which takes various numerical values is called a **variable**. A combination of constants and variables connected by the signs of addition, subtraction, multiplication and division is called an **algebraic expression**. In this chapter, we shall learn more about algebraic expression its terms, constants, coefficients etc. Then, we shall learn to apply operations on algebraic expressions, linear equations and solve some practical problems using these operations.



Algebraic Expressions

To understand algebraic expression we need to know about constant and variables.

Constant : A quantity having a fixed numeric value is called **constant**. For example : 1, 15, -6, $\frac{7}{11}$, $4\frac{2}{5}$.

Variable : A quantity which can have different numerical values is called **variable** or **literal**. We use small letters a, b, c, p, q, r, m, n, x, y, z ... etc. to denote variables.



Types of Algebraic Expressions

A collection of constants and literals (variables) connected by one or more fundamental operations (+, -, ×, ÷) is called an **algebraic expression**.

In algebraic expression different parts are connected by signs. These parts are called **terms**.

The algebraic expressions containing only one term is called **simple algebraic expression**. While a compound algebraic expression contains two or more than two terms.

Monomial : An algebraic expression containing only one term is called a **monomial**.

Binomial : An algebraic expression containing two terms is called a **binomial**.

Trinomial : An algebraic expression containing three terms is called a **trinomial**.

Polynomial : An algebraic expression containing two or more terms is called a **polynomial**.

Algebraic Expression	No. of Terms	Name	Terms
(a) $7x^2y$	1	Monomial	$7x^2y$
(b) $5x^2 - 7y^2z$	2	Binomial	$5x^2, -7y^2z$
(c) $2x^2 + \frac{3}{x}$	2	Binomial	$2x^2, \frac{3}{x}$
(d) $10x^2y - 3xy^2 + 7$	3	Trinomial	$10x^2y, -3xy^2, 7$
(e) $x^3 + 5x^2 - 9x + 7$	4	Polynomial	$x^3, 5x^2 - 9x$



We must remember that the terms of an algebraic expression do not separate by multiplication and division.

Factors : Each literal or constant quantity multiplied together to form a product is called a **factor** of the product. A constant **factor** is called 'numerical factor' and a factor containing only literals is called a **literal factor**.

In an algebraic expression $-10x^2y$, the numerical factor is -10 and x^2y is the literal factor.

Constant term : The term of an algebraic expression containing no literal factor is called its **constant term**, i.e., in the expression $4x^2 + 5z + 10$, the term 10 is the constant term.

Coefficients : In the literal factor of algebraic expression the numerical part is called the coefficient of the remaining factor of the term.

In particular, the constant part is called the **numerical coefficients** or generally the coefficient of the term and the remaining part is called the **literal coefficient** of the term.

Consider the expression $7x^2 - 5x^2y + 10$. In the term $-5x^2y$:

the literal coefficient $= x^2y$

the numerical coefficient $= -5$

the coefficient of $5y = -x^2$

the coefficient of $x^2 = -5y$

the coefficient of $-5xy = x$



Like and Unlike Terms

The terms containing same literal coefficients with same degree are called **like terms** while the terms containing different literal coefficients are called **unlike terms**.

Example :

- (i) $4xy, -7xy, \frac{5}{2}yx$ are like terms because these terms have same literal coefficient xy .
- (ii) $7m, 3n, 6x, -5y$ are unlike terms because terms have different literal coefficients.
- (iii) $6p^2qr, 11qp^2r, -7qrp^2$ are like terms because terms have same literal coefficient p^2qr .
- (iv) $5xy^2, 9x^2y$ are unlike term because these terms have different literal coefficient xy^2 and x^2y .



Polynomial in One Variables

An algebraic expression having one variable is said to be a **polynomial** in that particular variable, if the power of variable in each term is non-negative integer.

The greatest power of a variable in a polynomial is called its **degree**. For example :

- (i) $8 + 5x$ is a polynomial in x of degree 1.
- (ii) $7y^2 - 3y - \frac{4}{3}$ is a polynomial in y of degree 2.
- (iii) $-10 - 5p - 4p^3$ is a polynomial in p of degree 3.
- (iv) $9x^6 - 8x^3 + 5x - \frac{5}{7}$ is a polynomial in x of degree 6.



Facts to Know

- A polynomial in one variable is called a univariate polynomial, a polynomial in more than one variable is called a multivariate polynomial.



Polynomial in Two or More Variables

An algebraic expression having two or more variables is said to be a polynomial in those variables, if the power of variable in each term is non-negative integer. Take the sum of the powers of variables in each term, the greatest sum is the degree of the polynomial. For example:



- (i) $8 - 10x^2 - 12x^3y^2 - 6x^2y^2$ is a polynomial in two variables x and y . The degree of its terms are 0, 2, 3 + 2, 2 + 2. Therefore, the degree of the polynomial is 5.
- (ii) $9p - 11m^2n - 21n^3p + \frac{1}{4}$ is a polynomial in 3 variables m, n, p , the degree of its terms are 1, 2 + 1, 3 + 1, 0. Therefore, the degree of polynomial is 4.
- (iii) $5x^2 - \frac{6}{x} + 2x^2y + 7$ is not a polynomial. Because the power of variable in second term is a negative integer.

Example 1 : Consider the algebraic expression $9x^3y^2 - 7xy^3 - 5x^2y^2 - \frac{5}{2}$

- (a) What is the total number of terms? List all the term.
 (b) What is the numerical coefficient of the term $-7xy^3$?
 (c) What is the literal coefficient of the term $-5x^2y^2$?
 (d) Is the given expression a polynomial? If so, write its degree.
 (e) What is the coefficient of $7x$ in the term $-7xy^3$?
 (f) What is the coefficient of $-7xy$ in the term $-7xy^3$?

Solution : (a) There are 4 terms : $9x^3y^2, -7xy^3, -5x^2y^2, -\frac{5}{2}$
 (b) The numerical coefficient of the term $-7xy^3$ is -7 .
 (c) The literal coefficient of the term $-5x^2y^2$ is x^2y^2 .
 (d) Given algebraic expression is a polynomial of two variable x and y .
 The degree of its terms are 3+2, 1+3, 2+2, 0. So, the degree of the polynomial is 5.
 (e) The coefficient of $7x$ in the term $-7xy^3$ is $-y^3$.
 (f) The coefficient of $-7xy$ in the term $-7xy^3$ is y^2 .



Exercise 6.1

1. Write the following in algebraic form using variables, constants signs and symbols.

- (a) Meera have ₹ 250 less than me.
 (b) Moyan have ₹ 670 more than her friend.
 (c) Product of numbers a and b subtracted from 100.
 (d) The square of sum of the three consecutive numbers.
 (e) The sum of squares of two consecutive numbers.

2. Identify the terms in each expression and write their numerical factor and literal factor.

- (a) $5x - 6$ (b) $-5x + 8$ (c) $5x^2 - 6x$ (d) $x^2y^2 - 6xy$

3. In the term $15p^3q^4r^5z$, find the coefficient of the following:

- (a) p^3q^4 (b) q^4r^5 (c) p^3r^5 (d) $p^3q^4r^5$

4. Identify terms containing x^2 and give the coefficient of x^2 .

- (a) $4x^2y$ (b) $x^2 + 5y$ (c) $x^2y^2 - 11x$

5. Identify the like terms and unlike terms in the following :

- (a) $ab^2, 6a^2b, 5b^2a, 11ab$ (b) xyz, zyx, zy^2x, zx^2b
 (c) $14a, 17b, 15b, 18bc$ (d) $7x^2y^2z^2, 5y^3z^2x^2, 3xyz, -5xy^2z$



6. Classify the following into monomials, binomials and trinomials.

(a) 21

(b) $5x-4y$

(c) $4x-7x^2+3z$

(d) $x^2+11x^2-8x^2$

7. Identify the constant term of each of the following expression:

(a) $5x^2-11$

(b) ax^2+bx+c

(c) x^2+y^2+4xy

(d) a^2b-ab^2+15

8. Write the literal coefficient of each of the following :

(a) $\frac{7xy}{2}$

(b) $-\frac{3mn^2}{8}$

(c) $\frac{5}{4}xyz^2$

(d) $\frac{5}{9}xyz^2$



Power of a Term

Let m is a literal with different powers such as $m^2, m^3, m^4 \dots m^8$. m^2 is called second power of m , m^3 as the third power of m , m^4 as the fourth power of m and so on. Here, m is called the **base** and 2, 3, 4, 8 are all **exponents** of m . Thus, power is actually the exponent of the base.



Facts to Know

- When variables are multiplied, the powers are added to decide the degree of the term.



Degree of an Expression

The degree of an expression is the highest power of the variable present in the expression. Thus, the degree of expression x^2+5x+7 is 2, the degree of the expression $x^3-5x^2-7x^9+8$ is 9 and that of $x^7+x^{15}+x^{13}+4x-8$ is 16.

The degree of expression $x^2y^2+xy^3+x^2y^4+8xy+9$ is 6 as the highest power of the variable xy is $(2+4)$ i.e., 6.



Evaluation of Algebraic Expressions

An algebraic expression consists of one or more literal numbers. The literal numbers may have numerical value. We evaluate the algebraic expression by putting the numerical value or the literal numbers.

When we use the formulae from geometry algebra or mensuration with the help of literal numbers, we need to find the value of an algebraic expression. For example :

If we denote the length and breadth of a rectangle as l and b then, we express the area of a rectangle by formula as :

$$\text{Area} = l \times b$$

Suppose, length and breadth is given as 6 cm and 4 cm, we can find the area by putting the values of l and b , we get :

$$6 \text{ cm} \times 4 \text{ cm} = 24 \text{ cm}^2$$



This process of replacing the literal numbers in the algebraic expression by their numerical value is called the **substitution**.

Example 11 : Find the value of following expressions by putting the value of $x = 5$:

- (a) $5x + 10$ (b) $6x - 7$ (c) $18 - 6x^2$ (d) $2x^2 - x + 1$

Solution :

(a) $5x + 10 = (5 \times 5) + 10 = 25 + 10 = 35$
 (b) $6x - 7 = (6 \times 5) - 7 = 30 - 7 = 23$
 (c) $18 - 6x^2 = 18 - 6(5)^2 = 18 - 150 = -132$
 (d) $2x^2 - x + 1 = 2(5)^2 - (5) + 1 = 50 - 5 + 1 = 51 - 5 = 46$

Example 12 : Find the value of the following expressions when value of literal numbers are $p = 1, q = -2, r = 3$.

- (a) $p^2 + q^2 - r^2$ (b) $p^2 + (-q)^2 + (-r)^2$
 (c) $p^2q + pq^2 - r^2$ (d) $4pqr$
 (e) $p^2q + qr - rp$ (f) $pq - qr^2 - p^2q$

Solution : For $p = 1, q = -2$ and $r = 3$

(a) $p^2 + q^2 - r^2 = 1^2 + (-2)^2 - (3)^2$
 $= 1 + 4 - 9 = -4$
 (b) $p^2 + (-q)^2 + (-r)^2 = (1)^2 + (+2)^2 + (-3)^2$
 $= 1 + 4 + 9 = 14$
 (c) $p^2q + pq^2 - r^2 = 1^2(-2) + 1(-2)^2 - (3)^2$
 $= -2 + 4 - 9 = -7$
 (d) $4pqr = 4 \times 1 \times (-2) \times 3$
 $= -24$
 (e) $p^2q + qr - rp = 1^2(-2) + (-2)3 - 3 \times 1$
 $= -2 - 6 - 3 = -11$
 (f) $pq - qr^2 - p^2q = 1(-2) - (-2)3^2 - 1^2(-2)$
 $= -2 - (-18) - (-2)$
 $= -2 + 18 + 2 = 18$



Points to Remember

- ❖ A quantity which can have different values is said to be variable or literal.
- ❖ A quantity having a fixed or definite numerical value is called constant.
- ❖ A collection of variables and constants connected by one or more basic operations (+, -, ×, ÷) is called an algebraic expression.
- ❖ A term is a product of factors. These are the parts of an algebraic expression.
- ❖ The term of an algebraic expression containing no literal factors is called constant term.
- ❖ An algebraic expression having one variable is said to be a polynomial in one variable.
- ❖ The degree of an algebraic expression in the highest power of the variable present in the expression.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs)

Tick (✓) the correct options :

- | | | | |
|--|---|--|--------------------------|
| (a) A quantity having a fixed numerical value is called | ☐ (i) variable | ☐ (ii) constant | ☐ |
| | ☐ (iii) term | ☐ (iv) degree | ☐ |
| (b) A variable may have | ☐ (i) only one value | ☐ (ii) only two values | ☐ |
| | ☐ (iii) no values | ☐ (iv) different values | ☐ |
| (c) An algebraic expression different parts are connected by | ☐ (i) addition | ☐ (ii) subtraction | ☐ |
| | ☐ (iii) addition and subtraction | ☐ (iv) None of these | ☐ |
| (d) Which of the following is a monomial ? | ☐ (i) $5x$ | ☐ (ii) $5x + y$ | ☐ |
| | ☐ (iii) $3x + y = 0$ | ☐ (iv) $p + q$ | ☐ |
| (e) A constant factor is also known as : | ☐ (i) coefficient | ☐ (ii) numerical factor | ☐ |
| | ☐ (iii) literal factor | ☐ (iv) all of these | ☐ |
| (f) Coefficient of y in term $-10x^2y$ is : | ☐ (i) x^2 | ☐ (ii) $-10x$ | ☐ |
| | ☐ (iii) $10x^2$ | ☐ (iv) $-10x^2$ | ☐ |
| (g) Polynomial $9y^3 - 4y - \frac{2}{3}$ is in y of degree : | ☐ (i) 2 | ☐ (ii) 3 | ☐ |
| | ☐ (iii) $3 + 1$ | ☐ (iv) $3 + 0$ | ☐ |
| (h) We change the sign of every term of the expression then | ☐ (i) subtract | ☐ (ii) Add | ☐ |
| | ☐ (iii) multiply | ☐ (iv) none of these | ☐ |



2. Write the following in algebraic form using variables, constant, signs and symbols.
 - (a) The sum of 3 consecutive even number is 111.
 - (b) Ranjan has ₹ 1000 more than his friend
 - (c) Tapan has ₹ 90 less than Palak
 - (d) Product of numbers m and n subtracted from 676.
3. Identify the numerical coefficient of terms (other than constants) in each of the following expressions given below:
 - (a) $11 - 10x^2$
 - (b) $p + 9qr + 11q$
 - (c) $8x^2 - 5x$
 - (d) $a^2b^2 - 7ab$
4. Identify the like terms of the following :
 - (a) $pq^2, 3p^2q, 7q^2p, 9pq$
 - (b) abc, cab, x^2yz, x^2yz^2
 - (c) $11a, 111b, 11c, 11b$
 - (d) $5x^2y^2z^2, 9y^2z^2x^2, 7x^2yz, 6zy^2z^2$
5. Write the literal coefficient of each of the following :
 - (a) $\frac{5}{9}xy^2z$
 - (b) $-\frac{1a^2b}{4}$
 - (c) $\frac{3}{4}x^2a^2m^2$
 - (d) $-121x^2y^5$
6. Add the following algebraic expressions by horizontal and column methods.
 - (a) $p^3 - 5p^2q + 7pq^2 - q^3$ and $4p^3 - 7p^2q + 9pq^2 + 2q^3$
 - (b) $x^4 + 5xy^3 - 4x^3y + 8x^2y^2 + 7y^2$ and $-5x^4 - 9xy^3 + 11x^3y - 10x^2y^2 + 9y^2$.
7. Subtract the following by column method.
 - (a) $p^2 + q^2$ from $9p^2 - 10q^2$
 - (b) $x^2 - 7xy$ from $5x^2 - 10xy$
8. How much is $m^3 - 2m^2 + m + 9$ greater than $3m^3 + 5m^2 - 6m + 7$?
9. If $x = 3, y = 2$, find the value of each of the following.
 - (a) $x^2 + y$
 - (b) $x^2 - xy + y^2$
 - (c) $7(5x + 4) - 5(2 - 5x)$
 - (d) $3x^3 - 7(5x - 4)$
10. If $m = 7$, find the value of $m^3 - 7(m - 5)$.
11. Length and breadth of a rectangle is m and n respectively. Find its area and perimeter.



**H
O
T**

The perimeter of a triangle is $14x^2 + 20x + 13$. Two of its sides are $3x^2 + 5x + 1$ and $x^2 + 10x - 6$. Find its third side.



Lab Activity

Objective

: To evaluate an algebraic expression for different values by the activity method.

Materials Required

: White chart paper, coloured chart paper, a pair of scissors, sketch pen, gum.

Procedure : Let us try to evaluate $3y + 2$ for $y = 1$, $y = 2$ and $y = 3$

Follow these steps :

Step 1: We cut out 24 strips, each of $1 \text{ cm} \times 1 \text{ cm}$, from coloured chart paper.

Step 2: Draw a $12 \text{ cm} \times 12 \text{ cm}$ grid on a white chart paper.

Step 3: Let $y = 1$. So, paste 3 strips on the grid and colour 2 unit boxes (since the constant term is 2) using sketch pen as shown in Fig. (ii) (case 1.)

Step 4: Let $y = 2$. So, take 2 strips at a time and paste 2 sets of 3 strips on the grid and colour 2 unit boxes as shown in Fig. (ii) (case 2).

Step 5: Let $y = 3$. So, take 3 strips at a time and paste 3 sets of 3 strips on the grid and colour 2 unit boxes as shown on the grid as shown in Fig. (ii) (case 3).

Step 6: Count the number of coloured boxes in each case. You will find the value of $3y + 2$ for different value of y .

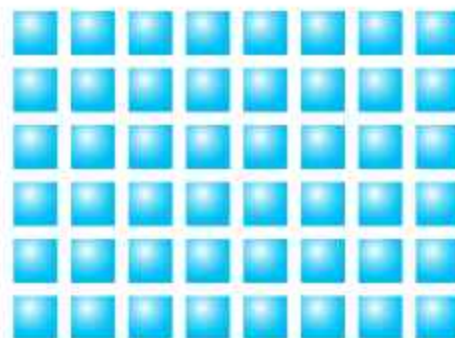


Fig. (i)

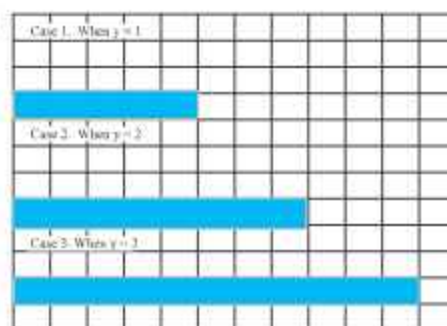


Fig. (ii)

Conclusion :

When $y = 1$, then

$$3y + 2 = 3 \times 1 + 2$$

$$= 5$$

When $y = 2$, then

$$3y + 2 = 3 \times 2 + 2$$

$$= 8$$

When $y = 3$, then

$$3y + 2 = 3 \times 3 + 2 = 11$$

You are well aware of algebraic expressions. You know that any algebraic expression has some terms. These terms have **constants** and **variables**. Now, let us move further. Assume that we have a situation. We want to multiply a variable with 100 and then we have to add 20 to that result.

Or, we can write:

$$100x + 20$$

This is an algebraic expression (you have read these in chapter 6). We are dealing with algebraic expressions that have only one variable.

Read another example: $\frac{4}{3}x + 36$

Here, $\frac{4}{3}$ and 36 are constants. The variable x can be given any value of a real number.

Therefore, algebraic expressions in one variable may have one or more terms. They have only one variable which shows certain conditions of scientific, commercial or mathematical nature. We have read about algebraic expressions in the previous class.



Equation

Let us consider the following situations.

Example : 6 subtracted from one third of y gives 5.

This can be written as :

$$\frac{1}{3}y - 6 = 5 \quad \dots\dots\dots (i)$$

Example : p multiplied by itself is 6 less than 5 times the number q .

This can be written as :

$$p^2 = 5q - 6 \quad \dots\dots\dots (ii)$$

Example : 7 added to double of m gives 10.

This can be written as :

$$2m + 7 = 10 \quad \dots\dots\dots (iii)$$

Example : The sum of number x and twice the number y is 20.

This can be written as:

$$x + 2y = 20 \quad \dots\dots\dots (iv)$$

Don't you think that the expressions shown in (i), (ii), (iii) and (iv) are different from the ones that we had studied in class VI? Yes, they have the equality sign. Moreover, there are a few terms (at least one) on the right side of equality.

They all are equations.

Definition of Equation

A statement of equality that involves some variables is called **equation**. We can also call it **algebraic equation**.

Examples :

$$\begin{aligned} 4x^2 + 30 &= 7 \\ 4x + 3 &= 7 \\ 2pqr &= 7q + 5p \\ 8 + (4x + 3y) &= 120 \end{aligned}$$



Linear Equation

It is an equation in which the maximum power of a variable is 1. Have a look at the given examples :

- (a) $7x^2 + 8x = 18$
- (b) $15y^3 + 36 = 112$
- (c) $7q + 88 = 0$

Out of these three examples only equation (c) has a variable q , whose power is 1. So, it is a **linear equation**. Other two are not linear equations.

Further, note that if the variables are more than, each one have to be considered independently to judge whether the algebraic expression is a linear equation or not.

Example : $6x + 9y = 15z - 4y$

The power of x , y and z is 1 each. So, it is also a linear equation, even if the number of different variables is 3.



Facts to Know

- The value of any number or radical with exponent 0 is always 1. Example : $x^0 = 1$

Linear Equation in One Variable

It is an equation, which has :

- (a) the equality sign;
- (b) a single variable; and
- (c) only one as power (1) of that variable.

These equations are also called **simple equation**.

Example :

$$\begin{aligned} 25 &= 18x + 7x \\ 14y - 7 &= 0 \\ 6z + 3z - 81 &= 0 \\ 15p + 36 &= 12p \end{aligned}$$

These all are linear equations in one variable.

Example : $6x^2 + 7x + 6 = 0$

This is not a linear equation because its highest power is not 1.

Example : $5x^2 + 6y^2 = 118$

This is not a linear equation, as it has two variables and the maximum power of each variable is 2.



Facts to Know

- The general equation of a linear equation in one variable is : $ax + b = 0$, $a \neq 0$.

Example 1 : Write the following statements in the form of equations:

- (a) Subtract 18 from 9 times a number r and you get 18.
- (b) One sixth of p is subtracted from 35 and the result is -1 .
- (c) Add 100 to a and divide it by 4 to get 25.
- (d) The sum of three times y is added to 8 and we get 38.

Solution :

$$\begin{aligned} \text{(a) 9 times a number } r &= 9r \\ \text{Subtract 18 from } 9r &= 9r - 18 \end{aligned}$$



So, $9r - 18 = 18$

(b) One sixth of p $= \frac{p}{6}$

Subtracted from 35 $= 35 - \frac{p}{6}$

So, $35 - \frac{p}{6} = -1$

(c) Add 100 to a $= a + 100$

Divide it by 4 $= \frac{a+100}{4}$

So, $\frac{a+100}{4} = 25$

(d) Three times y $= 3y$

$3y$ added to 8 $= 3y + 8$

So, $3y + 8 = 38$



Facts to Know

- The inequalities $>$ (greater than) and $<$ (less than), are not used to form equations.

Example : $6x + 17 > 0$ (Not an equation)

$15x + 28 = 0$ (Equation)

$22r + 65 < 0$ (Not an equation)

Example 2 : Write the following statements in the equation form:

(a) Six added to one fourth of a number n gives 101.

(b) 5 added to 7 times y gives 102.

(c) 25 subtracted from y is 60.

Solution : (a) One fourth of n $= \frac{n}{4}$
Add six to $\frac{n}{4}$ $= \frac{n}{4} + 6$

So, $\frac{n}{4} + 6 = 101$

(b) Seven times y $= 7y$

Add 5 to $7y$ $= 7y + 5$

So, $7y + 5 = 102$

(c) Subtract 25 from y $= y - 25$

So, $y - 25 = 60$

Example 3 : Check whether the value given in the brackets satisfies the given equation :

(a) $4m - 3 = 9$ ($m = 6$)

(b) $5r + 3 = 13$ ($r = 2$)

(c) $10x + 25 = 135$ ($x = 11$)

(d) $19a + a + 1 = 21$ ($a = 3$)



Solution : (a) For $m = 6$

$$\begin{aligned}\text{LHS} &= 4m - 3 \\ &= (4 \times 6) - 3 \\ &= 24 - 3 \\ &= 21 \\ \text{RHS} &= 9 \\ \text{LHS} &\neq \text{RHS} \\ \text{So, } m &= 6 \text{ does not satisfy the equation.}\end{aligned}$$

(b) For $r = 2$

$$\begin{aligned}\text{LHS} &= 5r + 3 \\ &= (5 \times 2) + 3 \\ &= 10 + 3 \\ &= 13 \\ \text{RHS} &= 13 \\ \text{LHS} &= \text{RHS} \\ \text{Hence, } r &= 2 \text{ satisfies the equation.}\end{aligned}$$

(c) For $x = 11$

$$\begin{aligned}\text{LHS} &= 10x + 25 \\ &= 10 \times 11 + 25 \\ &= 110 + 25 \\ &= 135 \\ \text{RHS} &= 135 \\ \text{LHS} &= \text{RHS} \\ \text{So, } x &= 11 \text{ satisfies the equation.}\end{aligned}$$

(d) For $a = 3$

$$\begin{aligned}\text{LHS} &= 19a + a + 1 \\ &= (19a + a) + 1 \\ &= 20a + 1 \\ &= (20 \times 3) + 1 \\ &= 60 + 1 = 61 \\ \text{RHS} &= 21 \\ \text{LHS} &\neq \text{RHS} \\ \text{Hence, } a &= 3 \text{ does not satisfy the equation.}\end{aligned}$$

Example 4 : In a test, the highest marks obtained by a student is four times the lowest marks plus 23. The highest score is 120. Form an equation in one variable with the help of this data.

Solution : Let lowest marks obtained by student = x

$$\begin{aligned}\text{4 times lowest marks} &= 4x \\ \text{Add 23} &= 4x + 23\end{aligned}$$

As per the statement, the term $4x + 23$ is equal to the highest score.

$$\Rightarrow 4x + 23 = 120$$

Exercise 7.1

1. Write the following equations in the statement form :

(a) $6m + 32 = 62$

(b) $\frac{7}{8}x + 31 = 120$

(c) $\frac{t}{2} - 10 = 103$

(d) $5/ = 125$

(e) $d - 30 = -20$

(f) $5a + 35 = 0$

(g) $\frac{x}{3} - 4 = 4$

(h) $\frac{15}{16}q = 225$

2. Form equations with the help of the following statements :

- (a) In an isosceles triangle, the base angles are equal. The vertex angle is twice of the base angle. Form an equation for the sum of all angles. (Take base angle as p).
- (b) A number is multiplied by 80. When 60 is added to it, the result becomes 365. Assuming the variable as t form an equation with zero 0 on RHS of equality.
- (c) A number is taken. Its $\frac{1}{200}$ value is obtained. When 40 is added to it the result is 1000. Form an equation with the help of this data. Assume the variable on your own.
- (d) Three times of a number reduced by 100 gives 330.
- (e) Suzen's father is thrice as old as Suzen. After 12 years, he will be twice as old as his daughter. Make an equation with the help of this data. The present age of Suzen is h years.

3. Check if the given values are the solutions of the respective equations:

Equation	Value	Status	
		Solution - (ü)	Not a Solution (û)
(a) $2(a + 5) = 8$	$a = -1$		
(b) $3r - 2 = 13$	$r = 5$		
(c) $25x = 625$	$x = 26$		
(d) $\frac{17}{t} - 1 = 16$	$t = \frac{1}{2}$		

4. Answer the following questions in yes or no :

- (a) Is equation $x - 3 = 2$ the same as equation $2 = 3 - x$?
- (b) Is $\frac{5x}{60} = 12x$?
- (c) Do we get the same value of r from $36r = 180$ and $\frac{r}{36} = \frac{1}{180}$?



Solution of Linear Equation in One Variable

The solution of an algebraic equation is also known as **root** of the equation. The root of an algebraic equation is the value of the variable that satisfies the equation.

We can start from a simple example.

$$\text{Let } x + 19 = 20 \quad \dots\dots\dots (i)$$

$$\Rightarrow x = 20 - 19 = 1$$

If we put $x = 1$ in equation (i)

We get :

$$\begin{aligned} \text{L.H.S.} &= x + 19 \\ &= 1 + 19 = 20 = \text{R.H.S.} \end{aligned}$$

Hence $x = 1$ is the solution or root of the equation given to us. We solved it with the help of the method of transposition.



Method of Solving Linear Equations in One Variable

Hit and Trial Method

In this method, we guess a number which may satisfy the given equation.

Example 5 : If $6t = 96$, find the value of t .

Solution : We think of a number in place of t , so that its multiplication with 6 gives us 96. The guesswork starts as per your convenience. You can start from $t = 2$ also. But it would take long time that way. So, start from $t = 11$.

$$6 \times 11 = 66$$

$$6 \times 12 = 72$$

$$6 \times 13 = 78$$

and so on

$$6 \times 16 = 96$$

$$\text{So, } t = 16$$

This method is no longer followed.

Transposition

It is the most commonly used method for solving linear equations. The meaning of 'transpose' is to "change the side of the number". When we do transposing, the following changes are to be made.

- (a) $-$ becomes $+$ on changing the side.
- (b) $+$ becomes $-$ on changing the side.
- (c) $\div$ becomes $\times$ on changing the side.
- (d) $\times$ becomes $\div$ on changing the side.

Example 6 : Solve by transposition.

$$\frac{x}{2} - 5 = 2$$

Solution : Let us take -5 to RHS of equality. Thus we have :

$$\frac{x}{2} = 2 - (-5) \quad (-5 \text{ is subtracted})$$

$$\Rightarrow \frac{x}{2} = 2 + 5 = 7$$

Now let us take 2 to the other side of equality,

$$x = 7 \times 2 \quad (2 \text{ is multiplied})$$

$$\Rightarrow x = 14 \text{ is the solution.}$$



Facts to Know

- "Changing the side" means we are going to either side of the equality sign. Left to right or right to left.

Verification :

We have

$$\frac{x}{2} - 5 = 2 \quad \dots\dots\dots (i)$$

Put $x = 14$ in equation (i), we get

$$\text{LHS} = \frac{14}{2} - 5$$

$$= 7 - 5$$

$$= 2 = \text{RHS, which is true.}$$

Hence, $x = 14$ is the solution of the equation $\frac{x}{2} - 5 = 2$.



Facts to Know

- Once a term is transferred from RHS of equation to its LHS, it is no longer in RHS.

Balancing an Equation

In this method, we use the concept that LHS and RHS of an algebraic equation are always equal to each other. If LHS seems to be light (less) than RHS, it means some weight must be added to it (in the unknown variable) to balance both sides.

The rules to be followed in this method are as follows :

- The same quantity can be added to both the sides of an equation without changing the equality.
- The same quantity can be subtracted from both the sides of an equation without changing the equality.
- The same quantity can be multiplied to both sides of an equation without changing the equality.
- Both sides of an equation can be divided by the same quantity without changing the equality.

Example 7 : Solve the following equation with the method of balancing the equation : $\frac{(x+1)}{3} = 2$

Solution : We have to eliminate 1 and 3 from LHS in this equation. First of all, let us remove 3 from LHS.

Multiplying both sides by 3, we get:

$$\frac{(x+1)}{3} \times 3 = 2 \times 3$$

$$\Rightarrow (x+1) = 2 \times 3$$

$$\Rightarrow x+1 = 6$$

Now subtract 1 from LHS. Naturally, we have to subtract 1 from RHS as well. We get,

$$x+1-1 = 6-1$$

$$\Rightarrow x = 5$$

Hence, $x = 5$ is the solution of the given equation.

If the method to be used to solve an equation is not mentioned, you can use any one of the three methods explained in this chapter.





Exercise 7.2

- Three times a certain number increased by 26 gives 227. Find out the number.
- The difference of two angles of a triangle is 39.8° . The sum of the same angles equals 89.2° . Find the measure of all angles of this triangle.
- Seema's age is two third of Reema's age. If 7 years from now, Reema will be 6 years older than Seema, what is the present age of Seema and Reema?
- Abraham has five times money as that of Jonathan. After giving ₹ 25 to Jonathan, Abraham has double the money Jonathan has now. How much money did Abraham have in the beginning?
- The denominator of a common fraction exceeds the numerator by 10. If 8 is added to the numerator and denominator the new fraction obtained is $\frac{5}{6}$. Find the original fraction.
- Some equations have been given below. Check whether the value given in the brackets is a solution for the equation or not :
 - $4m - 3 = 8$ ($m = 3$)
 - $2x + 18 = 38$ ($x = 11$)
 - $3x + 10 = \frac{10}{7}$ ($x = \frac{-20}{7}$)
 - $\frac{12y + 12}{12} = 1$ ($y = 0$)
- Write the following equations in the statement form :
 - $6x = 139$
 - $\frac{17x + 21}{121} = 87$
 - $5r - 108 = 12$
 - $\frac{l}{8} - 25 = 75$
 - $87p + 100 = 13$
 - $\left(\frac{a}{6} + 7\right) 3 = 3$
- Solve for x : $x - 5 = 3$. Verify your answer also.
- Solve for x : $\frac{2x}{3} - \frac{x}{6} = \frac{1}{2}$. Verify your answer also.
- Find the value of z by the method of balancing the equation.
 $\frac{2}{3}(z - 4) = 6$
- Solve for p . Verify the solution also.
 $\frac{p - 5}{10} - \frac{2(p - 3)}{5} = \frac{3(p - 4)}{15}$
- The sum of three consecutive numbers is 54. Find out the numbers.
- Fill in the blanks :
 - An equation having only one variable and only one power of that variable is called a _____ equation.
 - When a term is transposed to the either side of the equality sign, its sign is _____.
 - If the double of a number is 106, the number is _____.
 - If _____ = 3, then the value of x is _____.

Points to Remember

- ❖ An **equation** is a statement of equality involving variables and constants. The equality sign is a must in every algebraic equations.
- ❖ Equations contain algebraic expressions.
- ❖ A **linear equation in one variable** is an equation in which only one variable is used and the maximum power of the variable is 1.
- ❖ The value of the variable that satisfies the equation is called **solution of the equation**. A linear equation in one variable has only one solution.
- ❖ We can solve linear equations through three methods — hit and trial, transposition and balancing the equation.
- ❖ In the method of transposition, the terms can be taken to either side of the equality sign. If we do so, + becomes –, – becomes +, $\times$ becomes $\div$ and $\div$ become $\times$. The terms are processed according to their new signs in the method of transposition.
- ❖ In the method of balancing the equation, some process is done on both of the equality sign.
- ❖ After calculating the value of the unknown variable, we must verify the solution by putting the value of variable in the equation designed by us (or in the one given to us). The verification of answer is a must in all questions involving linear equations.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options.

- (a) $x, y, z, p, q, r, \dots$ etc are called _____ in algebraic equations.
- | | |
|---|---|
| ☐ (i) constants | ☐ (ii) powers |
| ☐ (iii) radicals | ☐ (iv) None of these |
- (b) All linear equations have the variables whose power is
- | | |
|------------------------------------|---|
| ☐ (i) two | ☐ (ii) three |
| ☐ (iii) one | ☐ (iv) cannot be determined. |
- (c) In an isosceles triangle, the base angles are equal. The vertex angle is 40° . What is the measure of base angles?
- | | |
|---|--|
| ☐ (i) 40° | ☐ (ii) 80° |
| ☐ (iii) 60° | ☐ (iv) 70° |
- (d) In the method of balancing the equation, if we divide LHS by 21, what we would do the following on RHS?
- | | |
|---|--|
| ☐ (i) Multiply RHS by 21 | ☐ (ii) Divide RHS by 42 |
| ☐ (iii) Divide RHS by 21 | ☐ (iv) Any one of these |
- (e) The difference of two angles of a triangle is 21° . The sum of these angles is 105° . The angles have the following measure :
- | | |
|---|--|
| ☐ (i) $53^\circ, 50^\circ, 77^\circ$ | ☐ (ii) $60^\circ, 60^\circ, 60^\circ$ |
| ☐ (iii) $42^\circ, 63^\circ, 75^\circ$ | ☐ (iv) None of these |





(f) In the process of the verification of solution, which of the following is essentially true.

(i) RHS is non-zero

☐ (ii) LHS is non-zero

(iii) $LHS \neq RHS$

☐ (iv) $LHS = RHS$

(g) A is 3 years elder to B. Five years ago, three fifth of A's age was equal to three fourth of the age of B. What is the age (in years) of A and B now?

(i) A – 17, B – 20

☐ (ii) A – 20, B – 17

(iii) A – 28, B – 25

☐ (iv) A – 25, B – 28

(h) The number 80 is to be divided in such a manner that the bigger part is four times the smaller one. The numbers are :

(i) 60, 20

☐ (ii) 68, 17

(iii) 64, 16

☐ (iv) 60, 20

(i) The sum of three consecutive natural numbers is 75. The numbers are :

(i) 18, 19, 20

☐ (ii) 23, 24, 25

(iii) 24, 25, 26

☐ (iv) 25, 26, 27

(j) In the algebraic equation $\frac{s}{3} = 5$ the value of s is :

(i) 6

☐ (ii) 12

(iii) 18

☐ (iv) 15

2. Write the following equations in the statement form :

(a) $7p + 111 = 201$

(b) $-12 = 20$

(c) $5x + 10 = 15$

(d) $\left(\frac{x+7}{3}\right) + 2 = 10$

3. Solve for x :

(a) $\frac{x-1}{3} + \frac{x+1}{2} + \frac{x+7}{2} = 1$

(b) $0.6x = 34 - 0.4x + 14$

(c) $\frac{x-2}{x+1} = \frac{3}{4}$

(d) $\frac{3(x-4)}{15} = \frac{x-5}{10} - \frac{2(x-3)}{5}$

(e) $\frac{2x}{3} - \frac{x}{6} = \frac{1}{2}$

4. Romi's father is 49 years of age. Her father is 24 years older than her. What is the present age of Romi?

5. Rashmi thinks of a number. If she takes away 7 from $\frac{5}{2}$ of that number she gets 8. What is the original number ?

6. Construct three linear equations with the following equations :

(a) $p = -\frac{11}{2}$

(b) $7x = 18$

(c) $14y = 84$

(d) $72 / + 11 = 102$

7. When you multiply a number by 6 and subtract 5 from the product, you get 7. What is the number ?

8. Find the two numbers whose difference is 18 and the ratio of the larger number to smaller one is 5 : 4.

9. Think of a number. Add 13 to it and divide the sum by 5. You get 6. What is the number ?

10. Think of a variable. Now, multiply it by 2 and deduct 17 from it. This difference is multiplied by 6 and the result is 126. What is the value of the variable?



If one side of a square is represented by $4X - 7$ and the adjacent side is represented by $3X + 5$. Find the value of X .



Objective : To understand simple linear equation.

Materials Required : Coloured pen.

Procedure :

In the chart given below, fill up the right-most column with the explanation of what is happening in the middle column. Do not miss any column.

S.N	Algebraic Process	What is Happening
1.	$\frac{19x - 50}{18} = 50$	
2.	$\frac{19x - 50}{18} \times 18 = 50 \times 18$	
3.	$19x - 50 = 50 \times 18$	
4.	$19x - 50 = 900$	
5.	$19x - 50 + 50 = 900 + 50$	
6.	$19x - 900 + 50$	
7.	$19x = 950$	
8.	$19x \times \frac{1}{19} = 950 \times \frac{1}{19}$	
9.	$x = \frac{950}{19}$	
10.	$x = 50$	





8 Percentage and its Applications

We come across various situations in our day-to-day life where the concept of percentage is used. See these examples:

- (i) Alisha scored 85 per cent marks in class VI.
- (ii) Bank gives 3.5 per cent interest on saving bank accounts.
- (iii) Bata has announced 50 per cent off during festive season.
- (iv) More than 30 per cent population of India fall below the poverty line.
- (v) The government allocates 3 per cent of GDP to education sector.

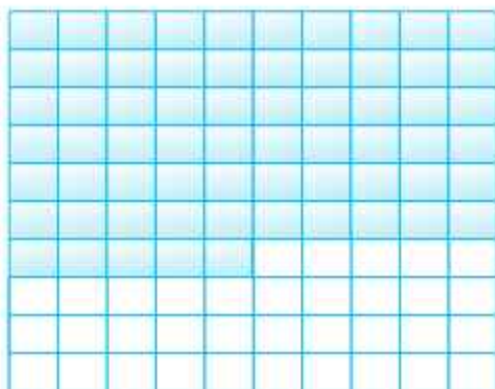
The common term in above statements is **per cent**. In this chapter, we shall discuss about percentage, percentage as a fraction and also as a ratio. We shall also learn conversion of fractions and decimals into percentage and vice-versa. Other than this, we shall work on the applications of percentage in problems related with profit and loss and simple interest.



Percentage

The word 'per cent' is taken from the Latin term 'per centum'. Per means out of and centum means one hundred. So, per cent means 'out of hundred'. The symbol used to denote per cent is '%'. Percentages are the fractions whose denominators are equal to 100. Per cent is used for comparison. When we say 70% students got A grade, it means out of 100 students 70 got A grade.

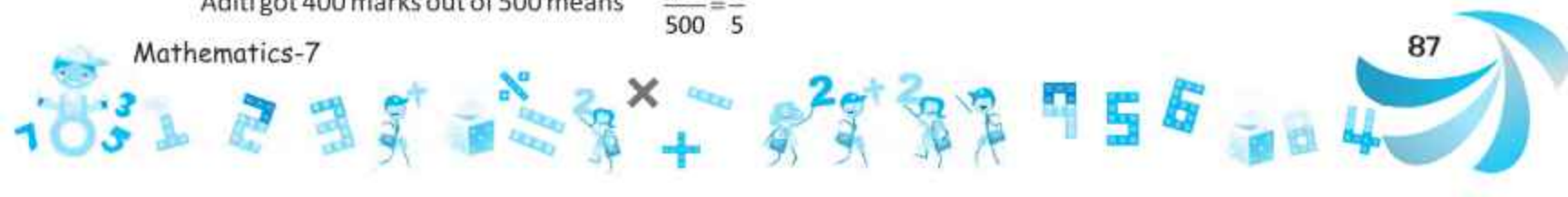
Let us consider a square divided into 100 equal parts, out of which 65 small squares are shaded. The shaded part comprises 65 out of 100, i.e. 65 per cent or 65%.



Let us understand the concept of percentage through an example. Adyant and Aditi showed their report card to their parents. Adyant got 450 marks out of 600 while Aditi got 400 out of 500. Adyant claimed that he deserved a reward as he had secured more marks than Aditi. Do you agree? Perhaps, no. Just by comparing the marks secured by each one can't reach at judgement, as the maximum marks out of which they got marks, are different.

Adyant got 450 marks out of 600 means $\frac{450}{600} = \frac{3}{4}$

Aditi got 400 marks out of 500 means $\frac{400}{500} = \frac{4}{5}$



Now, we have to compare the two ratios or two fractions,

$$3:4 \text{ and } 4:5 \text{ or } \frac{3}{4} \text{ and } \frac{4}{5}$$

Let us convert both the fractions with common denominator 100.

$$\frac{3}{4} = \frac{3 \times 25}{4 \times 25} = \frac{75}{100} = 75\%$$

$$\frac{4}{5} = \frac{4 \times 20}{5 \times 20} = \frac{80}{100} = 80\%$$

Hence, Aditi's performance is better than Adyant because she secured 80%, whereas Adyant secured 75%.



Facts to Know

- The word "percentage" is often a misnomer in the context of sports statistics, when the referenced number is expressed as a decimal proportion, not a percentage. The winning percentage of a team that has 500 winning percentage has won 50% of their matches.



Converting Fractions, Ratios and Decimals into Percentage

1. To convert a fraction into per cent

When a fraction is to be converted into percent, we multiply the fraction by 100 and then attach % symbol.

Example 1 : Convert the following fractions into per cent :

(a) $\frac{3}{5}$

(b) $4\frac{3}{4}$

(c) $\frac{18}{25}$

(d) $\frac{1}{50}$

Solution : (a) $\frac{3}{5} = \frac{3}{5} \times 100 = 60\%$

(b) $4\frac{3}{4} = \frac{19}{4} \times 100 = 475\%$

(c) $\frac{18}{25} = \frac{18}{25} \times 100 = 72\%$

(d) $\frac{1}{50} = \frac{1}{50} \times 100 = 2\%$

2. To convert a ratio into per cent

To convert a ratio into per cent, first write the ratio as fraction, and then multiply it by 100 and attach % symbol.

Example 2 : Express the following ratios as per cent :

(a) 5:8

(b) 3:8

(c) 2:5

(d) 1:10

Solution : (a) $5:8 = \frac{5}{8} \times 100 = 62.5\%$

(b) $3:8 = \frac{3}{8} \times 100 = 37.5\%$

(c) $2:5 = \frac{2}{5} \times 100 = 40\%$

(d) $1:10 = \frac{1}{10} \times 100 = 10\%$



3. To convert a decimal into per cent

To convert a decimal into per cent, multiply it by 100 and attach % symbol or move the decimal point two places to the right and attach % symbol.

Example 3 : Express the following decimals as per cent :

- (a) 2.75 (b) 0.0312 (c) 125.1 (d) 11.011

Solution :

(a) $2.75 = 2.75 \times 100 = 275\%$
(b) $0.0312 = 0.0312 \times 100 = 3.12\%$
(c) $125.1 = 125.1 \times 100 = 12510\%$
(d) $11.011 = 11.011 \times 100 = 1101.1\%$



Converting Percentage into Fractions, Ratios and Decimals

1. To convert a per cent into fraction

To convert a per cent into fraction, divide the number by 100 and drop % symbol. Express the fraction in its simplest form.

Example 4 : Express the following per cent into fraction :

- (a) 75% (b) 48% (c) 4% (d) 175%

Solution :

(a) $75\% = \frac{75}{100} = \frac{3}{4}$
(b) $48\% = \frac{48}{100} = \frac{12}{25}$
(c) $4\% = \frac{4}{100} = \frac{1}{25}$
(d) $175\% = \frac{175}{100} = \frac{7}{4} = 1\frac{3}{4}$

2. To convert a per cent into ratio

To convert a per cent into ratio, divide it by 100 and drop % symbol. Express the obtained fraction as ratio in its simplest form.

Example 5 : Express the following per cent into ratio :

- (a) 32% (b) 12% (c) 75% (d) 325%

Solution :

(a) $32\% = \frac{32}{100} = \frac{8}{25} = 8:25$
(b) $12\% = \frac{12}{100} = \frac{3}{25} = 3:25$
(c) $75\% = \frac{75}{100} = \frac{3}{4} = 3:4$
(d) $325\% = \frac{325}{100} = \frac{13}{4} = 13:4$

3. To convert a per cent into decimal

To convert a per cent into decimal, divide the number by 100 and drop % symbol or shift the decimal point by two places to the left and drop % symbol.

Example 6 : Express the following per cent into decimals :

- (a) 0.015% (b) 0.25% (c) 7.6% (d) 10.5%

Solution : (a) $0.015\% = \frac{0.015}{100} = 0.00015$

(b) $0.25\% = \frac{0.25}{100} = 0.0025$

(c) $76\% = \frac{76}{100} = 0.76$

(d) $10.5\% = \frac{10.5}{100} = 0.105$



To Find Percentage of a Number

To find the percentage (say $x\%$) of a number (say y), we multiply y by $\frac{x}{100}$, i.e.

$$x\% \text{ of } y = \frac{x}{100} \times y$$

Example 7 : Find the value of the following.

- (a) 80% of ₹ 120 (b) 25% of 6l (c) 12.5% of 400 (d) 50% of 210 km

Solution :

(a) $80\% \text{ of ₹ } 120 = \frac{80}{100} \times 120 = ₹ 96$

(b) $25\% \text{ of } 6l = \frac{25}{100} \times 6 = 1.5l$

(c) $12.5\% \text{ of } 400 = \frac{12.5}{100} \times 400 = 50$

(d) $50\% \text{ of } 210\text{km} = \frac{50}{100} \times 210 = 105 \text{ km}$

Example 8 : Vasu secured 360 marks out of 600 in the half yearly examination. Find the per cent score.

Solution : Let the percent score = x

According to the question,

$$x\% \text{ of } 600 = 360$$

$$\frac{x}{100} \times 600 = 360$$

$$x = \frac{360 \times 100}{600} = 60$$

Hence, Vasu secured 60% marks in the half yearly examination.

Example 9 : The price of commodity rises by 25%. How much per cent should a man reduce his consumption of the commodity so that his expenditure remains same?

Solution : Assume the man bought 100 units of commodity for ₹ 100

Increase in price = 25%

∴ Cost of 100 units after increase = $100 + 25 = ₹ 125$

Now, for ₹ 125, the quantity of commodity purchased is 100 units but the amount to be spent on commodity is only ₹ 100



$$\therefore \text{Quantity of commodity that will be bought for ₹ 100} = \frac{100}{125} \times 100 = 80 \text{ units}$$

Hence, consumption of commodity is to be reduced by $= 100 - 80 = 20\%$

Example 10 : In an election contested by Sania and Mahi. Sania got 48% of the votes cast. If the total number of votes cast is 60,000, find the votes obtained by Mahi.

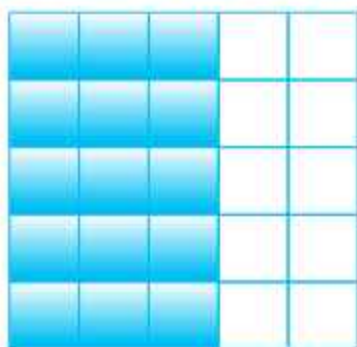
Solution : Votes obtained by Sania $= 48\%$ of 60,000
 $= 28,800$
 $\therefore$ Votes obtained by Mahi $= 60,000 - 28,800$
 $= 31,200$
 $\therefore$ Hence, votes obtained by Mahi $= 31,200$



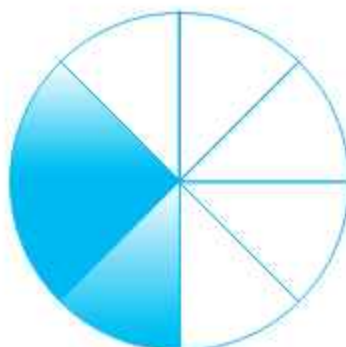
Exercise 8.1

1. Find the percentage of shaded portion of each figure:

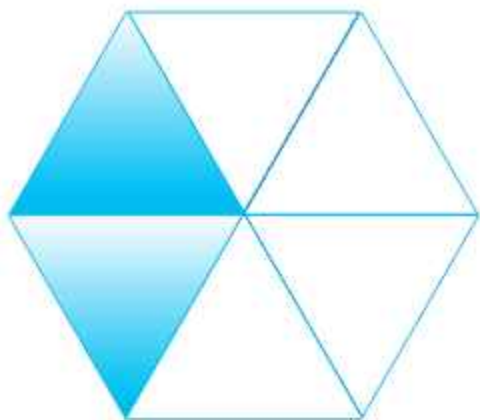
(a)



(b)



(c)



(d)



2. Express the following fractions as percentages:

(a) $\frac{1}{8}$

(b) $\frac{6}{25}$

(c) $2\frac{3}{4}$

(d) $2\frac{2}{5}$

3. Express the following ratios as per cent:

(a) 1:4

(b) 12:5

(c) 5:4

(d) 11:5

4. Express the following decimals as per cent:

(a) 0.16

(b) 1.25

(c) 0.625

(d) 265.25

5. Express the following per cent as fraction:

(a) 36%

(b) 125%

(c) 12.5%

(d) 8%



6. Express the following per cent as ratios in the simplest form :

- (a) 1.6% (b) 65% (c) $37\frac{1}{2}\%$ (d) 10.5%

7. Express the following per cents as decimals:

- (a) 18% (b) 22.5% (c) 225% (d) 1.123%

8. Find the value of the following :

- (a) 40% of 25l (b) 8.5% of ₹ 75,000 (c) 60% of 500 kg

- (d) $37\frac{1}{2}\%$ of 200 km (e) 6% of 1 hr (f) 15% of 90

9. Find the whole quantity if

- (a) 15% is 75 (b) 125% is 600 (c) 5% is 12 (d) 2.5% is 7

10. Avantika travelled 25 km by bus and 50 km by train. What per cent of the total journey did she travel by bus?

11. In a society 54% are adult, 26% children and the rest are old. If there are 26000 children, find the number of old in the society.

12. Mahesh scored 375 marks out of 400 and Naaz scored 450 marks out of 500. Who performed better?

13. A candidate must get 40% to pass in an examination. Pinky gets 250 marks and fails by 70 marks. Find the maximum marks.

14. In an examination, 85% of the candidates passed and 60 candidates failed. Find the number of total candidates who appeared in the examination.

15. A man spent 72% of his salary and remaining were his savings. If he saved ₹ 7,200 per month, find his monthly income.

16. Roshan gave 50% of the amount he had to his wife, 30% to his son and the remaining ₹ 50,000 to his daughter. Find the amount he had.

17. In a school, 55% of students are boys and the number of girls is 3600. Find the total number of students in the school.



Profit and Loss

Profit = SP - CP, when $SP > CP$; loss = CP - SP, when $CP > SP$.

We can learn basics of profit and loss from our day-to-day experiences. We buy articles from nearby shops. The shopkeepers purchase it either from the wholesalers or directly from manufacturers after paying a certain price.

The price at which an article is purchased is called the **cost price** and is written as **CP**.

The price at which an article is sold is called the **selling price** and is written as **SP**.

If the selling price of an article is more than the cost price, then the shopkeeper makes a profit.

$$\begin{aligned}\text{So, Profit} &= \text{Selling Price} - \text{Cost Price} \\ &= SP - CP\end{aligned}$$

If the cost price of the article is more than the selling price, then the shopkeeper makes a loss.

$$\begin{aligned}\text{So, Loss} &= \text{Cost Price} - \text{Selling Price} \\ &= CP - SP\end{aligned}$$

If the cost price and the selling price of the article is same, then there is no profit no loss in the transaction. Here, $CP = SP$.

Usually, a shopkeeper has to bear some additional expenditures like freight, wages, maintenance charges etc. These extra spendings are called **overhead charges**. Overhead charges are an essential part of cost price.



Thus,

Cost Price = Payment made while purchasing the articles + Overhead charges

Keep in mind that the profit and loss are always calculated on the cost price.

$$\text{Profit\%} = \frac{\text{Profit}}{\text{CP}} \times 100$$

$$\text{Loss\%} = \frac{\text{Loss}}{\text{CP}} \times 100$$



Facts to Know

- At each stage, the selling price of one becomes the cost (buying) price for the other.
- Profit and loss is always calculated on CP.

Example 11 : Viru bought a bicycle for ₹ 4,250 and sold it to Shyam for ₹ 3,750. Find his gain or loss.

Solution : CP of cycle = ₹ 4,250

SP of cycle = ₹ 3,750

Since CP > SP, so there is a loss.

$$\begin{aligned}\text{Loss} &= \text{CP} - \text{SP} \\ &= ₹ 4,250 - ₹ 3,750 = ₹ 500\end{aligned}$$

Hence, Viru suffered a loss of ₹ 500.

Example 12 : If the profit made on a toy is ₹ 24 and the selling price of the toy is ₹ 504, then find the profit %.

Solution : It is given that Profit = ₹ 24 and SP = ₹ 504

$$\begin{aligned}\text{CP} &= \text{SP} - \text{Profit} \\ &= ₹ 504 - ₹ 24 \\ &= ₹ 480\end{aligned}$$

$$\begin{aligned}\text{Profit \%} &= \frac{\text{Profit}}{\text{CP}} \times 100 \\ &= \frac{24}{480} \times 100 = 5\%\end{aligned}$$

Hence, the profit per cent on toy is 5 %.

Example 13 : Dinesh bought 15 dozen balloons at ₹ 24 a dozen for his birthday. He spent ₹ 40 on his transportation. Due to fight with his friends he cancelled the celebration and sold the balloons at ₹ 2.5 each. What was his profit or loss per cent.

Solution :

Cost of 1 dozen balloons	= ₹ 24
Cost of 15 dozen balloons	= ₹ (24 × 15)
	= ₹ 360
Overhead expense on transportation	= ₹ 40
∴ Cost Price	= ₹ (360 + 40)
	= ₹ 400
Selling Price of 1 balloon	= ₹ 2.5
Selling Price of 1 dozen balloons	= (2.5 × 12)
	= ₹ 30
Selling Price of 15 dozen balloons	= ₹ (15 × 30) = ₹ 450
As SP > CP, there is a profit on the cost price	
Profit	= SP - CP
	= ₹ (450 - 400)
	= ₹ 50



$$\begin{aligned}\text{Profit \%} &= \frac{\text{Profit}}{\text{CP}} \times 100 \\ &= \frac{50}{400} \times 100 \\ &= 12.5\%\end{aligned}$$

Hence, the profit per cent of Dinesh is 12.5%

Example 14 : The selling price of 12 articles is the same as the cost price of 16 articles. Find gain per cent.

Solution : Let the cost price of 1 article = ₹1
∴ The cost price of 12 articles = ₹12
But selling price of 12 articles = Cost price of 16 article = ₹16
As $SP > CP$, there is a profit.

$$\begin{aligned}\text{Profit} &= SP - CP \\ &= ₹(16 - 12) = ₹4\end{aligned}$$

$$\begin{aligned}\text{Profit \%} &= \frac{\text{Profit}}{\text{CP}} \times 100 \\ &= \frac{4}{12} \times 100 = 33.\bar{3}\%\end{aligned}$$

Hence, profit in the transaction is 33. $\bar{3}$ %.

Example 15 : Ashu bought two horses at ₹ 36,000 and ₹ 40,000 respectively. He sold first horse at a gain of 25% and second horse at a loss of 20%. Find the gain or loss per cent in the whole transaction.

Solution :

$$\begin{aligned}\text{Cost price of two horses} &= ₹ (36,000 + 40,000) \\ &= ₹ 76,000 \\ \text{Cost price of first horse} &= ₹ 36,000 \\ \text{Profit} &= 25\% \text{ of ₹ } 36,000 \\ &= \frac{25}{100} \times 36,000 = ₹ 9,000 \\ \text{Selling price of first horse} &= ₹ (36,000 + 9,000) \\ &= ₹ 45,000 \\ \text{Cost price of second horse} &= ₹ 40,000 \\ \text{Loss} &= 20\% \text{ of ₹ } 40,000 \\ &= \frac{20}{100} \times 40,000 = ₹ 8,000 \\ \text{Selling price of second horse} &= ₹ (40,000 - 8,000) \\ &= ₹ 32,000 \\ \text{Selling price of two horses} &= ₹ (45,000 + 32,000) = ₹ 77,000 \\ \text{As } SP > CP, \text{ there is a profit.} \\ \text{Profit} &= SP - CP \\ &= ₹ (77,000 - 76,000) \\ &= ₹ 1,000 \\ \text{Profit \%} &= \frac{\text{Profit}}{\text{CP}} \times 100 \\ &= \frac{1,000 \times 100}{76,000} = 1.316\% \text{ (approx)}\end{aligned}$$

Hence, Ashu made a profit of 1.316% (approx) in the transaction.





Exercise 8.2

1. Find the SP of the following :

- (a) $CP = ₹2250$, $Loss = ₹75$
- (b) $CP = ₹1235$, $Profit = ₹65$
- (c) $CP = ₹2390$, $Profit = ₹120.75$
- (d) $CP = ₹127$, $Loss = ₹12.25$

2. Find the CP of the following :

- (a) $SP = ₹1000$, $Profit = ₹200$
- (b) $SP = ₹2100$, $Loss = ₹137$
- (c) $SP = ₹1320$, $Loss = ₹75.5$
- (d) $SP = ₹778$, $Profit = ₹32$

3. Find the missing terms (wherever applicable) in each of the following:

S. No.	Cost Price	Selling Price	Profit	Profit%	Loss	Loss%
(a)	₹450	₹540				
(b)	₹2200			20%		
(c)		₹660	₹60			
(d)		₹180	₹30			
(e)			₹108	15%		

- 4. Roney bought a mobile for ₹12,000. At what price should he sell it so as to get a profit of 30%?
- 5. A shopkeeper purchased 50 dozen eggs for ₹1800. Five dozen eggs could not be sold because they got broken. At what price per dozen should the shopkeeper sell the remaining eggs so that he made an overall profit of 20%.
- 6. Mr. Parag sold his scooter for ₹24,000 making a loss of 20%. What was the cost of the scooter?
- 7. By selling a computer for ₹16,000 Arnav loses 20%. At what price should he sell it so that he gets 30% profit.
- 8. Pammy bought 60 articles at the rate of ₹80 each article. She sold three-fourth of them at the rate of ₹75 each article and the rest at the rate of ₹100 each article. Find her gain or loss per cent.
- 9. The selling price of 8 apples is equal to the cost price of 10 apples. Find the gain per cent.
- 10. Trisha purchased a bicycle for ₹5000 and sold it to Tipu at a profit of 25%. Tipu sold it to Tina at a loss of 15%. For how much did Tina buy it?
- 11. Aman bought five radio sets at rate of ₹320. He sold two radio sets at a loss of 25%. At what gain per cent should he sell the remaining radios to gain 25%, on the overall investment?
- 12. Deepak buys an article and sells it to Raju at a profit of 20%, Raju sells it to Mahesh gaining 30%. If Mahesh pays ₹1872 for it, how much did Deepak pay?
- 13. A shopkeeper buys 12 kg tea of one quality at the rate of ₹250 per kg and 18 kg tea of another quality at the rate of ₹300 per kg. He mixes them and sells at the rate of ₹290 per kg. Find his gain or loss per cent.
- 14. Jagan sold a trouser at a profit of 16%. Had he sold it for ₹27 more, the profit would have been 20%. Find the cost price of the trouser.
- 15. A reduction of 25% in the price of commodity enables a purchaser to get 3 kg more for ₹180. Find
 - (a) Reduced price per kg of commodity.
 - (b) Price per kg of commodity before reduction.





Simple Interest

Assume that some expected or unexpected expenditure suddenly comes like for hospital, family function, education, marriages etc, but saved money is not sufficient. You will perhaps borrow remaining amount from a friend, relative, a money lender or a bank. A friend or relative might not show interest in getting their money back, but others like money lenders and financial institutions lend us money, only if we agree to return the borrowed money within a specific period of time with some extra money for using their money.

The borrowed or invested money is called the **Principal** denoted by **P**. 'T' is the time for which the money is borrowed. The additional money to be paid after a specific period of time is called the **Simple Interest** and is denoted by **I**. The **Rate of Interest (Interest Rate)** is an agreed percentage of the sum borrowed at the time of taking the money throughout the loan period and is denoted by **R**. Generally the rate of interest is taken as "per cent per annum" which means ₹ 100 per year. When the interest for a specific period is added to the principal, then the sum is called the **Amount** and is denoted by **A**.

$$\text{Amount} = \text{Principal} + \text{Interest}$$

Example 16 : Mr. Mathur borrowed ₹ 8500 from a bank. He paid 10% per annum and returned the amount after 3 years. How much interest did Mr. Mathur pay in all?

Solution : $P = ₹ 8500$ Rs (hence, $P = \text{Principal}$)

$R = 10\% \text{ PA}$ (hence, $R = \text{ROI}$)

$T = 3 \text{ year}$ (hence, $T = \text{Time}$)

$$\begin{aligned} \text{Now } I &= \frac{P \times R \times T}{100} \\ &= \frac{8500 \times 10 \times 3}{100} \\ &= ₹ 2550 \end{aligned}$$

Hence Mr. Mathur Paid ₹ 2550 as interest.

Example 17 : Eliana borrowed ₹ 8000 from her friend at the rate of 15% for 3 years. Find the amount to be paid after 3 years.

Solution : Here,

$$\begin{aligned} \text{Principal} &= ₹ 8000 \\ \text{Rate} &= 15\% \\ \text{Time} &= 3 \text{ years} \\ I &= \frac{P \times R \times T}{100} \\ &= \frac{8000 \times 15 \times 3}{100} \\ &= ₹ 3600 \\ A &= P + I \\ &= ₹ (8000 + 3600) = ₹ 11600 \end{aligned}$$

Hence, Eliana will pay ₹ 11600 after 3 years.



Example 18 : At what rate will ₹ 3000 amount to ₹ 3600 in 4 years ?

Solution : Here,

$$\begin{aligned}\text{Amount} &= ₹ 3600 \\ \text{Principle} &= ₹ 3000 \\ \text{Time} &= 4 \text{ years} \\ \text{Interest} &= \text{Amount} - \text{Principal} \\ &= ₹ (3600 - 3000) \\ &= ₹ 600 \\ \text{Rate} &= \frac{I \times 100}{P \times T} \\ &= \frac{600 \times 100}{3000 \times 4} \\ &= 5\%\end{aligned}$$

Hence, the rate of interest is 5%.

Example 19 : At what rate of interest will a sum of money triple itself in 15 years ?

Solution : Let the principal (P) be x,

$$\begin{aligned}\text{Amount} &= 3x \\ \text{Interest} &= \text{Amount} - \text{Principal} \\ &= 3x - x \\ &= 2x \\ \text{Rate} &= \frac{I \times 100}{P \times T} \\ &= \frac{2x \times 100}{x \times 15} \\ &= 13.\bar{3}\%\end{aligned}$$

Hence, the rate of interest is 13. $\bar{3}$ %.

Example 20 : Bhola borrowed ₹ 75,000 from his friend Bhalla. He gave ₹ 40,000 at the interest rate of 15% and the remaining amount at 18%. How much interest did he pay in 4 years ?

Solution : Interest paid on ₹ 40,000 for 4 years at 15%,

$$\begin{aligned}I_1 &= \frac{40,000 \times 15 \times 4}{100} \\ &= ₹ 24,000\end{aligned}$$

$$\begin{aligned}\text{Remaining amount} &= ₹ (75,000 - 40,000) \\ &= ₹ 35,000\end{aligned}$$

Interest paid on ₹ 35,000 at 18% for 4 years

$$\begin{aligned}I_2 &= \frac{35,000 \times 18 \times 4}{100} \\ &= ₹ 25,200\end{aligned}$$

$$\begin{aligned}\text{Total interest} &= I_1 + I_2 \\ &= ₹ (24,000 + 25,200) = ₹ 49,200\end{aligned}$$

Thus, Bhola paid ₹ 49,200 after 4 years as interest.



Example 20 : In how many years will a sum of money double itself at 10% interest per annum?

Solution : Let the principal (P) be x

$$\text{Amount} = 2x \text{ (double)}$$

$$\text{Rate} = 10\% \text{ P.A}$$

$$I = \text{Amount} - \text{Principal}$$

$$= 2x - x$$

$$= x$$

$$\text{Now} = \frac{I \times 100}{P \times R}$$

$$= \frac{X \times 100}{X \times 10}$$

$$= 10 \text{ years}$$



Exercise 8.3

1. Fill in the blanks:

S.No.	Amount	Principal	Simple Interest	Rate	Time
(a)		₹ 1800	₹ 216	6%	
(b)		₹ 5000	₹ 1200		4 Years
(c)	₹ 900			10%	6 Years
(d)	₹ 5000		₹ 1000	10%	

- What sum of money lent out at 5% per annum simple interest produces ₹ 500 as interest in 2.5 years?
- What sum of money will amount to ₹ 27930 at the rate of 10% per annum simple interest in 3 years?
- A sum of money doubles itself in 6 years. Find the rate of simple interest per annum.
- Sophiya borrowed some amount at 18% per annum. He had to pay ₹ 225 as interest after 4 years. How much did he borrow?
- In what time will the simple interest on a certain sum of money at 10% per annum be $\frac{2}{5}$ of itself?
- At what rate per cent simple interest will be a sum of money amount to $\frac{5}{4}$ of itself in 2 years?
- A certain sum of money amounts to ₹ 4800 in 4 years and ₹ 5200 in 6 years. Find the sum and the rate of simple interest.



9. A village moneylender wants one eighths of the amount loaned, every year as interest. What will be the rate of interest, if a farmer borrows ₹ 12000 for 1 year from the moneylender? What is the amount that he has to pay back altogether?
10. A sum of money lent at 8% per annum simple interest for 5 years yields a certain amount of interest. Had it been lent for 7 years, it would have yielded ₹ 960 more. Find the sum.

Points to Remember

- ❖ **Per cent** is a fraction with denominator 100 or a ratio with 100 as the second term.
- ✓ All fractions, ratios and decimals can be expressed as percentages and vice-versa.
- ✓ **Cost Price** of an article is the amount paid to purchase it.
- ✓ Overhead expenses like cartage, labour, taxes etc, are included in the cost price.
- ✓ **Selling Price** of an article is the amount at which it is sold.
- ✓ If $SP > CP$, there is profit. Profit = $SP - CP$
- ✓ If $CP > SP$, there is loss. Loss = $CP - SP$
- ✓ Profit % = $\frac{\text{Profit} \times 100}{CP}$; Loss % = $\frac{\text{Loss} \times 100}{CP}$
- ✓ The money borrowed or invested is called the **Principal**.
- ✓ The extra money to be paid after specific period of time is called the **Simple Interest** or **Interest**.
- ✓ The rate of interest (R) is the agreed percentage of the sum borrowed at the time of taking the money throughout the loan period.
- ✓ Interest = $\frac{\text{Principal} \times \text{Rate} \times \text{Time}}{100} = \frac{PRT}{100}$
- ✓ Amount = Principal + Interest



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options :

- (a) The word per cent is taken from Latin words

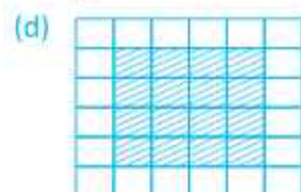
(i) per cent ☐ (ii) per centage ☐ (iii) per centum ☐ (iv) per santa ☐

- (b) Converting $1\frac{1}{5}$ in per cent we get

(i) 12% ☐ (ii) 60% ☐ (iii) 120% ☐ (iv) 83.3% ☐

- (c) Aditya scored 45% marks in Mathematics. How many marks she got if the maximum marks was 80 ?

(i) 36 ☐ (ii) 38 ☐ (iii) 40 ☐ (iv) 42 ☐



The percentage of shaded portion in the given figure is

(i) 16% ☐ (ii) 20% ☐ (iii) 25% ☐ (iv) 45% ☐



(e) What per cent of 150g is 1kg?

(i) 15%

☐

(ii) 666.6%

☐

(iii) 115%

☐

(iv) 66.6%

☐

(f) Find the whole quantity if its 7.5% is 150.

(i) 20

☐

(ii) 200

☐

(iii) 2000

☐

(iv) 20000

☐

(g) Rinky traveled $\frac{3}{4}$ of the journey by car and the rest by bus. If she covered 120 km in total, what per cent of journey she travelled by bus.

(i) 75%

☐

(ii) 20%

☐

(iii) 10%

☐

(iv) 25%

☐

(h) A sum of ₹1600 is lent for 2.5 yrs at rate of 4% per annum. The amount to be returned after 2.5 years is

(i) ₹160

☐

(ii) ₹1340

☐

(iii) ₹1760

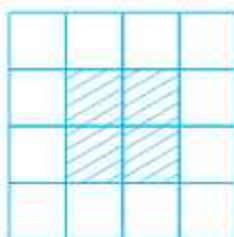
☐

(iv) ₹2000

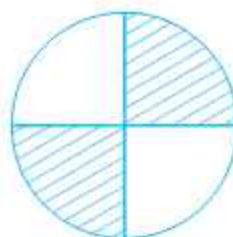
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2. Find the percentage of unshaded portion of each figure :

(a)



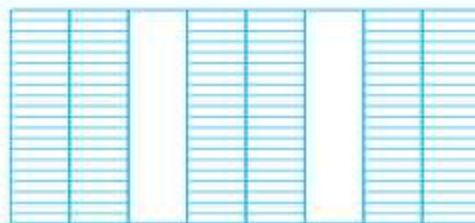
(b)



(c)



(d)



3. Find the value of the followings :

(a) 7.5% of ₹ 500

(b) 50% of 124 /

(c) 8.0% of ₹ 1600 km

(d) 12 % of 2 kg.

4. Shikhar hit six fours in two overs whereas Gambhir hit four fours in one over. Who has a better strike rate in terms of percentage?
5. The wholesale price of wheat rises by 12.5%. By how much per cent should a family reduce his consumption of commodity so that his expenditure remains same?
6. A candidate must score 60% marks to pass in an examination. Rahul gets 240 marks and fails by 60 marks. Find the maximum marks.
7. On selling a computer for ₹ 18,000 Mr. Pandey earned profit of ₹ 4500. Find his profit %.
8. Rakesh bought two electronic items at ₹ 800 and ₹ 1200 respectively. He sold the first item at profit of 20% and second item at loss of 20%. Find the profit or loss per cent in the whole transaction.
9. Tipu buys an article and sells it to Sindhu at a profit of 10%, Sindhu sells it to Amit gaining 20%. If Amit pays ₹1980 for it, how much did Tipu pay?
10. Shreyas sold his bicycle at gain of 10%. If he had bought it for 10% less and sold it for ₹ 45 more, he would have gained 25%. Find the cost price of the bicycle.



11. Oman borrowed ₹ 5000 from his uncle at the rate of 12% for 5 years . Find the amount to be paid after 5 years.
12. In how many years will ₹ 2500 amount to ₹ 3200 at rate of 4% ?
13. At what rate of interest will a sum of money doubles itself in 12.5 years.
14. What sum of money amounts to ₹ 8250 in 4 years at 8% per annum ?



HOLES

A factory grants raises at two different times a year. If 62% of the workers received raises in the first period and 10% of these did not receive a raise in the second period, what percentage of the people received raises in both the periods.



Lab Activity

Objective

: To find the per cent of multi-coloured figure.

Materials Required

: White circular chart paper, black sketch pen and blue sketch pen.

Procedure :

Step 1 : Take a white coloured circular chart paper and shade it with different colours as shown below.

Step 2 : Find the coloured parts in fractions.

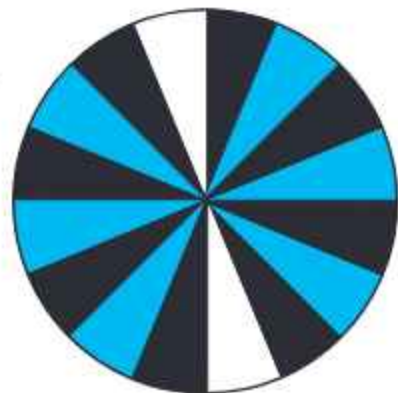
$$\text{White parts} = \frac{2}{16}, \text{ Blue parts} = \frac{6}{16}, \text{ Black parts} = \frac{8}{16}$$

Step : Convert the fractions into percentage.

$$\text{White parts} = \frac{2}{16} \times 100 = 12.5\%$$

$$\text{Blue parts} = \frac{6}{16} \times 100 = 37.5\%$$

$$\text{Black parts} = \frac{8}{16} \times 100 = 50\%$$



Revision Test Paper-II

(Based on Chapters 6 to 8)

A. Multiple Choice Questions (MCQs).

(10)

Tick (✓) the correct options :

- The coefficient of x in $7x^2y^3z^4$ is
 (i) 7 ☐ (ii) 2 ☐ (iii) $7y^3z^4$ ☐ (iv) $7xy^3z^4$ ☐
- The value of the algebraic expression $5x^2y^3$ if $x = -2$ and $y = -3$ is
 (i) 90 ☐ (ii) -90 ☐ (iii) -540 ☐ (iv) 540 ☐
- $\frac{3}{5}$ of a number is 45. The number is
 (i) 135 ☐ (ii) 225 ☐ (iii) 45 ☐ (iv) 75 ☐
- If 5 subtracted from 3 times a number gives 28; the number is
 (i) 76 ☐ (ii) 11 ☐ (iii) 3 ☐ (iv) 13 ☐
- The mean proportion between 9 and 25 is
 (i) 112.5 ☐ (ii) 25 ☐ (iii) 15 ☐ (iv) 17 ☐
- The word percent is taken from latin words.
 (i) percent ☐ (ii) percentage ☐ (iii) per centum ☐ (iv) per santa ☐
- A 10% reduction on the price of a suit is equal to 75. The original price of the suit is
 (i) ₹ 7500 ☐ (ii) ₹ 2075 ☐ (iii) ₹ 750 ☐ (iv) ₹ 705 ☐
-



The percentage of shaded portion is

-
-
-
-
-
-
-
-
- When $SP = ₹ 725$ and $Loss = ₹ 75$, CP is
 (i) ₹ 800 ☐ (ii) ₹ 650 ☐ (iii) ₹ 575 ☐ (iv) ₹ 825 ☐
- On selling her mobile for ₹ 5000, Preety makes a profit of 25%. The cost price of mobile is
 (i) ₹ 6000 ☐ (ii) ₹ 5500 ☐ (iii) ₹ 4500 ☐ (iv) ₹ 4000 ☐

B. Fill in the blanks of the following :

(10)

- An algebraic expression that contains three terms is called a _____.
- A letter used to represent a number is called _____.
- The value of a variable which satisfies the equation (for which $RHS = LHS$) is called the _____ of the equation.
- When a , b and c are in _____ proportion, then $b^2 = ac$.

5. The money repaid or given back, which includes the interest and principal is called the _____.
6. Each literal or constant quantity multiplied together to form a product is called _____.
7. The term of an algebraic expression containing no literal factor is called _____.
8. The denominator is also called _____.
9. _____ is a fraction with denominator 100.
10. The extra money to be paid after specific period of time is called the _____.

C. Write 'T' for true statement and 'F' for false statement :

(10)

1. A variable takes various numerical values in different situations.
2. $18 - 6x^2 = -132$, then $x = 5$
3. The value of 7^2 is equal to $(7^2)^3$.
4. An equation in one variable is called a linear equation if the highest power of the variable is more than one.
5. Profit is calculated on CP and loss is calculated on SP.
6. $8m, 9n, 6x, -11y$ are like terms.
7. $20 + 2x + 7x^3$ is a polynomial in x of degree 3
8. $\frac{x+1}{3} = 2$, then $x = 6$.
9. 3.8 is equal to 37.5%
10. 50% of 210 km is 105 km.

Model Test Paper-I

(Based on Chapters 1 to 8)

SECTION - A

[11 × 2 = 22]

1. Multiply 64×105 using distributive property.
2. Ramu was eating a cake. He had eaten one-fourth of the cake, when his three friends joined. He divided the remaining cake equally and gave them. What fraction of the cake did each friend get?
3. Find the product of $\frac{2}{3} \times \frac{1}{7} \times \frac{35}{5}$
4. Multiply 12.345 by 27.
5. Express $\frac{-243}{32}$ in power notation.
6. If $x = -2$ and $y = 3$, find the value of $3x^2 - y^3 + 4$.
7. The sum of three consecutive numbers is 45. Find the numbers.
8. The cost of 15 m cotton cloth is ₹ 1875. Find the cost of 8 m cloth.
9. Find the number whose $3\frac{1}{8}\%$ is 500.
10. If the profit made on a packet of toothpaste is ₹ 7 and the cost price of the packet is ₹ 35, then how much is the profit percentage?
11. Priya borrowed ₹ 1250 from her friend at the rate of 5% per annum for 3 years. Find the amount paid by her after 3 years.

SECTION - B

[10 × 3 = 30]

12. Find the difference between the sum of odd numbers and sum of even numbers between 20 and 30.
13. Represent $-\frac{4}{3}$ and $\frac{4}{3}$ on a number line.
14. Arrange $-\frac{4}{3}, -\frac{3}{4}, 1, \frac{2}{3}, \frac{4}{3}, \frac{5}{6}$ in descending order.
15. If x is a rational number and p, q and r are all different integers, then prove that $\frac{x^p}{x^q} \times \frac{x^q}{x^r} \times \frac{x^r}{x^p} = 1$.
16. If $A = 7x^2 + 5x^3 - 2x^2 - 17$, $B = 6x^3 + 5x^2 - 5$ and $C = 2x^4 - 6x^3 + 3x^2$, find $(A - B) + C$.
17. The numerator of a fraction is 5 less than the denominator. If 3 is added to both its numerator and denominator, it becomes $\frac{1}{2}$. Find the fraction.
18. Express the following rational numbers as decimals using the long division method.

(a) $\frac{5}{6}$

(b) $\frac{2}{7}$

(c) $\frac{5}{8}$



19. Mannu bought a second hand mobile for ₹ 3600 and spent ₹ 1200 on its repairs. If he sold it for ₹ 5000, what was his profit or loss %?
20. In how many years will a sum of money doubles itself at 12% per annum.
21. In an examination 85% of the candidates passed and 45 candidates failed. How many students appeared in the examination ?

SECTION - C

[7 × 4 = 28]

22. In a competitive examination paper consisting of 100 questions, 4 marks are awarded for each correct answer, 1 mark deducted for each incorrect answer and no mark added or deducted for not attempted questions.
- (a) Arunoday attempted 80 questions. If only 64 are correct, what is his score?
- (b) For a candidate to qualify he must get 280 marks. Arnav attempted 75 question, out of which 15 are incorrect. Will he pass or not ?
23. Solve for 'x' verify the solution also.
- $$\frac{x+3}{4} - \frac{3x+5}{6} = \frac{4x+3}{5}$$
24. Abdulla bought 1800 balls at ₹ 8 a dozen. He sold 1200 of them at ₹1 each ball and rest at ₹10 a dozen. Find his gain or loss per cent.
25. There are three prizes to be distributed in a quiz contest. The value of second prize is five-sixth of the value of first prize and the value of third prize is four-fifth of second prize. If the total value of three prizes is ₹ 2625, find the value of each prize.
26. A bag contains 25 paise and 50 paise coins whose total value is ₹45. If the number of 25 paise coins is four times that of 50 paise coins, find the number of each type of coins.
27. Pandey borrowed ₹ 125000 from a money lender for 3 years. He returned ₹ 75000 at the interest rate of 8% and the remaining amount at 12%. How much interest did he pay in 3 years?



Triangle and Its Properties

A triangle is a closed figure formed by three line segments, and denoted by the symbol $\triangle$.

We see many things which have the word 'tri' embedded in their names. Eg: Tricycle, tri-series and so on. Similarly, we have a concept in geometry which is based on 'tri'. The meaning of 'tri' is **three**.

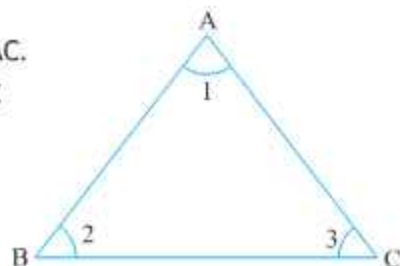
The word **triangle** literally means a figure having three angles. It also has three sides. It is a closed figure. It has been categorised as a polygon with three sides. Look at Figure given here, it shows triangle ABC. We can conclude about the following features of triangles:

- ❖ **Sides**: There are three sides of a triangle ABC. It has three sides, viz. AB, BC and AC.
- ❖ **Angles**: There are three angles of a triangle. In Figure given here, triangle ABC has three angles. They are

$$\angle BAC = \angle A = \angle 1$$

$$\angle ABC = \angle B = \angle 2$$

$$\angle ACB = \angle C = \angle 3$$



- ❖ **Vertices**: There are three vertices of a triangle. In Figure given here, the three vertices of triangle ABC. They are A, B and C.

Further, in $\triangle ABC$, shown in Figure given above, vertex A is opposite side BC. Similarly, vertex B is opposite side CA, vertex C is opposite side AB.

In $\triangle ABC$, $\angle A$ is opposite side BC. Further, $\angle B$ is opposite side CA. Finally, $\angle C$ is opposite side AB.



Facts to Know

- The three sides and three angles of a triangle together are called six elements of triangle.



Interior and Exterior of Triangle

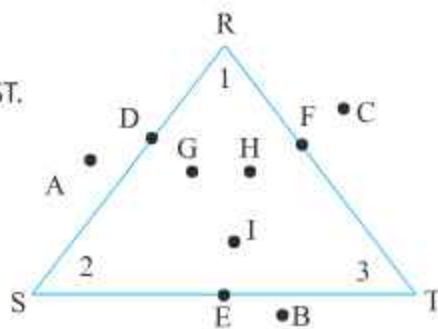
Let us draw $\triangle RST$.

In figure given here, we have shown some points **on**, **inside** and **outside** $\triangle RST$.

Note that:

- ❖ Points A, B, C are in the **exterior** of $\triangle RST$.
- ❖ Points D, E, F are **on** the $\triangle RST$
- ❖ Points G, H, I are in the **interior** of $\triangle RST$.

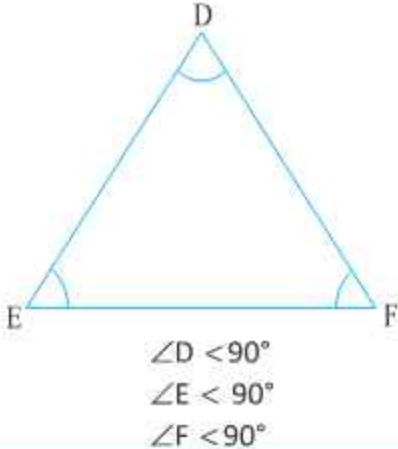
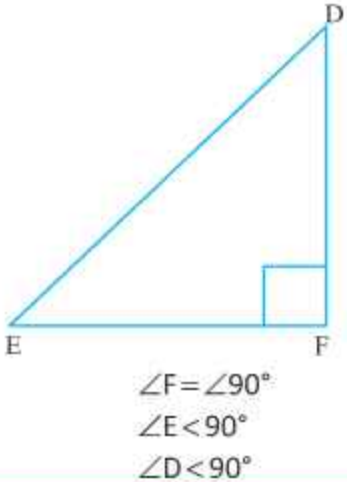
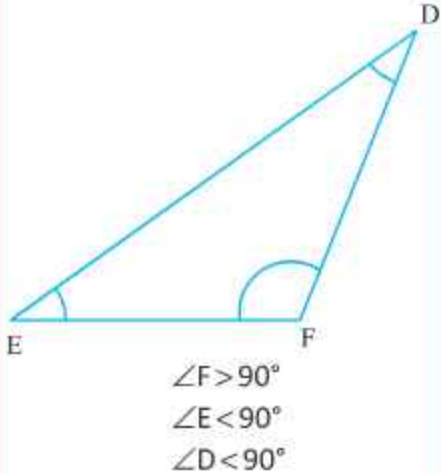
In sum the points lying in $\triangle RST$ and inside the three sides of $\triangle RST$ are called **Triangle Interior**. All other parts are called **exterior**.



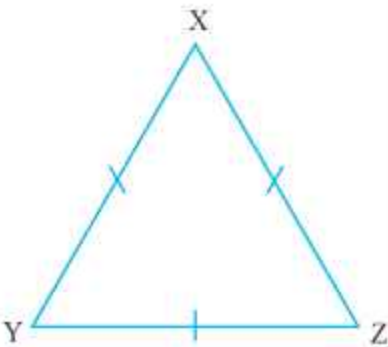
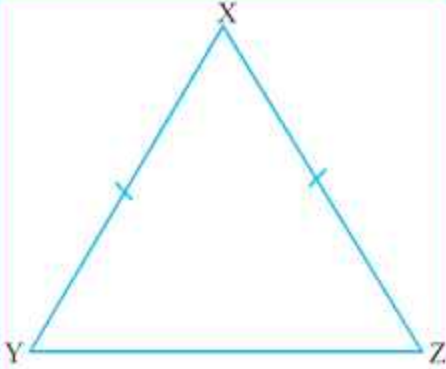
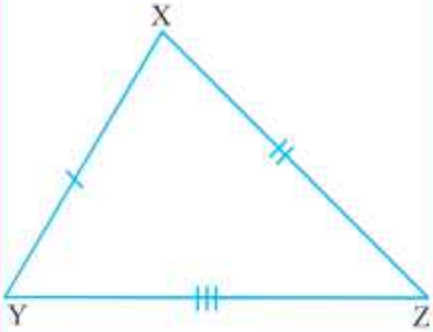


Classification of Triangles

Classification on the Basis of Angles

Name of Triangles	Figure	Definition
1. Acute-angled triangle	 $\angle D < 90^\circ$ $\angle E < 90^\circ$ $\angle F < 90^\circ$	A triangle with all acute angle is called acute-angled triangle .
2. Right-angled triangle	 $\angle F = 90^\circ$ $\angle E < 90^\circ$ $\angle D < 90^\circ$	A triangle with one angle of 90° and other two acute angles is called right-angled triangle .
3. Obtuse - angled triangle	 $\angle F > 90^\circ$ $\angle E < 90^\circ$ $\angle D < 90^\circ$	A triangle with one angle more than 90° and other two acute angles is called obtuse-angled triangle .

Classification on the Basis of Sides

Name of Triangle	Figure	Definition
1. Equilateral Triangle	 $XY = YZ = ZX$	A triangle having all three equal sides is called equilateral triangle .
2. Isosceles Triangle	 $XY = XZ$ $XY \neq YZ$ $XZ \neq YZ$	A triangle having two equal sides and one side different from two equal sides is called isosceles triangle .
3. Scalene triangle	 $XY \neq YZ \neq ZX$	A triangle having all sides unequal to one another is called scalene triangle .



Features Associated With Triangle

In this section, we shall discuss some features of triangles that are of great use in this class as well as higher classes. Consider the figure given here.

Base of Triangle

The horizontal line on which the triangle is constructed is called **base of triangle**. In Figure (a) BC is the base of $\triangle ABC$.

Altitude of Triangle

The perpendicular drawn from any vertex to the opposite side that vertex is called **altitude of triangle**. Since there are three vertices and sides of a triangle, we have three altitudes, too.

Median of Triangle

The line joining a vertex of the triangle to the mid-point of the side opposite to that vertex is called **median of triangle**. Since there are three vertices and sides of a triangle, we have three medians, too. $\triangle ABC$, AD, BE and CF are three medians in Figure (c).

Interior Angle

An angle inside the triangle area is called **interior angle of triangle**. In the Figure (a) $\angle 2$ is an interior angle. Note that $\angle 2 = \angle BCA$. In Figure (b) $\angle 1$ is the interior angle.

Exterior Angle

An angle outside the triangle area is called **exterior angle of triangle**. In Figure (a) $\angle 1$ is an exterior angle. It was formed by extending BC to D. In Figure (b) $\angle 2$ is the exterior angle. It was formed by extending CB to E.

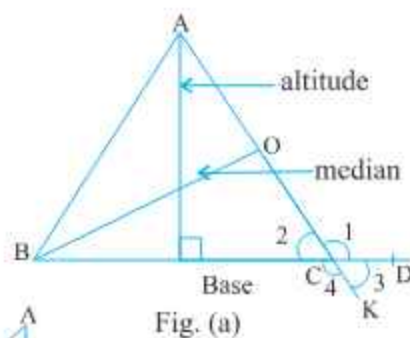


Fig. (a)

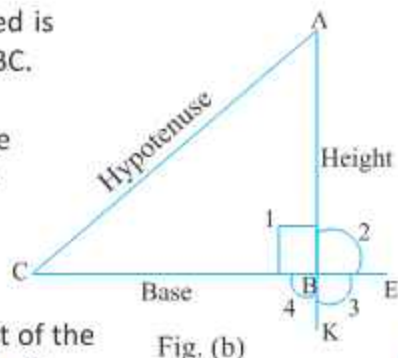


Fig. (b)

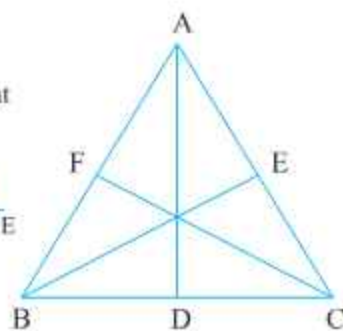


Fig. (c)



Facts to Know

- All triangles have three interior angles and three exterior angles each. That is quite logical.

Right Angle

An angle of 90° is called **right angle**. The triangles having one angle of 90° are called **right-angled triangles**. Figure (b) is right-angled triangle.

Hypotenuse

In a right-angled triangle, the slant line which is also the longest side is called **hypotenuse** shown in Figure (b).

Height

In a right-angled triangle, the perpendicular to the base of triangle is called **height**. Note that perpendicular and height are the same in all triangles. Figure (b) shows the height BA of $\triangle ABC$.

Interior Opposite Angle

In Figure (a) $\angle A$ and $\angle B$ are interior opposite angles. They are the interior angles which are opposite to each other. Similarly, $\angle A$ and $\angle 2$ are interior opposite angles. Finally, $\angle B$ and $\angle 2$ are also interior opposite angles.

Vertically Opposite Angles

Refer Figure (a). We have extended AC up to K. Thus, we have $\angle 3$ and $\angle 4$, which are exterior angles.

$$\angle 2 = \angle 3$$

$$\angle 1 = \angle 4$$





There two pairs of angles are equal since they are vertically opposite angles. If two unparallel lines intersect each other, the opposite pairs of angles are called vertically opposite angles. Moreover, these angles are equal to each other.

In Figure (b) we have extended AB up to K.

$$\Rightarrow \angle 1 = \angle 3$$

$$\text{and } \angle 2 = \angle 4$$

Vertically opposite angles



Facts to Know

- Angles are measured in degrees. The value of angle in degrees is called **measure of angle** and is denoted as m . For example, if an angle measures 107° , we would write $m\angle ABC = 107^\circ$.



Properties of Triangle

Angle Sum Property of Triangle

The angle sum property of triangle states that the sum of all angles of a triangle is equal to 180° . In $\triangle ABC$ shown in Figure, the sum of angles is equal to 180° .

$$\Rightarrow m\angle A + m\angle B + m\angle C = 180^\circ$$

Exterior Angle Property of Triangle

The exterior angle property of triangle states that the exterior angle of a triangle is equal to the sum of its opposite interior angles.

Refer to Figure given here, we have $\triangle ABC$. Base BC has been extended to D. So, $\angle 4$ is the exterior angle.

Now, $\angle 1$, $\angle 2$ and $\angle 3$ are the interior angles of $\triangle ABC$. According to the exterior angle property, we have :

$$\angle 4 = \angle 1 + \angle 2$$

This means that the exterior angle is equal to the sum of measure of two interior opposite angles.

The sum of all the exterior angles of triangle is always 360° .

Side Sum Property of Triangle

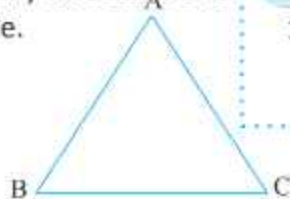
According to this property, the sum of the length of any two sides of a triangle is always greater than the length of the third side.

In the figure, $\triangle ABC$, we have :

$$AB + BC > AC$$

$$BC + AC > AB$$

$$AC + AB > BC$$



Facts to Know

$$\begin{aligned} 180^\circ &= 90^\circ + 90^\circ \\ &= 1 \text{ right angle} + 1 \text{ right angle} \\ &= 2 \text{ right angles.} \end{aligned}$$

Equal Side Property of Triangle

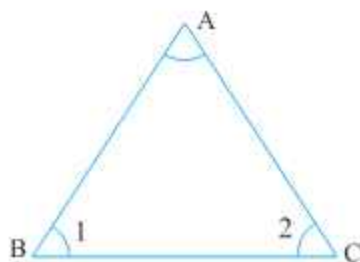
According to this property, if two angles of a triangle are equal the sides opposite to equal angles of a triangle are also equal. In $\triangle ABC$, if $\angle 1 = \angle 2$, then we have :

$$AB = AC$$

$\angle 1$ is opposite side AC.

$\angle 2$ is opposite side AB.

Since these angles are equal, these two sides are also equal to each other.



Equal Angle Property of Triangle

This property has been taken from the previous one. According to this property, if two sides of a triangle are equal to each other then the angles opposite to these two sides are also equal to each other. In above triangle ABC, if $AB = AC$, we have

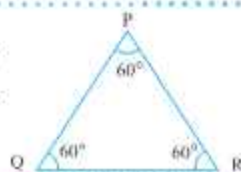
$$\angle 1 = \angle 2$$

So, if the two sides of a triangle are equal, the angles opposite these two sides are also equal to each other.



Facts to Know

In an equilateral triangle, all angles are equal. Each angle is 60° . Further, all sides are also equal to one another in this triangle.



Theorem 1. Prove that the sum of the angles of a triangle is 180° .

Given: A triangle PQR. It has three angles $\angle 1$, $\angle 2$ and $\angle 3$.

To Prove: $\angle 1 + \angle 2 + \angle 3 = 180^\circ = 2$ right angles.

Construction: Draw RT parallel to PQ.

Also, extend QR to S.

Thus, $\angle 4$, $\angle 5$ are clearly visible in the figure shown here.

Proof:

PQ and RT are two parallel straight lines and PR is a transversal that cuts through them.

Hence, $\angle 1 = \angle 4$ (i) (alternate angles)

Again PQ and RT are two parallel straight lines and QS is a transversal that cuts through them.

Hence, $\angle 2 = \angle 5$ (ii) (corresponding angles)

Adding the equation (i) and equation (ii)

$$\angle 1 + \angle 2 = \angle 4 + \angle 5 \text{ (iii)}$$

Adding $\angle 3$ to both sides of equation (iii), we get,

$$\angle 1 + \angle 2 + \angle 3 = \angle 3 + \angle 4 + \angle 5 \text{ (iv)}$$

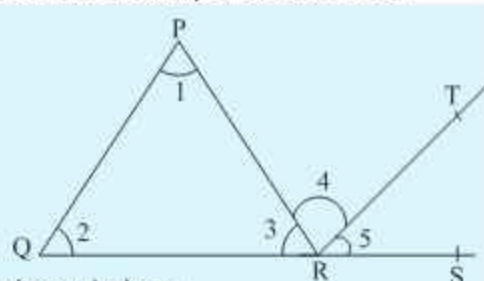
But $\angle 3$, $\angle 4$ and $\angle 5$ are the parts of a straight angle whose measure is 180° .

Thus, $m(\angle 3 + \angle 4 + \angle 5) = m \angle QRS$

$$= 180^\circ$$

Hence, $\angle 1 + \angle 2 + \angle 3 = 180^\circ$ (from equation iv)

Hence, the sum of three angles of a triangle is $180^\circ = 2$ right angles.



Example 1 : In $\triangle PQR$, $\angle P = 67^\circ$, $\angle Q = 77^\circ$, what is the measure of $\angle R$?

Solution : We have

$$\angle P + \angle Q + \angle R = 180^\circ$$

Put values in this equation.

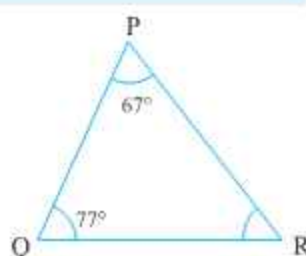
$$67^\circ + 77^\circ + \angle R = 180^\circ$$

$$\angle R = 180^\circ - 67^\circ - 77^\circ$$

$$= 180^\circ - 144^\circ$$

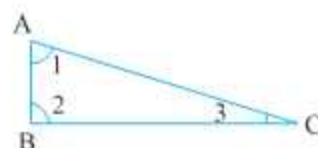
$$= 36^\circ$$

$$\text{So, } m \angle R = 36^\circ$$



Example 2 : Name six elements of the triangle given here.

Solution : The 6 elements of $\triangle ABC$ are : Perpendicular AB, Base BC, Hypotenuse CA, interior angle $\angle 1 = \angle A$, right angle $\angle 2 = \angle B$ and interior angle $\angle 3 = \angle C$.



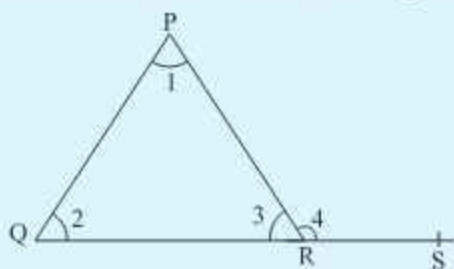
Facts to Know

The case study of triangle is well known as triangle geometry.



Theorem 2 : Prove that the exterior angle of a triangle is equal to the sum of its interior opposite angles.

Given : A triangle PQR. QR has been extended to S. The interior angles are $\angle 1$, $\angle 2$, $\angle 3$. The exterior angle is $\angle 4$.



To Prove : $\angle 4 = \angle 1 + \angle 2$

In $\triangle PQR$, we have

$$\angle 1 + \angle 2 + \angle 3 = 180^\circ \dots\dots\dots (i) \quad (\text{Angle sum property})$$

Now, $\angle 3$ and $\angle 4$ are lying on a straight angle QRS. Thus, their sum is 180° .

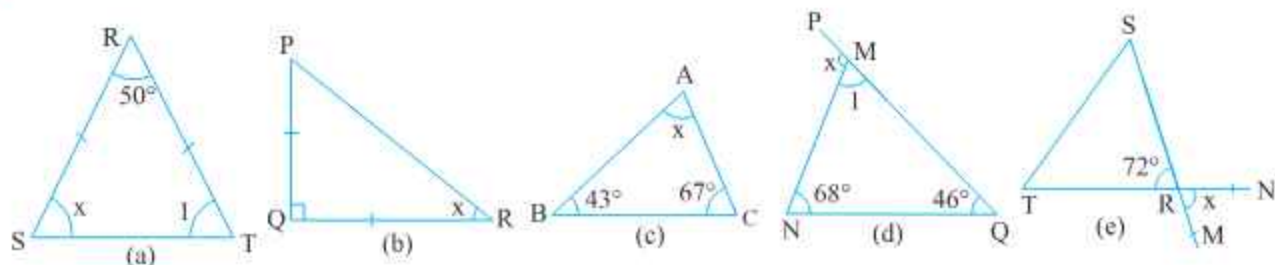
$$\angle 3 + \angle 4 = 180^\circ \dots\dots\dots (ii)$$

Both equation (i) and equation (ii) are equal since their RHS are equal.

Hence, $\angle 1 + \angle 2 + \angle 3 = \angle 3 + \angle 4$

or, $\angle 1 + \angle 2 = \angle 4$ Hence proved.

Example 3 : Find the value of x in each one of the following figures.



Solution : (a) $x + 50^\circ + \angle 1 = 180^\circ \dots\dots\dots (i)$

$$RS = RT$$

$$x = \angle 1 \dots\dots\dots (ii)$$

Put (ii) in (i), we get,

$$x + 50^\circ + x = 180^\circ$$

$$2x + 50^\circ = 180^\circ$$

$$2x = 180^\circ - 50^\circ = 130^\circ$$

$$x = \frac{130^\circ}{2} = 65^\circ$$

(b) $\angle Q = 90^\circ$

So, $\triangle PQR$ is a right-angled triangle.

In a right-angled triangle, the angles other than the right angle are 45° each in measure.

Hence, $x = 45^\circ$

(c) $x + 43^\circ + 67^\circ = 180^\circ$

$$x + 110^\circ = 180^\circ$$

$$x = 180^\circ - 110^\circ = 70^\circ$$

(d) $\angle 1 + 68^\circ + 46^\circ = 180^\circ$

$$\angle 1 + 114^\circ = 180^\circ$$

$$\angle 1 = 180 - 114 = 66^\circ$$

Now, $\angle 1$ and x are 2 parts of the straight angle QMN.

$$\begin{aligned}\Rightarrow \quad \angle QMN &= 180^\circ \\ \angle 1 + x &= 180^\circ \\ x &= 180^\circ - \angle 1 \\ &= 180^\circ - 66^\circ = 114^\circ\end{aligned}$$

- (e) It is clear that TN and SM are intersecting each other at R.
Hence, $x = 72^\circ$ (vertically opposite angles)

Example 4 : The angles of a triangle are in the ratio 2 : 3 : 4. Find out the angles.

Solution : Let the angles be $2x$, $3x$ and $4x$. We have used the given ratio to define these angles.

$$\begin{aligned}2x + 3x + 4x &= 180^\circ \\ 9x &= 180^\circ \\ x &= \frac{180}{9} = 20^\circ\end{aligned}$$

So, the angles are :

- (i) $2x = 2 \times 20^\circ = 40^\circ$
- (ii) $3x = 3 \times 20^\circ = 60^\circ$
- (iii) $4x = 4 \times 20^\circ = 80^\circ$

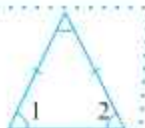
Example 5 : A triangle has been shown here. Draw its medians. Use a scale or compass to find out the midpoints of sides.

Solution : The mid-points can be obtained with the help of scale (ruler). Join mid-points of sides with opposite vertices.



Facts to Know

An isosceles triangle has two equal sides. Since the sides are equal, the angles opposite to those sides are also equal. Hence in the adjacent figure, $\angle 1 = \angle 2$.



Example 6 : In the figure shown here, QR is parallel to ST. $\angle PQR = 68^\circ$. Also, $\angle RTS = 42^\circ$. Find the values of p and q .

Solution : QR is parallel to ST and PT is a transversal that cuts it at points R and T.

Hence, $\angle 1 = 42^\circ$ (corresponding angles.)

In $\triangle PQR$, $\angle P + \angle Q + \angle 1 = 180^\circ$

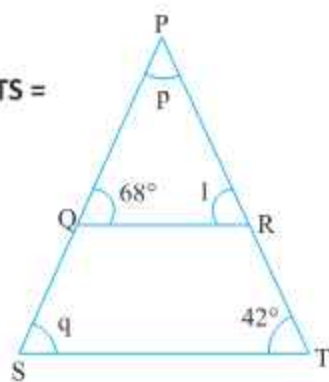
Putting the value of $\angle Q$ and $\angle 1$, we get,

$$\begin{aligned}\angle P + 68^\circ + 42^\circ &= 180^\circ \\ \Rightarrow \quad \angle P &= 180^\circ - 68^\circ - 42^\circ \\ &= 70^\circ\end{aligned}$$

QR and ST are parallel lines, and PS is a transversal at that cuts through them.

Hence, $\angle Q = \angle q$ (corresponding angles are equal)

So, $\angle q = 68^\circ$



Example 7 : AM is the median of $\triangle ABC$. Is $AB + BC + CA > 2 AM$?

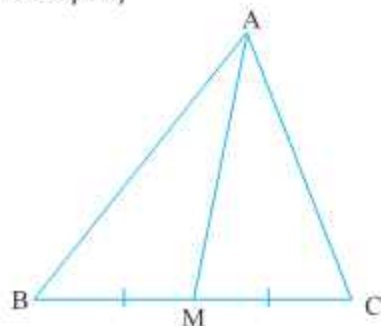
Solution : In $\triangle ABC$, AM is the median.

M is the mid-point of BC

Hence, $BM = MC$ and $BM + MC = BC$

In $\triangle ABM$, we have.

$AB + BM > AM$ (i)





In $\triangle ACM$, we have.

$$AC + CM > AM \dots\dots\dots (ii)$$

Adding equation (i) and equation (ii) we get,

$$AB + BM + AC + CM > AM + AM$$

$$\text{Or, } AB + AC + BM + CM > 2 AM$$

$$\text{Or, } AB + AC + (BM + MC) > 2 AM$$

$$\text{Or, } AB + AC + BC > 2 AM (\because BC = BM + MC)$$

Hence proved.

Example 8 : The length of two sides of a triangle is 12 cm and 15 cm. Between what two measures should the length of the third side fall ?

Solution : We know that the sum of length of two sides is greater than the length of the third side.

Two sides are 12 cm and 15 cm.

Add up, we get :

$$\text{Sum} = 12 + 15 = 27 \text{ cm.}$$

The third side cannot be more than 27 cm.

Subtract now, we get :

$$\text{Difference} = 15 - 12 = 3 \text{ cm.}$$

The third side cannot be less than the difference of length of other two sides.

Hence, the third side's minimum length would be more than 3 cm and its maximum length would be less than 27 cm.

Example 9 : Is there a triangle whose sides have the length 10.2 cm, 5.8 cm and 4.5 cm ?

Solution :

$$a = 10.2 \text{ cm}$$

$$b = 5.8 \text{ cm}$$

$$c = 4.5 \text{ cm}$$

$$a + b = 10.2 + 5.8 = 16.0$$

$$16 > 4.5 \quad \text{true}$$

$$b + c = 5.8 + 4.5 = 10.3$$

$$10.3 > 10.2 \quad \text{true}$$

$$c + a = 4.5 + 10.2 = 14.7$$

$$14.7 > 5.8 \quad \text{true}$$

Since all three side sum properties are true, this triangle is possible.

Example 10 : Classify the following triangles as acute-angled, obtuse-angled or right-angle triangles.

$$(a) \angle A = 90^\circ, \quad \angle B = 45^\circ, \quad \angle C = 45^\circ$$

$$(b) \angle A = 30^\circ, \quad \angle B = 80^\circ, \quad \angle C = 70^\circ$$

$$(c) \angle A = 0^\circ, \quad \angle B = 60^\circ, \quad \angle C = 60^\circ$$

$$(d) \angle A = 107^\circ, \quad \angle B = 30^\circ, \quad \angle C = 43^\circ$$

Solution :

- (a) Right - angled triangle
- (b) Acute - angled triangle
- (c) Acute - angled triangle (equilateral)
- (d) Obtuse - angled triangle

Example 11 : Find the values of x , y and z in the figure that follows.

Solution : In $\triangle PQR$, we have

$$x + 50^\circ + 110^\circ = 180^\circ \quad (\text{Angle sum property})$$



$$x + 160^\circ = 180^\circ$$

$$\Rightarrow x = 180^\circ - 160^\circ = 20^\circ$$

Now, $\angle QRS$ is a straight angle.

Hence, $110^\circ + y = 180^\circ$

$$y = 180^\circ - 110^\circ = 70^\circ$$

In $\triangle PRS$, we have.

$$\angle RPS + \angle PRS + \angle RSP = 180^\circ$$

$$60^\circ + y + z = 180^\circ$$

$$60^\circ + 70^\circ + z = 180^\circ$$

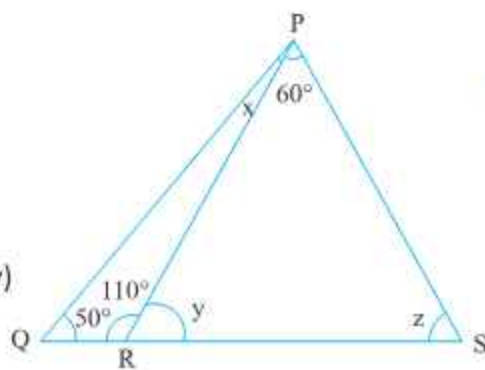
$$130^\circ + z = 180^\circ$$

$$z = 180^\circ - 130^\circ = 50^\circ$$

Therefore $x = 20^\circ$, $y = 70^\circ$ and $z = 50^\circ$.

(angle sum property)

[$y = 70^\circ$ calculated]



Example 12 : In the figure shown here, $PQ = QR$
Further $\angle SQR = 162^\circ$. Find the value of x .

Solution : $\angle PQS$ is a straight angle.

So, $\angle SQR + \angle y = 180^\circ$

$$162^\circ + \angle y = 180^\circ$$

$$\angle y = 180^\circ - 162^\circ = 18^\circ$$

$\triangle PQR$ is isosceles.

So, $PQ = QR$

$$x = \angle z$$

(given)

(Equal sides have equal angles opposite them)

In $\triangle PQR$, We have

$$\angle y + \angle z + x = 180^\circ$$

But $x = \angle z$

$$\angle y + x + x = 180^\circ$$

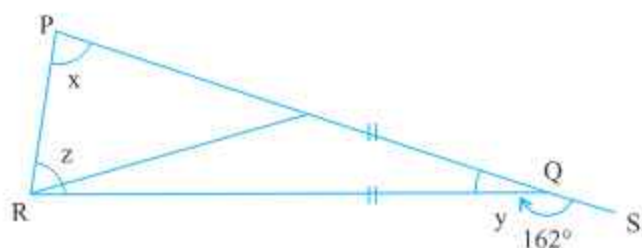
$$\angle y + 2x = 180^\circ$$

But $\angle y = 18^\circ$

So, $18^\circ + 2x = 180^\circ$

$$2x = 180^\circ - 18^\circ = 162^\circ$$

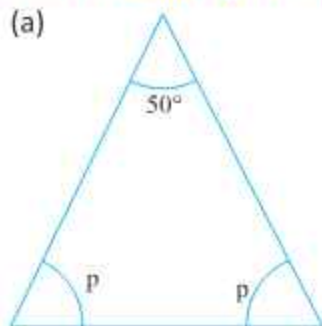
$$x = \frac{162^\circ}{2} = 81^\circ$$



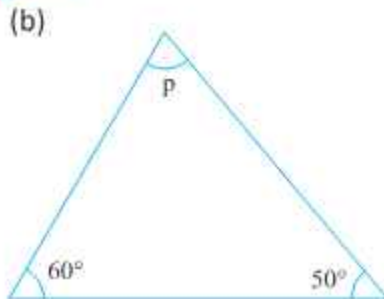
Exercise 9.1

- The angles of a triangle are in the ratio 1 : 3 : 5. Find out all the angles of the triangle.
- Find out the sum of four angles of a quadrilateral using the angle sum property of triangle.
- Find the value of p in the following figures.

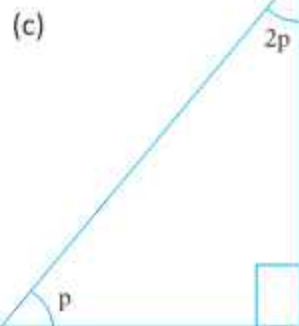
(a)

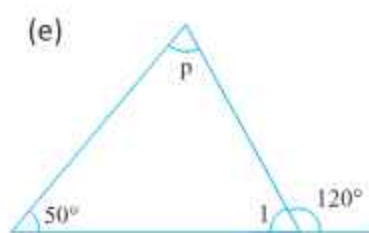
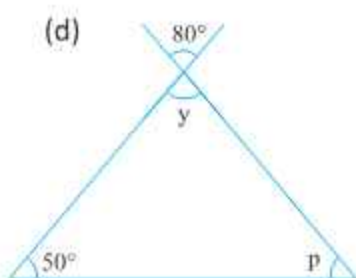


(b)

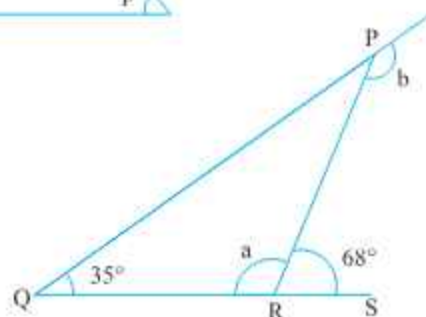


(c)





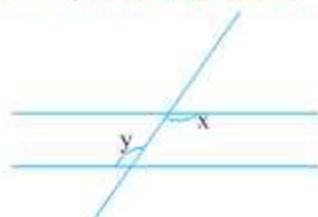
4. Find the value of a and b .



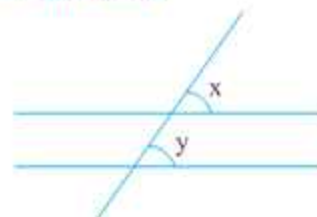
5. (a) Define the angle sum property of triangle. Can a triangle have two angles of 90° each?
 (b) Can we have a triangle with sides 6 cm, 3 cm and 7 cm?
 (c) Identify the type of triangle if $\angle ABC = 30^\circ$, $\angle BCA = 65^\circ$ and $\angle CAB = 85^\circ$
 (d) $\angle ABC = 2(x + 5)$, $\angle BCA = 2(x + 5)$ and $\angle CAB = 2(x + 5)$. Then, what type of triangle $\triangle ABC$ is?
6. In an isosceles triangle, the vertex angle is 6° more than one base angle. Find out the measures of all angles of this triangle.
7. Fill up the blank spaces by writing the type of angle that each figure shown here represents.



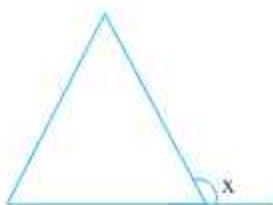
(a)



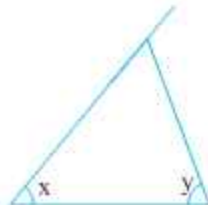
(b)



(c)



(d)

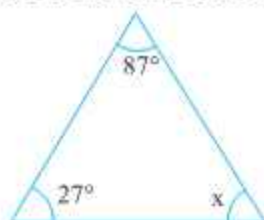


(e)

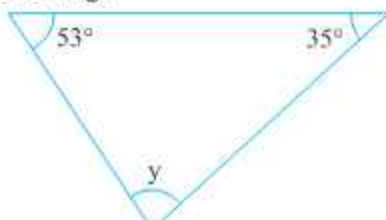


(f)

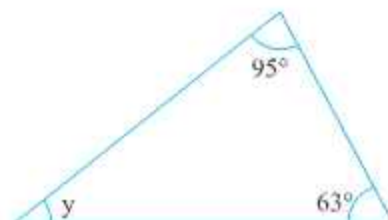
8. What are the two major differences between an equilateral triangle and an isosceles triangle?
9. Find out the value of x and y in the following.



(a)



(b)



(c)

10. The length of two sides of a triangle is 6 cm and 8 cm. Between which two numbers can the length of third side fall?





Right-angled Triangle

A right-angled triangle has one angle of 90° . The other two angles are acute angles, i.e. less than 90° . There cannot be two angles of 90° of each in any triangle. Look at the figure shown here.

Look at the figure shown here. In this figure, OM is the perpendicular, MP is the base and OP is the hypotenuse of $\triangle OMP$. $\angle OMP$ is equal to 90° . The hypotenuse is the longest side of the right-angled triangles. The sides other than the hypotenuse are called **legs** of the right-angled triangle. We can all represent the sides of this triangle by small letters.

Pythagoras theorem

Pythagoras, a Greek philosopher of early sixth century B.C., found a very useful property of right-angled triangles. That property is called **Pythagorean theorem**. In ancient India, the Indian mathematician (Bandhayan) had also given a similar property of right-angled triangles.

According to Pythagoras, **the square of the hypotenuse is equal to the sum of the squares of legs**.

Let us consider a right-angled triangle ABC. So, ABC is right-angled at B. Look at the figure shown here.

AC is the hypotenuse. $\overline{AB}$ and $\overline{BC}$ are the legs. Therefore, according to Pythagoras :

$$(AC)^2 = (AB)^2 + (BC)^2$$

$$\text{Or, } AC = \sqrt{AB^2 + BC^2}$$

Let us draw a triangle with one right angle. The hypotenuse and other two sides have been shown in Figure. The three squares have been drawn on three sides. You can measure the areas of these three squares. They have been marked as a^2 , b^2 and c^2 in the Figure shown here. You can confirm that $a^2 = b^2 + c^2$. Thus, it is a right-angled triangle.



Facts to Know

If the Pythagorean property is valid for a triangle, it must be a right-angled triangle.

Further, note that if $a^2 \neq b^2 + c^2$, then the triangle is not a right-angled triangle. This concept of building squares on the three sides of the right-angled triangle was, in fact, given by Baudhayan, an ancient Indian mathematician.

Pythagorean triplet

Any three positive integers or natural numbers are said to form a Pythagorean triplet if the square of one number is equal to the sum of squares of other two numbers.

Let us consider three numbers : 3, 4 and 5.

$$3^2 = 9$$

$$4^2 = 16$$

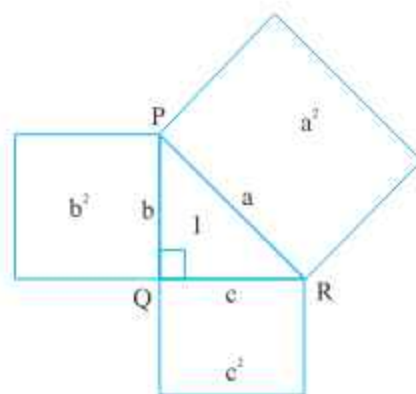
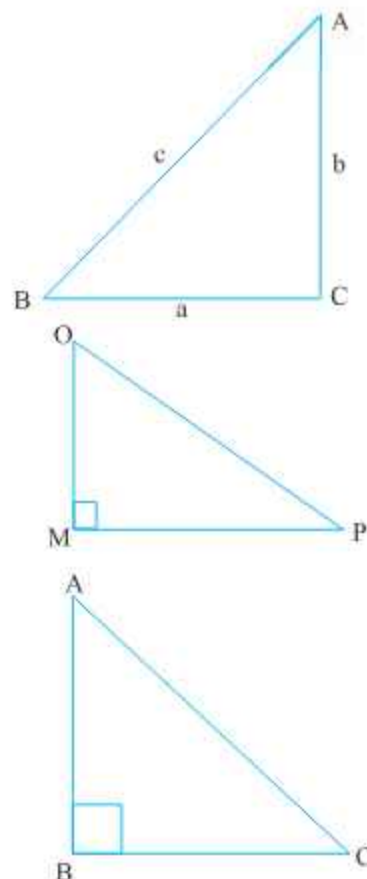
$$5^2 = 25$$

$$25 = 9 + 16$$



Facts to Know

If the sides of a triangle form the Pythagorean triplet, then that triangle is a right-angled triangle.



Thus,

$$25 = 9 + 16$$

$$(5)^2 = (3)^2 + (4)^2$$

Or,

$$(3)^2 + (4)^2 = (5)^2$$

So, 3, 4, 5 form a Pythagorean triplet.

Example 13 : Which one of the following are Pythagorean triplets ?

(a) 15, 10, 25

(b) 16, 12, 20

(c) 2.5, 6, 6.5

Solution : (a) We have three sides : 15, 10, 25

$$(15)^2 = 225$$

$$(10)^2 = 100$$

$$(25)^2 = 625$$

$$(10)^2 + (15)^2 = 100 + 225$$

$$= 325$$

$$325 \neq 625$$

$$(10)^2 + (15)^2 \neq (25)^2$$

Hence, these numbers do not form a Pythagorean triplet.

(b) We have three sides : 16, 12, 20

$$(16)^2 = 256$$

$$(12)^2 = 144$$

$$(20)^2 = 400$$

$$(12)^2 + (16)^2 = 144 + 256 = 400$$

$$\Rightarrow (12)^2 + (16)^2 = 400 = (20)^2$$

$$\Rightarrow (12)^2 + (16)^2 = (20)^2$$

Hence, 12, 16 and 20 form the Pythagorean triplet.

(c) We have three sides : 2.5, 6, 6.5

$$(2.5)^2 = 6.25$$

$$(6)^2 = 36$$

$$(6.5)^2 = 42.25$$

$$(2.5)^2 + (6)^2 = 6.25 + 36$$

$$= 42.25$$

$$(2.5)^2 + (6)^2 = 42.25 = (6.5)^2$$

$$(2.5)^2 + (6)^2 = (6.5)^2$$

Hence, 2.5, 6 and 6.5 form the Pythagorean triplet.

Example 14 : In the figure shown here, $PR = 50$ cm, $SQ = 120$ cm, T is the mid-point of PR and SQ. Further, $SQ \perp PR$. Find out the length of SR and PQ.

Solution : T is the mid-point of PR.

$$\Rightarrow PT = TR$$

$$\text{But } PR = 50 \text{ cm}$$

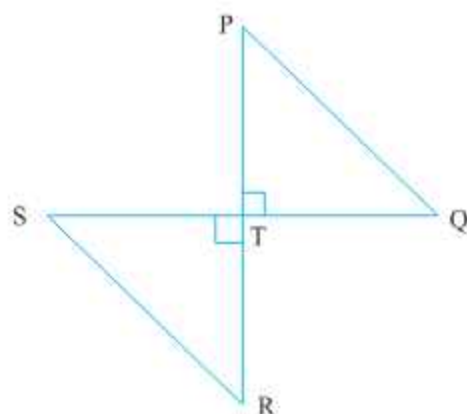
$$\Rightarrow PT = TR = \frac{PR}{2} = 25 \text{ cm}$$

T is the mid-point of SQ.

$$\Rightarrow ST = TQ$$

$$\text{But } SQ = 120 \text{ cm}$$

$$\Rightarrow ST = TQ = \frac{SQ}{2} = \frac{120}{2}$$





$$= 60 \text{ cm}$$

$$\angle PTQ = 90^\circ \text{ (given)}$$

Hence, $\triangle PTQ$ is a right-angled triangle.

Hence, we have:

$$PT^2 + TQ^2 = PQ^2 \quad \dots\dots\dots (i)$$

Here,

$$PT = 25 \text{ cm}$$

$$TQ = 60 \text{ cm}$$

Putting these value in equation (i), we get

$$(25)^2 + (60)^2 = PQ^2$$

$$\Rightarrow PQ^2 = (25)^2 + (60)^2$$

$$= 625 + 3600$$

$$= 4225$$

$$\Rightarrow PQ = \sqrt{4225}$$

$$= 65 \text{ cm}$$

Further,

$$\angle STR = 90^\circ \text{ (given)}$$

$\Rightarrow \triangle RTS$ is a right-angled triangle

$$\Rightarrow RT^2 + TS^2 = SR^2 \quad \dots\dots\dots (ii)$$

$$RT = TR = 25 \text{ cm}$$

$$TS = ST = 60 \text{ cm}$$

Putting these values in equation (ii), we get

$$(25)^2 + (60)^2 = SR^2$$

$$\Rightarrow SR^2 = (25)^2 + (60)^2$$

$$= 625 + 3600 = 4225$$

$$\Rightarrow SR = \sqrt{4225}$$

$$= 65 \text{ cm}$$

The exterior angle of a triangle is equal to the sum of the interior opposite angle.

The exterior angle of a triangle is always greater than either of the interior opposite angle.

Example 15 : In the given figure find the value of exterior angle $\angle PRS$.

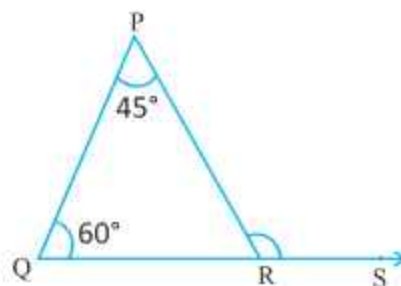
Solution :

$$\Rightarrow \angle PRS = (\angle QPR + \angle PQR)$$

$$\Rightarrow \text{or, } \angle PRS = 45^\circ + 60^\circ$$

$$\Rightarrow \text{or, } \angle PRS = 105^\circ$$

The exterior angle is equal to the sum of the interior opposite angle of a triangle.



Example 16 : $\triangle ACB$ is an isosceles triangle, right-angled at C. Show that $AB^2 = 2AC^2$.

Solution :

In right-angled $\triangle ACB$, $\angle C = 90^\circ$.

Further, the hypotenuse of a right-angled triangle is the longest side of it

So, it cannot be one of two equal sides

$$\text{Hence, } AC = CB$$

That is why it is also an isosceles triangle.

Now since $\triangle ACB$ is right-angled at C, we have :

$$AB^2 = AC^2 + CB^2 \quad \dots\dots\dots (i)$$

But

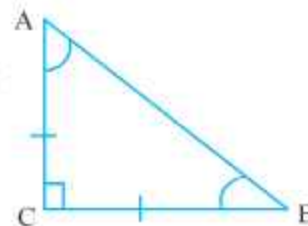
$$AC = CB$$

Put

$$CB = AC \text{ in equation (i)}$$

$\Rightarrow$

$$AB^2 = AC^2 + AC^2 = 2AC^2$$





Example 17 : Find x , if the angles of triangle have measures $(x + 40^\circ)$, $(2x + 20^\circ)$ and $3x$. Also, state which type of triangle this is.

Solution : $x + 40 + 2x + 20 + 3x = 180^\circ$ (angle sum property)

$$\text{or, } 6x + 60^\circ = 180^\circ$$

$$\text{or, } 6x = 120^\circ$$

$$\text{or, } x = 20^\circ$$

$$\text{now, } x + 40^\circ = 20^\circ + 40^\circ = 60^\circ$$

$$2x + 20^\circ = 2 \times 20^\circ + 20^\circ$$

$$= 60^\circ$$

$$3x = 3 \times 20^\circ = 60^\circ$$

The three angles of the triangle is equal. Thus the triangle is an "EQUILATERAL TRIANGLE".

Example 18 : A tree is broken at a height of 5 m from the ground. Its top touches the ground at a distance of 12 m from the base of the tree. Find the original height of the tree.

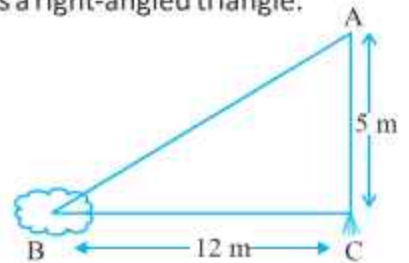
Solution : The fallen tree is making an angle of 90° with the ground. So, ABC is a right-angled triangle.

BC = 12 m and AC = 5 m

$$\begin{aligned} \Rightarrow AB^2 &= BC^2 + AC^2 \\ &= (12)^2 + (5)^2 \\ &= 144 + 25 \end{aligned}$$

$$AB^2 = 169 \text{ m}$$

$$\Rightarrow AB = \sqrt{169} = 13 \text{ m}$$



Example 19 : A ladder is 10 m long. It reaches a window that is 8 m above the ground on one side of the road. Keeping its foot at the same point, the ladder is turned to the other side of the road to reach a window whose height is 6 m. What is the width of the road?

Solution : The figure is as follows :

OQ = SQ = length of ladder = 10 m

SR = 6 m and OP = 8 m

In $\triangle SRQ$, $\angle R = 90^\circ$

$$\Rightarrow SR^2 + RQ^2 = SQ^2$$

$$\begin{aligned} \Rightarrow RQ^2 &= SQ^2 - SR^2 \\ &= (10)^2 - (6)^2 \end{aligned}$$

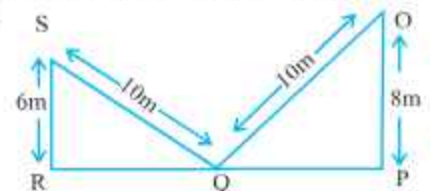
$$100 - 36 = 64$$

$$\Rightarrow RQ = \sqrt{64} = 8 \text{ m}$$

In $\triangle OPQ$, $\angle P = 90^\circ$

$$\Rightarrow OP^2 + PQ^2 = OQ^2$$

$$\begin{aligned} \Rightarrow PQ^2 &= OQ^2 - OP^2 \\ &= (10)^2 - (8)^2 \end{aligned}$$



(Pythagorus Theorem)

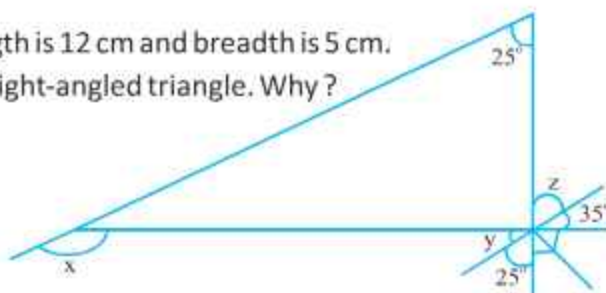


$$\begin{aligned}
 &= 100 - 64 \\
 &= 36 \\
 \Rightarrow \quad &PQ = 6 \text{ m} \\
 \text{Hence, } RP &= \text{length of the entire road} \\
 &= RQ + QP \\
 &= 8 + 6 = 14 \text{ m}
 \end{aligned}$$



Exercise 9.2

1. A man goes 7 km east and then 24 km north. How far is he away from the initial point?
2. In a right-angled triangle, one side is equal to 15 cm and the other equal to 20 cm. Find out length of the hypotenuse side.
3. Find the perimeter of a rhombus whose diagonal measure 16 cm and 30 cm. Note that the diagonal of a rhombus intersect each other at right angles.
4. Find out the length of the diagonal of a rectangle whose length is 12 cm and breadth is 5 cm.
5. A triangle has sides of length 6 cm, 7.5 cm and 4.5 cm. It is a right-angled triangle. Why?
6. Find out the value of x , y and z in the figure shown here.



Points to Remember

- ❖ A triangle is a polygon having three sides. It is a closed figure.
- ❖ The six elements of the triangle are its three sides and three angles.
- ❖ The sum of the angles of a triangle is 180° or two right angles (angles sum property).
- ❖ If we classify triangles on the basis of angles, we have three categories : acute-angled, right-angled and obtuse-angled triangles.
- ❖ If we classify triangles on the basis of side, we have three categories : equilateral, isosceles and scalene triangles.
- ❖ The basic features of triangles are height (perpendicular) base, median, altitude, interior, exterior, interior angle and exterior angles.
- ❖ The exterior angle of a triangle is equal to the sum of its opposite interior angles. (exterior angle property)
- ❖ The length of any two sides of a triangle, if added up, will always be more than the length of the third side. (side sum property)
- ❖ The sides opposite to the equal angles of a triangle are also equal. (equal side property)
- ❖ The angles opposite to the equal sides of a triangle are also equal. (equal angle property)
- ❖ A right-angled triangle has one angle of 90° , a hypotenuse, one base and one perpendicular.
- ❖ A right-angled triangle cannot have more than one angles of 90° measure.
- ❖ The square of the hypotenuse is equal to the sum of the squares of the other two sides or legs. (Pythagorean theorem)
- ❖ If the Pythagorean triplet is valid for a triangle, it is a right-angled triangle.
- ❖ If the square of one side of a triangle equals the sum of squares of the other two sides, then the triangle is a right-angled triangle and also, the angle opposite to the longest side is a right angle. (converse of Pythagorean theorem)



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs) :

Tick (✓) the correct options :

(a) The six elements of a triangle are its three sides and

- (i) One angle ☐ (ii) Two angles ☐
 (iii) Three angles ☐ (iv) None of these. ☐

(b) The figure shown here, $\angle M$ is equal to

- (i) 22° ☐ (ii) 90° ☐
 (iii) 45° ☐ (iv) Cannot be determined. ☐

(c) A triangle ABC has been shown here. Which one of the following is true ?

- (i) $AB + BC = AC$ ☐ (ii) $AC^2 = AB^2 - BC^2$ ☐
 (iii) $AB^2 + BC^2 = AC^2$ ☐ (iv) $\angle C = 90^\circ$ ☐

(d) In a right-angled triangle, the hypotenuse is the :

- (i) Longest side ☐ (ii) Smallest side ☐
 (iii) Sum of the other two sides ☐ (iv) Difference of the other two sides ☐

(e) Is the following set of number a Pythagorean triplet ?

4 5 7

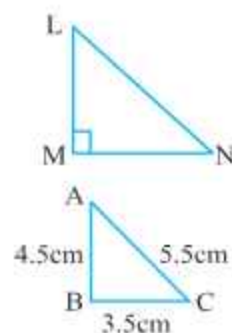
- (i) Yes ☐ (ii) No ☐
 (iii) Cannot be determined ☐ (iv) Need more data. ☐

(f) The angle sum property of the triangle states that

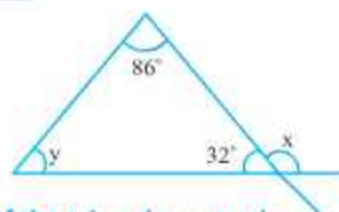
- (i) Three sides are equal ☐ (ii) Two sides are equal ☐
 (iii) Sum of two angles is 180° ☐ (iv) None of these. ☐

(g) The angles of an acute-angles triangle are :

- (i) Less than 90° ☐ (ii) More than 90° ☐
 (iii) Equal to 90° ☐ (iv) None of these ☐



2. Find the measure of x, y in the following figure.



3. Whether $\triangle PQR$ is possible in the following conditions ? Also tell about the type of the triangle so made.

- (a) $PQ = m$ cm and $QR = (m + 3)$ cm
 $RP = (m + 2)$ cm, where $m > 1$ cm
 (b) $PQ = 9$ cm, $QR = 10$ cm and $RP = 11$ cm
 (c) $\angle PQR = 28^\circ 30'$, $\angle QRP = 90^\circ$ and $\angle RPQ = 61^\circ 30'$
 (d) $\angle P = 90^\circ$, $\angle Q = 90^\circ$ and $\angle R = 33^\circ 10'$
 (e) $\angle PQR = x$, $\angle QRP = x + 80^\circ$ and $\angle RPQ = x + 94^\circ$





4. (a) State the angle sum property of triangle.
 (b) Prove that the exterior angle of a triangle is equal to the sum of its interior opposite angles.
5. One of the acute angles of a triangle (having one angle of 90°) is 47° . Find out the measure of the third angle. Is it an acute or obtuse angles?

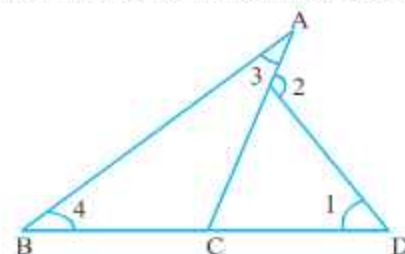
6. In the figure shown here,

$$\angle 1 = 43^\circ$$

$$\angle 2 = 94^\circ$$

$$\angle 3 = 32^\circ$$

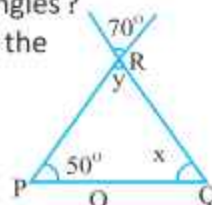
Find out the measure of $\angle 4$.



7. (a) What is the difference between scalene and isosceles triangles?

- (b) State Pythagorean theorem, draw a sketch to illustrate the concept of right-angled triangle given by Bandhayan.

- (c) Find the value of x and y in the figure shown here.



8. Fill in the blanks.

- (a) The angles of a triangle are in the ratio of $2 : 3 : 4$. The angles are _____, _____ and _____.

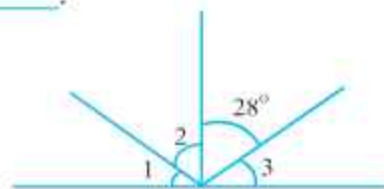
- (b) If x and 107° are vertically opposite angles, then the value of x is _____.

- (c) In the figure shown here,

$$\angle 1 = 25^\circ$$

$$\angle 1 + \angle 2 = 90^\circ$$

So, the sum of $\angle 1 + \angle 2 + \angle 3$ is equal to _____.



- (d) Three angles $60^\circ, 60^\circ, 60^\circ$ are the angles of an _____ triangle.

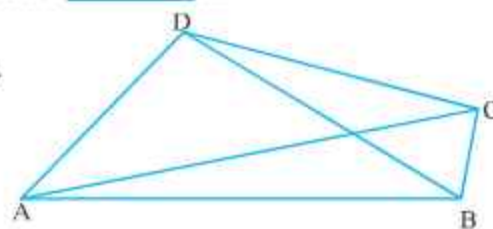
- (e) In a right-angle triangle, the sum of the other two angles is _____.

- (f) The length of a rectangle is 40 m. Its diagonal is 41 m. So, its perimeter is _____ m.

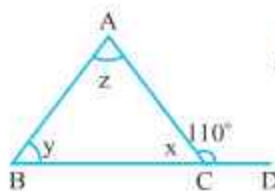
- (g) In a right-angled triangle, the hypotenuse is the _____ side.

- (h) If a, b and c are the three sides of a triangle, $a + b$ is _____ than c .

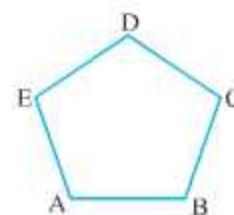
9. In the figure given here, prove that $AB + BC + CD + AD > AC + BD$.



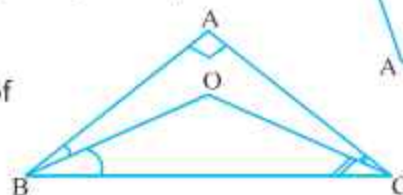
10. In the figure given here, $y : z = 5 : 6$. Further, $\angle ACD = 110^\circ$. Find out the values of x, y and z .



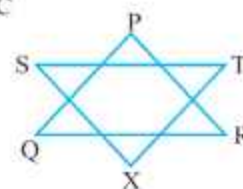
11. Prove that the sum of the interior angles of a regular pentagon is equal to 540° .



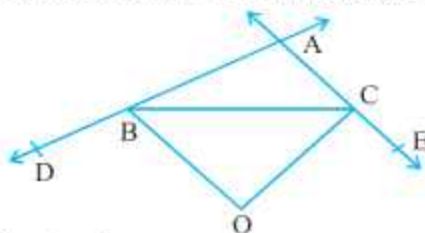
12. In a triangle ABC, right angled at A, the bisectors of $\angle B$ and $\angle C$ meet at O. Find the measure of $\angle BOC$.



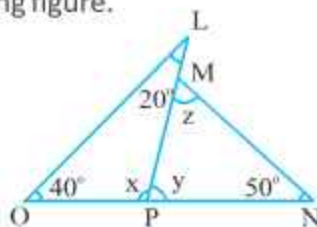
13. In the figure given here, find the sum of all angles that are the vertices of the figure.



14. The length of two sides of a triangle is 5 cm and 11 cm, respectively. Find the maximum and minimum limits of the length of the third side of this triangles.
15. The sides AB and AC of $\triangle ABC$ have been produced up to D and E, respectively. The bisectors of exterior angles at B and C intersect each other at O. Prove that $\angle BOC = 90^\circ - \frac{\angle A}{2}$.



16. Find out the value of x , y and z in the following figure.



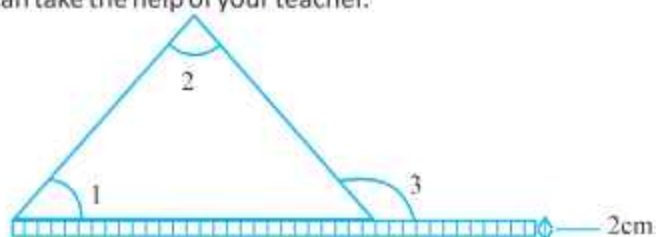
HO-9

Construct an isosceles triangle whose base is equal to 9 cm, and whose altitude from the opposite vertex to the base is 7 cm. [Hint: Altitude of an isosceles triangle divides the base into half.]



Lab Activity

Take a cardboard of size 1 foot by 1 foot. Draw the following figure on it with pencil, scale and compass. You can take the help of your teacher.



Now, cut out the figure from the cardboard sheet. You would get a thick base line, show as shaded part in figure. The solid triangle shape and its step must be cut neatly with the help of a cutter and scale. The base strip can be 2 cm thick.

Now, measure $\angle 1$, $\angle 2$, and $\angle 3$. What do you observe?

Write down your observation here.

I am _____ (name)

My class is _____ (class)

I have observed about $\angle 1$, $\angle 2$ and $\angle 3$ that

.....

Signature



Perimeter is the measure around something. In the previous class we have already learnt about the perimeters of plane figures and areas of squares and rectangles. We learnt that perimeter signifies the distance around a closed figure, whereas area is the part of a plane or region occupied by the closed figure. Here, we will recapitulate what we have learnt last year and will try to learn more about perimeters and areas of some more plane figures.



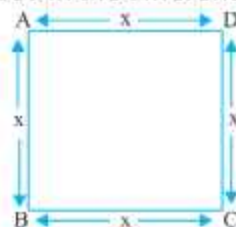
Perimeter

Perimeter is the distance measured around a closed figure. The word perimeter is made of two words **peri** means **around** and **meter** means **measure**. It means perimeter is the measure around something. You will come across many everyday applications of the perimeter. For example, groundmen measure the perimeter of a cricket ground to fix the boundary. As perimeter signifies the distance around a figure, it is expressed in the different units like *m*, *cm*, *km* etc.

Perimeter of a Square

ABCD is a square of side measuring unit

$$\begin{aligned}\text{Perimeter (P)} &= AB + BC + CD + DA \\ &= x + x + x + x \\ &= 4x \\ &= 4 \times \text{side}\end{aligned}$$



Perimeter of a Rectangle

ABCD is a rectangle of length *l* units and breadth *b* units

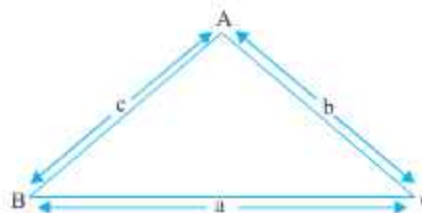
$$\begin{aligned}\text{Perimeter (P)} &= AB + BC + CD + DA \\ &= l + b + l + b \\ &= 2(l + b) \\ &= 2(\text{length} + \text{breadth})\end{aligned}$$



Perimeter of a Triangle

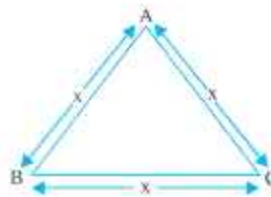
ABC is a triangle with sides measuring *a*, *b* and *c* units.

$$\begin{aligned}\text{Perimeter (P)} &= AB + BC + CA \\ &= c + a + b \\ &= a + b + c \\ &= \text{sum of all sides}\end{aligned}$$



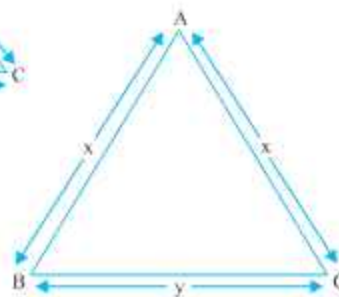
Perimeter of an equilateral triangle (all sides equal)

$$\begin{aligned}&= AB + BC + CA \\ &= x + x + x \\ &= 3x\end{aligned}$$



Perimeter of an isosceles triangle (only two sides equal)

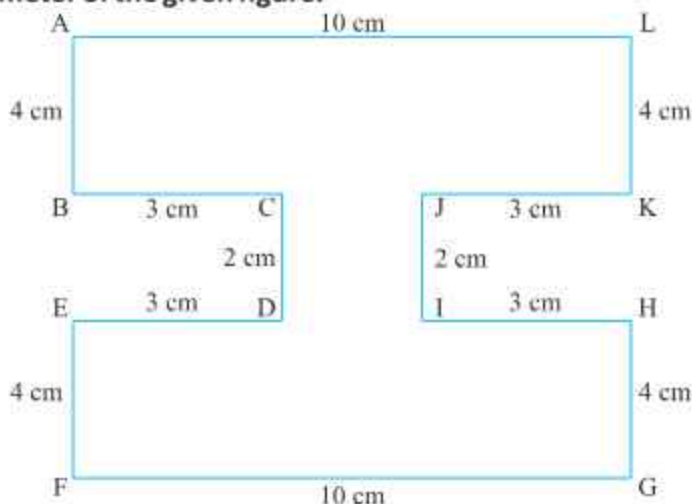
$$\begin{aligned}&= AB + BC + CA \\ &= x + y + x \\ &= 2x + y\end{aligned}$$



Facts to Know

- The perimeter of any figure is the sum of all its sides.

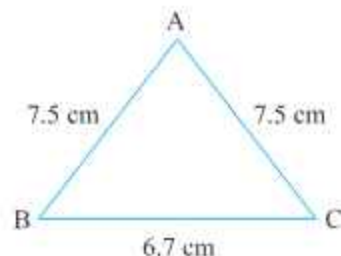
Example 1 : Find the perimeter of the given figure.



Solution : Perimeter = $AB + BC + CD + DE + EF + FG + GH + HI + IJ + JK + KL + LA$
 $= 4 \text{ cm} + 3 \text{ cm} + 2 \text{ cm} + 3 \text{ cm} + 4 \text{ cm} + 10 \text{ cm} + 4 \text{ cm} + 3 \text{ cm} + 2 \text{ cm} + 3 \text{ cm} + 4 \text{ cm} + 10 \text{ cm}$
 $= 52 \text{ cm}$

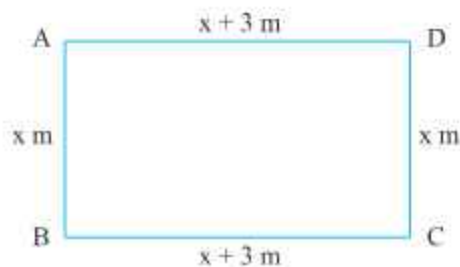
Example 2 : Find the perimeter of an isosceles triangle that has its equal side 7.5 cm and third side 6.7 cm.

Solution : Perimeter of isosceles triangle
 $= AB + BC + CA$
 $= 7.5 \text{ cm} + 6.7 \text{ cm} + 7.5 \text{ cm}$
 $= 21.7 \text{ cm}.$



Example 3 : Find the length and breadth of a rectangle, if its length is 3 m longer than its breadth and its perimeter is 86 m.

Solution : Let the breadth of the rectangle be x .
 Length = $x + 3$ m
 According to the question,
 Perimeter of the rectangle = $2(\text{length} + \text{breadth})$
 $\Rightarrow 86 \text{ m} = 2(x + 3 + x)$
 $\Rightarrow 4x + 6 = 86 \text{ m}$
 $\Rightarrow 4x = (86 - 6) \text{ m}$
 $\Rightarrow x = \frac{80}{4} = 20 \text{ m}$
 Hence, breadth = 20 m and length = 23 m.



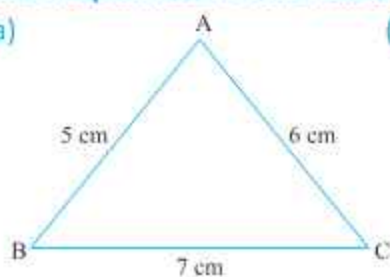
Exercise 10.1

- Find the perimeter of an equilateral triangle with its side measuring 7.2 m.
- Find the perimeter of the rectangles given that
 - length = 7 cm and breadth = 9 cm.
 - length = 3.4 cm and breadth = 5.6 cm.

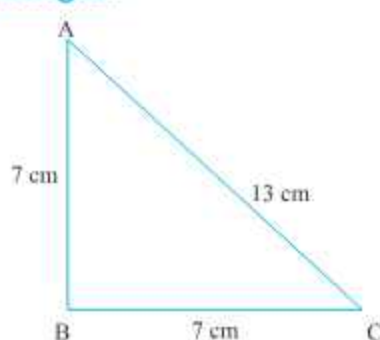


3. Find the perimeter of the following triangles.

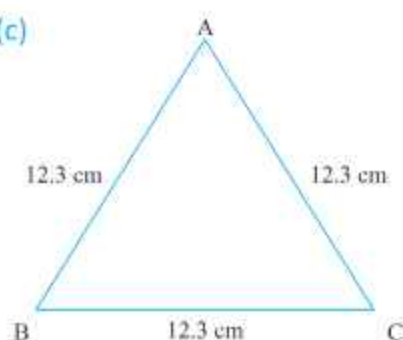
(a)



(b)



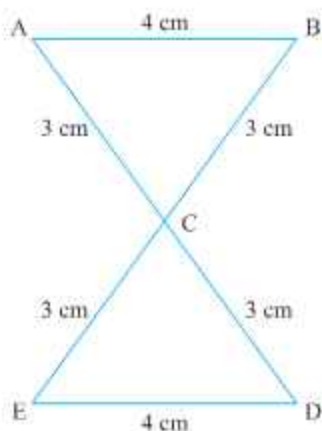
(c)



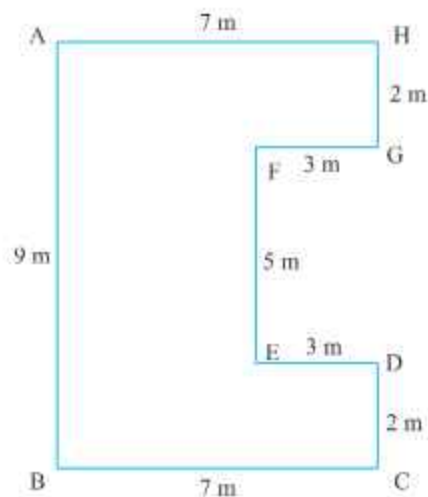
4. If the perimeter of an equilateral triangle is 111m, find the length of each side.
5. The length of equal sides of an isosceles triangle is 16.7 cm. Find the length of third side if its perimeter is 50 cm.
6. The length of a rectangular field is 3 times its breadth. If the perimeter of the field is 96 m, find its length and breadth.
7. The measure of two adjacent sides of a rectangle are in the ratio 4 : 3. If the perimeter of the rectangle is 686 cm, find its length and breadth.
8. Three sides of a triangle are in the ratio 2 : 3 : 4. Find the measurement of each side if its perimeter is 108 m.
9. If the perimeter of a regular pentagon is 105 cm, find the measure of its sides.

10. Find the perimeter of the following figures :

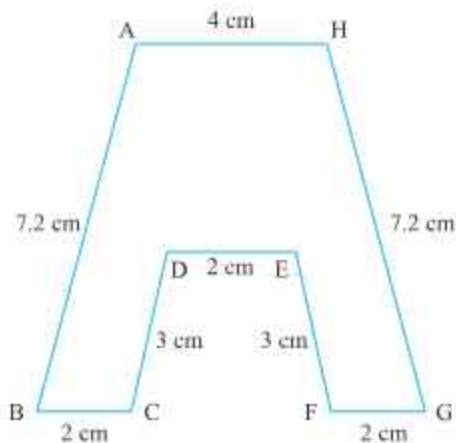
(a)



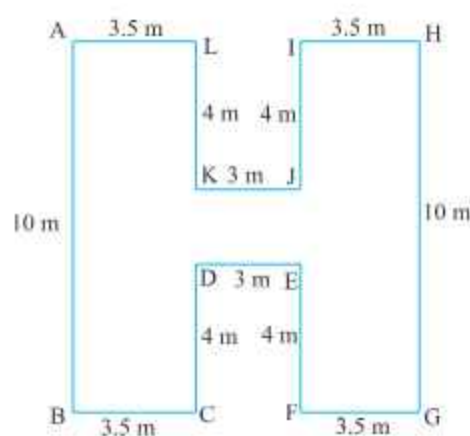
(b)



(c)

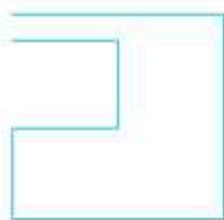


(d)

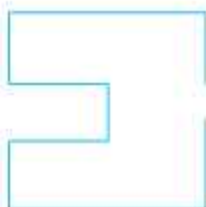




Concept of Area



(a)



(b)



(c)



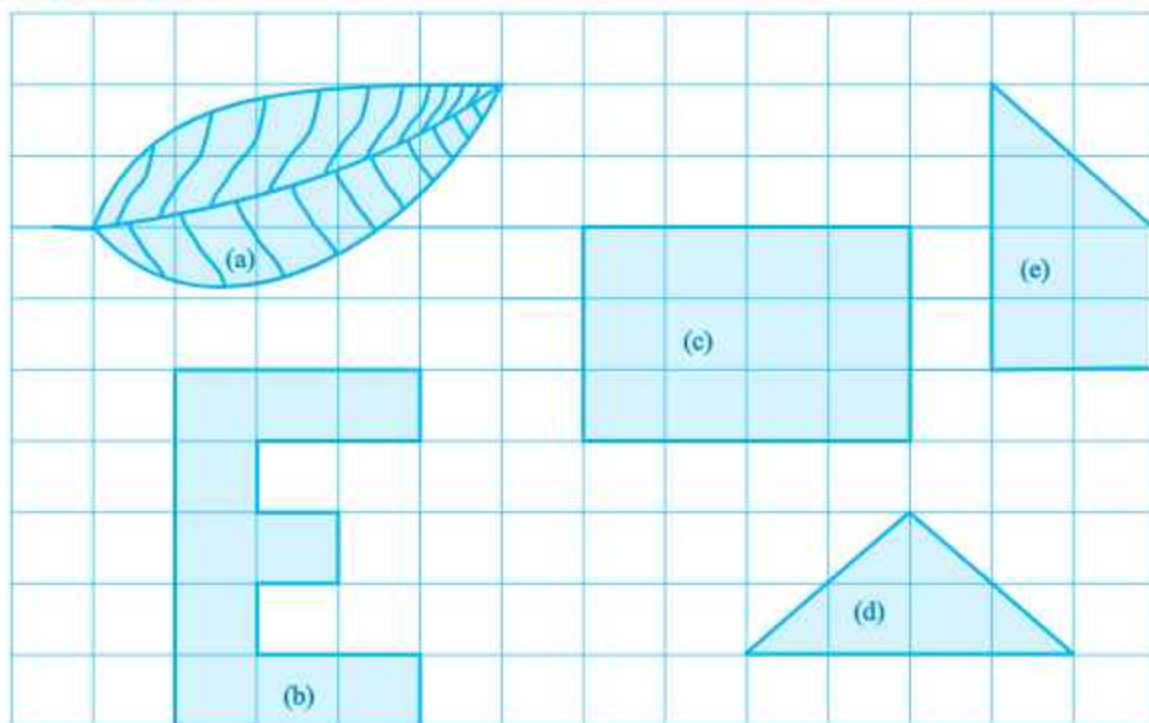
(d)

You are well versed with the concept of area. Do you think the above given figures represent area ?

The answer is obvious. Only figure (d) represents area as it is a closed figure. Rest of the figures are open ended. A closed figure occupies some amount of surface. The amount of the space within a closed figure is called its **area**.

To measure the area of a figure we generally find the numbers of square units contained in the figure. For example, a square that is 1 unit on all sides covers an area of 1 square units. If the unit of measurement is cm, then area is measured in square centimetre. Other area measuring units are like square decimetre, square metre, square kilometre etc. Generally we use square centimetre as standard unit of a square. It is briefly written as sq. cm or cm^2 .

Look at the given figure :



Can you measure the area of the above given shapes? The area of any figure can be measured by counting the number of square units the figure occupied. You can easily measure the area of figures (b) and (c) as the square units fit them evenly. Follow these steps to measure the area of (a), (d) and (e) :

- ❖ Count the full squares.
- ❖ Count the squares as one which are more than half.
- ❖ Neglect the squares which are less than half.
- ❖ Count the half squares as half units.





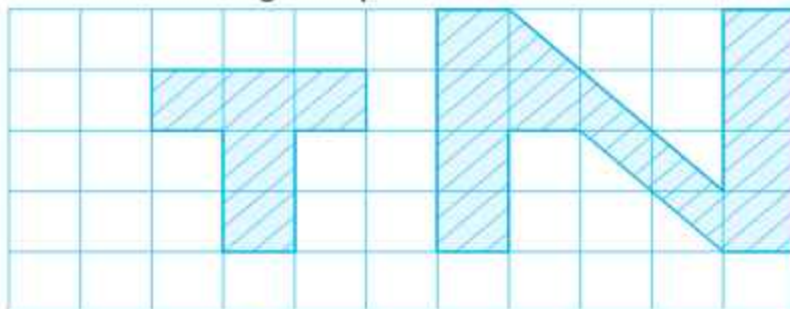
Area of a figure = No. of full squares + $\frac{1}{2} \times$ No. of half squares + No. of squares which are more than half.

Let's find area of each figure separately.

$$\begin{aligned}
 \text{Area of figure (a)} &= 3 + 7 \\
 &= 10 \text{ sq. units} \\
 (\because \text{No. of full squares} &= 3 \text{ and squares more than half} = 7) \\
 \text{Area of figure (b)} &= 10 \text{ sq. units} \\
 (\because \text{No. of full squares} &= 10) \\
 \text{Area of figure (c)} &= 12 \text{ sq. unit} \\
 (\because \text{No. of full squares} &= 12) \\
 \text{Area of figure (d)} &= 2 + \frac{1}{2} (4) \\
 &= 4 \text{ sq. units} \\
 (\because \text{No. of full squares} &= 2 \text{ and half square} = 4) \\
 \text{Area of figure (e)} &= 5 + \frac{1}{2} (2) \\
 &= 6 \text{ sq. units} \\
 (\because \text{No. of full squares} &= 5 \text{ and half squares} = 2)
 \end{aligned}$$

You must be observing that it is difficult to measure the area enclosed by a figure if the square units don't fit into them evenly. Also, it is not always practical to measure the area of a particular figure by counting the number of units as it is not accurate and gives us only an estimated area. Therefore, we use generalised formula to find the area of a closed figure.

Example 4 : Find the area of the given alphabets.

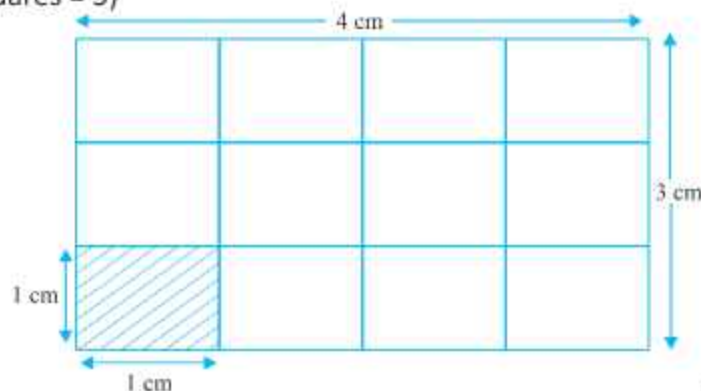


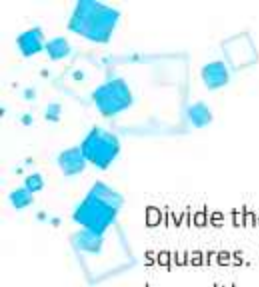
Solution :

$$\begin{aligned}
 \text{Area of alphabet T} &= 5 \text{ sq. units} \\
 (\because \text{No. of full squares} &= 5) \\
 \text{Area of alphabet N} &= 9 + \frac{1}{2} (5) \\
 &= 9 + 2\frac{1}{2} \\
 &= 11\frac{1}{2} \text{ sq. units} \\
 (\because \text{No. of full squares} &= 9 \text{ and half squares} = 5)
 \end{aligned}$$

Area of a Rectangle

Let us take a rectangle with its length and breadth as 4 cm and 3 cm respectively.





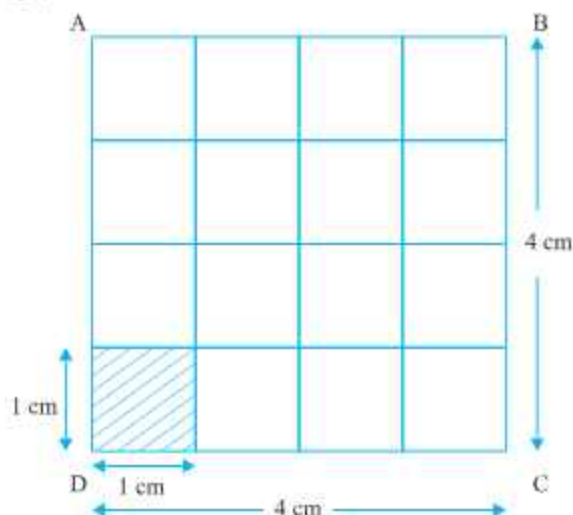
Divide the rectangle into unit squares such that each unit square is of 1 square centimetres. There are 12 such unit squares. We can say that the area of the rectangle is 12 sq. centimetres. Now, find the product of length and breadth of the rectangle and you will find that the product obtained is also 12 square centimetres. Thus, we conclude that,

Area of a rectangle = length $\times$ breadth

or, $A = l \times b$ where ' l ' is the length and b is the breadth.

Area of a Square

Let us take a square of side 4 cm. Divide the square into unit squares such that each unit square is of 1 square centimetre (shown is figure by linings).



There are 16 such unit squares. We can say that the area of the square is 16 square centimetres. Now, find the area of this square by conventional method (i.e., side $\times$ side) and you will find that the area obtained is also 16 square centimetres.

Thus, we conclude that

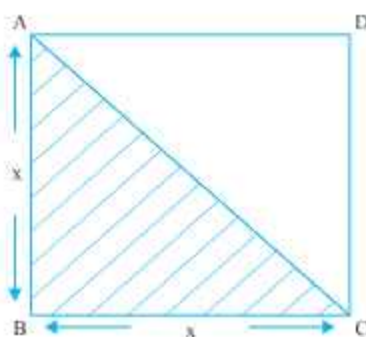
Area of a square = side $\times$ side

$$= \text{side}^2$$

= a^2 , where a is the side of the square.

Area of a Right Isosceles Triangle

Let us take a square ABCD of side x units. Diagonal AC divides it into two congruent-isosceles triangles $\triangle ABC$ and $\triangle ADC$, i.e. $\triangle ABC \cong \triangle ADC$



$$\text{Area of square ABCD} = \text{Area of } \triangle ABC + \text{Area of } \triangle ADC$$

$$\Rightarrow x^2 = 2 \text{ Area of } \triangle ABC$$

$$\Rightarrow \text{Area of } \triangle ABC = \frac{1}{2} x^2$$

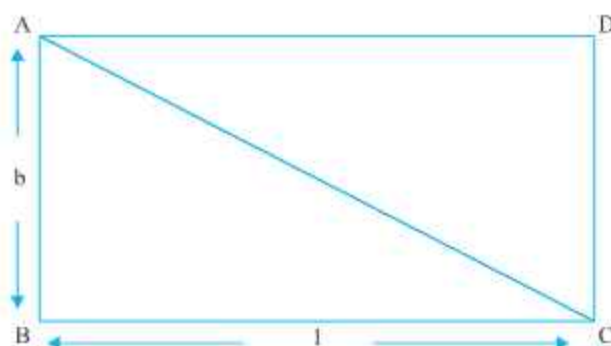
Therefore, the area of right-isosceles triangle is half the square of its base.





Area of a Right-angled Triangle

Let us take a rectangle ABCD with its length and breadth as l units and b units respectively. Diagonal AC bisect it into two congruent right-angled triangle $\triangle ABC$ and $\triangle ADC$, i.e., $\triangle ABC \cong \triangle ADC$

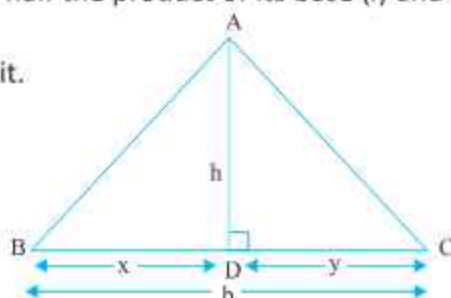


$$\begin{aligned}
 \text{Area of given figure} &= \text{Area of rectangle ABCD} \\
 \Rightarrow \text{Area of } \triangle ABC + \text{Area of } \triangle ADC &= \text{length} \times \text{breadth} \\
 \Rightarrow 2 \times \text{Area of } \triangle ABC &= l \times b \\
 \Rightarrow \text{Area of ABC} &= \frac{1}{2} \times l \times b
 \end{aligned}$$

Therefore, the area of a right-angled triangle is half the product of its base (l) and altitude (b).

Area of a Triangle

Let us take a triangle ABC with its base BC as b unit.



A perpendicular AD measuring h is drawn on line BC, such that it divides base BC into two parts BD and DC measuring x and y respectively. This perpendicular AD represents the altitude of $\triangle ABC$.

Area of $\triangle ABC$ = Area of $\triangle ADB$ + Area of $\triangle ADC$

$$\begin{aligned}
 &= \frac{1}{2} \times BD \times AD + \frac{1}{2} \times DC \times AD \\
 &= \frac{1}{2} \times AD \times (BD + DC) \\
 &= \frac{1}{2} \times h \times (x + y) \\
 &= \frac{1}{2} \times h \times b \quad [\because BC = BD + DC]
 \end{aligned}$$

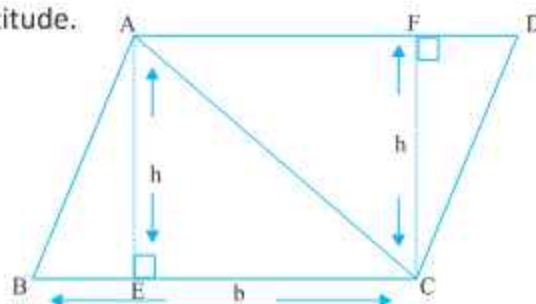
or, **Area of $\triangle ABC$** = $\frac{1}{2} \times b \times h$

Therefore, the area of a triangle is half the product of its base and altitude.

Area of a Parallelogram

Let us take a parallelogram ABCD with its base as b unit. Diagonal AC divide it into two triangle, $\triangle ABC$ and $\triangle CDA$.

Draw $AE \perp BC$ and $CF \perp AD$ as shown in the figure.



Facts to Know

- All the congruent triangles are equal in area but the triangles equal in area need not be congruent.





For a parallelogram ABCD.

$BC \parallel AD$, so $AE = CF$ (say h unit)

And $BC = AD = b$ unit

Area of parallelogram ABCD = Area of $\triangle ABC$ + Area of $\triangle CDA$

$$= \frac{1}{2} \times BC \times AE + \frac{1}{2} \times AD \times CF$$

$$= \frac{1}{2} \times b \times h + \frac{1}{2} \times b \times h$$

$$= b \times h \quad [\because BC = AD \text{ and } AE = CF]$$

or, **Area of a parallelogram** = $b \times h$

Therefore, the area of a parallelogram is the product of its base and altitude.

Example 5 : Find the area of the following :

(a) A rectangle with its sides measuring 16 m and 8 m.

(b) A square with its side measuring 19 m.

Solution : (a) Area of a rectangle = length $\times$ breadth

$$= 16 \times 8$$

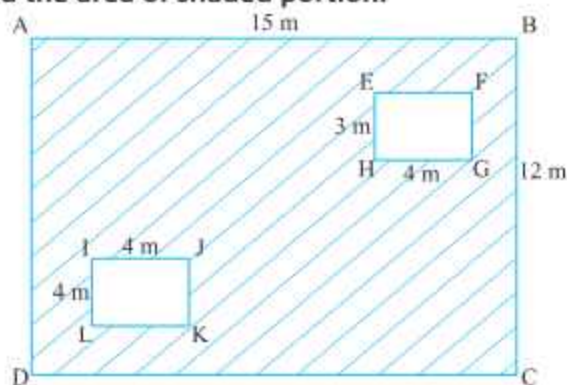
$$= 128 \text{ m}^2$$

(b) Area of a square = side²

$$= 19 \times 19$$

$$= 361 \text{ m}^2$$

Example 6 : Find the area of shaded portion.



Solution : Area of rectangle ABCD = length $\times$ breadth

$$= 15 \times 12$$

$$= 180 \text{ m}^2$$

Area of rectangle EFGH = length $\times$ breadth

$$= 4 \times 3$$

$$= 12 \text{ m}^2$$

Area of square IJKL = side²

$$= 4 \times 4$$

$$= 16 \text{ m}^2$$

Area of shaded portion = Area of rectangle ABCD – (Area of rectangle EFGH + Area of square IJKL)

$$= 180 - (12 + 16)$$

$$= 180 - 28$$

$$= 152 \text{ m}^2$$



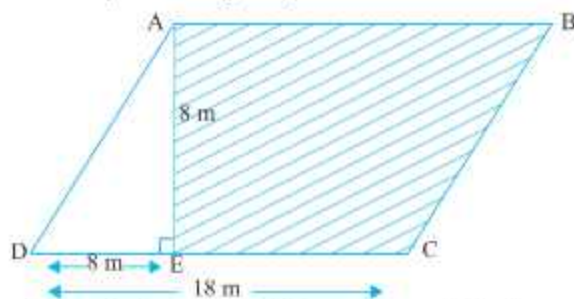
Example 7 : Find the area of a right angled isosceles triangle which has its equal sides measuring 16 m.

Solution : Area of right angled isosceles triangle = $\frac{1}{2} \times (\text{equal side})^2$
 $= \frac{1}{2} \times 16 \times 16$
 $= 128 \text{ m}^2$

Example 8 : Find the area of a rectangular field if its perimeter is 210 m and its length and breadth are in the ratio 4 : 3.

Solution : Let length and breadth of the rectangle be $4x$ and $3x$ respectively.
 Perimeter of a rectangle = $2 (\text{length} \times \text{breadth})$
 $\Rightarrow 210 \text{ m} = 2 (4x + 3x)$
 $\Rightarrow 7x = 105 \text{ m}$
 $\Rightarrow x = 15 \text{ m}$
 Length = $4x = 60 \text{ m}$ and breadth = $3x = 45 \text{ m}$
 Area of a rectangle = length $\times$ breadth
 $= 60 \times 45$
 $= 2700 \text{ m}^2$

Example 9 : If ABCD is a parallelogram, find the area of the shaded portion.



Solution : Area of parallelogram ABCD = base $\times$ altitude
 $= 18 \times 8$
 $= 144 \text{ m}^2$

Area of $\triangle AED = \frac{1}{2} \times \text{base} \times \text{altitude}$
 $= \frac{1}{2} \times 8 \times 8$
 $= 32 \text{ m}^2$

Area of shaded portion ABCD = Area of parallelogram ABCD – Area of $\triangle AED$
 $= 144 - 32 = 112 \text{ m}^2$

Example 10 : The base and the altitude of a triangle are in the ratio 3 : 4 and its area is 1350 m^2 . Find its base and altitude.

Solution : Let the base and the altitude of the triangle be $3x$ and $4x$ respectively.
 Area of a triangle = $\frac{1}{2} \times \text{base} \times \text{altitude}$
 $\Rightarrow 1350 = \frac{1}{2} \times 3x \times 4x$
 $\Rightarrow 6x^2 = 1350$

$$\Rightarrow x^2 = \frac{1350}{6} \text{ m}^2$$

$$\Rightarrow x^2 = 225 \text{ m}^2$$

$$\Rightarrow x = 15 \text{ m}$$

Base = $3x = 45 \text{ m}$ and altitude = $4x = 60 \text{ m}$



Exercise 10.2

1. Find the area of the following rectangles :

(a) Length = 15 m ; Breadth = 8 m

(b) Length = 7.5 m ; Breadth = 6 m

(c) Length = 12 m ; Breadth = 7.5 m

(d) Length = 14.5 m ; Breadth = 4 m

2. Find the area of a square ABCD, given that :

(a) BC = 7.5 m

(b) AB = 13 m

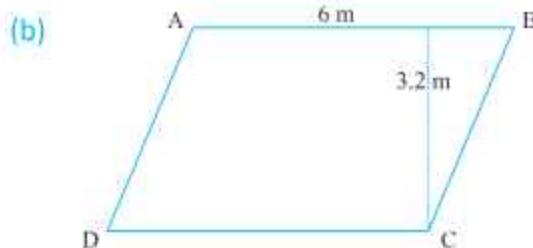
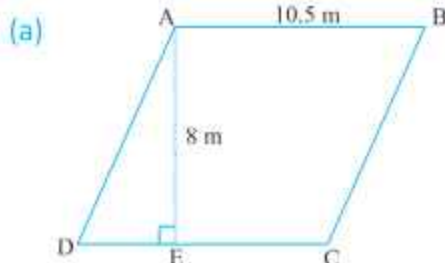
(c) CD = 7.2 m

(d) DA = 12 m

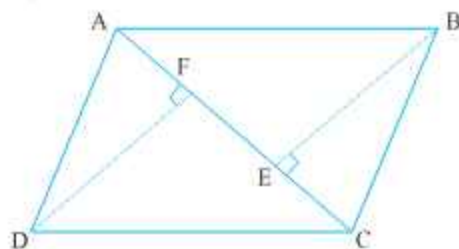
3. Find the area of $\triangle ABC$, right angled at B and AB and BC measuring 16 cm and 10 cm respectively.

4. The cost of ploughing a rectangular field at the rate of ₹4 per m^2 is ₹1280. If the length of the field is 20 m, find its width.

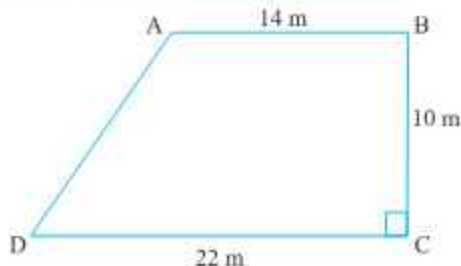
5. Find the area of the following parallelograms.



6. Find the area of a parallelogram ABCD, if AC = 36 m and BE = DF = 12 m.



7. Find the area of the quadrilateral ABCD as shown in the figure.

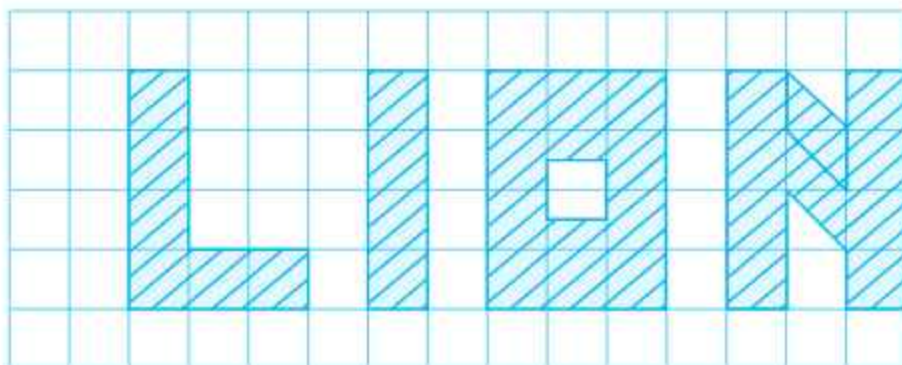


8. The base and the altitude of a parallelogram are in the ratio 3 : 2. Find the measures of its base and altitude if the area of the parallelogram is 3750 m^2 .

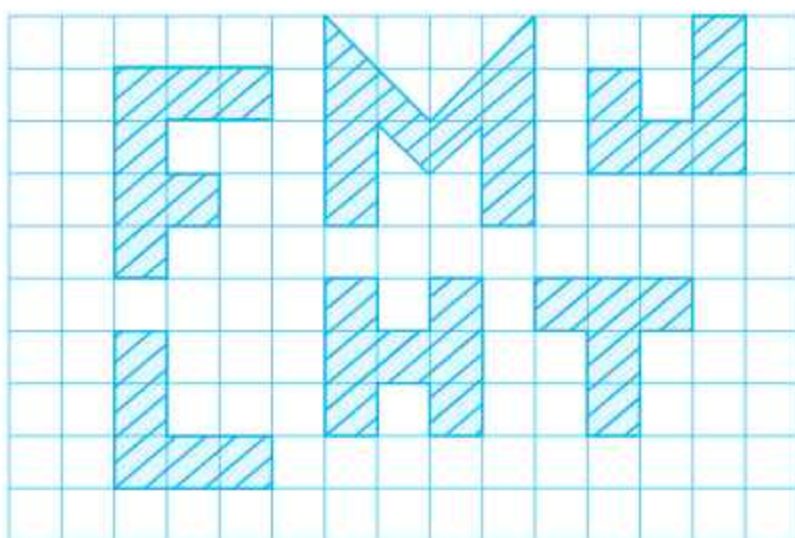




9. Following figure have been drawn on squared paper. Find the area of shaded word (LION). Take each square as 1 cm^2 .



10. Find the area of the shaded alphabets drawn on squared paper. (Take each square as 1 cm^2)

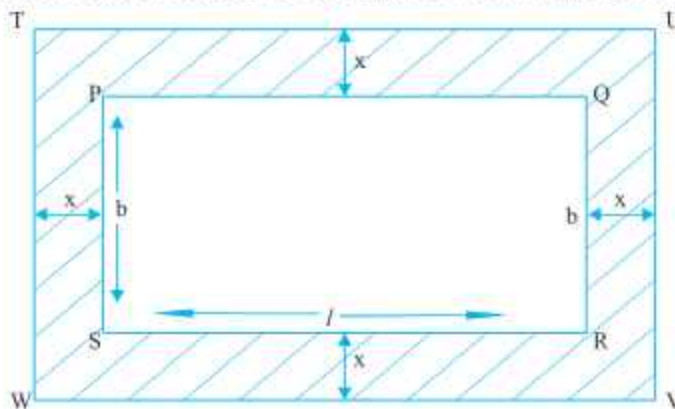


11. The length and breadth of a rectangular field are 64 m and 16 m respectively. If it is exchanged with a square field of the same area, find the side of the square field.
12. The cost of ploughing a triangular field at the rate of ₹ 7 per m^2 is ₹ 6300. If the base of the field is 25 m, find its altitude.



AREA BETWEEN TWO RECTANGLES

Let us take a rectangular field PQRS with length l units and breadth b units. A path of x units width runs around the field as shown below :





Here, length of the outer rectangle TUVW is $TU = x + l + x = l + 2x$

Breadth of the outer rectangle TUVW is $UV = x + b + x = b + 2x$

Area of outer rectangle $= (l + 2x) \times (b + 2x)$

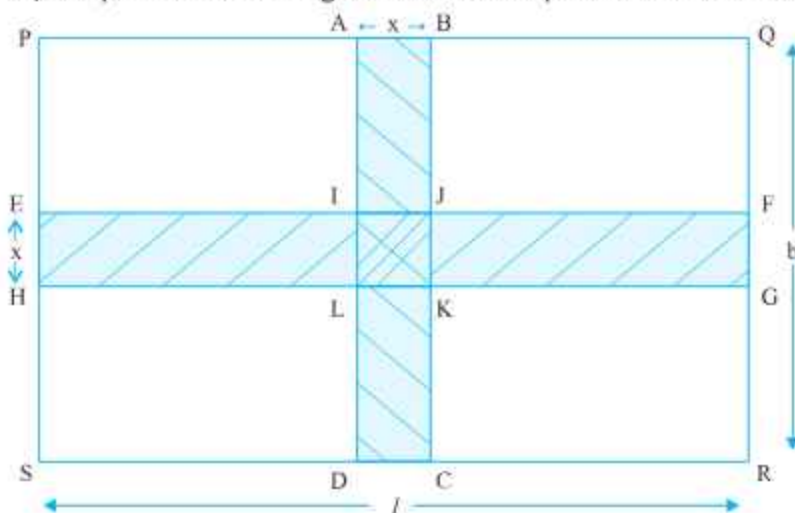
Area of inner rectangle $= l \times b$

Area of path $= \text{Area of outer rectangle} - \text{Area of inner rectangle.}$

$= [(l + 2x)(b + 2x) - l \times b] \text{ sq. units}$

Area of Cross Roads

Let us take a rectangular field PQRS with length l units and breadth b units. Two paths of width x units run across in the middle of a garden, one parallel to the length and the other parallel to the breadth as show in the figure.



Area of path EFGH parallel to length $= l \times x \text{ sq. units}$

Area of path ABCD parallel to breadth $= b \times x \text{ sq. units}$

Here, the total area of the path can not be equal to the sum of the areas of paths along its length and breadth because the area of junction IJKL is added twice.

Hence,

Area of path $= \text{Area of path along the length} + \text{Area of the path along breadth} - \text{Area of junction}$

$= \text{Area of EFGH} + \text{Area of ABCD} - \text{Area of IJKL}$

$= (l \times x) + (b \times x) - (x \times x) \text{ sq. units}$

Example 11 : A rectangular plot measuring $44 \text{ m} \times 25 \text{ m}$ is surrounded externally by a 3 m wide path. Find the area of the path.

Solution : Area of inner rectangular plot

$= 44 \times 25$

$= 1100 \text{ m}^2$

Length of outer rectangle

$= 44 + 3 + 3$

$= 50 \text{ m}$

Breadth of outer rectangle $= 25 + 3 + 3$

$= 31 \text{ m}$

Area of outer rectangular plot $= \text{length} \times \text{breadth}$

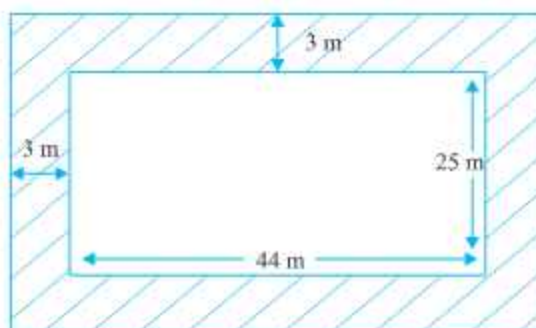
$= 50 \times 31$

$= 1550 \text{ m}^2$

Area of path $= \text{Area of outer rectangle} - \text{Area of inner rectangle}$

$= 1550 - 1100$

$= 450 \text{ m}^2$



Example 12 : A rectangular lawn is $36\text{ m} \times 26\text{ m}$. It has two roads, each 2 m wide running in the middle of it one parallel to the length and other parallel to the breadth. Find the area of the roads.

Solution : Area of path parallel to length

$$= 36 \times 2$$

$$= 72\text{ m}^2$$

Area of path parallel to breadth

$$= 26 \times 2$$

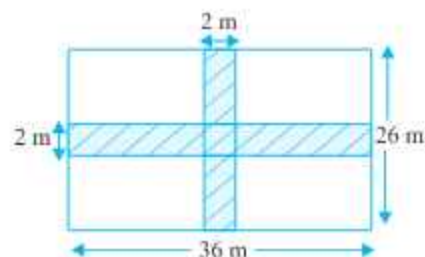
$$= 52\text{ m}^2$$

Total area of path

$$= \text{Area of path along the length} + \text{Area of path along the breadth} - \text{Area of Junction.}$$

$$= 72 + 52 - 4$$

$$= 120\text{ m}^2$$



Example 13 : A path 1.5 m wide is running around a square field whose side is 36 m . Determine the area of the path.

Solution : Area of inner square $= 36^2$

$$= 1296\text{ m}^2$$

Side of the outer square

$$= 36 + 1.5 + 1.5 = 39\text{ m}$$

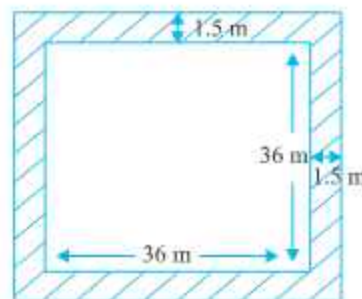
Area of outer square $= 39^2$

$$= 1521\text{ m}^2$$

Area of path $= \text{Area of outer square} - \text{Area of inner square}$

$$= 1521 - 1296$$

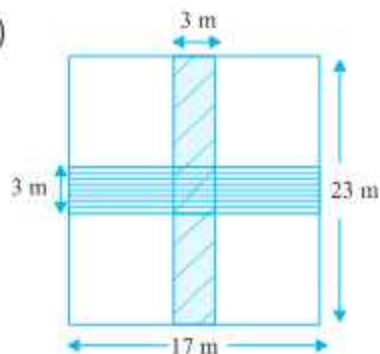
$$= 225\text{ m}^2$$



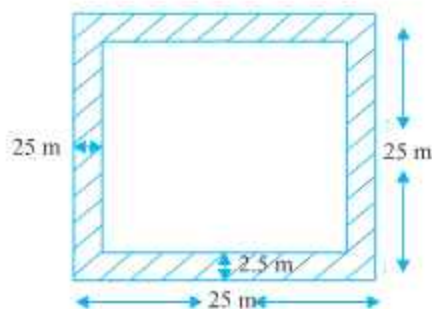
Exercise 10.3

1. Find the area of the path of the following.

(a)

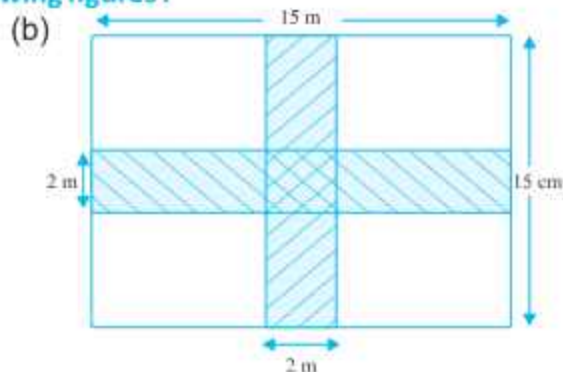


(b)



- A garden is 44 m long and 40 m broad. A path 2.5 m wide is to be added outside around it. Find the area of the path.
- A rectangular field measuring $36\text{ m} \times 24\text{ m}$ is to be surrounded externally by a path which is 2.5 m wide. Calculate the cost of constructing this path at the rate of ₹ 4.5 per m^2 .
- Two paths of 5 m wide running perpendicular to each other in the centre of a rectangular path 80 m long and 70 m wide. Find the area of the remaining park.

5. A 2 m wide flower bed is to be constructed around a football ground of dimension 80 m by 60 m. Find the cost of gardening the beds at the rate of ₹ 8 m².
6. Two crossroads, each of width 4 m, run at right angles through the centre of a rectangular park of length 60 m and width 45 m and parallel to its sides. Find the cost of constructing the roads at the rate of ₹ 225 per m².
7. A sheet of paper measures 36 cm by 24 cm. A strip of 2.5 cm wide is cut from it all round. Find the cost of colouring the remaining sheet at the rate of ₹ 2.5 per cm².
8. A rectangular plot is 50 m long and 45 m broad. A path 4 m wide is to be built all around it along its border. Find the area of the path.
9. Find the area of the shaded region in each of the following figures :

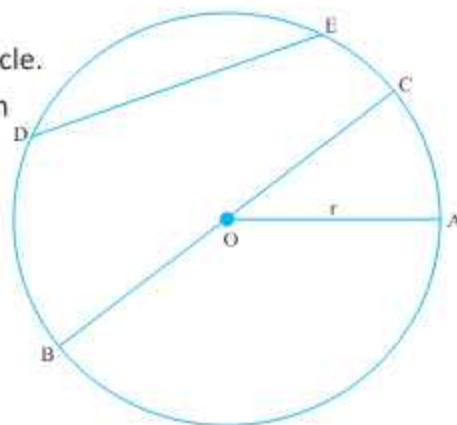


CIRCUMFERENCE OF A CIRCLE

We are well versed with the word 'circle'. Let's recall the basics of circle once again. A **circle** is described as a closed figure in a plane in which all the points on its boundary are equidistant from a fixed point. This fixed point is called the **centre** of a circle. It is generally denoted by O.

Radius is the line segment joining the centre of a circle to any point on the circle.

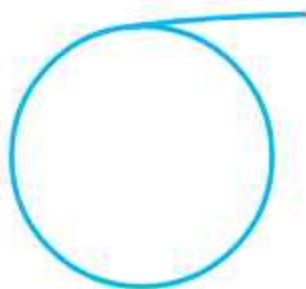
It is denoted by 'r'. **Diameter** of the circle is the line segment passing through the centre of the circle with its end points lying on the circle. It is generally denoted by 'd'. **Chord** of a circle is a line segment joining any two points on a circle. In the given figure is the centre, OA is the radius and BC is the diameter of the circle. DE and BC are the chords of the given circle. In a circle, its diameter is always twice of its radius.



$$d = 2r$$

$$\text{Diameter} = 2 \times \text{radius}$$

The perimeter of a circle is called its **circumference**. It is the distance around a circular region. It is denoted by 'c'.



Let's find the circumference of circular hard-board without using the formula. Put the circular hard-board on a table and put a string around it completely. Now spread this thread as straight line and measure its length using a scale. This measurement is the circumference of the hard-board.

Have a look at the given table. Draw circles of radii 2.5 cm, 3 cm and 3.5 cm and find their circumference by using string. Fill the rest of blanks.





Radius	Diameter	Circumference	Ratio of circumference to diameter
2.5 cm	5 cm	15.714 cm	
3 cm	6 cm		
3.5 cm	7 cm	22 cm	3.14

You will observe that

$$\frac{\text{Circumference}}{\text{Diameter}} = \frac{c}{d} = \text{constant}$$

This ratio is a constant and is denoted by π (pi).

Its approximate value is $\frac{22}{7}$ or 3.14.

Now, $\frac{c}{d} = \text{constant}$

or, $\frac{c}{d} = \pi$

or, $c = \pi d$

or, $c = 2\pi r$ ($\because$ Diameter = $2 \times$ radius)

Thus, **circumference** = $2 \times \pi \times$ radius

Example 14 : The radius of a circular pipe is 28 cm. What length of tape is required to wrap it twice around the pipe?

Solution : Radius of the pipe (r) = 28 cm
 Circumference of the pipe = $2\pi r$
 $= 2 \times \frac{22}{7} \times 28$
 $= 176$ cm

So, length of the tape needed to wrap twice around the pipe = $2 \times 176 = 352$ cm

Example 15 : Julie goes for morning walk daily. If she takes 7 rounds of a circular park of radius 42 m, how much distance does she actually cover?

Solution : Radius of the circular park (r) = 42 m
 Circumference of the park = $2\pi r$
 $= 2 \times \frac{22}{7} \times 42$
 $= 264$ m

So, total distance covered by Julie = $7 \times 264 = 1848$ m

Example 16 : Circumference of a circular boundary is 770 m. How much distance a kid will cover if he has to reach at the centre from the boundary?

Solution : Circumference of circular boundary = 770 m
 $\Rightarrow 2\pi r = 770$

$$\Rightarrow r = \frac{770 \times 7}{2 \times 22}$$

$$\Rightarrow r = 122.5 \text{ m}$$

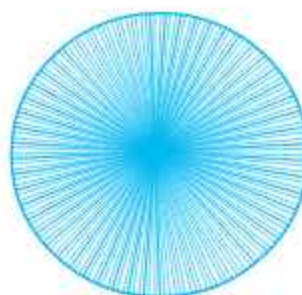
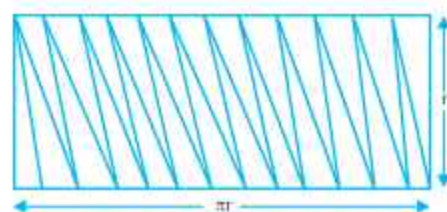
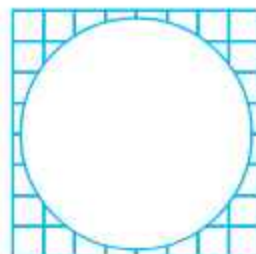
So, the kid will cover 122.5 m to reach at the centre.



AREA OF A CIRCLE

There are more than one method to find the area of a circle. We can find its area by drawing it on a graph paper and counting the numbers of enclosed squares. We only get a rough estimate of the area of circle as its edges are not straight.

Let's see another method of finding the area of a circle. Draw a circle of any measurement and divide it in maximum numbers of sectors and arrange these as shown. It represents almost like a rectangle with length measuring πr and breadth measuring r .



$$\begin{aligned} \text{Area of the circle} &= \text{Area of rectangle thus formed} \\ &= \text{length} \times \text{breadth} \\ &= \pi r \times r = \pi r^2 \end{aligned}$$

Thus, the area of the circle = πr^2 unit²

Example 17 : Find the area of a circular cricket ground whose diameter is 56 m.

Solution : Diameter of the cricket ground (d) = 56 m

$$\text{So, radius (r)} = \frac{56}{2} = 28 \text{ m}$$

$$\begin{aligned} \text{Area of a circle (A)} &= \pi r^2 \\ \Rightarrow &= \pi \times (28)^2 \\ \Rightarrow &= \frac{22}{7} \times 28 \times 28 = 2464 \text{ m}^2 \end{aligned}$$

Thus, area of the cricket ground = 2464 m²

Example 18 : The circumference of a circle is 88 cm. Find its area.

Solution :

Circumference = 88 cm

$$\Rightarrow 2\pi r = 88$$

$$\Rightarrow r = \frac{88}{2\pi}$$

$$\Rightarrow r = \frac{88 \times 7}{2 \times 22}$$

$$\Rightarrow r = 14 \text{ cm}$$



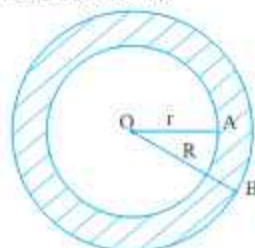
$$\begin{aligned}\text{Area of circle (A)} &= \pi r^2 \\ &= \frac{22}{7} \times 14 \times 14 = 616 \text{ m}^2\end{aligned}$$

Area between two Concentric Circles

Circles with the same centre are called **concentric circles**. Observe the given figure. Both circles, inner circle with radius $OA = r$ and outer circle with radius $OB = R$, have the same centre as O . So, these circles are concentric.

Area of shaded region = Area of outer circle – Area of inner circle

$$\begin{aligned}&= \pi R^2 - \pi r^2 \\ &= \pi (R^2 - r^2) \\ &= \pi (R + r) (R - r) \\ \text{or, } A &= \pi (R + r) (R - r)\end{aligned}$$



Example 19 : The given figure shows two circles with the same centre. The diameter of the larger circle is 36 m and the radius of the smaller circle is 12 m. Find the area of the shaded portion.

Solution : Diameter of the larger circle = 36 m

$$\text{Radius of the larger circle (R)} = \frac{36}{2} = 18 \text{ m}$$

$$\text{Area of the larger circle} = \pi R^2 = \pi \times 18^2$$

$$\text{Radius of smaller circle (r)} = 12 \text{ m}$$

$$\text{Area of the smaller circle} = \pi \times 12^2$$

$$\text{Area of the shaded portion} = \text{Area of larger circle} - \text{Area of smaller circle}$$

$$= \pi \times 18^2 - \pi \times 12^2$$

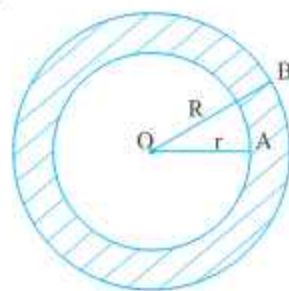
$$= \pi (18^2 - 12^2)$$

$$= \frac{22}{7} \times (18 + 12) (18 - 12)$$

$$= \frac{22}{7} \times 30 \times 6$$

$$= 565.714 \text{ m}^2$$

Thus, the area of the shaded portion = 565.714 m²



Exercise 10.4

1. Find the circumference of a circle whose radius is :

- (a) 28 cm (b) 3.5 cm (c) 10.5 m (d) 4.2 cm

2. Find the circumference of a circle whose diameter is :

- (a) 7 m (b) 4.2 cm (c) 84 m (d) 14 m

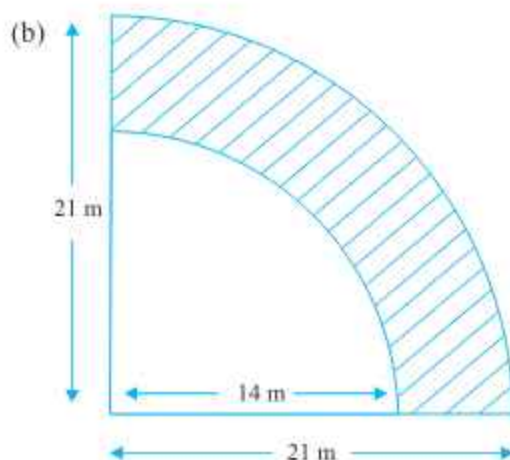
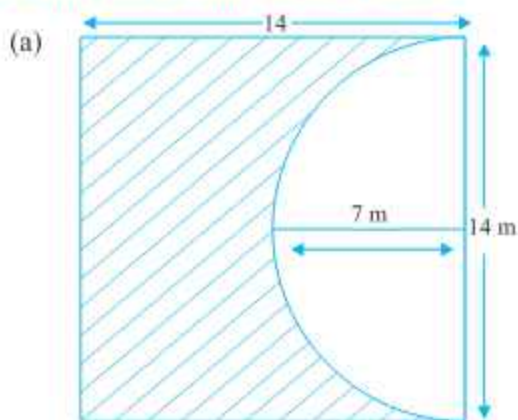
3. If the circumference of a circular sheet is 308 m, find its area.

4. The perimeter of a square-shaped wire is 88 cm. If it is shaped into a circle, find its area.

5. The radius of the given figure is 35 m. Two circles of radii 3.5 m and 2.8 m, and rectangle of length 7 m and breadth 4 m are removed. Find the area of the shaded portion.



6. A circle of radius 10.5 cm is cut out from a square piece of an iron sheet of side 23 cm. What is the area of the left over iron sheet?
7. Two cows are tied with a rope to a pole in the middle of a grass field. The radius of the ropes are 18 m and 11 m respectively. Find the difference in their area covered while grazing the grass.
8. The diameter of the flower bed is 56 cm. If this has to be surrounded by a path 7 cm wide, what is the area of this path?
9. Find the area of a circular ring whose inner and outer radii are 22 cm and 13 cm.
10. Find the area of the shaded portion :



Points to Remember

- Perimeter is the distance measured around a closed figure.
- Perimeter of a square = $4 \times \text{side}$, Perimeter of a rectangle = $2(\text{length} + \text{breadth})$.
- Perimeter of scalene triangle = $a + b + c$, isosceles triangle = $2a + c$ (equal sides measure a), equilateral triangle = $3a$ (all sides measure a)
- Area is the amount of space within a closed figure.
- Area of rectangle = $\text{length} \times \text{breadth}$, Area of square = side^2 , Area of parallelogram = $\text{base} \times \text{altitude}$.
- Area of triangle = $\frac{1}{2} \times \text{base} \times \text{altitude}$
- Area of path around the rectangular field = Area of outer rectangle – Area of inner rectangle.
- Area of crossroads = Area of path along length + Area of path along breadth – Area of junction.
- The ratio of circumference and diameter of any circle is always constant. It is known as π (pie). Its value is $\frac{22}{7} = 3.14$ (approx)
- Circumference of circle = $\pi \times \text{diameter}$.
- Area of circle = πr^2 .
- Area between two concentric circles with radii R and r = $\pi(R^2 - r^2) = \pi(R + r)(R - r)$



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options.

(a) Perimeter of an isosceles triangle is

- (i) $a + b + c$ ☐ (ii) abc ☐ (iii) $a + a + b$ ☐ (iv) $2ab$ ☐

(b) If the side of a square becomes thrice, then its area becomes

- (i) 6 times ☐ (ii) 9 times ☐ (iii) 3 times ☐ (iv) 27 times ☐

(c) If the length of a rectangle is multiplied by 4 and its breadth is divided by 2, the area increases by

- (i) 2 times ☐ (ii) 4 times ☐ (iii) 6 times ☐ (iv) no change ☐

(d) Area of parallelogram is

- (i) $\times \text{side} \times \text{side}$ ☐ (ii) side^2 ☐ (iii) $2(l + b)$ ☐ (iv) $\text{base} \times \text{altitude}$ ☐

(e) The area of a square field is 196 m^2 , its side is

- (i) 13 m ☐ (ii) 14 m ☐ (iii) 56 m ☐ (iv) 49 m^2 ☐

(f) The perimeter of an isosceles triangle with equal sides 14 m and other side 13 m is

- (i) 40 m ☐ (ii) 41 m ☐ (iii) 182 m ☐ (iv) 27 m ☐

(g) The ratio of the radii of two circles is 3 : 4. The ratio of their perimeter is

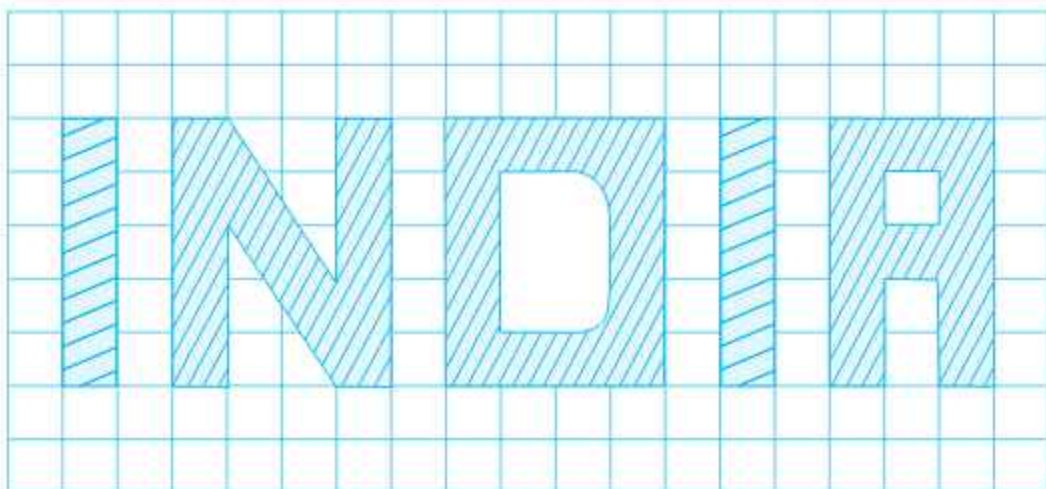
- (i) 9 : 16 ☐ (ii) 16 : 9 ☐ (iii) 4 : 3 ☐ (iv) 3 : 4 ☐

(h) The diameter of a circular lawn whose circumference is 154 m is

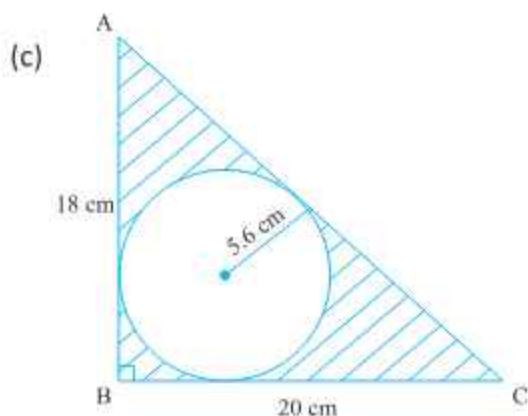
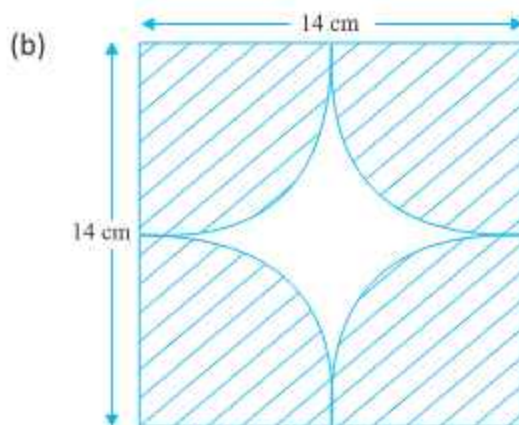
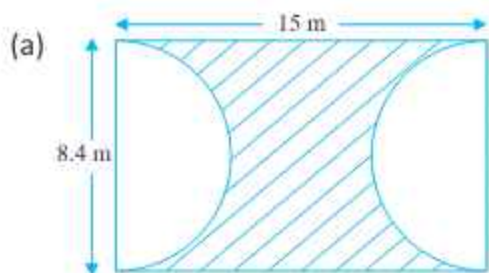
- (i) 14 m ☐ (ii) 28 m ☐ (iii) 49 m ☐ (iv) 50 m ☐

2. The length of a rectangular field is 2.5 times its breadth. If the perimeter of this field is 119 m, find its length and breadth.
3. Three sides of a triangle are in the ratio 3 : 2 : 2. Find the measurement of each side if its perimeter is 84 m.
4. The cost of putting an embankment around a square shaped pond at the rate of ₹ 15/ m is ₹ 3360. Find the measure of its side.
5. Rahul and Shweta are health conscious. Rahul on morning walk takes 5 rounds of a rectangular park measuring 80 m long and 75 m wide. Shweta goes for evening walk and complete 4 rounds of a square shaped garden with side 80 m. Who covers more distance and how much ?
6. Find the area of a rectangle field if its perimeter is 450 m and its length and breadth are in the ratio 5 : 4.
7. The length and breadth of a rectangle are in the ratio 5 : 2. If the area of this parallelogram is 490 m^2 find its perimeter.
8. The side of a square-shaped field is 72 m. Its perimeter is exchanged with a rectangular field of length 48 m. Find the area of this rectangular field.

9. Find the area of the shaded alphabets drawn on squared paper. (Take each square as 1 cm^2)



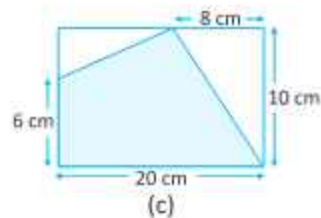
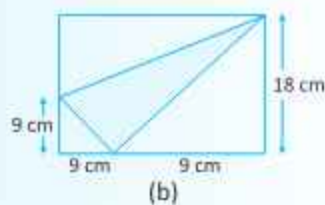
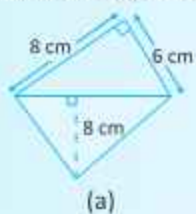
10. A sheet of paper measures 24 cm by 18 cm . A strip of 2 cm is cut from it all around. Find the cost of colouring the remaining sheet at the rate of ₹ 4 per cm^2 .
11. A rectangular park is $80 \text{ m} \times 60 \text{ m}$. It has two footpaths, each 3 m wide running in the middle of it - one parallel to the length and other parallel to the breadth. Find the area of the footpaths.
12. Two paths each of width 5 m , are running perpendicular to each other in the centre of a rectangular park measuring 75 m by 55 m . Find the area of the remaining park.
13. An athlete complete 8 rounds of circular field of radius 105 m . Find the total distance covered by him.
14. Find the area of the shaded portion :





HOTS

Find the area of the shaded portions in each of the following:



Lab Activity

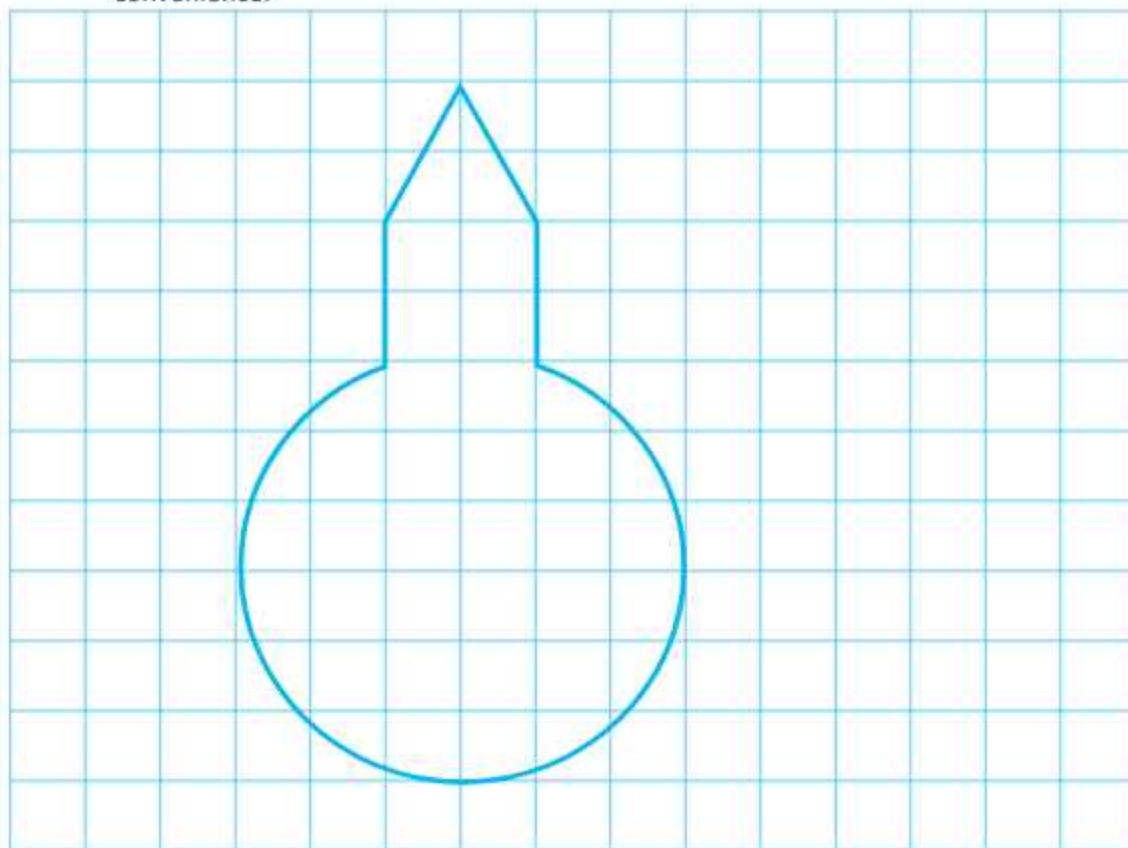
Objective

: To determine the area of closed figures by counting the numbers of squares on a graph sheet.

Materials Required : Graph sheet, pencil.

Procedure : Step 1.

Take a graph sheet and make a closed figure of your choice. A figure is drawn for your convenience.



Step 2.

Count the numbers of full squares. Here it is 22.

Step 3.

Count the squares as one which are more than half. These are 14.

Step 4.

Neglect the squares which are less than half.

Step 5.

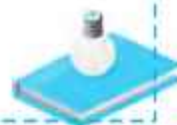
Count the half squares as half units. Here there are none.

Step 6.

Add the counted numbers of step 2, step 3 and step 5.

Step 7.

Area of the given figure = $22 + 14 + 0$
= 35 square units.



Revision Test Paper-III

(Based on Chapters 9 to 10)

A. Multiple Choice Questions (MCQs).

(10)

Tick (✓) the correct option.

- Two angles are said to be supplementary angles, if the sum of measures of two angles is equal to
 (i) 360° (ii) 180° (iii) 90° (iv) 60°
- In a right-angled triangle, the hypotenuse is the _____.
 (i) longest side (ii) smallest side
 (iii) sum of the other two sides (iv) difference of the other two sides
- In a right angle triangle, the hypotenuse is the :
 (i) longest side (ii) smallest side
 (iii) sum of the other two sides (iv) difference of the other two sides
- Pythagoras theorem is applicable for :
 (i) obtuse-angled triangle (ii) right-angled triangle
 (iii) acute angled triangle (iv) equilateral triangle
- In $\triangle XYZ$, the angle opposite of side XY is :
 (i) $\angle X$ (ii) $\angle Y$ (iii) $\angle Z$ (iv) None of these
- Is the following set of number a pythagoreum triplet? [457]
 (i) yes (ii) no (iii) cannot be determind (iv) Need-more data
- The number of lines of symmetry in a circle is :
 (i) 1 (ii) 2 (iii) 3 (iv) None of these
- A corner point where two or more than two edges of a solid meet is called its :
 (i) net (ii) vertex (iii) edge (iv) face
- Sphere is a solid figure which has
 (i) 4 vertices and 4 edges (ii) 6 faces and 8 vertices
 (iii) 4 vertices and 0 edge (iv) No vertex and no edge
- If the side of a square becomes thrice, then its area becomes :
 (i) 6 times (ii) 9 times
 (iii) 3 times (iv) 27 times

B. Fill in the blanks :

1. The diameter of circle is passing through its _____.
2. Perimeter of a rectangle _____.
3. The area of a triangle is half of the product of its _____ and _____.
4. The exterior angle of a triangle is equal to the _____ of its interior opposite angles.
5. The complement of 73° is _____.
6. A triangle having two equal sides and one side different from two equal sides is called _____.
7. Each angle of an equilateral triangle is _____.
8. Sum of two smaller sides of a triangle is _____ than the third side.
9. Value of the constant π is _____.
10. Parimeter of a parallelogram is _____.

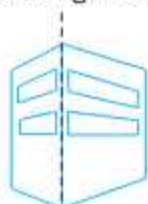
C. Write 'T' for true statement and 'F' for false statement :

(10)

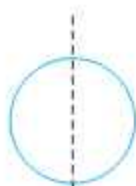
1. A triangular pyramid is also named as a tetrahedron.
2. Area of circle $= \pi r^2$.
3. Area is the amount of space within a closed figures.
4. The sum of two sides of a triangle is equal to the third side.
5. Vertically opposite angles are always equal to each other.
6. Rotational order $= \frac{360^\circ}{x}$, where $x \geq 180^\circ$.
7. If the pythagorean triplet triangle, it is not a right angled triangle.
8. Bisecting a line segments signifies the division of a line segment into two equal parts.
9. The exterior angle of a triangle is not equal to the sum of its opposite interior angles.
10. The triangles having one angle of 90° are called right angled triangles.

Look at the following figures or designs :

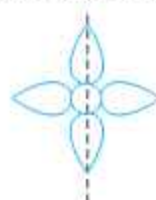
Don't you think these figures or designs have something special about them ? They are uniform in terms of shape.



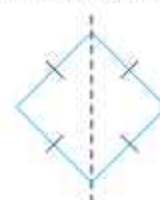
Building



Circle



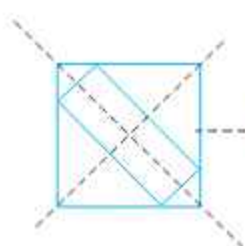
Flower



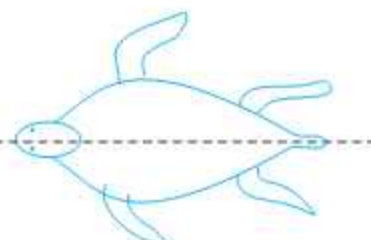
Rhombus



T-Shape



Pattern



Turtle



Leaves on a branch

Dotted lines divide them into two equal halves or two congruent figures. Note that if a geometrical figure is exactly similar to another figure in terms of shape and size, the two figures are congruent to each other. In the figures shown here, the dotted lines are dividing the bigger figure into two exactly equal (congruent) halves. Note that if these figures are folded along their dotted lines, the two halves so obtained will be exactly equal to each other. Such figures are said to have **line symmetry**.



Line Symmetry

We observed the examples of line symmetry in the previous section. We had stated that if the figure is folded along a particular line (axis), it divides the entire figure into two exactly equal halves. This is the concept of line symmetry. We shall define it as follows.

"A figure has line symmetry if there is a line about which the figure may be folded so that its two half parts (formed due to such folding) coincide with each other and are congruent to each other in terms of shape and size." "The line or axis of symmetry is the line around which the figure shows symmetry."

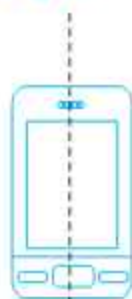
These are the figures which show line symmetry around at least one line or axis of symmetry. They can be folded along that line and we can see two parts, which would be convenient to each other. "A figure that shows line symmetry about at least one line or axis is called **symmetry figure**."



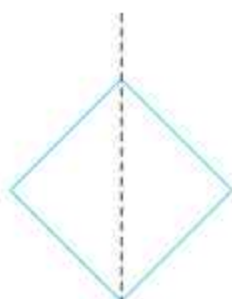
Facts to Know

- The line of symmetry and axis of symmetry are the same.
- The line of symmetry can be horizontal, vertical or slant.

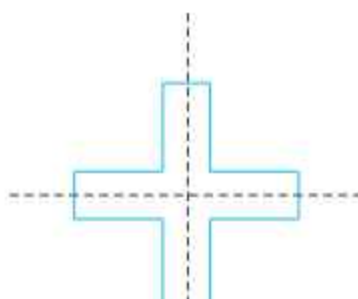
Look at the following pictures. They all show symmetry along at least one line of symmetry: mobile, kite, red cross and triangle:



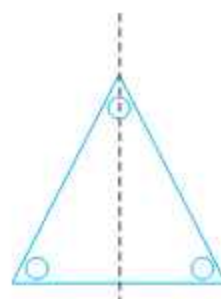
Mobile



Kite



Red Cross



Triangle



Facts to Know

- If only one-half part of a symmetric figure has been given, we can make the other half part easily.
- The number of lines of symmetry of a parallelogram is zero.
- A figure that is symmetrical about a straight line is a mirror image of its own self.



Asymmetrical Figures

We do not always come across nice and symmetrical figures in our everyday life. Look at the following figures.



Seven



Key



Figure



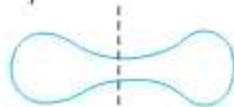
Design

In these figures, if the lines of symmetry are inserted and figures are folded along those lines of symmetry, the two parts of obtained would not coincide with each other. In other words, the two parts would not be congruent to each other. "A figure that displays this property is called **Asymmetric figure**. It means the figure does not have a single straight line about which it is symmetric. It is easily identified as **unshapely**, **odd** and **asymmetric**.



Facts to Know

- Figures with straight lines are not the only ones that can be symmetric. Even curved figures can also be symmetric. Look at these figures.



(a)



(b)



(c)



(d)



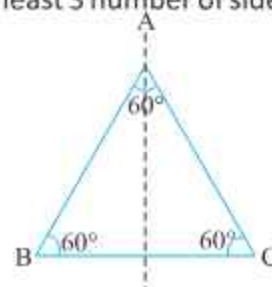
(e)



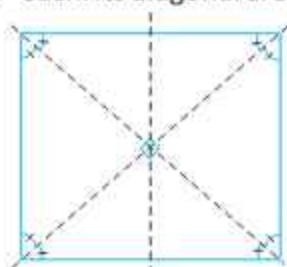
Lines of Symmetry for Regular Polygons

A polygon is a closed figure it has several line segments. A triangle is a polygon that has the least 3 number of sides. A polygon is regular if all its sides are of equal length and all its angles are equal.

Look at the figure here. $\triangle ABC$ is an equilateral triangle. Each one of its angles is 60° . So, it is a regular polygon of three sides (because all of its sides are of equal length). Its line of symmetry has been shown by the dotted line.



Now, look at the following figure. It shows a square, which is a polygon with four sides. It is a regular square (because the length of its sides is equal). Further, all of its angles are 90° each. Its diagonals are the perpendicular bisections of each other.

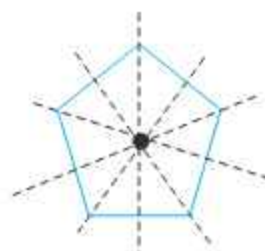


Its four lines of symmetry have been shown in the figure. They also include its two diagonals.

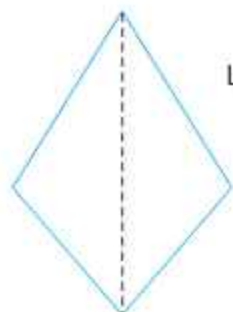
Now, refer to the next figure. It is a regular pentagon, with all five sides equal. It has five angles. It has five lines of symmetry.

Thus, we conclude that the number of lines of symmetry of a regular polygon is equal to the total number of its sides.

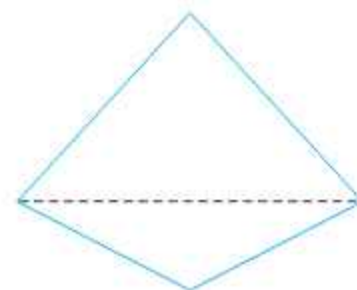
In each one of these cases, we can conclude that if a mirror



is propped along a line of symmetry of any other portion will be shown on its reflection. So, the concept of symmetry is related to mirror reflection. A mirror line helps us understand and imagine the concept of line of symmetry.



Look at this figure, in this figure, the dotted line is a mirror line.

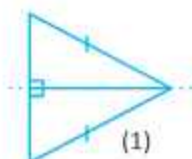


Here, the dotted line is **NOT** a mirror line.

Some Figures and their Lines of Symmetry

The number of lines of symmetry have been given in parentheses.

Isosceles triangle



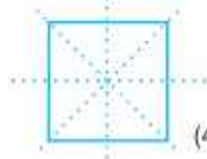
(1)

Circle



(Infinite)

Square



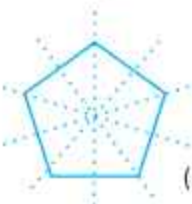
(4)

Rectangle



(2)

Pentagon



(5)

Hexagon



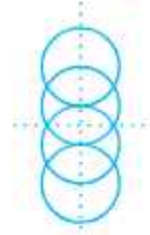
(6)

Kite



(1)

Chain of rings

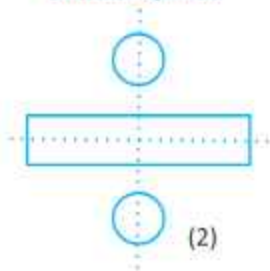


(2)

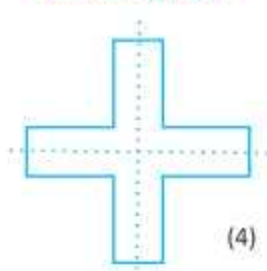




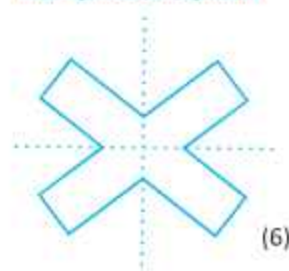
Division symbol



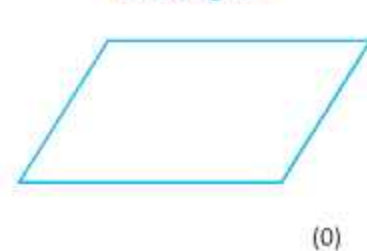
Addition symbol



Multiplication symbol



Parallelogram



(2)

(4)

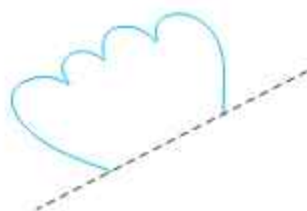
(6)

(0)

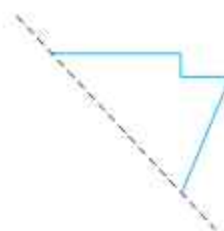
Example 1 : Complete the following figures using the line of symmetry.



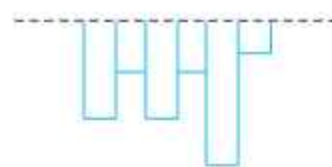
(a)



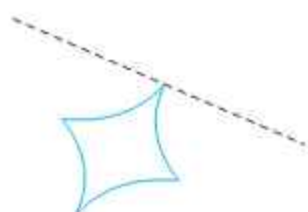
(b)



(c)



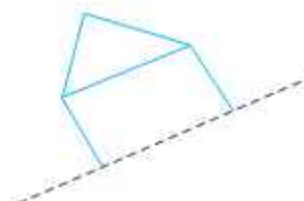
(d)



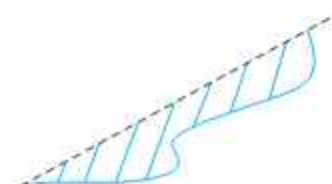
(e)



(f)

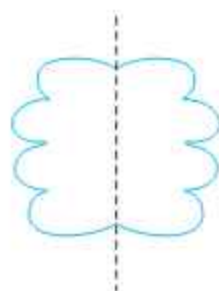


(g)

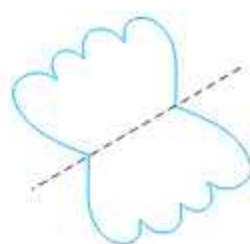


(h)

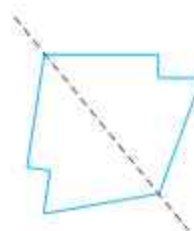
Solution :



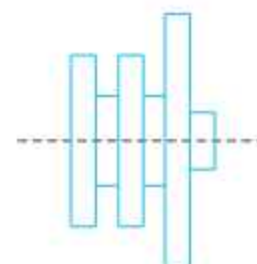
(a)



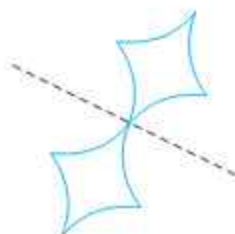
(b)



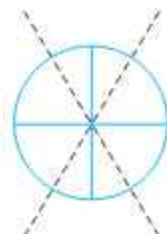
(c)



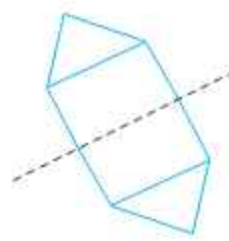
(d)



(e)



(f)



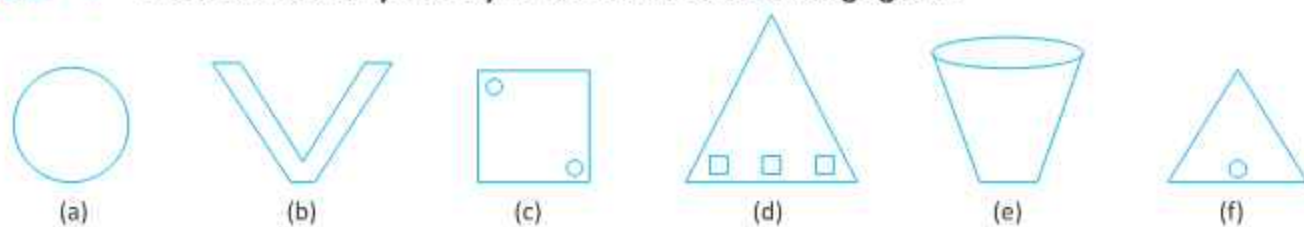
(g)



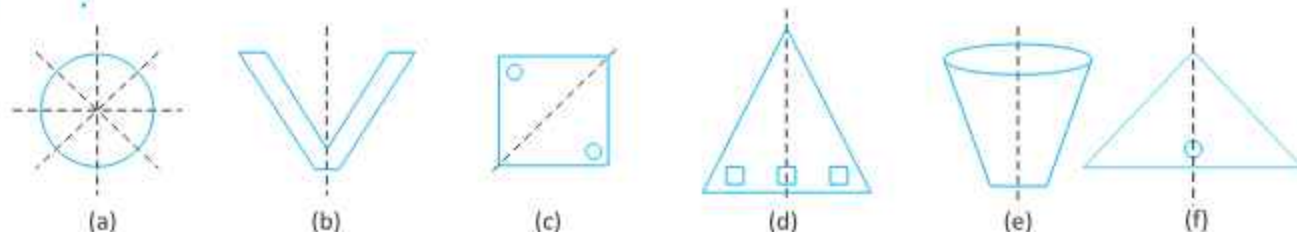
(h)



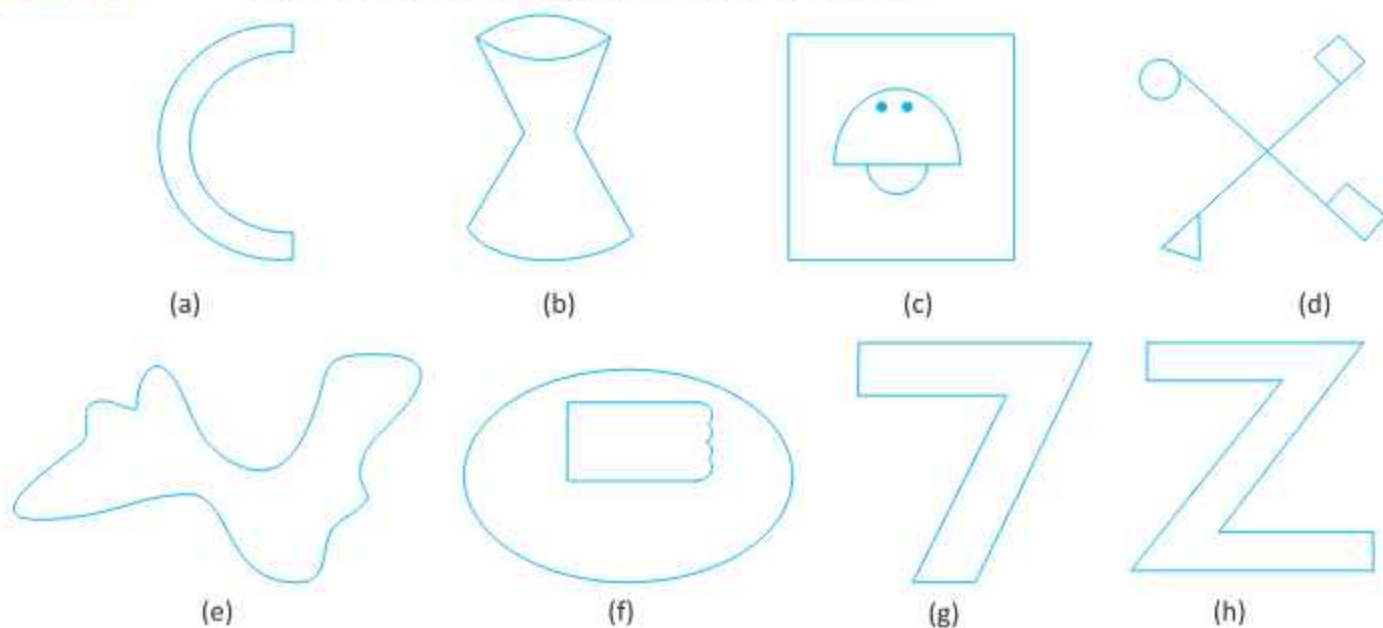
Example 2 : Draw the lines of symmetry in each one of the following figures.



Solution :

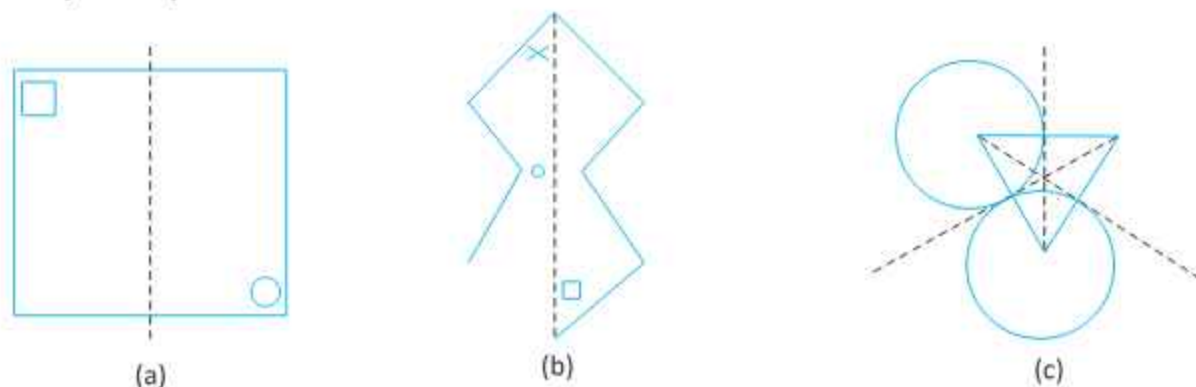


Example 3 : Which ones of the following figures are symmetrical?

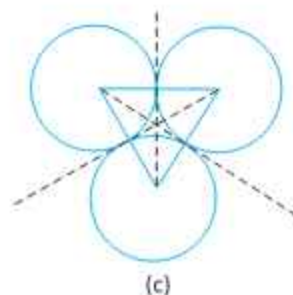
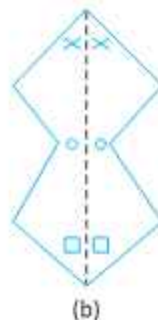
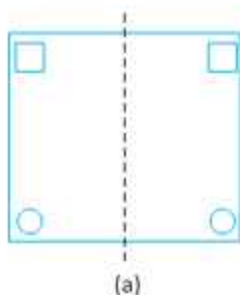


Solution : Except figures (d), (e), (f), (g) and (h), all others are symmetrical about at least one axis. So, figures (a), (b), and (c) are symmetrical.

Example 4 : Complete these figures. The objects missing in the following figures are to be provided to give symmetry to them.



Solution :



Example 5 : How many lines of symmetry are there for each one of the following figures ?

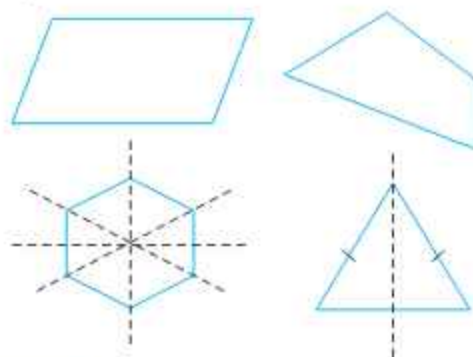
- (a) Parallelogram (b) Quadrilateral (c) Regular hexagon (d) Isosceles triangle

Solution : (a) Parallelograms have not even a single line of symmetry.

- (b) Quadrilaterals do not have a single line of symmetry. They are irregular in most cases. Note that rectangles, squares and rhombuses are special cases of quadrilaterals. So, they have lines of symmetry.

- (c) Regular hexagon has six lines of symmetry.

- (d) An isosceles triangle has one line of symmetry.

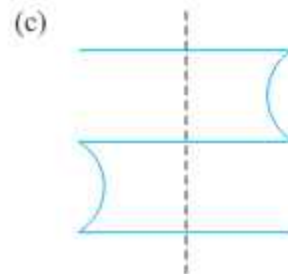
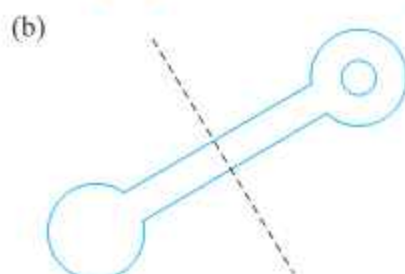
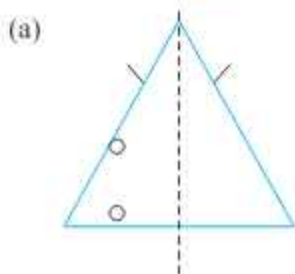


Exercise 11.1

1. How many lines of symmetry are there for each one of the following figures ? Draw sketches, too :

- | | | |
|----------------------|------------------------------|------------------------------|
| (a) Rectangle | (b) Circle | (c) Square |
| (d) Rhombus | (e) Equilateral triangle | (f) Regular pentagon |
| (g) Scalene triangle | (h) The English Alphabet 'X' | (i) A star with six vertices |
| (j) Semi-circle | (k) Kite | (l) Isosceles triangle |

2. Provide the missing parts in the following figures to make them symmetrical.



3. Draw the lines of symmetry for the following letters of the English Alphabet?

A	B	C	D	E	H	M
O	T	U	V	W	X	Y

4. Write 'T' for True and 'F' for False for the following statements.

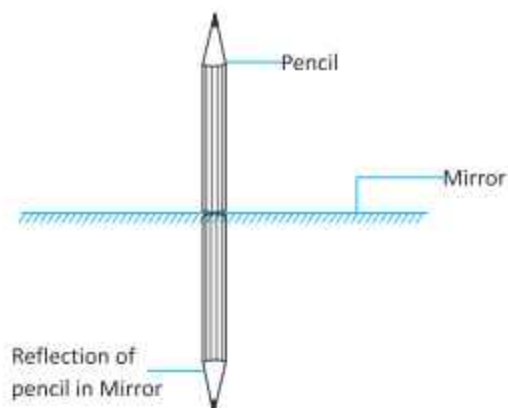
- (a) A semi-circle has an infinite number of lines of symmetry.
- (b) The line of symmetry is different from the axis of symmetry.
- (c) The two halves created by an axis of symmetry are congruent.
- (d) The shape of heart is symmetrical about only one axis.
- (e) The letter Z is not symmetrical about any axis.



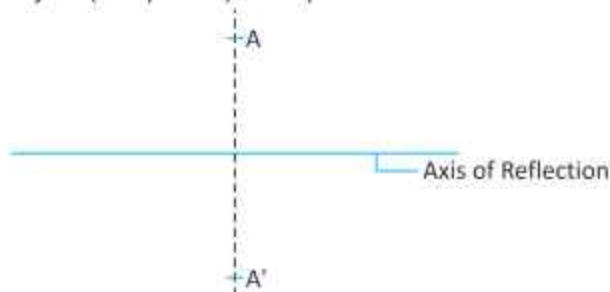
Reflection

Let us assume that a pencil has been placed on a mirror in the erect position. The mirror is lying flat on the table. Look at the figure shown here.

The pencil shown here is exactly equal, in terms of shape and size, to its reflection in the mirror. This reflection is also called **image**. This mirror is acting as an **axis of reflection** or **line of reflection** for the pencil. You have learnt in Class VI that you can construct a point symmetric to a point with respect to a line of symmetry. Now, you will be able to find out a point on the other side of line of reflection using the same principle.

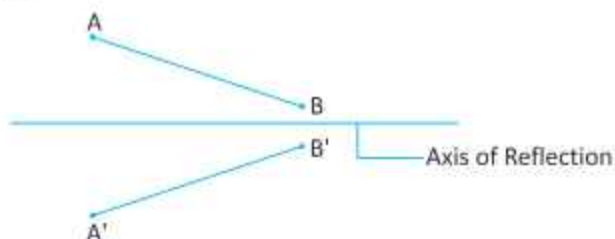


Look at this figure. Here, A is a real object (like pencil). The point A' is a reflected image of the object A.



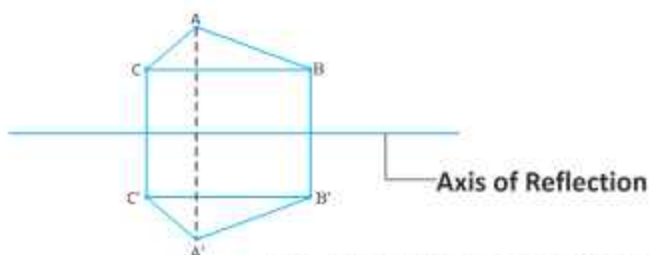
(i) Point Reflection (about x-axis)

We can use the same principle to get the reflection of a line segment AB, along an axis of reflection.



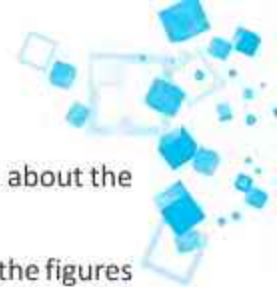
(ii) Line segment reflection (about x-axis)

Look at this figure now. We can use the same principle to make the reflection of a triangle, ABC.



(iii) Triangle Reflection (about x-axis)

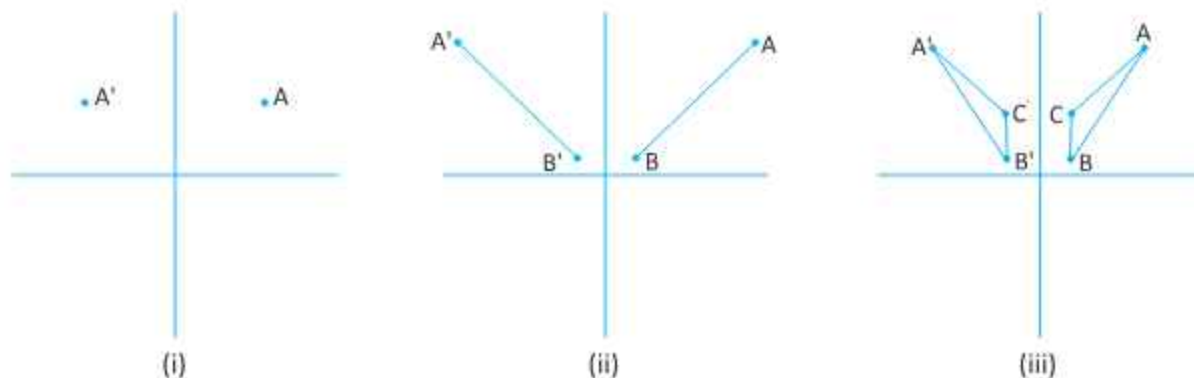




In these three cases, we have reflected a point, a line segment and a triangle along a mirror-like object, about the horizontal axis. It is the case of reflection along the x-axis.

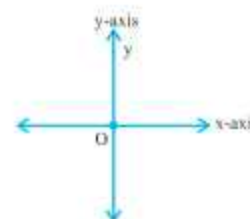
We can get the reflection images of point, line segment and triangle about a vertical axis as well. Look at the figures shown ahead. They show us the three cases of reflection about the vertical axis.

Vertical reflection of point line segment and triangle about vertical axis (y-axis).



Facts to Know

- The point A has two coordinates. The coordinate along x-axis is known as **abscissa**. The coordinate along y-axis is known as **ordinate**. They lie in the xy plane.



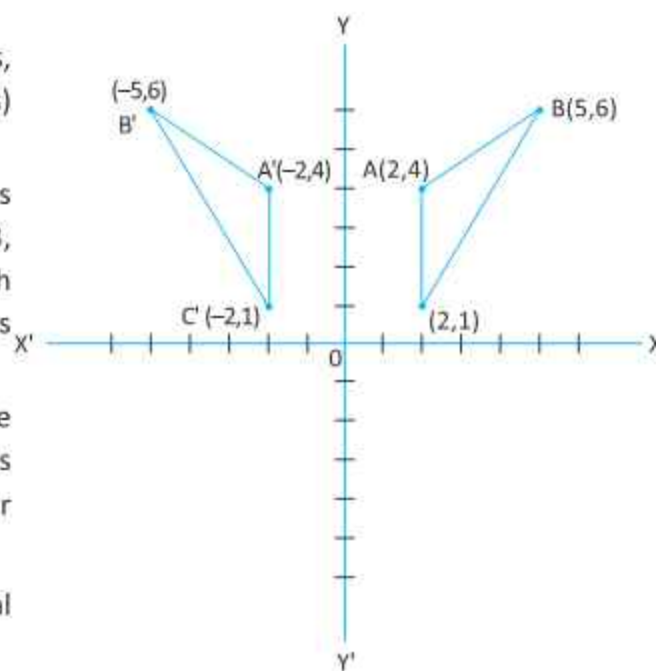
Reflection on an XY-Plane

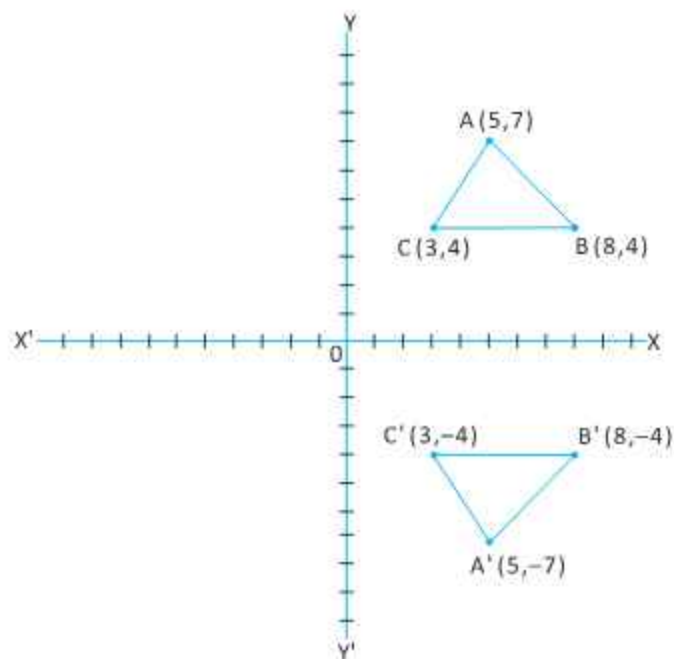
If we want to find out the coordinates of reflected points, line segments or shapes about the horizontal axis (x-axis) or vertical axis (y-axis), we can do so on the graph paper.

Use a graph paper. Draw (x-axis) and (y-axis) on it. Label its grades (0, 1, 2, 3,) on x-axis. Label its grades (0, 1, 2, 3,) on y- axis. Do the same on the negative sides of both axis. Now, plot the following figure about the y-axis (as has been shown). Draw the reflection of the figure as well.

Note that all values of abscissa (points on the x-axis) have changed to negative values. The values of ordinates remain the same. The $\Delta A'B'C'$ is a mirror image or reflection of ΔABC .

Now, let us see the reflection of ΔABC about the horizontal axis or x-axis.





Here, we can see that the abscissa do not change in terms of sign. They remain the same. The values of ordinates are changed. $\triangle A'B'C'$ is a mirror image of $\triangle ABC$ when the reflection is about the horizontal axis (x-axis).

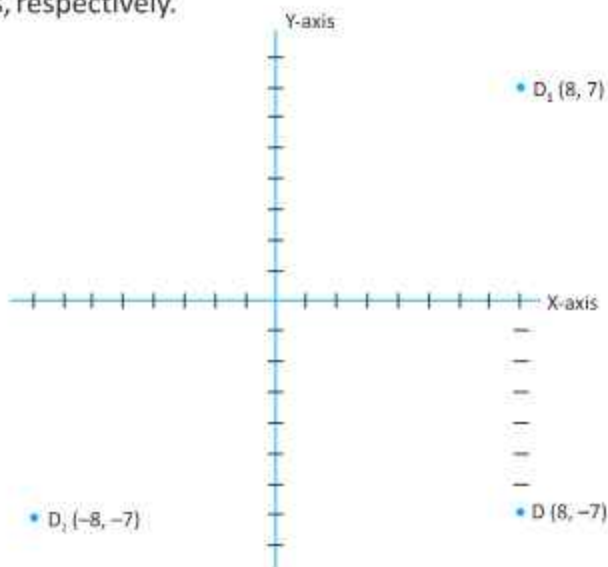


Laws of Reflection

1. Every point on the axis of reflection remains unchanged upon reflection.
2. The shape and size of geometrical figure do not change.
3. If a line is parallel or perpendicular to the axis of reflection, its image will also be parallel or perpendicular to the axis of reflection.
4. The orientation of a figure is reversed upon reflection. Its LHS becomes RHS and vice-versa. If it is pointing upwards, its image points downwards. If it is facing LHS, it seems to be facing RHS in the reflection.

Example 6 : Plot a point $D(8, -7)$ on the graph paper. Then, plot its reflection D_1 , and D_2 , along the x - axis and y - axis, respectively.

Solution :



Example 7 : Draw a point $x(6, 3)$ on a graph paper. Now, draw its reflection on the x -axis as x_1 and on the y -axis as y_1 . What are the coordinates of x_1 and y_1 ? Can you find the coordinates of x_1 and y_1 without plotting them?

Solution : See the graph paper and the reflection of x as x_1 and y_1 .

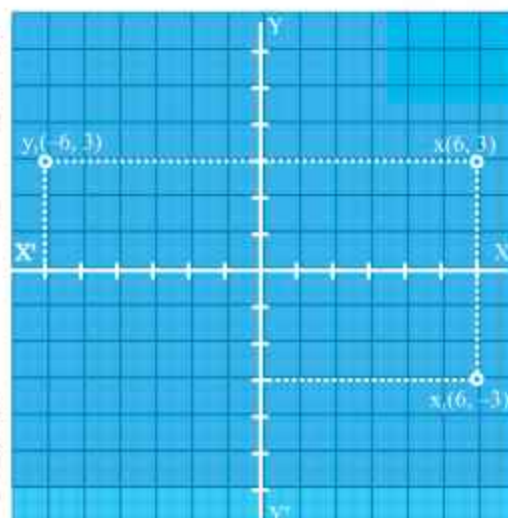
The coordinates of x_1 are $(6, -3)$.

The coordinates of y_1 are $(-6, 3)$.

Yes, we can find out the coordinates of x_1 and y_1 without plotting them on the graph paper. For x_1 , the value of ordinate will be negative, the value of abscissa remaining the same. Hence, $x_1 \leftrightarrow (6, -3)$.

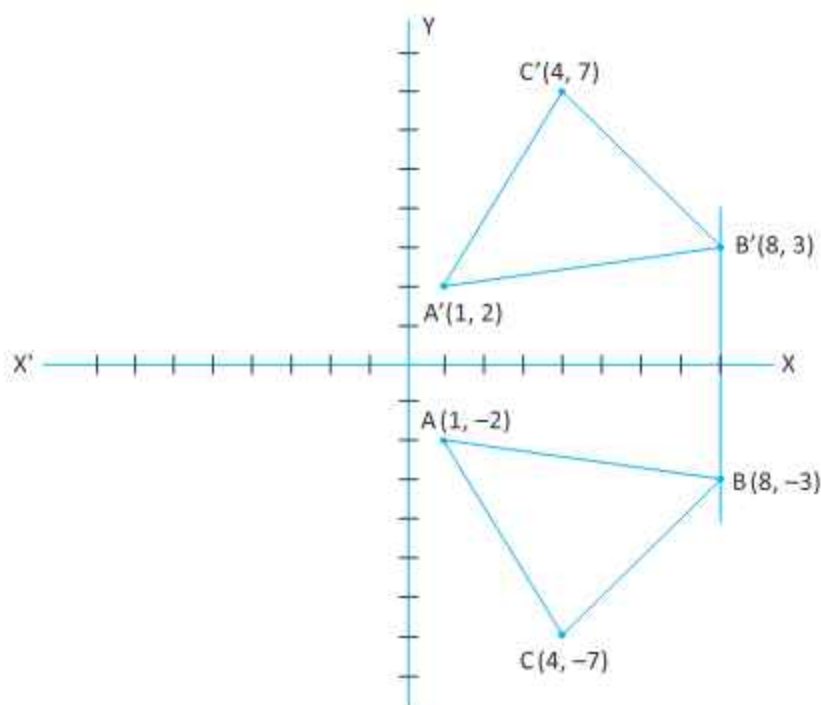
For y_1 , the value of abscissa will be negative, the value of ordinate remaining the same.

Hence $y_1 \leftrightarrow (-6, 3)$.



Example 8 : Find out the coordinates of $\triangle ABC$ where $A \leftrightarrow (1, -2)$, $B \leftrightarrow (8, -3)$ and $C \leftrightarrow (4, -7)$ and the axis of reflection is the x -axis.

Solution :



The reflection of $\triangle ABC$ is $\triangle A'B'C'$.

The coordinates of its vertices are as follows :

$A' \leftrightarrow (1, 2)$

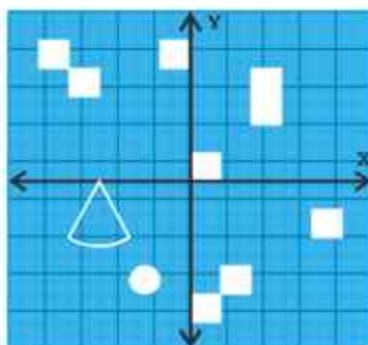
$B' \leftrightarrow (8, 3)$

$C' \leftrightarrow (4, 7)$

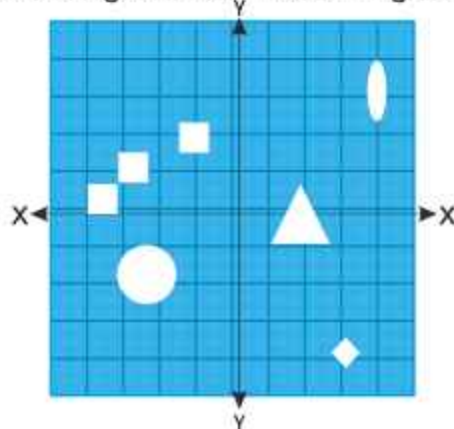


Exercise 11.2

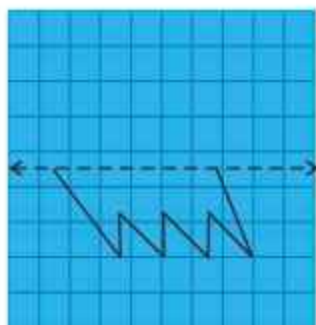
1. Draw three points MNP on the graph paper such that $M \leftrightarrow (4, -7)$, $N \leftrightarrow (8, -9)$ and $P \leftrightarrow (7, -6)$. Draw the reflections of $\triangle MNP$ along horizontal and vertical axis.
2. Assuming that reflection is taking place along the X-axis make this figure symmetrical along the X-axis.



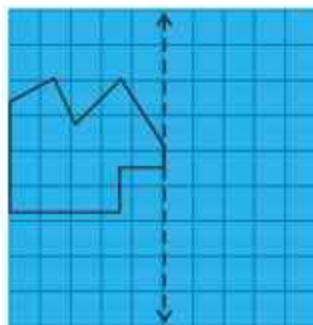
3. Assuming that reflection is taking place along the Y-axis make this figure symmetrical along the Y-axis.



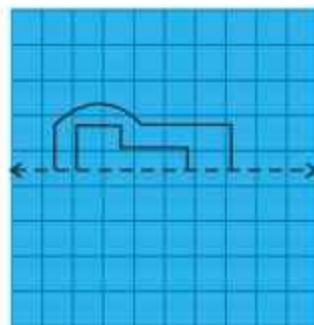
4. Make the following shapes symmetric about the dotted lines.



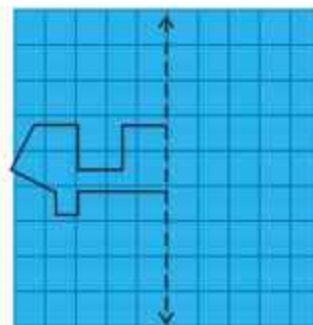
(a)



(b)



(c)



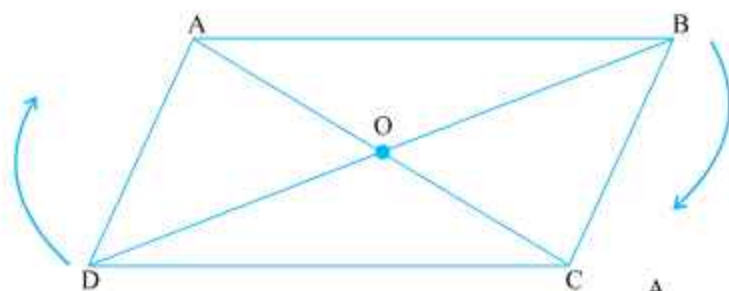
(d)



Point Symmetry

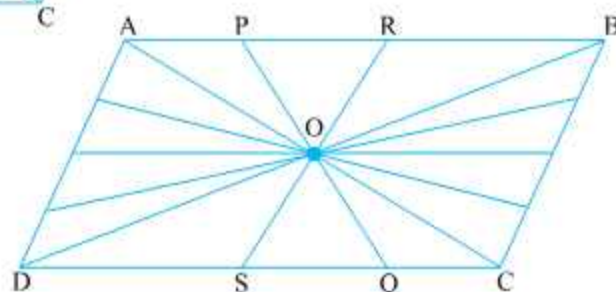
A parallelogram is not a symmetric figure. Because it is not symmetric about any one of its axes. Hence, it is asymmetric about its diagonals and bisectors of its sides.





Let us rotate the parallelogram about the point O, which is the point of intersection of its diagonals. When we do so, we find that it rotates evenly about point O. Hence, we can state that the parallelogram ABCD is symmetrical about point O.

When we go deeper, we find that the point O bisects all line segments that pass through it. So, $AO = OC$, $BO = OD$, $PO = OQ$ and $RO = OS$ and so on.



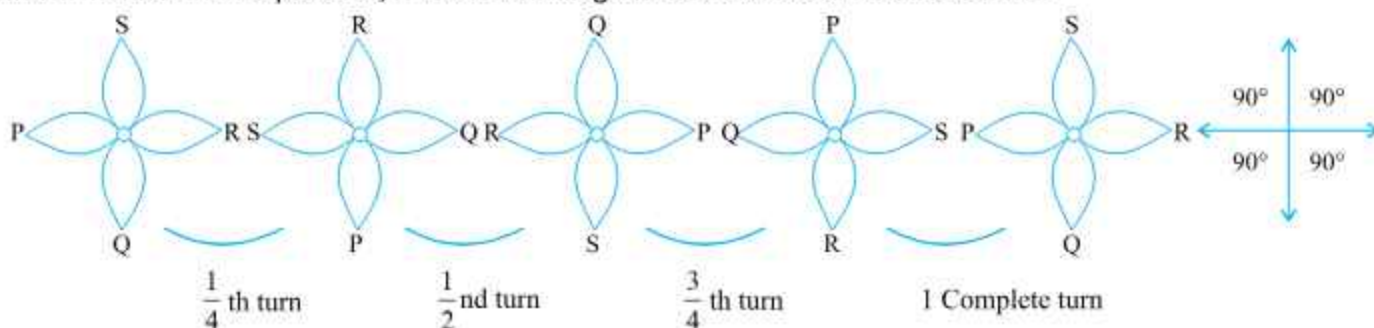
Here, O is called **point of symmetry**.

The size and shape of geometrical figure remains unchanged, if it is rotated by an angle of 360° .



Rotation

You must have seen a fan rotating on the ceiling of your home. It has four blades. These blades evolve around one point. When this fan rotates around a fixed point, called **axis of rotation**, the blades change their position in a uniform manner in the space. So, let us draw a diagram to understand this movement.



With each quarter turn, the single blade moves ahead by an angle of 90° . All other blades naturally move ahead. They all are turning about a point. The axis of rotation passes through a point. The direction of the rotation can be clockwise or anti-clockwise.



Facts to Know

- When an object is rotated about a fixed point, every point on the object rotates through the same angle relative to the fixed point.



Rotational Symmetry and Rotational Order

A figure is said to have rotational symmetry, if it appears to be the same when rotated by an angle of x° , where $x \leq 180^\circ$. Further, the quotient of $\frac{360^\circ}{x^\circ}$ is called **Rotational Order** of the figure.



Let us take up a few examples :

- (a) Rotational order of square = $\frac{360^\circ}{90^\circ} = 4$ 
- (b) Rotational order of triangle = $\frac{360^\circ}{120^\circ} = 3$ 
- (c) Rotational order of parallelogram = $\frac{360^\circ}{180^\circ} = 2$ 
- (d) Rotational order of hexagon = $\frac{360^\circ}{180^\circ} = 2$ 
- (e) Rotational order of letter N = $\frac{360^\circ}{180^\circ} = 2$ 
- (f) Rotational order of letter Z = $\frac{360^\circ}{180^\circ} = 2$ 



Facts to Know

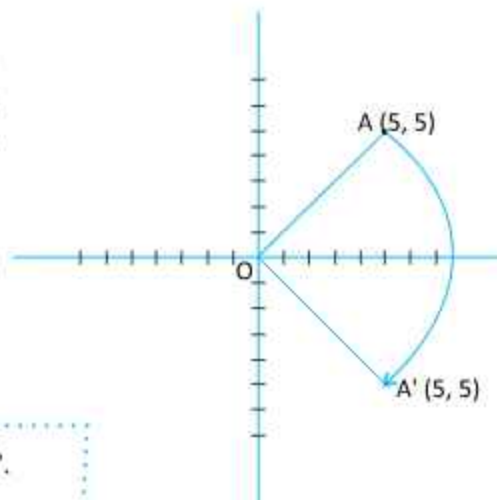
- When an object rotates, its size and shape remain unchanged.



Rotation of a Point

If a point is rotated about a centre, its distance from the centre of rotation remains unchanged. Look at the graph shown here. The point A (5, 5) is rotating in a circle. The centre of rotation is O. The distance OA does not change even as the point A rotates about O.

In the figure given here, the point A is moving in a clockwise direction. Note that anti-clockwise movement of this point about centre O is also possible.



Facts to Know

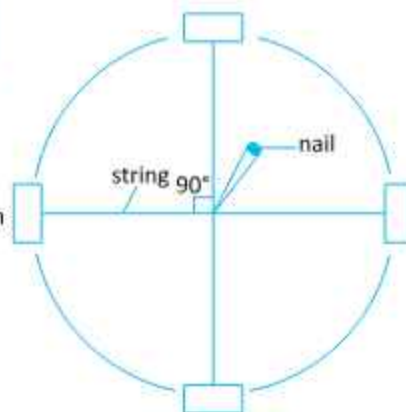
- One complete turn of an object about the point of rotation covers 360° .
So, $\frac{1}{4}$ th turn = 90° .
- As already stated, this movement can be in clockwise and anti-clockwise directions. When A reaches A' it has covered an angle of 90° .



Rotation of Line Segment

Consider a piece of plastic in the rectangle shape for this activity. Now tie the plastic rectangle in the middle with a nylon rope. On a wooden table, nail down the other end of the string. The length of plastic rectangle can be 5 inches. The length of nylon rope can be 10 inches. That depends on the size of table top you have.

Original Position



Rotate the plastic rectangle by 90° in each turn. The position and size of line segments do not change when they rotate about a fixed point. The plastic rectangle gets inverted when it is rotated by an angle of 180° . The same is true for triangles, pencils and polygons.



Laws of Rotation of Line Segments

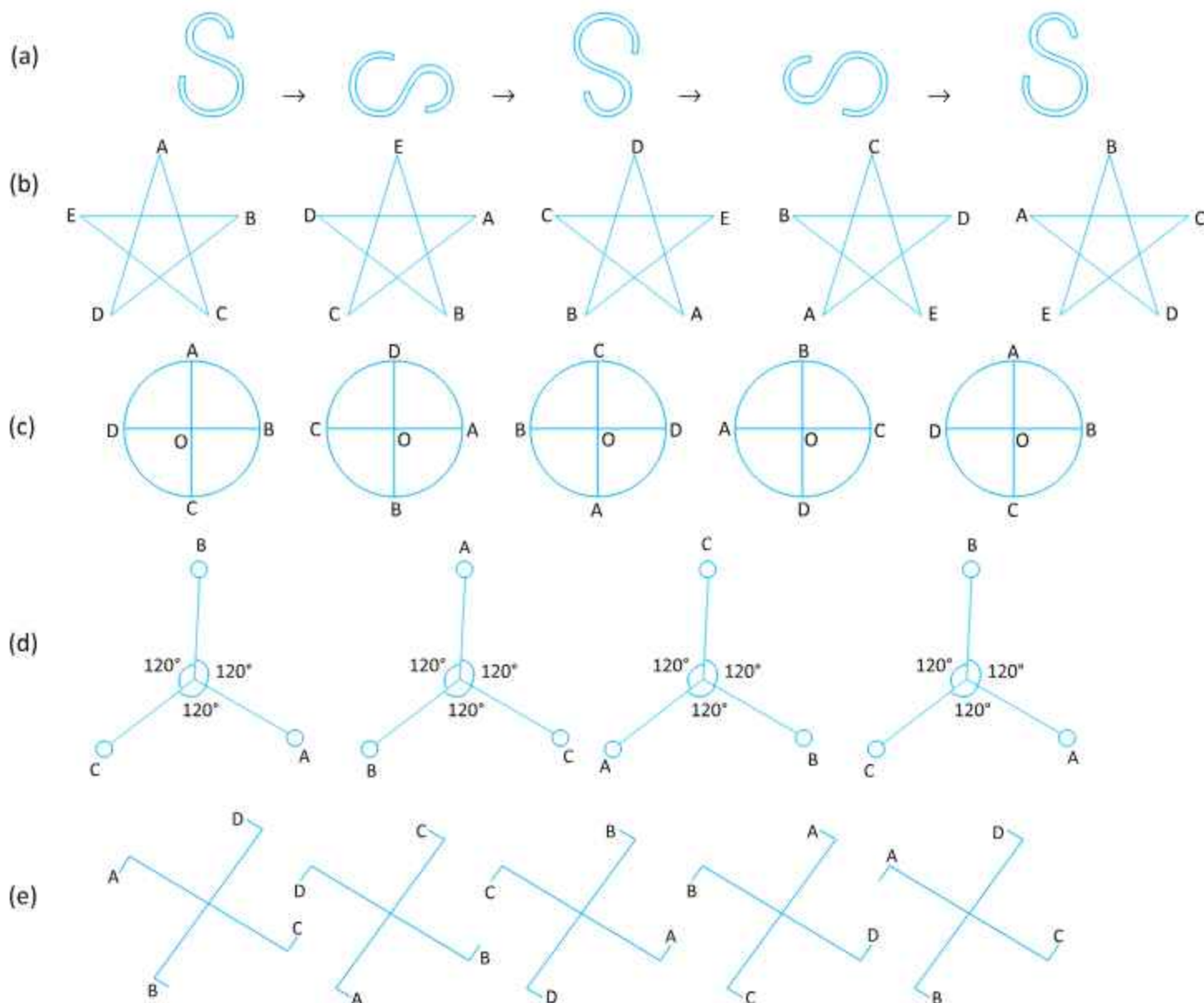
1. The size and shape of the rotating figure do not change.
2. The centre of rotation remains fixed.
3. The distance between the figure and centre of rotation remains fixed.
4. If the figure is a solid object, it is inverted upon turning by an angle of 180° .



Facts to Know

- If you rotate a figure through 90° in the clockwise direction, it is the same as rotating the same figure through an angle of 270° in the anti-clockwise direction.

Example 9 : Write the centre of rotation, angle of rotation, direction of rotation and order of rotation for the following figures.





(f)

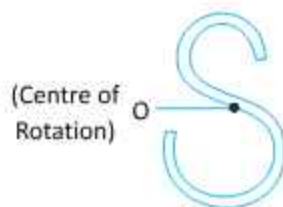


Facts to Know

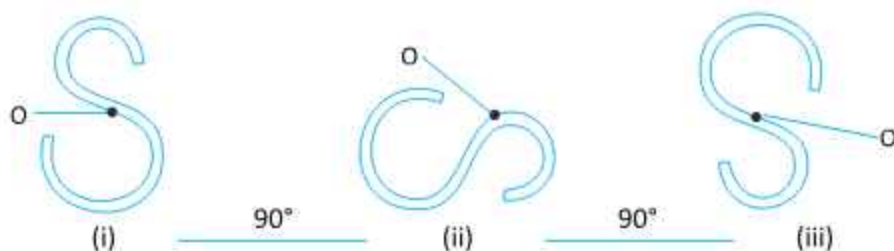
- When the direction of rotation has not been mentioned in the question, assume that the figure is rotating in the anti-clockwise direction.
- Rotational order or order of rotation are the same concept.

Solution

(a) The letter S has the centre of rotation as shown here.



The angle of rotation is the angle through which a figure must rotate to look like the original figure. Note that the figure should look alike the figure at the first (original) position. It is not necessary that it may come to its original state. If we apply this rule, we find that S has to turn through an angle of 180° to look like the original position (shown by (i) here). The position of the centre of rotation is clearly visible here (in all three figures).



The direction of rotation is clockwise.

$$\text{Order of Rotation} = \frac{360^\circ}{x}$$

where x = angle rotated in degrees by the figure to come to a state in which it looks exactly like the figure in the original position (the figure may not have come to its original state).

$$\text{So, order of rotation for S} = \frac{360^\circ}{180^\circ} = 2.$$



(b) The centre of rotation for this figure has been shown ahead.

If this figure rotates by an angle of 72° , then it comes to a state in which it looks like the original figure.

Hence, We have

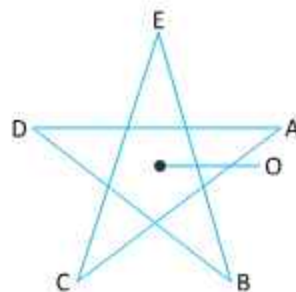
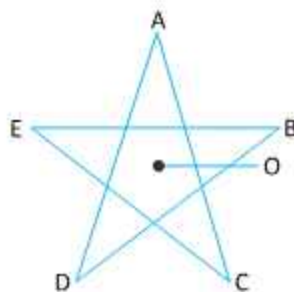
$$\text{Angle of rotation} = 72^\circ$$

$$\text{Direction of rotation} = \text{clockwise}$$

$$\text{Order of rotation} = \frac{360^\circ}{x}$$

$$\text{Hence, } x = 72^\circ$$

$$\text{Order of rotation} = \frac{360^\circ}{72^\circ} = 5$$



Facts to Know

- If we rotate a figure by 180° , the centre of rotation remains unchanged. Also, the size and shape of the figure remain the same. Every point of figure remains equidistant from the centre of rotation.
- A circle is a polygon with an infinite number of sides.

(c) The centre of rotation of this figure is O, which has been shown below.

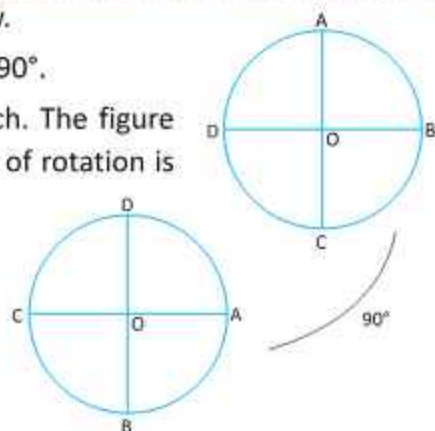
It is clear from the figure that point A has moved ahead by an angle of 90° .

So, all other points are also moving ahead by an angle of 90° each. The figure remains the same when the angle of rotation is 90° . The direction of rotation is clockwise.

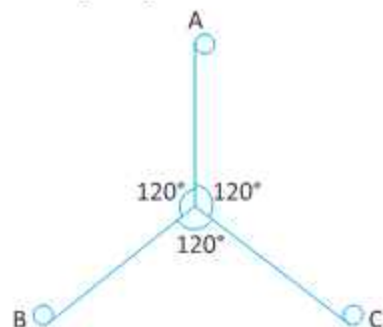
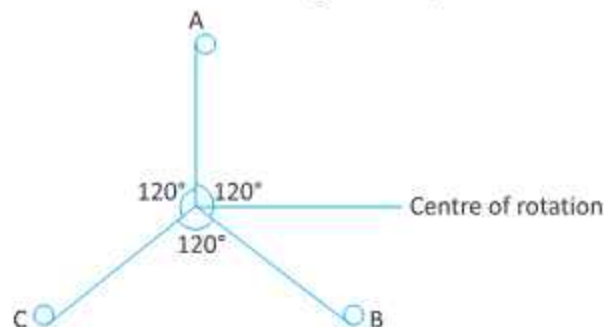
$$\text{Order of rotation} = \frac{360^\circ}{x}$$

$$x = 90^\circ$$

$$\Rightarrow \text{Order of rotation} = \frac{360^\circ}{90^\circ} = 4$$



(d) The centre of rotation of this figure is O, which has been shown in the figure given here.



It is clear that this figure is moving ahead by an angle of 120° with each step.

The direction of rotation is anti-clockwise.

$$\text{Order of rotation} = \frac{360^\circ}{x}$$

$$\text{Here, } x = 120^\circ$$

$$\Rightarrow \text{Order of rotation} = \frac{360^\circ}{120^\circ} = 3$$





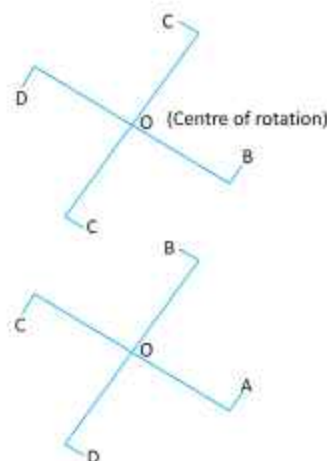
- (e) The centre of rotation of this figure is O, which has been shown in the figure given here.

It is clear from the set of given figure that the figure is rotating by an angle of 90° . After turning through this angle, the figure remains similar to its original state. Further the direction of rotation of this figure is anti-clockwise.

$$\text{Order of rotation} = \frac{360^\circ}{x}$$

$$\text{Where } x = 90^\circ$$

$$\Rightarrow \text{Order of rotation} = \frac{360^\circ}{90^\circ} = 4$$



- (f) The centre of rotation of this figure has been shown as point O in the figure given here.

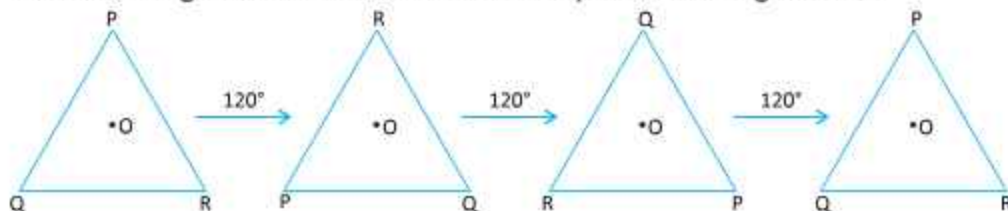


Further, the figure is moving by an angle of 360° to come to its original or similar-to-original state. So, $x = 360^\circ$
But, $x \leq 180^\circ$ for calculating order of rotation.

Hence order of rotation of this figure cannot be calculated. Direction of rotation is clockwise.

Example 10 : Discuss the rotational symmetry of an equilateral triangle.

Solution : Look at the figure shown here. It shows an equilateral triangle ΔPQR .



It is clear that ΔPQR is rotating in an anti-clockwise direction.

The angle of rotation is 120° . It means that when the triangle rotates by an angle of 120° in the anti-clockwise direction, it assumes the same state as the original position (although its vertices are not at their original positions).

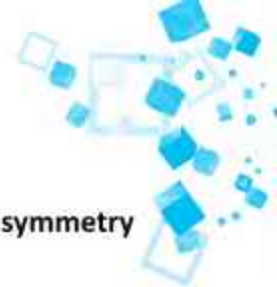
The centre of rotation ΔPQR is O, which has shown in the figure given here. When ΔPQR rotates through an angle of 360° (after three turns of 120° each), then its vertices come back to their original (initial) position. But it assumes the shape of the original state by turning through an angle of 120° .

$$\text{Order of rotation} = \frac{360^\circ}{x}$$

$$\text{Where, } x = \text{angle turned per time of rotation} \\ = 120^\circ$$

$$\text{Order of rotation} = \frac{360^\circ}{120^\circ} = 3$$





Example 11 : Give the tabular format of line symmetry, number of lines of symmetry, rotational symmetry and order of rotational symmetry of the following letters of the English Alphabet.

S	O	N	H	C	E
---	---	---	---	---	---

Solution : The data is as follows .

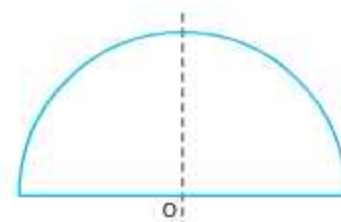
Alphabet	Line symmetry	No. of lines of symmetry	Rotational Symmetry	Order of Rotational Symmetry
S	No	0	Yes	2
O	Yes	2	Yes	2
N	No	0	Yes	2
H	Yes	2	Yes	2
C	Yes	1	No	0
E	Yes	1	No	0

Example 12 : (a) Is there any symmetry for a semicircle?

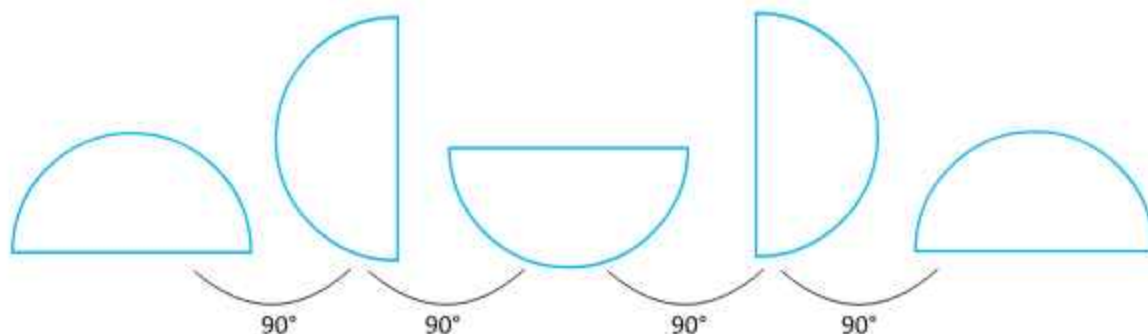
(b) Does a semicircle have rotational symmetry?

Solution : (a) The semicircle has symmetry about the right bisector of its diameter. Now look at the figure shown here.

If it is folded along the right bisector at O (dotted line), the two halves so obtained would be congruent to each other.



(b) By definition a figure has rotational symmetry, if it obtains its original state or a state exactly similar to its original state by rotating through an angle of x , where $x \leq 180^\circ$. In



case of the semi-circle the rotation has to be done through an angle of 360° ($90^\circ \times 4$) to obtain its original or similar to original state. Hence, the semicircle does not satisfy the condition for rotational symmetry.



Exercise 11.3

- Give the centre of rotation of isosceles triangle, circle, square, rhombus, equilateral triangle, regular pentagon and regular hexagon.
- What is the order of rotational symmetry of a ceiling fan with :
 (a) 3 blades (b) 4 blades (c) 2 blades
- Name the shapes of the figures that have rotational symmetry and whose angle of rotation are as follows.
 (a) 45° (b) 60° (c) 90° (d) 120°
- A line segment has coordinates A (4, 10) and B (0, 0). Rotate $\overline{AB}$ by 90° in the clockwise direction about the origin and find the coordinates of the image $(\overline{A'B'})$ of $\overline{AB}$.
- Find the coordinate of the images of the following points when they are rotated about the origin by 90° in the anti-clockwise direction.
 (a) $P \leftrightarrow (-2, 3)$ (b) $Q \leftrightarrow (-5, -4)$ (c) $R \leftrightarrow (4, 2)$ (d) $S \leftrightarrow (5, -3)$
- Find the coordinates of the images of the following points when they are rotated about the origin by an angle of 180° in the clockwise direction.
 (a) $P \leftrightarrow (-2, 3)$ (b) $Q \leftrightarrow (-5, -4)$ (c) $R \leftrightarrow (2, 4)$ (d) $S \leftrightarrow (4, -6)$
- Plot a quadrilateral with points as follows :
 $A \leftrightarrow (-6, 5)$
 $B \leftrightarrow (8, 4)$
 $C \leftrightarrow (7, -6)$
 $D \leftrightarrow (-8, -4)$
 Plot its image if it is rotated by an angle of 180° in the anti-clockwise direction.

Points to Remember

- Figures can be symmetrical or asymmetrical.
- A figure has line symmetry if there is a line about which the figure may be folded so that its two half parts coincide with each other exactly and are congruent with each other in terms of shape and size.
- The axis of symmetry is the line around which figure shows line symmetry.
- A figure that shows line symmetry about at least one line or axis is called **Symmetrical figure**.
- Curved figures can also be symmetric, besides straight lines and line sketches.
- The total number of lines of symmetry of a regular polygon is equal to the number of its sides.
- Figure can be reflected about horizontal, vertical or slant axis (lines) of reflection.
- Laws of reflection are followed with reflecting objects or figures about axis. There are four laws of reflection.
- A figure is symmetrical about a point if that point bisects all line segments of the figure. That can be drawn in it. A figure may not be symmetrical about any axis but it may be symmetrical about a point.
- Rotation of a point around a fixed centre does not change the distance between the point and that centre.
- When a figure like rectangle is rotated about a fixed point, it gets inverted upon rotating by an angle of 180° .
- Four laws of rotation govern the rotation of line segments around a fixed point.
- Rotational order = $\frac{360^\circ}{x}$, where $x \leq 180^\circ$
- When an object rotates, its size and shape remain unchanged.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

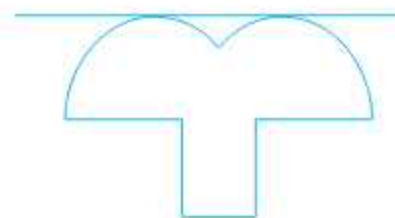
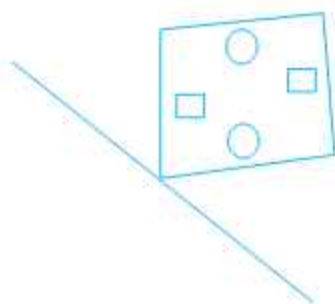
Tick (✓) the correct options :

- | | | | |
|---|--|--|--------------------------|
| (a) The reflection of point $P \leftrightarrow (3, -8)$ along y-axis is | ☐ (i) $P' \leftrightarrow (-3, -8)$ | ☐ (ii) $P' \leftrightarrow (-3, 8)$ | ☐ |
| | ☐ (iii) $P' \leftrightarrow (3, 8)$ | ☐ (iv) $P' \leftrightarrow (8, 3)$ | ☐ |
| (b) The rotational order of a regular octagon is | ☐ (i) two | ☐ (ii) four | ☐ |
| | ☐ (iii) six | ☐ (iv) eight | ☐ |
| (c) A parallelogram has | ☐ (i) No point of rotation | ☐ (ii) One axis of rotation | ☐ |
| | ☐ (iii) One point of rotation | ☐ (iv) None of these | ☐ |
| (d) An equilateral triangle, if rotated by an angle of 180° will become a/an | ☐ (i) rhombus | ☐ (ii) isosceles triangle | ☐ |
| | ☐ (iii) scalene triangle | ☐ (iv) none of these | ☐ |
| (e) If a small scale is rotated about the point $(0, 0)$ on a graph paper, after covering an angle of 180° , it will | ☐ (i) remain as such | ☐ (ii) get inverted | ☐ |
| | ☐ (iii) become a square | ☐ (iv) become a point object | ☐ |
| (f) The orientation of a figure is reversed upon | ☐ (i) drawing | ☐ (ii) rotating | ☐ |
| | ☐ (iii) reflection | ☐ (iv) deletion | ☐ |
| (g) The number of lines of symmetry for a rectangle is | ☐ (i) 4 | ☐ (ii) 3 | ☐ |
| | ☐ (iii) 1 | ☐ (iv) 2 | ☐ |
| (h) The number of lines of symmetry in a circle is | ☐ (i) 1 | ☐ (ii) 2 | ☐ |
| | ☐ (iii) 3 | ☐ (iv) None of these | ☐ |

2. Draw all lines of symmetry for the following.

V W X Y M U B A T

3. Draw the reflections of the following figures along the dotted lines.





4. Find the coordinates of the images of the following points when they are rotated as has been described.

- | | |
|---|---|
| (a) $P \leftrightarrow (-7, 6)$; clockwise 90° | (d) $A \leftrightarrow (7, 21)$; anti-clockwise 180° |
| (b) $T \leftrightarrow (-18, -12)$; anti-clockwise 180° | (e) $B \leftrightarrow (0, -4)$; anti-clockwise 180° |
| (c) $R \leftrightarrow (6, -20)$; clockwise 90° | (f) $D \leftrightarrow (-11, 8)$; anti-clockwise 180° |

5. Find the coordinates of the images of the following points when rotated about the origin by an angle of 180° .

- | | |
|----------------------------------|----------------------------------|
| (a) $M \leftrightarrow (6, 18)$ | (d) $D \leftrightarrow (10, -5)$ |
| (b) $T \leftrightarrow (-4, -9)$ | (e) $X \leftrightarrow (-7, 0)$ |
| (c) $P \leftrightarrow (-7, 2)$ | (f) $Y \leftrightarrow (0, 11)$ |

6. Write T for true and F for False for the following statements.

- | | |
|--|--------------------------|
| (a) The rotational order of a parallelogram is zero. | ☐ |
| (b) If a triangle is reflected along y-axis, the abscissae of its points would get opposite signs. | ☐ |
| (c) If a quadrilateral is reflected along x-axis, the ordinates of its point would get opposite signs. | ☐ |
| (d) A parallelogram is asymmetrical about any axis. | ☐ |
| (e) A point $P \leftrightarrow (-4, 12)$ is reflected along y-axis, its reflection P' has the coordinates $(12, -4)$. | ☐ |
| (f) The point $x(-6, -3)$ has been rotated by an angle of 180° . Hence, its reflection is $x'(6, 3)$. | ☐ |
| (g) The total number of lines of symmetry of a regular polygon is equal to the number of its sides. | ☐ |
| (h) Rotation of a figure around a point changes the shape and size of such a figure. | ☐ |
| (i) Rotational order = $\frac{360^\circ}{x}$, where $x \leq 180^\circ$ | ☐ |
| (j) If, after rotation, the object looks exactly the same as it was in its original state, it is said to have rotational symmetry. | ☐ |

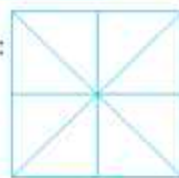
7. Draw the lines of symmetry for the following.

- | | |
|-------------------|--------------------|
| (a) straight line | (b) line segment |
| (c) kite | (d) inverted heart |
| (e) rhombus | (f) the letter, J |



Make 3 copies of the shape alongside. Shade triangles in such a way as to create shapes with:

- (a) 1 line of symmetry
 (b) 2 lines of symmetry
 (c) Rotation symmetry of order 2





Lab Activity

Objective :

To make designs with rotating shapes

Materials Required :

Chart papers, a pair of scissors, sketch pens, fevicol

Procedure :

Step 1. Draw a rectangle and make a shape as shown :



Step 2. Cut out the shape as shown. Make 10 identical shapes :



Step 3. Take another chart paper and mark a dot. Place one cutout shape on the dots as shown :



Step 4. Rotate the shapes to a new position and paste it, keeping the same point of the shape on the dot as shown :



Step 5. Continue rotating and pasting the shapes until you complete the circle.



Step 6. Colour the design, and make it more attractive.



In previous classes, we studied length, breadth, height and area. These properties were studied, for two dimensional figures. Example : Land field, table top, floor, sheet of paper etc. All these have **length** and **breadth** or **breadth** and **height** as their two vital parameters. But in our everyday life, we do not see flat objects at all times. We see ice-cream cone, football, gas cylinder, room, hall, tumbler, tiffin box, book, pen, cake etc. All of these are solid shapes, not flat shapes. So, we have three types of things around us. We can have things having only length (like straight line). Then, we can have things having two dimensions, which can be **length** and **breadth** or **breadth** and **height** (like table top, wall of classroom, blackboard surface, notebook page, book page, top view of a frisbee etc.). Finally, we can have things having three dimensions, which are **length**, **breadth** and **height**. The third category is also called **solid objects** or **three-dimensional shapes**.

Let us recall the shapes. The figures with only one-dimension have been shown here.



Line segment



Straight line

One-dimensional figures

Now, we can have a look at the two-dimensional figures.



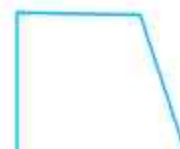
Triangle



Square



Rectangle



Quadrilateral



Pentagon



Hexagon



Circle



Oval

Two-dimensional figures

Finally, we can have a look at the three-dimensional figures.



Cone



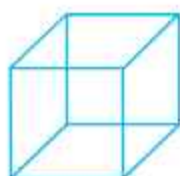
Sphere



Triangular Pyramid



Cylinder



Cube



Square Pyramid



Rectangular Cuboid



Prism

Three-dimensional (solid) figures



One-dimensional figure is a simple figure.

Two-dimensional figure is a 2-D figure.

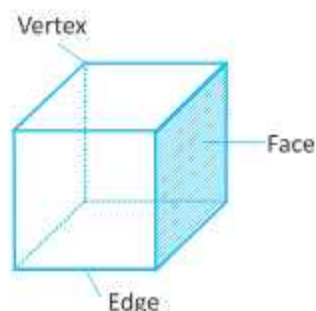
Three-dimensional figure is a 3-D figure.

In this chapter, we shall discuss 3-D figures and their representation in terms of 2-D figures.



Definitions Regarding Solid Objects

Look at this figure. It is a cube. Let us discuss its various features.



We can see that a three-dimensional object like cube can be made on a sheet of paper. This cube has the following features:

1. It has six surfaces.
2. It has twelve edges. An **edge** is formed when two adjacent surfaces of a solid intersect.
3. It has six square-shaped faces. A plane surface enclosed by an edge or edges is called **face**.
4. It has eight vertices. A **vertex** is a point where three surfaces meet. A vertex of a solid can also be called **corner**.

We have done this exercise for the cube. We can find out these properties for other solids as well. Read the table that follows:

Solid	Prism	Square pyramid	Cuboid	Triangular pyramid
Edges	9	8	12	6
Faces	5	5	6	4
Vertices	6	5	8	4

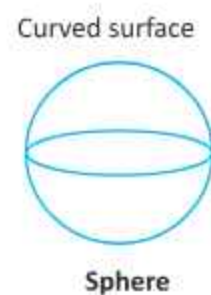
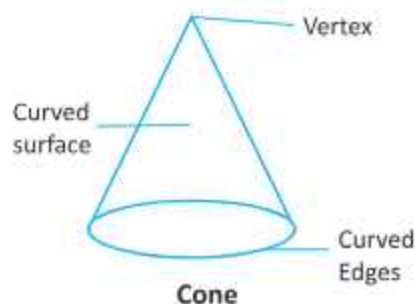
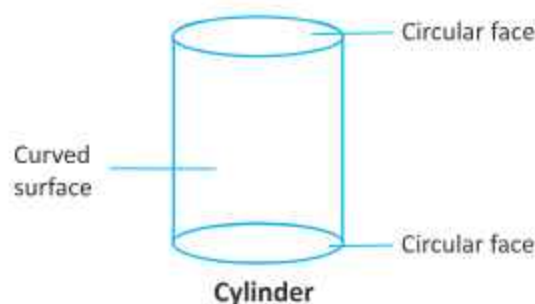


Facts to Know

The 3-D shapes whose faces are polygons are called **Polyhedrons**. Example : cube, cuboid etc. The faces can be triangle, rectangle, square and so on. These objects have straight surfaces, not curved ones.

Definitions Regarding Solid Curvilinear Objects

The cylinder, cone and sphere have curved surface. So, we have the concept of curved surface, curved edge, curved face and circular face in case of curvilinear solid shapes. Look at the figure shown here :



Read the table that follows :

Solid	Cone	Cylinder	Sphere
Curved Edges	1	2	1
Curved Surfaces	1	1	1
Circular Faces	1	2	1
Vertices	1	0	1



Facts to Know

For any polyhedron (with straight surfaces), we have :

$$F - E + V = 2,$$

where, F = no. of faces of polyhedron

E = no. of edges of polyhedron

V = no. of vertices of polyhedron

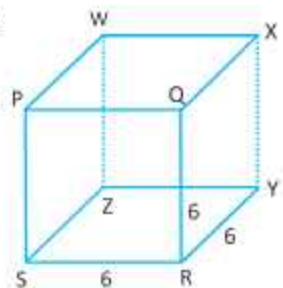


Showing 3-D Objects in 2-D (Oblique Sketches)

We can represent 3-D objects in 2-D very easily. Let us start with the cube. Look at this figure. It is a cube of side 6 cm. Now, let us represent it on a sheet of paper in a 2-D format.

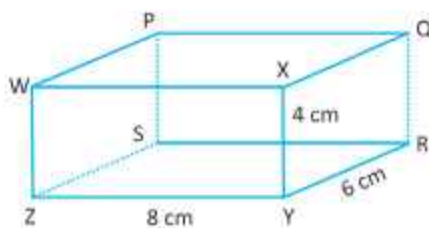
Take the following steps :

- Draw a square PQRS, so that each one of its sides is equal to 6 cm in length. Label the vertices too.
- With PQ as a base, draw a parallelogram PQXW. You can use any acute or obtuse angle. But it cannot be a right angle. The sides of the parallelogram are also equal, i.e., 6 cm each.
- From W and X, draw dotted vertical lines. Thus, draw $WZ = 6$ cm and $XY = 6$ cm.
- Join Z with Y, R with Y and S with Z.
- This is the required cube. Its vertices are P, Q, R, S, X, Y, Z, W.
- It has 6 faces, 8 vertices and 12 edges. Each one of its edges is 6 cm long.



Now, let us draw a cuboid on a sheet of paper in the same manner. Look at the figure shown here.

Take the following steps :



- Draw a rectangle WXYZ on the plane sheet of paper, so that $ZY = WX = 8$ cm, $XQ = WP = 6$ cm and $WZ = XY = 4$ cm.
- With WX as the base, draw a parallelogram WXQP, so that $WX = PQ = 8$ cm and $XQ = WP = 6$ cm. You need not make a specific angle, it can be an acute or obtuse angle. It cannot be a right angle in any case (because parallelograms do not have right angles).
- From P and Q, draw dotted vertical lines. Thus, draw $PS = 4$ cm and $QR = 4$ cm.

- Join Z with S, Y with R and S with R.
- This is the required cuboid. Its vertices are : W, X, Y, Z, P, Q, R, S.
- It has 6 faces, 8 vertices and 12 edges. Its length is 8 cm, breadth is 6 cm and height is 4 cm.

Similarly, we can draw the objects, which are in 3-D, on a sheet of paper in a 2-D format. In this chapter, we shall draw many 3-D objects on sheets of paper (in a 2-D format) to clear the concept.

From these two examples, it is clear that 3-D objects can be drawn on plane surfaces, in a 2-D format.



The following points can be noted in this context :

1. The images on plane surfaces (for all 3-D objects) are distorted.
2. The angles between various edges may be 90° in some 3-D objects but on paper (in a 2-D format), there may be oblique angles to represent 90° .
3. All faces of the 3-D object are not visible. It is obvious because the sketch on a plane surface cannot show more than two dimensions.
4. All the lengths are not equal to those in the original 3-D object. That is because of the limitations of the length and breadth of the plane surface.



Showing 3-D Objects in 2-D (Isometric Sketches)

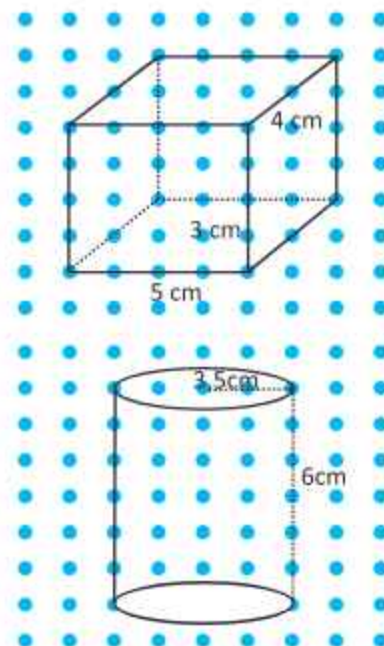
There is another way of making 3-D images on 2-D (plane) surfaces. Let us use the dotted paper to draw some sketches. It is available in markets. Alternatively, you can print dotted paper from the printer. This paper has small dots in the form of equilateral triangles.

Your computer lab assistant in school can help you get these sheets on printer. In this case, the dimensions of the 3-D objects are exactly the same on this type of paper, just as they actually are. Let us draw a cuboid of length 5 cm $\times$ 4 cm $\times$ 3 cm on the dotted paper.

Let us draw a cylinder on the dotted sheet of paper. The height of cylinder is 6 cm. The radius of its upper and lower bases is 3.5 cm. Let us draw this 3-D figure in 2-D.

The dotted paper we used here is called **Isometric Paper**. In this sketch, the dimensions of the object remain the same on the 2-D (dotted) sheet.

The sketch of a solid in which measurements are the same as the original ones (in 3-D) is called **Isometric Sketch**. The 2-D isometric sketches are exactly same as the 3-D solids but they are in 2-D format.

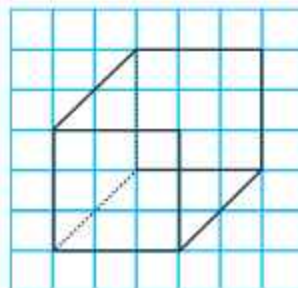
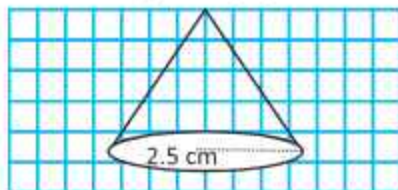


Showing 3-D Objects in 2-D (Squared Paper)

We can also show 3-D objects in a 2-D format on a squared paper. This sheet is available in stationary shops. Alternatively, your school's computer lab assistant would get it printed.

Let us draw the shape of a cone with radius 2.5 cm and height 3 cm on the squared paper, which has small squares of equal size. We can show only the 2-D format of cone on this squared paper.

Further, let us draw a cube of side 3 units on the squared paper.



Facts to Know

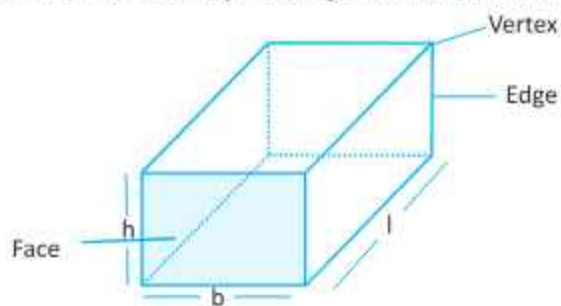
We can represent 3-D shapes on plain paper, in 2-D format, in three ways:

- (i) As oblique sketches
- (ii) As isometric sketches
- (iii) On squared paper



Example 1 : Describe various parts of a cuboid by making a sketch and label it neatly.

Solution :



Example 2 : Give the specifications and line diagram of a square pyramid.

Solution : A square pyramid has been shown here. We can note the following specifications of this pyramid from the figure drawn here:

No. of edges = 8

No. of faces = 5

No. of vertices = 5

Shape similar to the pyramids is located in Giza (Egypt)



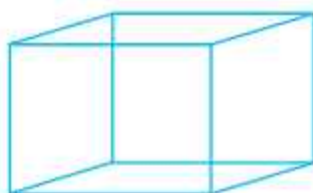
Example 3 : Give the shapes of the following objects:

- | | | | |
|------------------|-----------------|---------------|------------|
| (a) Football | (b) Candle | (c) Train | (d) Wire |
| (e) Book | (f) Dice | (g) Lunch box | (h) Coin |
| (i) Cake of soap | (j) Joker's hat | (k) Laddu | (l) Eraser |
- Solution :**
- | | | | |
|------------|--------------|------------|--------------|
| (a) Sphere | (b) Cylinder | (c) Cuboid | (d) Cylinder |
| (e) Cuboid | (f) Cube | (g) Cuboid | (h) Disc |
| (i) Cuboid | (j) Cone | (k) Sphere | (l) Cuboid |

Example 4 : Name the shapes of the following 3-D objects.



(a)



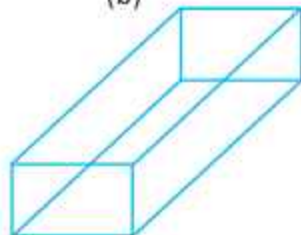
(b)



(c)



(d)



(e)



(f)

Solution

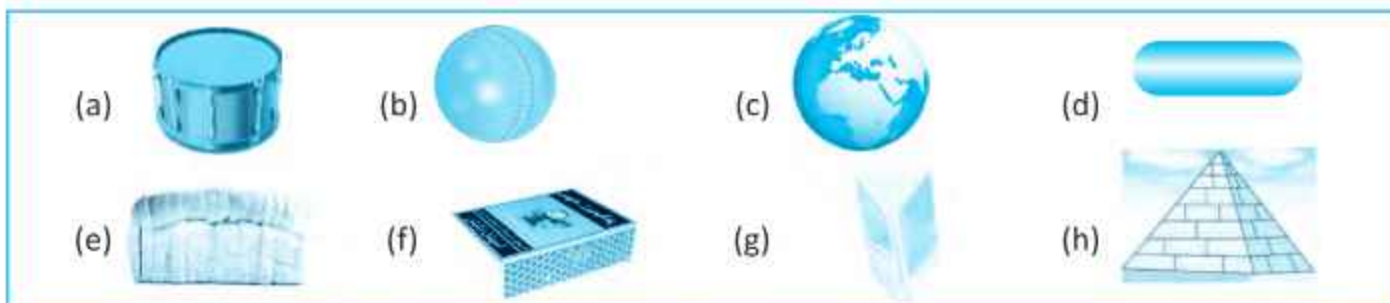
- | | | |
|----------|------------|--------------------|
| (a) Cone | (b) Cube | (c) Cylinder |
| (d) Oval | (e) Cuboid | (f) Square pyramid |





Exercise 12.1

1. Give the shapes of the following 3-D objects:



2. Draw the shape of an object whose length is 7 m, breadth is 5 m and height is 2 m. Draw it on a squared paper. Use the scale 2 m = 1 cm. What do you see?
3. Draw the shape of a room whose length, breadth and height are equal. Identify the edge, vertex, face and total number of faces of this 3-D object. Draw this object as an oblique sketch.
4. Write the number of vertices of the following :
- (a) Sphere (b) Cylinder (c) Cube (d) Cone (e) Square Pyramid



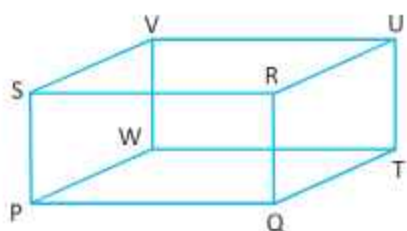
Using Nets to Depict 3-D Objects

We all write, read or view in 2-D environments. The book is single-dimensional. The TV is flat. The figures of geometry on our classroom's blackboard are in 2-D. Then, how can we represent 3-D objects in 2-D environment. This is a big problem. However, this problem can be solved with the help of nets. We can show three dimensions of a solid object in 2-D very easily. When we try to show the 3-D images on the sheet of paper (which is a 2-D object), we are unable to show all vertices, edges and faces. We shall use nets to show those hidden parts of 3-D objects.

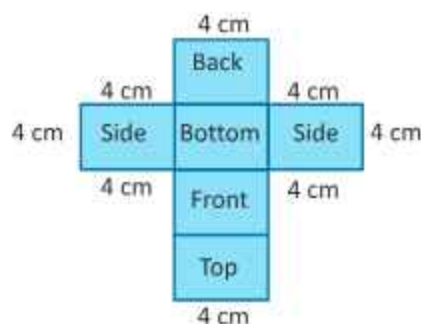
We use the shapes (that can be used on sheets of paper) to depict 3-D objects. For example, we can use squares, triangles, circles, rhombuses etc. to show solid (3-D) objects. The tool that we shall use is called **net**.

Using Net to Show a Cube

Look at this figure. It is a cube. It is a 3-D object. We have to represent it in 2-D. The length of each side of this cube is 4 cm.



Its net representation is as follows:

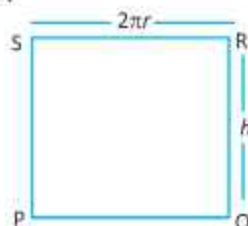
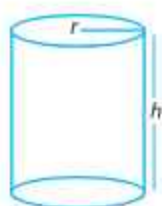




We can easily form a cube with the help of this net. Simply fold the square-shaped surfaces along the edges and the cube would be ready. You can try this by making this net on the sheet of cardboard. Cut it from the main cardboard. Now, fold it along marked edges. When the sides are lifted, the cube will be formed. Use cello-tape to fix the sides on the sides of their edges.

Using Net to Show a Cylinder

A right cylinder can be represented in the form of a net as follows :



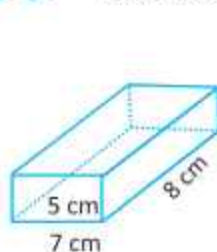
It is clear that when the cylinder is cut open (from one side), its height remains the same and its circular edges become straight lines.



Facts to Know

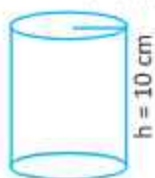
We can represent all objects in 3-D on a sheet of paper. The hidden dimensions or edges can be shown with the help of dotted lines.

Example 5: Draw the nets of the following 3-D object.

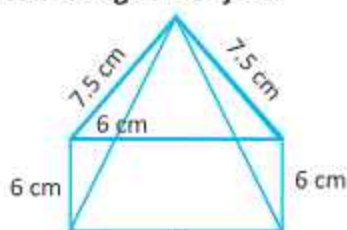


(a)

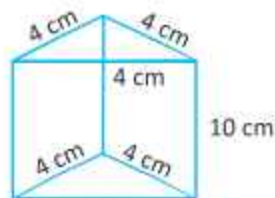
$r = 7\text{ cm}$



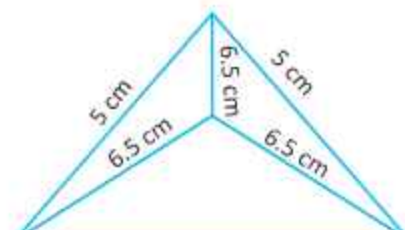
(d)



(b)



(e)

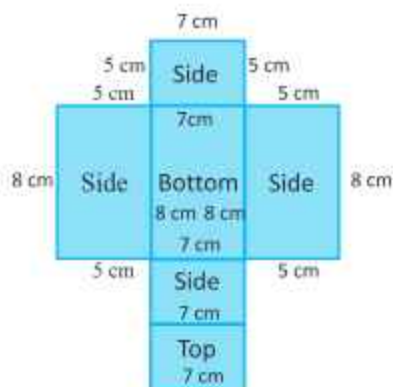


(c)

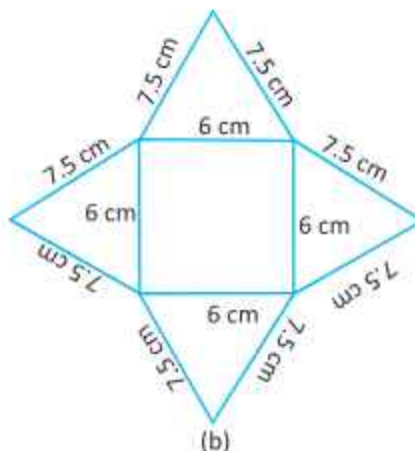


(f)

Solution :

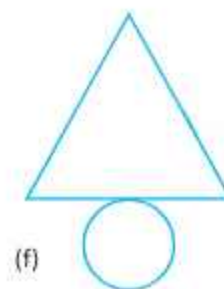
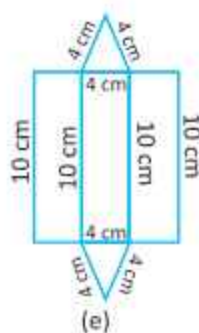
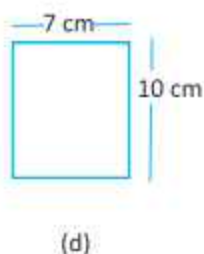
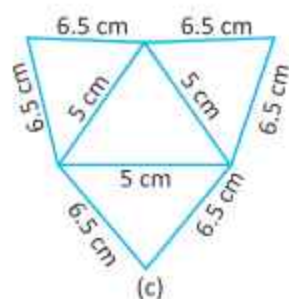


(a)



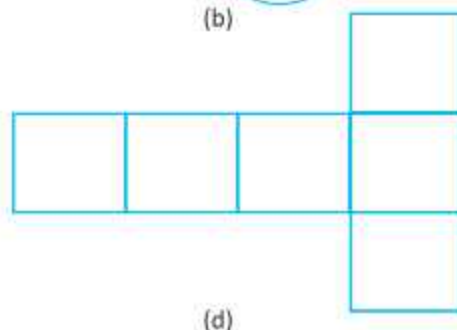
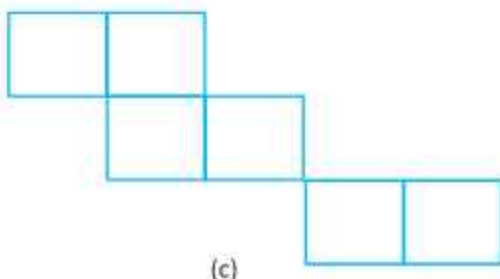
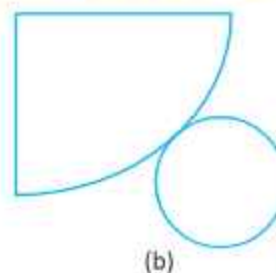
(b)





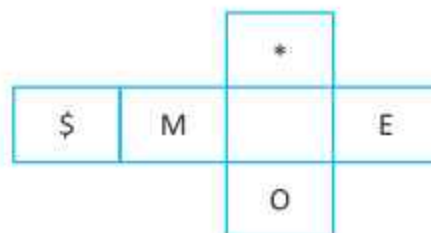
Exercise 12.2

1. The nets of the 3-D images of some objects have been shown here. Draw the 3-D object for the same.



2. Given below is the net of a cube. Some signs have been marked on each one of the parts of the net, which are, in fact the faces of the cube. Now, answer the following questions :

- What is seen at the bottom?
- What is seen at the front?
- Which thing can you see at the top?
- What is located at the back?
- Who are the two vertically faced neighbours of M?
- Which one out of M, *, E and \$ is not on the vertical face?
- Which faces are adjacent to the one having circle (O) ?
- Name the face pairs of the cube.



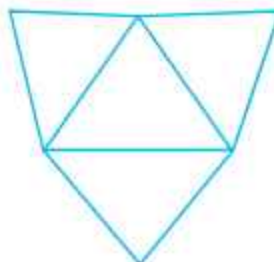
3. Draw the nets for the following objects :

- A water pipe
- A dice of dimensions $2\text{ cm} \times 2\text{ cm} \times 2\text{ cm}$
- A book of size $20\text{ cm} \times 12\text{ cm} \times 4\text{ cm}$.
- A copper wire of radius 14 cm and length 112 cm .

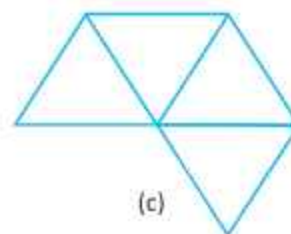
4. Find the odd one out.



(a)

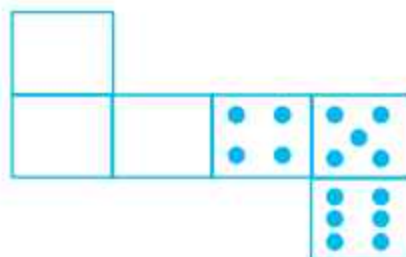


(b)



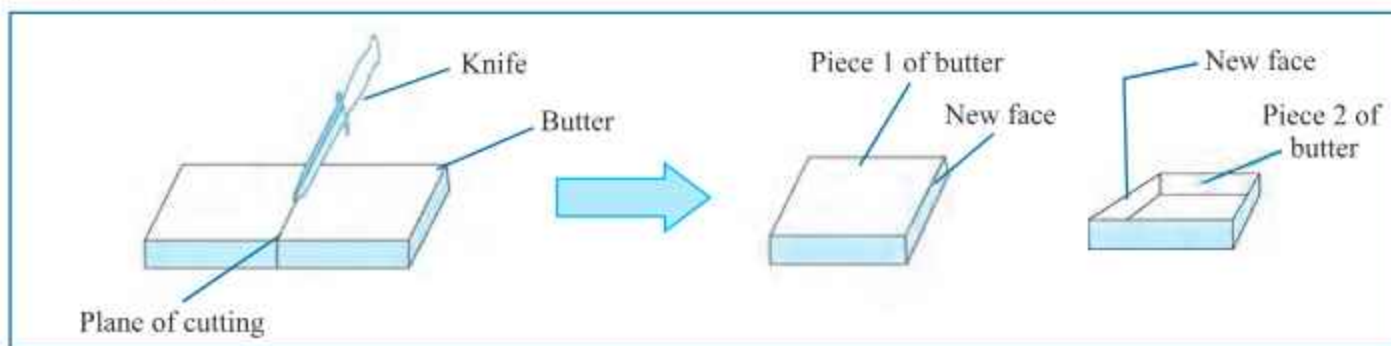
(c)

5. The sum of the number of dots on the opposite faces of a dice is always equal to seven. Fill up the dots in the empty squares of the net of this dice.



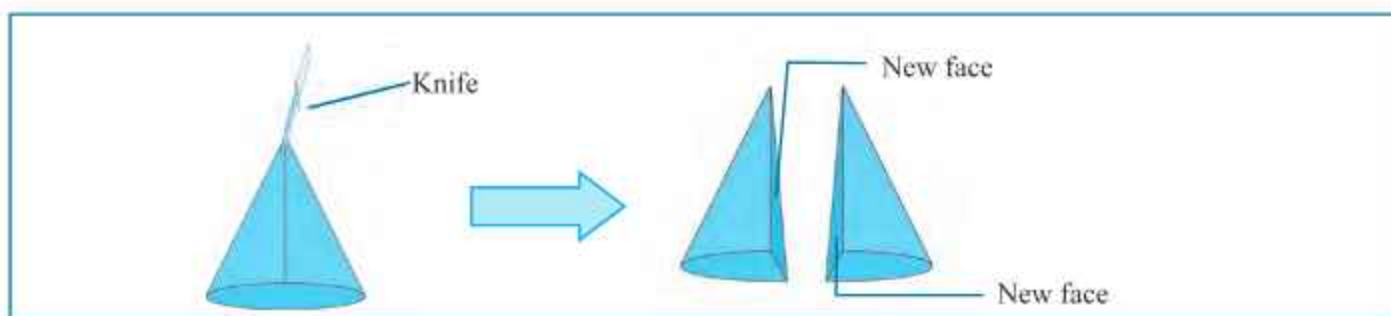
Visualising 3-D Objects : Cutting Through an Object

A 3-D object can be cut into a number of parts. When we cut a 3-D object with a knife, we get two parts. We also get two new faces at the cut portion (where we had used the knife). These new faces are known as **cross-sections of solid or 3-D shape**. Let us cut through a piece of butter, which is in the shape of a cuboid. We are cutting it into exactly two equal parts.



The new faces (cross-sections) are in the shape of rectangle.

Now, let us cut a solid cone in a vertical direction.



The new faces so obtained (in the case of cone) are in the shape of rectangle.

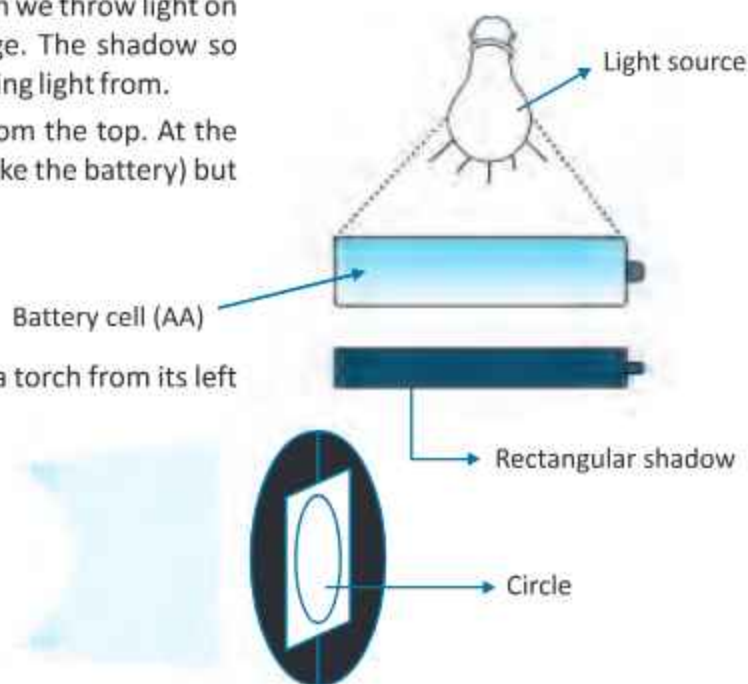




Visualising 3-D Objects : Creating Shadows of 3-D Solid Shapes

The shadow of a 3-D object (solid) is a 2-D image. When we throw light on a 3-D solid from one of its sides, we obtain an image. The shadow so obtained would depend upon which side we are throwing light from.

Let us throw light on a pencil-like cell (AA battery) from the top. At the bottom, we shall get a shadow that is not cylindrical (like the battery) but a rectangle.



Now, take a ball and throw light on it with the help of a torch from its left side. What do you observe?



It is obvious that the shadow so obtained is a circle. In this case, we can throw light on the ball from any side. The shade obtained in any case would be a dark circle. So, the shape is also important while getting shades of 3-D objects.

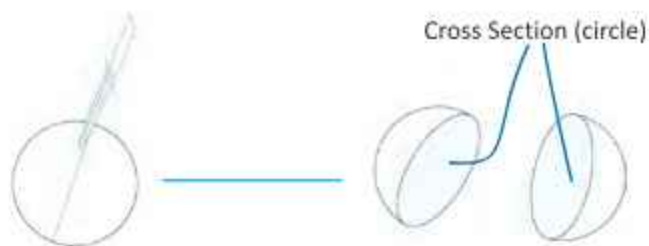


Facts to Know

When we get shadows of 3-D objects, we observe the following:

1. The shades are 2-D images, they are dark too.
2. The side (face) from which we throw the light on the object is important.
3. The shape of object is equally important.

Example 6 : Cut through a ball and inform about the cross-sections so obtained.



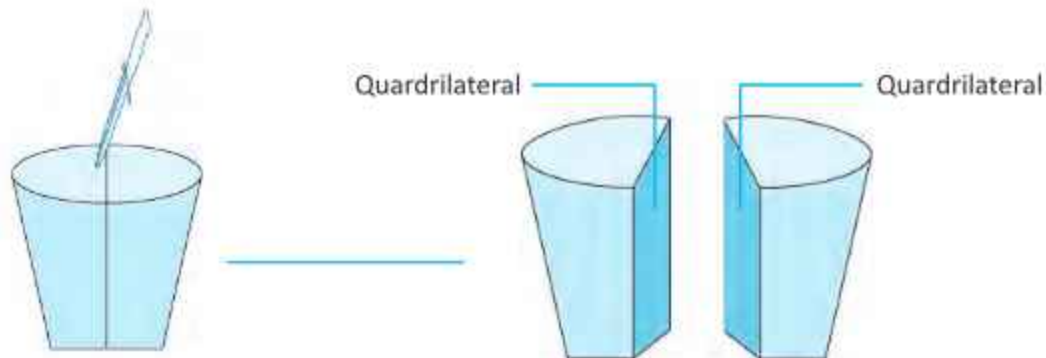
Solution : When we cut through the ball, we get two hemispheres. The cross-sections obtained after cutting are two circles. If the ball is not cut at any of its diameters, the two parts are not equal to each other. But cross sections of these parts are circles only.



Example 7 : Cut through a solid tumbler and inform about the cross-sections so obtained.

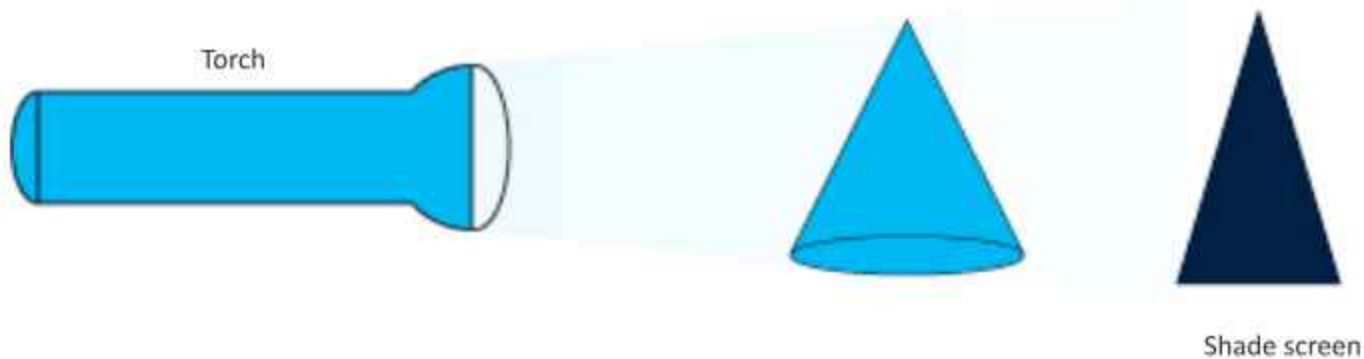
Solution : Look at the figure shown here. We assume that it is a solid tumbler.

Thus, we observe that when a solid tumbler is cut, its cross-sections are quadrilaterals. If the tumbler is not cut at any of the diameters of the top of tumbler, the quadrilaterals (of the two cross-sections) would not be equal to each other.



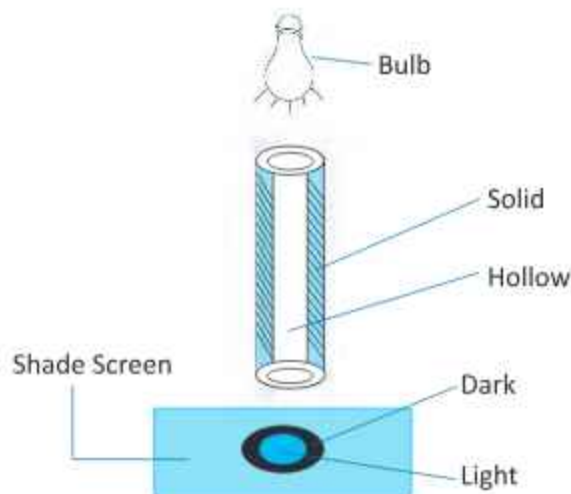
Example 8 : What shadow would you get on throwing light on a cone from its slant side?

Solution : If we throw light on a cone from its slant side, we get a triangle on the shade screen.



Example 9 : What would be the shadow if a water pipe is shown light from its one end?

Solution : The shadow of the pipe would be a dark circle in the middle of the light. The dark circle is the shadow of the pipe.





Exercise 12.3

1. Cut a cylinder across its length. What are the shapes of two cross-sections so obtained?
2. A pyramid has a pentagon at its base. Its height is 18 cm. It is cut by a knife at a point 7 cm from its top, parallel to the pentagon base. What are the shapes of the cross-sections so obtained?
3. Light is thrown on a dice from its bottom and the shade is obtained on a shade screen above the dice. What is the shade so obtained?
4. What is the shape of the shadow of a book, if it is subjected to torch light from its top and the shadow is obtained at a shade screen located exactly below it?

Points to Remember

- ❖ One-dimensional objects are — line, line segment and ray etc.
- ❖ Two-dimensional objects are — square, triangle, circle, rectangle, rhombus etc.
- ❖ Three-dimensional objects are cube, cuboid, prism, pyramid, cone etc.
- ❖ The corners of a solid object are called vertices. Its line segments, formed due to faces, are called edges. Its faces are the surfaces that are present on all of its sides.
- ❖ A 3-D object can be drawn — as a 2-D figure in three ways — (a) as an oblique sketch (b) as an isometric image (c) on a squared paper.
- ❖ The dimensions of a 3-D object on an isometric sheet of paper are exactly equal to its original dimensions.
- ❖ Solid curvilinear objects have curved surface, curved edge, curved face and circular face. Not all of them may be present in them.
- ❖ We can use nets to depict 3-D objects.
- ❖ We can cut through a 3-D object. The cut portions of a 3-D object are called cross-sections.
- ❖ We can create shadows of 3-D objects.
- ❖ The type and size of shadow depend upon which side of the 3-D object we are throwing light from. The shape of the object is also equally important.
- ❖ For solids, the Euler's Formula is $F + V - E = 2$, where F = number of faces, V = number of vertices and E = number of edges.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs) :

Tick (✓) the correct options.

- (a) We cannot get the 2-D image of the following on a sheet of paper.

(i) cube

☐ (ii) cone

(iii) pyramid

☐ (iv) circle

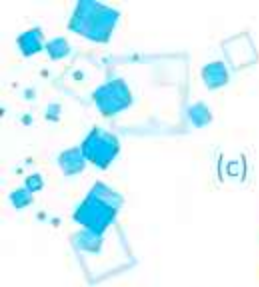
- (b) If light is thrown on a rectangular block from the top, the shade at the bottom would be a

(i) circle

☐ (ii) square

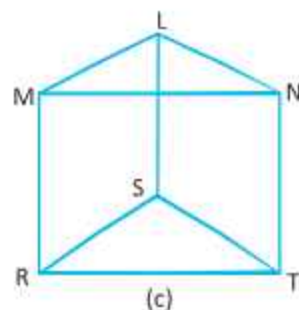
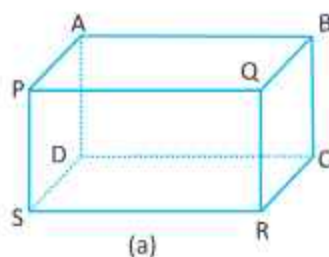
(iii) prism

☐ (iv) none of these

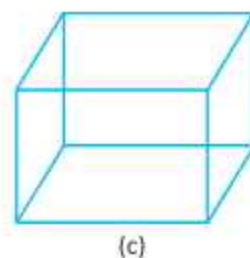
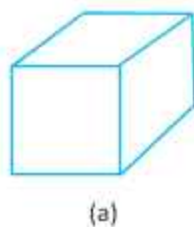


- (c) The dimensions of a 3-D object on an isometric paper are the same as the ones
- | | | | |
|-----------------------------------|--------------------------|-------------------------------|--------------------------|
| (i) on a squared paper | ☐ | (ii) of the 3-D object itself | ☐ |
| (iii) of the plain sheet of paper | ☐ | (iv) of another 3-D object | ☐ |
- (d) The shadow of a ball is always a
- | | | | |
|---------------|--------------------------|--------------------|--------------------------|
| (i) circle | ☐ | (ii) square | ☐ |
| (iii) pyramid | ☐ | (iv) straight line | ☐ |
- (e) The Euler's formula is
- | | | | |
|-----------------------|--------------------------|----------------------|--------------------------|
| (i) $V - E + F = 6$ | ☐ | (ii) $V + F - E = 4$ | ☐ |
| (iii) $V - F - E = 2$ | ☐ | (iv) $V + F - E = 2$ | ☐ |
- (f) The 3-D shapes, whose faces are polygons, are called
- | | | | |
|-------------------|--------------------------|-------------------|--------------------------|
| (i) polyholes | ☐ | (ii) polycites | ☐ |
| (iii) polyhedrons | ☐ | (iv) tetrahedrons | ☐ |
- (g) If a rectangular room is cut into exactly two equal halves, its cross-section would be
- | | | | |
|-------------|--------------------------|-----------------|--------------------------|
| (i) circles | ☐ | (ii) rectangles | ☐ |
| (iii) cones | ☐ | (iv) areas | ☐ |
- (h) A circular prism has no
- | | | | |
|------------|--------------------------|--------------------|--------------------------|
| (i) edge | ☐ | (ii) vertex | ☐ |
| (iii) base | ☐ | (iv) none of these | ☐ |
- (i) A triangular pyramid is also called
- | | | | |
|----------------|--------------------------|------------------|--------------------------|
| (i) polyhedron | ☐ | (ii) tetrahedron | ☐ |
| (iii) pyramid | ☐ | (iv) 3-D shape | ☐ |

2. Name the vertices, faces and edges of the following figures. Then, check whether Euler's formula is applicable to them.



3. Draw the nets for the following.





(d)



(e)

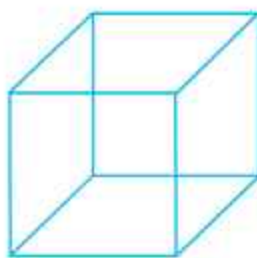


(f)

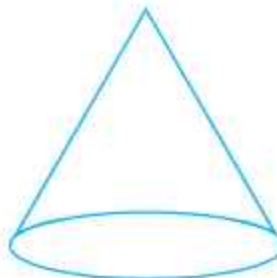
4. What shadows would emerge if light is thrown on the following 3-D shapes? The direction of light has been shown.



(a)



(b)

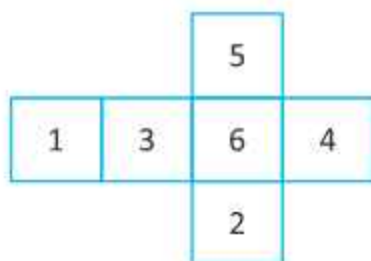


(c)



(d)

5. Look at the net of a cube. Then answer the following questions:



- (a) Which ones of the faces are not exactly opposite to each other?

(i) 5 and 2

☐ (ii) 4 and 6

☐

(iii) 6 and 1

☐ (iv) 3 and 4

☐

- (b) Which face is not adjacent to 6?

(i) 1

☐ (ii) 5

☐

(iii) 3

☐ (iv) 2

☐

- (c) If face 1 is put on the RHS of face 4, which face would face in that case?

(i) 5

☐ (ii) 2

☐

(iii) 6

☐ (iv) none of these

☐

- (d) Which face is exactly opposite to face 2?

(i) 4

☐ (ii) 3

☐

(iii) 1

☐ (iv) 5

☐



6. Match the shadow with their 3-D objects if the light is thrown from the top :

Column A

Column B

(a)



(i) volleyball

(b)



(ii) tetrahedron

(c)



(iii) cone

(d)



(iv) cube

7. Match the nets with solids:

Column A

Column B

(a)



(i)



(b)



(ii)



(c)



(iii)



(d)



(iv)



8. Using a paper of $16\text{ cm} \times 12\text{ cm}$, how many cylinders can be made ? What can be the height of these cylinders?

9. (a) What is the difference between oblique sketch and isometric sketch?

(b) Prove that Euler's formula is applicable to the following figure.

(c) What is the difference between the circular face and curved surface of a right cylinder?

(d) What is the sum of number of dots on any two opposite faces of a dice?

(e) Can we have more than one net for a 3-D object? Give examples.



10. Write T for True and F for False for the following statements :

(a) All faces of a prism are triangles.

(b) The horizontal cross-section of a cone is a circle.

(c) A triangular pyramid has five vertices.

(d) If we cut through a cuboid, we get two cross-sections, both being rectangles.

(e) The isometric sketches of a 3-D object have the same dimensions as the object.

(f) An ice-cream cone is a type of prism.

☐
☐
☐
☐
☐
☐


- (g) There can be more than one net for a 3-D object.
- (h) A cuboid has 6 faces and 8 vertices.
- (i) We cannot draw 2-D sketches on a squared paper.
- (j) A birthday cap is a hollow cone.



If 3 cubes of dimensions 2 cm by 2 cm by 2 cm are placed side by side, what would be the dimensions of the resulting cuboid? Represent it with the help of
(i) oblique sketch (ii) Isometric sketch



Identifying 3D shapes

Objective : To identify 3D shapes through verbal reasonings.

Materials Required : Paper, pencil, ruler

Preparation : Students play in pairs.

- Step 1** – Let Student A observe all the solids studied and select one of the solids. Write the name of that solid on a piece of paper and fold it up. Student B should not be told what A has selected.
- Step 2** – Keep this folded piece of paper at the centre.
- Step 3** – Student B now asks suitable questions of student A in order to find out the solid selected by A.
- Step 4** – Student A will answer B's questions only in 'yes' or 'no'.
- Step 5** – The aim of Student B is to ask such questions so as to get 'yes' or 'no' answer. He should try to find the name of the solid by asking the least number of questions.
- Step 6** – When B succeeds in getting the name of the solid, the roles of A and B are reversed and the game continues.

Example After student A has selected a solid, Student B could ask the following questions :

- (a) Does the object have any curved surface?

Ans : No

(That means it is not a cone or cylinder.)

- (b) Does it have 6 equal faces?

Ans : Yes

Then the object is a cube. If the answer is 'no' it is a cuboid.

So, we have reached a conclusion by asking only 2 questions.



Record the activity –

Solid	Questions	Answer
Cube		
Cone		
Cylinder		
Cuboid		

Copy this table in your note book or on a chart paper and play the game for all the solids you have studied so far.





Measures of Central Tendency

After collecting and tabulating the data, the next step is to calculate a single number (value) which can represent or summarise the whole data. This single value is nothing but a **measure of central tendency**. Suppose Sohan rides on an average 8 hours daily as sales executive. It means that he may ride more than 8 hours on some days and less than 8 hours on some other days. Thus, the calculated average shows central value of a group of organised data. There are three types of such measures (averages): **Mean**, **Median** and **Mode**.

Mean : The mean (arithmetic mean) is the sum of all observations divided by total number of observations i.e.,

$$\text{Mean} = \frac{\text{Sum of all observations}}{\text{Total number of observations}}$$

Example 1: The weights (in kg) of 10 players of India Hockey team are as follows :

65, 55, 75, 70, 66, 72, 65, 73, 59, 60

Find the mean (arithmetic mean) of weight of these players.

Solution : Mean = $\frac{65 + 55 + 75 + 70 + 66 + 72 + 65 + 73 + 59 + 60}{10} = \frac{660}{10} = 66 \text{ kg}$

The mean of weights of 10 players is 66 kg.

Median : Median of a group of numbers (observations) is the number (observation) in the middle (centre), when the numbers are arranged in an order (either ascending or descending order).

If the number of observations is **odd**, then the **middle number** is the median. For example, the prices (in ₹) of eleven kitchen items are arranged in ascending order as

94, 96, 98, 100, 110, 112, 115, 115, 117, 120, 123

Here, median is 112.

If the number of observations is **even**, then the median is the average (central value) of **two middle numbers**. For example, the heights (in cm) of 10 students of your class have been arranged in ascending order as

90, 95, 96, 97, 110, 110, 112, 112, 120, 125

Here, median is $\frac{110 + 110}{2} = 110 \text{ cm}$

Mode : Mode of a group of observations is the number with maximum frequency i.e., the most frequent occurring value.

Example 2: The prices (in ₹) of T-shirts sold in a shopping mall on a particular day are as follows :

330, 250, 150, 330, 150, 200, 250, 250,
330, 250, 260, 360, 260, 200, 150, 360,
330, 150, 250, 260

Find the mode.

Solution : We can tabulate it.

Prices (in ₹)	360	330	260	250	200	150
Number of T-shirts sold	2	4	3	5	2	4

We can see that mode of this data is ₹ 250. This value is the most frequent value.

Range : Range of observations gives us an idea about the spread distribution of observations. So, range is the difference between the highest and lowest observations.

$$\text{Range} = \text{Highest observation} - \text{Lowest observation}$$

Example 3 : The runs scored by 10 players of a team in Delhi Ranji Cricket One Day Domestic match are as follows :

8, 90, 70, 72, 60, 40, 10, 5, 20, 85

Find the range.

Solution : The lowest value (runs) = 5

The highest value (runs) = 90

$$\text{Range} = 90 - 5$$

$$= 85$$

Hence, range is 85

In all, we conclude that it is better to find range, mean, median and mode of data in order to get the complete picture.

Exercise 13.1

1. Popular books read by bookreaders of Delhi are as given below :

Book	Geeta	Ramayana	Midnight drama	True lies
No. of Readers	80	150	16	46

Find the mean.

2. Find median, mode and range of the data.

36, 40, 45, 46, 50, 46, 58, 45, 46, 35



Facts to Know

- The data having two modes is called Bimodal data.
- The data having many modes is called Multimodal data.



3. The heights (in cm) of 20 children in a group are as :

96, 98, 90, 96, 105, 90, 96, 120, 115, 96, 98, 112, 90, 88, 110, 90, 96, 90, 110, 92

Find the range, mean, median and mode of the data.

4. Find mean of first five odd numbers.
5. Find the value of x , if the mean of data is 12:

15, 17, 6, 2, 1, 3, 6, x , 10, 7, 3



Bar Graphs

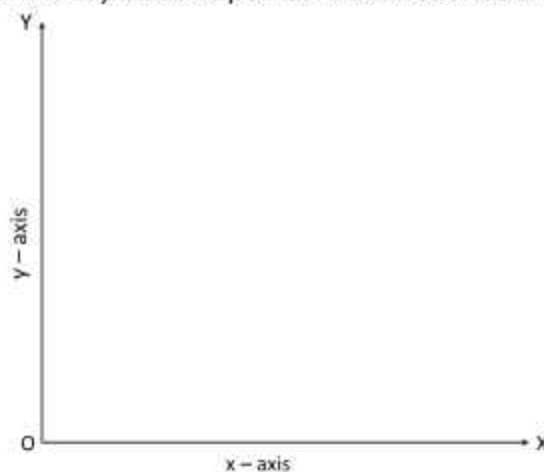
You are already familiar with bar graph. Bar graph represents numbers using bars (rectangles) of uniform width, drawn horizontally or vertically with equal spacing in between them. In a bar graph, the following aspects are important.

- (1) All bars should be of same width
- (2) The distance between any two consecutive bars should be same.
- (3) The scale should be clearly and carefully written on the graph.
- (4) Each rectangle (bar) indicates only one numerical value of the data. Therefore, you can draw as many bars as the number of values in data.

We draw some conclusions from the tabular representation of large amount of numerical data using bar graph.

To draw a bar graph, follow the steps.

- (1) Draw two mutually perpendicular lines on graph paper.
- (2) Name horizontal line as x -axis, vertical line as y -axis and point of intersection as origin (generally denoted by O).



You can understand it more clearly by going through the following examples.

Example 4 : Draw a bar graph to represent number of students taking part in extra curricular activities held in your school.

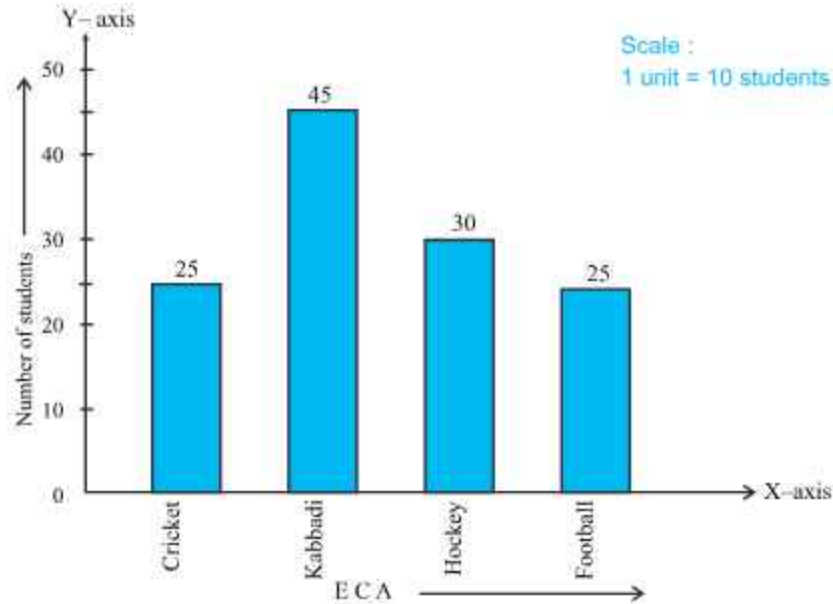
Extra Curricular Activities (ECA)	Cricket	Kabbadi	Hockey	Football
Number of students	25	45	30	25



Solution : Before drawing the graph, fix the scale. Here, maximum value is 45, So we must mark units up to 50. Let us assume 1 unit as 10 students.

Draw two perpendicular axes. Along the X-axis, mark spaces for 4 bars equal distance apart. Write the names of extra curricular activities.

Draw bar graph as shown below. We see that maximum number of students play kabbadi. So, this is the mode of data.



Example 5 : Draw a bar graph for daily production of Washing Machines in a factory for 7 days a week.

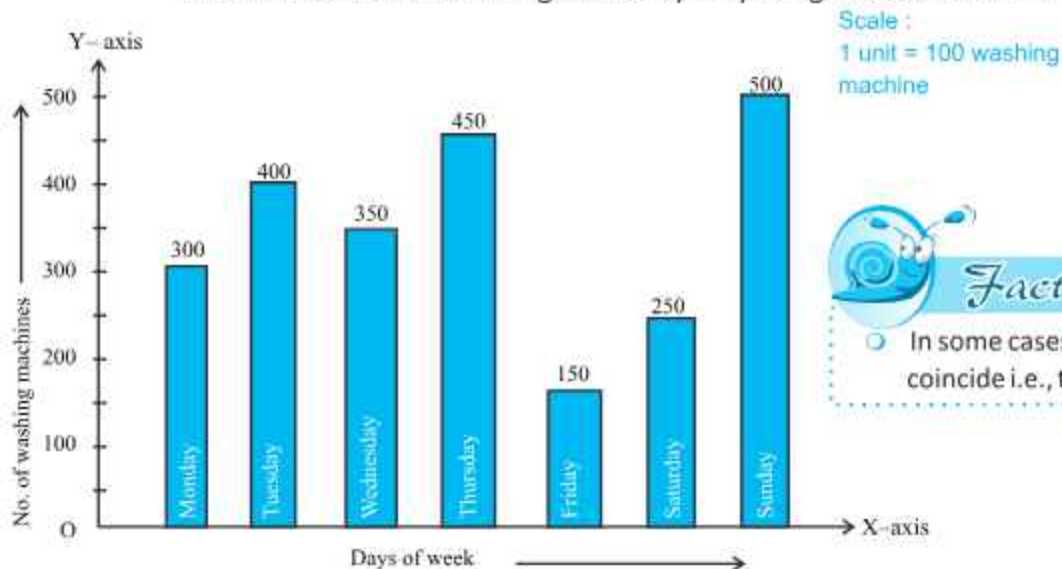
Days of week	Mon	Tue	Wed	Thur	Fri	Sat	Sun
No. of Washing Machines	300	400	350	450	150	250	500

Solution : We draw two perpendicular lines OX and OY, respectively intersecting each other at the origin O as shown in the figure.

The maximum value is 500. So, we must mark units up to 500.

Take 1 unit = 100 washing machine.

We draw bars of suitable heights and equal spacing in between them.



Facts to Know

- In some cases, Median and Mode may coincide i.e., they have same value.



Double Bar Graphs

Double bar graph helps us to compare or represent more than one types of information, we can draw the bar graphs of both set of observations on the same graph.

To draw a double bar graph, do remember some basic procedures.

- Draw two bars for a single reading.
- Keep no space between two bars for single reading. Shade them differently.
- Keep equal space between two consecutive sets of double bar.

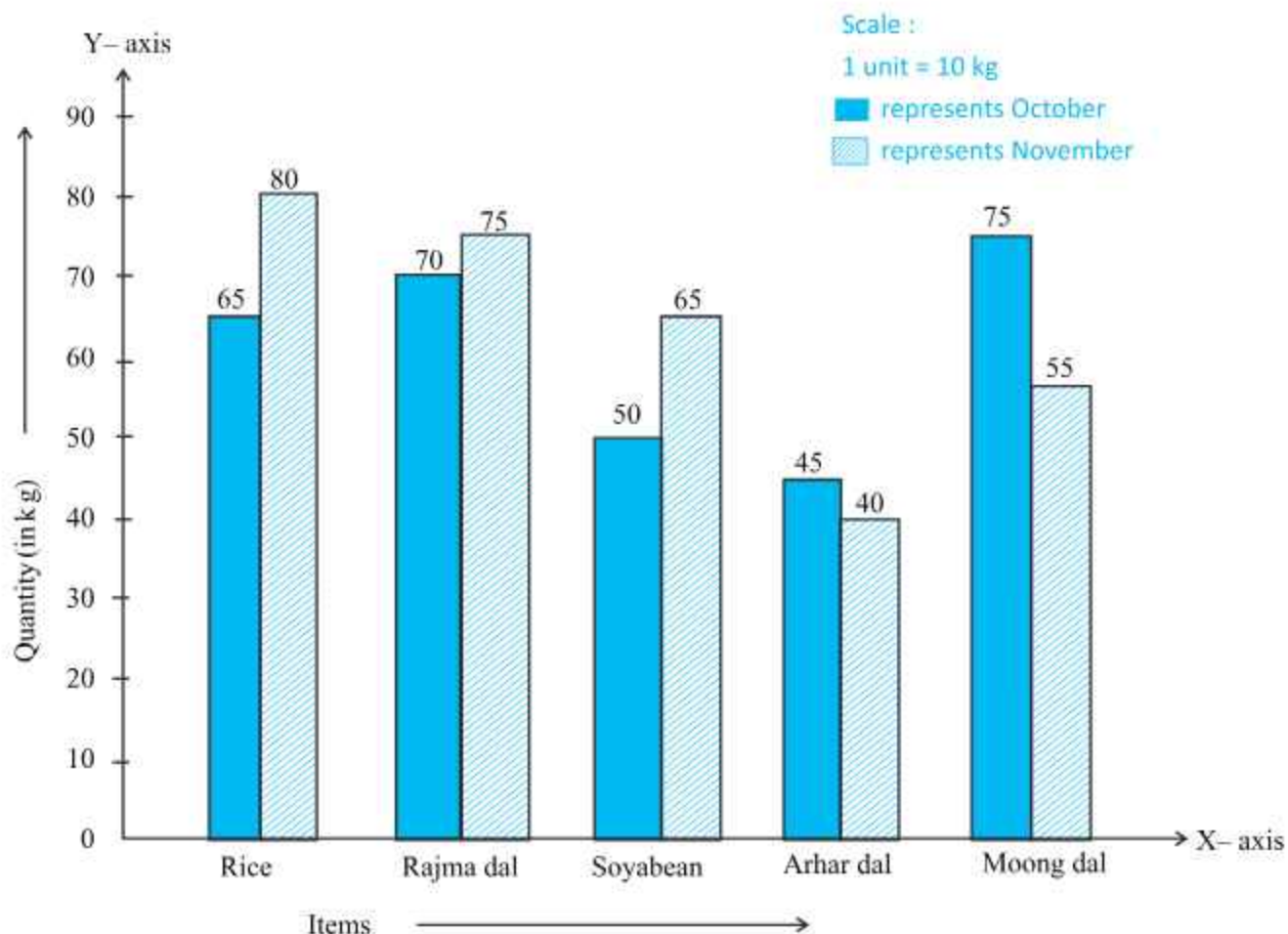
Example 6 : A restaurant owner purchases following items for two consecutive months. Draw and compare it by using double bar graph.

Item (in kg)	Rice	Rajma dal	Soyabean	Arhar dal	Moong dal
October	65	70	50	45	75
November	80	75	65	40	55

Solution : The highest value is 80, so we mark the units up to 90. We select scale of 1 unit as 10 kg.

Draw two axes. Mark the space for 5 double bars along X-axis.

Write the names of items. Draw bars and shade them differently.





Exercise 13.2

1. The following bar graph shows the purchase of books in four consecutive months. Answer the questions given below :

- In which month was the purchase minimum?
- How many books were purchased in July?
- Which month was the purchase maximum?
- Which month shows the purchase between 300 to 400?



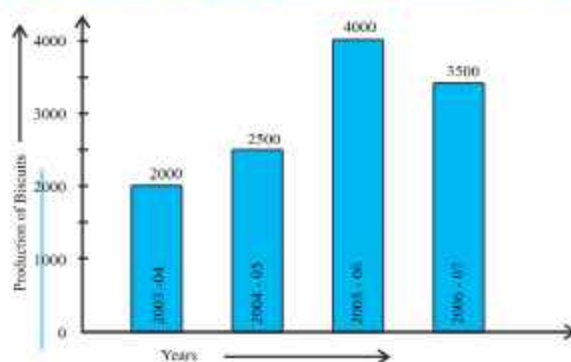
2. Construct a bar graph to represent the data collected about the quantities of Rice used in 5 households :

Household	A	B	C	D	E
Quantities of Rice (in kg)	50	40	25	45	35

- What is the range of the data?
- What is the median of the data?

3. Observe the graph and answer the following questions:

- What was the production of biscuits in the year 2005-06?
- In which year, the production of biscuits was minimum?
- In which year the production of biscuits was in between 4000 kg to 3000 kg.



4. The income and expenditure of Amit for 5 consecutive months are given below.

Month	January	February	March	April	May
Income (in ₹)	7000	8000	6500	7500	8500
Expenditure (in ₹)	5000	4500	4000	6000	5500

Represent the data with the help of double bar graph.

Points to Remember

- Data handling is the process of gathering, capturing and recording the data in a systematic manner. So that it could be meaningful and useful to us.
- When data is collected and put as it is without any specific arrangement, it is called raw or ungrouped data.
- The number of time a particular value repeats itself is called its frequency.
- Data can be organised in tabular form which is called frequency distribution table.
- Arithmetic mean is the sum of all observations divided by total number of observations.
- Median is the middle value of a group of observations when these observations are arranged in an order.
- Mode is the number (value) with maximum frequency.
- Range is the difference between highest observation and lowest observation.
- Bar graph represents numbers using bars (rectangles) of uniform width. These bars are drawn horizontally or vertically with equal spacing in between them.
- Double bar graph compares more than one types of information by drawing bar graphs on the same graph.



EXERCISE

1. MULTIPLE CHOICE QUESTIONS (MCQs):

Tick (✓) the correct options.

(a) The mean of 8, 12, 15, 20, 17 is

(i) 12.4

☐

(ii) 14.4

☐

(iii) 15.4

☐

(iv) 18.4

☐

(b) The median of 5, 7, 9, 3, 11, 12, 15 is

(i) 5

☐

(ii) 15

☐

(iii) 9

☐

(iv) 12

☐

(c) The mode of 2, 0, 3, 2, 5, 7, 2, 3, 0, 7, 2 is

(i) 0

☐

(ii) 7

☐

(iii) 3

☐

(iv) 2

☐

2. Arunoday studies for 5 hours, 4 hours, 7 hours and 8 hours, respectively on four consecutive days. How many hours does he study each day on an average?

3. The appointments in a company during five consecutive years were recorded as follow:

200, 450, 368, 196, 256

Find the mean of appointments.

4. Following are the runs scored by tenth (10th) player of a cricket team in two consecutive tournaments.

1, 3, 4, 2, 5, 6, 1, 2, 3, 3, 1, 4, 5, 3, 5, 6, 1, 3, 4, 3, 2, 3

Find the mode of this data.

5. A private mathematics tutor wants to judge, whether the new technique of teaching (that he applied after quarterly school test of students) was effective or not. He takes the scores (out of 25) of the 5 weakest students in the two successive quarterly tests.

Student	Vijay	Mohit	Neelam	Kanchan	Sanjay
Quarterly Test (1st)	8	15	10	20	10
Quarterly Test (2nd)	18	10	16	15	14

Represent this information using double bar graph.





A family decides to hold two parties, one on Christmas Eve and one on Christmas Day. The youngest person to attend the Christmas Eve party is 15 and the oldest is 29. The youngest person to attend the Christmas Day party is 27 and the oldest is 42. Which party has a larger age range of visitors?

Lab Activity

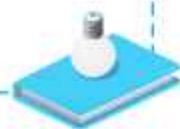
Objective : To understand the concept of mean, median, mod and reading bar graph.

Materials Required : Survey sheets, Markers or coloured pencils, Graph paper or a whiteboard for drawing the bar graph.

Procedure :

- Step 1:** Each student takes one survey sheet with the question: "What is your favourite ice cream flavour?". Survey your classmates and record the responses on your sheets.
- Step 2:** Organise the data from the students and create a class list of the number of students who chose each flavour.
- Step 3:** Create a bar graph on the graph paper. Label the x-axis with ice cream flavours and the y-axis with the number of students.
- Step 4:** Calculate the mean (average) number of favourite ice cream flavours across the class.
- Step 5:** Find the median by ordering the number of students who chose each flavour and identifying the middle value or average of the middle values.
- Step 6:** Identify the mode by finding the flavour(s) with the highest frequency in the data.

Survey Sheet		
Flavour of Ice cream	Tally	Total
Vanilla		
Chocolate		
Strawberry		
Butter Scotch		
Blueberry		
Pista		



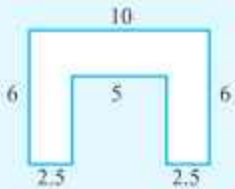
Revision Test Paper-IV

(Based on Chapters 11 to 13)

A. Multiple Choice Questions (MCQs).

(10)

Tick (✓) the correct option.

- Two squares are congruent if they have
 (i) same side ☐ (ii) same area ☐ (iii) same perimeter ☐ (iv) All of these ☐
- If $\triangle ABC \cong \triangle XYZ$ which of the following is true?
 (i) $AC = XY$ ☐ (ii) $BC = XY$ ☐ (iii) $AB = XY$ ☐ (iv) None of these ☐
- 

The perimeter of the given shape is

- (i) 16 unit ☐ (ii) 26 unit ☐ (iii) 36 unit ☐ (iv) 32 unit ☐
- Area of a parallelogram is
 (i) $b \times h$ ☐ (ii) $\frac{1}{2}bh$ ☐ (iii) $2(b+h)$ ☐ (iv) $\frac{3}{4}bh$ ☐
- The area of circular ring with outer and inner radii 9 cm and 5 cm respectively is
 (i) 440 cm^2 ☐ (ii) 220 cm^2 ☐ (iii) 496 cm^2 ☐ (iv) 220 cm^2 ☐
- Numerical data is represented by means of bars with equal spacing between them in a
 (i) Pictograph ☐ (ii) Line graph ☐ (iii) Bar graph ☐ (iv) Pie graph ☐
- The mean of first 5 odd numbers is
 (i) 5 ☐ (ii) $8.1\bar{6}$ ☐ (iii) 9 ☐ (iv) 11 ☐
- The total line of symmetry that a regular hexagon has.
 (i) 5 ☐ (ii) 6 ☐ (iii) 7 ☐ (iv) 8 ☐
- The mean of 7 numbers is 17. The sum of 7 numbers is
 (i) 24 ☐ (ii) 10 ☐ (iii) 109 ☐ (iv) 119 ☐
- The circumference of a circle is 154 m. Its diameter is
 (i) 24.5 m ☐ (ii) 49 m ☐ (iii) 308 m ☐ (iv) 77 m ☐

B. Fill in the blanks:

(10)

- If the side of a square is doubled, then the area becomes _____ times.
- _____ is the science of drawing useful facts from some data.
- Circles having the same centre are called _____ circles.
- Two angle are said to be _____, their measures are equal.

5. An equilateral triangle has _____ lines of symmetry.
6. _____ is the distance measured around a closed figure.
7. _____ is the line segment joining the centre of a circle to any point on the circle.
8. Perimeter of a square is _____.
9. _____ is the amount of space within a closed figure.
10. Area between two concentric circles with radii R and r is _____.

C. Write 'T' for true statement and 'F' for false statement :

(10)

1. Rectangles having equal perimeter are congruent.
2. The distance from center to the boundary of a circle is its circumference.
3. Most common value of a data is called mode.
4. When an object rotates, its size and shape remain unchanged.
5. Numeral data is represented in a circular form is called a pie chart or circle chart.
6. We cannot find the area of three dimensional shapes.
7. The perimeter of a circle is called its circumference.
8. The value of π is 3.41459.
9. The perimeter of a rectangle is $2(\text{Length} + \text{breadth})$.
10. 3-D shapes whose faces are polygons are called polyhedrons.



Model Test Paper-II

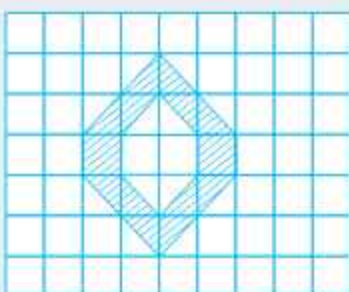
(Based on Chapters 9 to 13)

SECTION - A

- Find the perimeter of an isosceles triangle that has its equal side 7.5 cm and third side 6.7 cm.
- One of the angles of a triangle has measure 50° and the other two angles are equal. Find these angles.
- Draw lines of symmetry of 8.
- Write the number of edges, faces and vertices of a cuboid.
- When $\triangle ABC \cong \triangle POR$, write all congruent sides and angles.
- Write the conditions for the construction of a triangle.
- The area of a square-shaded park is 1024 m^2 . What is its perimeter?
- Rahul Dravid scored the following runs in 5 different innings :
125, 270, 0, 75, 37
Find the average runs scored by him.
- The diameter of a circular field is 154 m. How much distance an athlete will cover in 8 rounds?

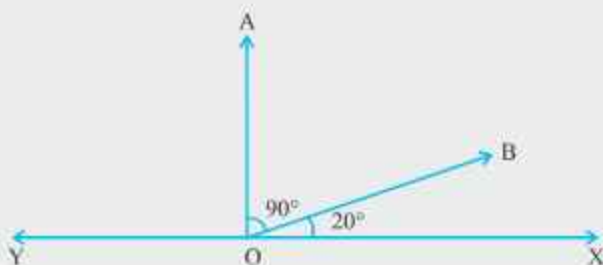
[11 × 2 = 22]

10.



Find the area of the shaded portion.

- In the given figure if $\angle AOB = 90^\circ$, find the $\angle AOY$.



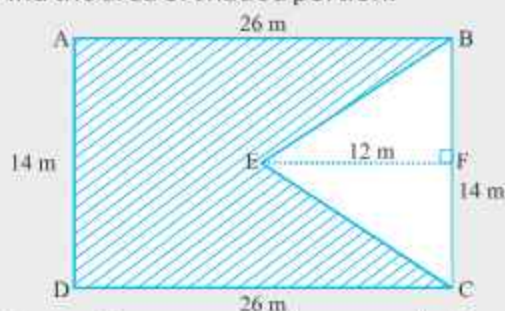
SECTION - B

- The angles of a triangle are $(x - 30^\circ)$, $(2x + 15^\circ)$ and $(\frac{x}{2} + 120^\circ)$. Find the angles.
- Two poles of height 7 m and 15 m stand upright in a playground. If their feet are 15 m apart, find the distance between their tops.
- Show three alphabets of your choice with two lines of symmetry.
- Draw an accurate, full-size net of a cube of side 2 cm.

[10 × 3 = 30]



16. Is there a triangle whose side have the length 10.2cm, 5.8 and 4.5 cm?
17. Find the area of shaded portion.



18. Five tourists were asked to guess the length of Qutab Minar. The observations were recorded as follows :

Persons	1	2	3	4	5
Lenghts (in m)	110	117	105	117	120

Find the mean, median and mode.

29. Find x , if the angles of triangle have measures $(x+40)$, $(2x+20)$ and $3x$, also state which type of triangle is this?
20. The base and height of a triangle are in ratio 4 : 3 and its area is 726 m^2 . Find its base and height.

SECTION - B

[7 × 4 = 28]

21. The side PQ of a ΔPQR is produced on both sides. Show that the sum of the exterior angles so formed is greater than $\angle R$ by two right angles.
22. Rotate  through 90° , 180° , 270° and 360° about O. Find the angle of rotation when the image look alike to the original and hence find the rotational order.
23. A ladder of length 145 cm reaches a window which is 144 cm above the ground on one side of a street, at the same point it reaches a window of 143 cm high in a wall on opposite side. Find the width of the street.
24. A rectangular plot measuring $44\text{m} \times 25\text{m}$ is surrounded externally by a 3m wide path. Find the area of the path.
25. In ΔPQR , PS is the bisector of $\angle P$ such that $PS \perp QR$. Is ΔPQR an isosceles triangles ? Prove it.
26. A rectangular park is 64 m by 78 m. It has two roads each 3.5 m wide running in the middle of it, one parallel to its length and the other parallel to its breadth. Find the amount of putting marbles on it at rate of ₹ 127/ m^2 .
27. The data given below depicts the viewership of news channels of the residents of a locality :

News channel	Zee News	ABP News	India TV	NDTV India	DD News	Live India
No. of People	425	375	400	550	125	250

Draw a bar graph by choosing the appropriate scale.

Answers

Ch-1 Knowing the Numbers

Exercise 1.1

- (a) -28, -12, -7, -1, 1, 3, 7 (b) -5, -4, 1, 3, 6, 8, 11
- (a) 15, 9, 6, 3, -7, -10, -12, -14 (b) 14, 13, 8, 6, 2, 0, -8, -10, -16
- (a) 41 (b) 3 (c) 83 (d) 27
- (a) 16 (b) -137 (c) 7 (d) 484
- (a) 7°C (b) 0°F (c) -14°C (d) 44°F
- (a) 0, 3, 6, 9 (b) 69, 75, 81, 87
- (a) -2 (b) 330 (c) -1 (d) 999 (e) -210 (f) 187

Exercise 1.2

- (a) 0 (b) 144 (c) 0 (d) 132 (e) -77 (f) -120
- (a) -80 (b) -54 (c) 0 (d) 90 (e) 1800 (f) 1000 (g) 0 (h) 600
- (a) -96 (b) 16 (c) -10 (d) 75 (e) 4 (f) -3 (g) -6 (h) -7 (i) 3 (j) 100
- (a) 20 (b) -12 (c) -2 (d) -12 (e) -21 (f) 37 (g) 9 (h) 1 (i) -9 (j) 10
- (a) 12 (b) 6 (c) 2 (d) 100
- 3
- 12
- 84

Exercise 1.3

- (a) -20 (b) -25 (c) 0 (d) 26 (e) 16 (f) 0 (g) -5 (h) -5, -10 (i) -8, -4 (j) -5
- (a) T (b) F (c) F (d) F (e) T (f) F
- (a) 2540 (b) 735 (c) -25
- (a) -8550 (b) 224 (c) 252 (d) -9100
- (a) 1836 (b) -5015 (c) 1246 (d) -3589
- 117
- 9
- 164 m

Exercise

- (a) (iii) (b) (ii) (c) (iii) (d) (i) (e) (ii) (f) (ii) (g) (iv)
- (a) 143 (b) -64 (c) 90 (d) -1000
- (a) 4 (b) -21 (c) 0 (d) -21 (e) 36 (f) -8
- (a) 16 (b) -14 (c) 14 (d) 4
- (a) -493 (b) -663 (c) -1034 (d) -1200 (e) 3400 (f) 7200
- 12 moves
- 5400

Ch-2 Rational Numbers

Exercise 2.1

- $\frac{6}{0}$
- 4, -3, 2, -7
- (a), (b), (e)
- Do it yourself
- (a) $\frac{-3}{4}$
- (b) $\frac{-5}{3}$
- (c) $\frac{3}{5}, \frac{1}{5}, \frac{7}{5}, \frac{4}{5}$
- (d) $\frac{-7}{8}, \frac{-5}{8}, \frac{-3}{8}, \frac{1}{8}, \frac{3}{8}$
- (a) $\frac{17}{56}$ (b) $\frac{1}{9}$ (c) $\frac{-1}{13}$ (d) $\frac{10}{51}$
- (a) $\frac{-6}{14}, \frac{-9}{21}, \frac{-12}{28}, \frac{-15}{35}$ (b) $\frac{4}{6}, \frac{6}{9}, \frac{8}{12}, \frac{10}{15}$ (c) $\frac{-22}{14}, \frac{-33}{21}, \frac{-44}{28}, \frac{-55}{35}$
- (d) $\frac{12}{22}, \frac{18}{33}, \frac{24}{44}, \frac{30}{55}$ (a) $x = \frac{-45}{4}$ (b) $x = -24$ (c) $x = -21$ (d) $x = 20$ (e) $x = \frac{216}{5}$
- (a) $\frac{-3}{21}, \frac{-5}{23}$ (b) $\frac{+13}{35}, \frac{15}{42}$ (c) $\frac{5}{10}, \frac{6}{12}$ (d) $\frac{-7}{7}, \frac{-8}{7}$
- (a) $\frac{7}{3}, \frac{4}{3}, \frac{2}{3}, \frac{1}{3}, \frac{-1}{3}, \frac{-2}{3}, \frac{-7}{3}$ (b) $\frac{7}{3}, \frac{6}{3}, \frac{2}{3}, \frac{1}{3}, \frac{-13}{3}, \frac{-14}{3}$ (c) $\frac{4}{3}, \frac{2}{5}, \frac{2}{6}, \frac{-1}{2}, \frac{-3}{4}$ (d) $\frac{7}{10}, \frac{2}{5}, \frac{-2}{5}, \frac{-6}{5}, \frac{-7}{5}$
- (a) $\frac{-4}{9}$ (b) $\frac{14}{27}$ (c) $\frac{-8}{15}$ (d) $\frac{-3}{4}$

Exercise 2.2

- (a) $\frac{17}{5}$ (b) $\frac{-53}{42}$ (c) $\frac{-3}{7}$ (d) $\frac{-7}{11}$ (e) $\frac{29}{42}$ (f) $\frac{-919}{280}$

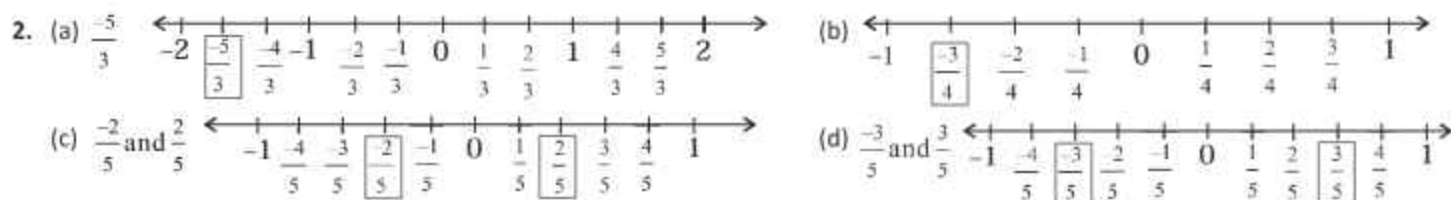
2. (a) $\frac{11}{12}$ (b) $\frac{-12}{7}$ (c) $\frac{44}{75}$ (d) $\frac{-5}{12}$ (e) $\frac{-1}{42}$ (f) $\frac{29}{15}$
 3. (a) $\frac{119}{8}$ (b) $\frac{13}{60}$ (c) $\frac{-48}{35}$ (d) $\frac{24}{35}$ (e) $\frac{-1}{2}$ (f) $\frac{-7}{24}$
 4. (a) $\frac{-8}{25}$ (b) $\frac{35}{48}$ (c) $\frac{-35}{64}$ (d) $\frac{1}{2}$ (e) $\frac{-1}{5}$ (f) $\frac{9}{10}$
 5. (a) $\frac{6}{7}$ (b) $\frac{-73}{168}$ (c) $\frac{1}{20}$ (d) $\frac{35}{64}$ (e) $\frac{-31}{30}$ 6. $\frac{-23}{21}$ 7. $\frac{-11}{28}$ 8. $\frac{-2}{5}$

Exercise 2.3

1. (a) 2.6 (b) -0.28 (c) 0.024 (d) -0.175 2. (a) non-terminating (b) terminating
 (c) non-terminating (d) terminating (e) terminating (f) non-terminating (g) terminating (h) terminating
 3. (a) 0.13 (b) 0.428571 (c) 0.875 (d) 0.68 (e) 0.5 (f) 3.25 (g) 15.625 (h) 0.48
 4. (a) $\frac{5}{4}$ (b) $\frac{281}{40}$ (c) $\frac{34}{9}$ (d) $\frac{2322}{90}$ (e) $\frac{7}{30}$ (f) $\frac{3353}{999}$ (g) $\frac{71}{90}$ (h) $\frac{307}{300}$
 5. (a) $5\frac{7}{9}$ (b) $9\frac{112}{99}$ (c) $\frac{89}{198}$ (d) $10\frac{943}{990}$ 6. $4\frac{1}{10}$ 7. $x=289, y=999$
 8. (a) ✓ (b) ✓ (c) ✗ (d) ✓ (e) ✗ (f) ✓

Exercise

1. (a) (i) (b) (ii) (c) (i) (d) (iv) (e) (ii) (f) (iii) (g) (i) (h) (iv)



3. (a) $\frac{-13}{45}$ (b) $\frac{23}{49}$ (c) $\frac{-1}{8}$ (d) $\frac{11}{650}$ 4. (a) $\frac{15}{14}$ (b) $\frac{11}{36}$ (c) $\frac{19}{15}$ (d) $2\frac{1}{5}$
 5. (a) $\frac{3}{4}$ (b) $\frac{-5}{3}$ (c) $\frac{5}{11}$ (d) $\frac{3}{4}$ 6. (a) $\frac{-7}{8}, \frac{-5}{6}, \frac{5}{8}, \frac{2}{3}, \frac{3}{4}$ (b) $\frac{-3}{7}, \frac{-5}{14}, \frac{-6}{35}, \frac{3}{10}$
 (c) $\frac{-5}{6}, \frac{-2}{3}, \frac{-1}{3}, \frac{1}{3}, \frac{2}{3}, \frac{5}{6}$ (d) $-2, \frac{-3}{5}, \frac{-1}{2}, 0, \frac{1}{2}, \frac{3}{5}, 2$ 7. (a) $\frac{-13}{7}$ (b) $\frac{11}{35}$ (c) $\frac{-13}{51}$ (d) $\frac{-11}{4}$
 8. (a) $\frac{-7}{17}$ (b) $\frac{-9}{26}$ (c) $\frac{-16}{13}$ (d) 1 9. (a) $\frac{16}{75}$ (b) $\frac{-9}{10}$ 10. $\frac{1}{4}$ 11. $\frac{-144}{5}$ 12. $\frac{5}{12}$
 13. (a) $x = \frac{-1}{56}$ (b) $x = \frac{-14}{15}$ (c) $x = \frac{24}{35}$ 14. (a) 0.4 (b) 0.857142 (c) 0.06 (d) 0.416
 15. (a) $\frac{1}{40}$ (b) $\frac{63}{20}$ (c) $\frac{230}{9}$ (d) $\frac{188}{495}$ 16. (a) $8\frac{31}{990}$ (b) $\frac{35}{99}$ (c) $1\frac{461}{990}$ (d) $41\frac{649}{990}$
 17. $\frac{100}{9}$ 18. (a) $\frac{77}{27}$ (b) $\frac{113}{50}$

Ch-3 Fractions

Exercise 3.1

1. (a) $\frac{35}{11}$ (b) $\frac{19}{2}$ (c) $\frac{42}{5}$ (d) 6 (e) $\frac{56}{9}$ (f) $\frac{64}{3}$ 2. (a) $\frac{21}{2}$ (b) $\frac{18}{11}$ (c) $5\frac{5}{6}$
 (d) $8\frac{1}{2}$ (e) $22\frac{2}{9}$ (f) $\frac{56}{405}$ 3. (a) $3\frac{1}{3}$ (b) $\frac{2}{5}$ (c) $\frac{1}{6}$ (d) $\frac{68}{665}$
 4. ₹ 90 5. $22\frac{1}{2}$ km 6. $7\frac{1}{2}$ litres

Exercise 3.2

1. (a) $\frac{6}{5}$ (b) $\frac{25}{6}$ (c) $\frac{31}{21}$ (d) $\frac{13}{22}$ 2. (a) $\frac{2}{27}$ (b) $\frac{1}{10}$ (c) $\frac{3}{44}$ (d) $\frac{31}{49}$
 3. (a) $\frac{44}{3}$ (b) $\frac{1000}{3}$ (c) $\frac{7}{5}$ (d) $\frac{84}{5}$ 4. $\frac{203}{66}$ 5. 16 pen 6. $130\frac{1}{2}$ kg 7. ₹ $48\frac{3}{4}$ 8. ₹ 946

Exercise

1. (a) (iii) (b) (iii) (c) (iv) (d) (iii) (e) (ii) (f) (ii) (g) (ii) (h) (i)
 2. 3 3. ₹ 26 4. 15 km 5. ₹ 140 6. $\frac{4}{3}$ litres 7. 7 girls 8. 233 students 9. 49 km

Revision Test Paper-I

- A. 1. (ii) 2. (i) 3. (i) 4. (iii) 5. (iii) 6. (iii) 7. (iv) 8. (iv) 9. (ii) 10. (i)
 B. 1. $\frac{13}{3}$ 2. multiplication inverse 3. standard 4. litre 5. zero 6. mixed 7. decima 8. proper 9. irrational numbers 10. integers
 C. 1. F 2. T 3. F 4. T 5. F 6. T 7. F 8. F 9. F 10. T

Ch-4 Decimals

Exercise 4.1

1. (a) 79.5 (b) 145 (c) 1530 (d) 675 (e) 5.5 (f) 3567 (g) 279010 (h) 2873.3
 2. (a) 350.474 (b) 140 (c) 87.36 (d) 29.7 (e) 157.76 (f) 27572.4 (g) 26077.8 (h) 24.475
 3. (a) 14.3715 (b) 17.358 (c) 3.9345 (d) 598.558 (e) 153.552 (f) 139.649 (g) 0.9375
 (h) 0.16605 4. 164.01 km 5. 320.41 m²

Exercise 4.2

1. (a) 0.2 (b) 0.1 (c) 1.8 (d) 0.63 (e) 3.99 (f) 2 2. (a) 0.1728 (b) 0.926
 (c) 0.005685 (d) 0.075399 3. 13.63 4. 0.95 cm² 5. ₹ 15050

Exercise 4.3

1. (a) 7000 ml (b) 25000 m (c) 3500 gm (d) 2.900 kg (e) 5000/ (f) 2.945 kg (g) 0.00725/ (h) 2 m
 2. 26 books 3. 124.23 kg 4. 4525 kg 5. 106.8 cm and 1.068 m

Exercise

1. (a) (ii) (b) (iii) (c) (iv) (d) (iii) (e) (iii) (f) (ii) (g) (iii)
 2. ₹ 14400.00 3. 388.8 g 4. ₹ 1213.10 extra money required 5. ₹ 823.50
 6. 48.267 m² 7. 725.5 kg 8. 20.58 litres 9. ₹ 5373.3 10. 29.25 km

Ch-5 Exponents and Powers

Exercise 5.1

1. (a) 64 (b) 2187 (c) 125 (d) 256 (e) 729 (f) -343
 2. (a) base = 5, exponent = 3 (b) base = -5, exponent = 4 (c) base = -1, exponent = 11 (d) base = y, exponent = m
 (e) base = m, exponent = y (f) base = -100, exponent = 5 3. (a) y³ (b) 9⁵ (c) a² (d) (7)³(3)² (e) (n)³(m)²
 (f) (x)³(y)²(z)² 4. (a) 9¹ > 1⁹ (b) 3⁶ > 6³ (c) 9¹⁰ > 10⁹ (d) 5² > (-2)⁵
 (e) (10)³ > (-1)¹⁰ (f) (3)⁷ > (7)³ 5. (a) 3 × 5 × 5 = 3 × 5² (b) 2³ × 3² × 5³ (c) 5⁴ (d) 3⁶ × 5
 (e) 2⁴ × 3² × 5² (f) 3³ × 5² 6. (a) 3000 (b) 3072 (c) 6400 (d) 2304 (e) 225 (f) 500
 7. (a) -50 (b) -64 (c) -8 (d) 40 (e) 30375 (f) 256

Exercise 5.2

1. (a) 2² × 3² (b) 5⁻⁴ (c) a²b (d) 2¹ (e) p¹² (f) 2¹⁰⁰ (g) 5² × 2⁻³ × 3⁻¹ (h) 3²p² = (3p)²
 2. (a) 5²⁺⁴⁺³ = 5⁹ (b) -3⁵⁺⁴ = (-3)⁹ (c) p⁴⁺⁵ = p⁹ (d) 5¹⁵ (e) 10¹⁰⁰ (f) 1 (g) (m × n)⁷ (h) 3³⁺² = 3⁵
 (i) 8^{x-3} 3. (a) 2³ × 3⁴ (b) 2⁴ × 3¹ × 5³ (c) 3¹⁰
 (d) 2¹¹ × 3¹ × 5² (e) (3⁷) × (5⁴) 4. (a) 2¹⁶ × (5/7)³ (b) 2¹⁰ × 5¹ (c)
 5. (a) False (b) False (c) False (d) False (e) True 6. (a) x = 8 (b) x = 21 (c) x = 19 (d) x = 3

Exercise 5.3

1. (a) 9 × 10¹ + 3 × 10¹ + 4 × 10¹ + 6 × 10¹ + 5 × 10¹ - 7 × 10⁰ (b) 8 × 10⁷ + 8 × 10⁻⁴ + 8 × 10² + 7 × 10⁰
 (c) 3 × 10⁵ + 2 × 10³ + 1 × 10⁴ + 3 × 10¹ + 1 × 10⁰ + 2 × 10⁰ (d) 7 × 10⁴ + 1 × 10² + 8 × 10⁰
 2. (a) 7005030 (b) 57890
 (c) 403050 (d) 76100
 3. (a) 9 × 10⁷ (b) 4.1569 × 10⁹ (c) 5.9 × 10⁵ (d) 5.9 × 10⁵
 4. (a) 3 × 10⁸ m (b) 1.2756 × 10⁶ m (c) 1.2 × 10¹⁰ Years (d) 1.027 × 10⁹ (e) 3.84 × 10⁸ m (f) 1.4 × 10⁹ m

Exercise

1. (a) (ii) (b) (iv) (c) (ii) (d) (iii) (e) (iii) (f) (iii) (g) (ii) (h) (iii) (i) (i)
 2. (a) 256 (b) 1024 (c) 125 (d) 46656 (e) 243 (f) -343 3. (a) base = 7, power = 7 (b) base = -11, power = 10
 (c) base = xy, power = a (d) base = m, power = 0 (e) base = 101, power = 1 (f) base = x, power = y
 4. (a) m³ (b) (-1)⁴ (c) 3⁵ (d) 2³ × m × n (e) 5³ × 7² (f) m³ × n² × p³
 5. (a) 5³ (b) equal (c) (-2)³ (d) 7² (e) 5⁴ (f) (-1)³



6. (a) $5 \times 2^2 \times 3^3$ (b) $5^3 \times 7^2$ (c) $2^5 \times 5^2 \times 3$ (d) $2^3 \times 3^4$
 7. (a) 500000 (b) 225 (c) 64 (d) $(-4)120$ (e) m^9 (f) 0.25
 8. (a) $2^6 \times 3^5 \times 5^7$ (b) 21^5 (c) 5^4 (d) $5^{17} \times 3^{10}$ 9. (a) False (b) False (c) True (d) True
 10. (a) $y=5$ (b) (c) $y=6$ (d) $y=14$
 11. (a) $5 \times 10^5 + 7 \times 10^3 + 3 \times 10^2 + 4 \times 10 + 5 \times 100$ (b) $5 \times 10^6 + 7 \times 10^2 + 8 \times 10 + 5 \times 100$
 (c) $4 \times 10^5 + 9 \times 10^4 + 5 \times 10^3 + 7 \times 10^2 + 8 \times 10 + 1 \times 100$ (d) $6 \times 10^5 + 7 \times 10^4 + 9 \times 10^3 + 1$
 12. (a) 50830201 (b) 460094 13. (a) 7×10^7 (b) 3.1678×10^9 (c) 1.353×10^9

Ch-6 Algebraic Expression

Exercise 6.1

1. (a) $x+250$ (b) $x-670$ (c) $100-a \times b$ (d) $(x+x+1+x+2)2$ (e) $(x)2+(x+1)2$
 2.

Algebraic Expression	Terms	Numerical factor	Literal Factor
(a) $5x-6$	$5x, -6$	$5, -6$	x
(b) $-5x+8$	$-5x, 8$	$-5, 8$	x
(c) $5x^2-6x$	$5x^2, -6x$	$5, -6$	x^2, x
(d) $x2y2-6xy$	$x2y2, -6xy$	$1, -6$	x^2y^2, xy

 3. (a) $15r^5z$ (b) $15p^3z$ (c) $15q^4z$ (d) $15z$ 4. (a) $4x^2y, 4y$ (b) $x^2, 1$ (c) x^2y^2, y^2
 5. (a) like = $ab^2, 5b^2a$, unlike = $6a^2b, 11ab$ (b) like = (xyz, zyx) , unlike = zy^2x, zx^2b
 (c) like = $17b, 15b$, unlike = $14a, 18bc$ (d) like = $7x^2y^2z^2, 5y^2z^2x^2$ unlike = $3xyz, -5xy^2z$
 6. (a) constant (b) Binomial (c) Trinomial (d) Monomial 7. (a) -11 (b) No (c) No (d) 15
 8. (a) xy (b) mn^2 (c) xyz^2 (d) xyz^2

Exercise 6.2

1. (a) 10 (b) 1 (c) 3 (d) 21 2. (a) 8 (b) -5 (c) -1 (d) -5
 3. (a) 32 (b) 0 (c) 0 (d) -16 4. 179 5. 64 6. 31

Exercise

1. (a) (ii) (b) (iv) (c) (iii) (d) (i) (e) (ii) (f) (iv) (g) (iii) (h) (i) (i) (iii) (j) (iii)
 2. (a) $2x-2+2x+2=111$ (b) $x+1000$ (c) $x-90$ (d) $676-m \times n$ 3. (a) -10 (b) 9,11 (c) 8,-5 (d) -7
 4. (a) $pq^2, 7q^2p$ (b) abc, cab (c) $111b, 11b$ (d) $5x^2y^2z^2, 9y^2z^2x^2$ 5. (a) xy^2z (b) a^2b (c) $x^2a^2m^2$ (d) x^2y^5
 6. (a) $5p^3-12p^2q+16pq^2+q^3$ (b) $-4x^4-4x^3y+7x^2y^2-2x^2y^2+16y^2$ 7. (a) $8p^2-11q^2$ (b) $4x^2-3xy$
 8. $-2m^3-7m^2+7m+2$ 9. (a) 11 (b) 7 (c) 198 (d) 4 10. 329
 11. Area = $m \times n$ and Perimeter = $(m+n) \times 2$

Ch-7 Simple Linear Equation

Exercise : 7.1

1. (a) 32 added to 6 times m gives 62 (b) 31 added to $7/8$ times x gives 120 (c) 10 subtracted from half of t gives 103
 (d) 5 times l gives 125 (e) 30 subtracted from d gives -20 (f) 35 added to 5 times a gives 0
 (g) 4 subtracted from one-third x gives 4 (h) $15/16$ times q gives 225
 2. (a) $\angle p + \angle p + \angle 2p = 180^\circ$ (b) $80x + 60 = 365, 80x - 305 = 0$ (c) $x/200 + 40 = 1000$ (d) $3x - 100 = 330$
 (e) $3h + 12 = 2(h + 12)$ 3. (a) $\checkmark$ (b) $\checkmark$ (c) $\times$ (d) $\times$ 4. (a) No (b) No (c) No

Exercise : 7.2

1. 67 2. $64.5^\circ, 24.7^\circ$ and 90.8° 3. Sunita's age = 18 years ; Kamal's age = 12 years 4. ₹125
 5. $\frac{42}{52}$ 6. (a) $\frac{1}{5}t + 10 = 14t$ (b) $\frac{y}{88} = 4$ (c) $19r - 10 = 180$ (d) $7r + 11 = 81$
 (e) $\frac{(x \times 7) + 110}{100} = \frac{12}{13}$ (f) $\frac{(200 - m)}{17} = \frac{1}{6}$ 7. (a) No (b) No (c) Yes (d) Yes
 8. (a) Six times of x gives 139.
 (b) A number x is multiplied by 17 and 21 is added to it. This entire term is divided by 121, we get 87.
 (c) 108 subtracted from five times of l gives 12.
 (d) 25 is subtracted from of a number l gives 75.
 (e) A number p is multiplied by 87 and 100 is added to it, the result is 13.
 (f) Seven is added to one Sixth of a number. This entire term is multiplied by 3, we get 3.
 9. 8 10. 1 11. 13 12. 3 13. (a) 70 (b) 10 (c) -7 (d) 20 14. 17, 18, 19
 15. (a) simple (b) changed (c) 53 (d) 63 (e) 3 16. $p = ₹816$ 17. 150 km 18. 42 and 24
 19. Dolly earns ₹ 18000, Sally earns ₹ 15000. 20. 10



Exercise

- (a) (iv) (b) (iii) (c) (iv) (d) (iii) (e) (iii) (f) (iv) (g) (ii) (h) (iii) (i) (iii) (j) (iv)
- (a) One hundred eleven added to seven times p gives two hundred one. (b) A number of y subtracted twelve gives twenty.
(c) Ten added to five times of x gives fifteen. (d) 7 is added to x then divided by 3 and 2 more is added equal to the 10.
- (a) $x = -2$ (b) $x = 48$ (c) $x = 11$ (d) $x = 3$ (e) $x = 1$ 4. Present age of Rupa is = 25 years 5. 6
- (a) $2p + 11 = 0$, $4p + 22 = 0$, $6p + 33 = 0$ (b) $7x - 18 = 0$, $14x - 36 = 0$, $21x - 54 = 0$ (c) $14y - 84 = 0$, $7y - 42 = 0$, $2y - 12 = 0$
(d) $72l - 91 = 0$, $144l - 182 = 0$, $216l - 273 = 0$ 7. 2 8. 90 and 72 9. 17 10. 19

Ch-8 Percentage and its Applications

Exercise 8.1

- (a) 60% (b) 37.5% (c) 33.33% (d) 75% 2. (a) 12.5% (b) 24% (c) 275% (d) 240%
- (a) 25% (b) 340% (c) 125% (d) 220% 4. (a) 16% (b) 125% (c) 62.5% (d) 26525%
- (a) $\frac{9}{25}$ (b) $\frac{5}{4}$ (c) $\frac{1}{8}$ (d) $\frac{2}{25}$ 6. (a) 2:125 (b) 13:20 (c) 3:8 (d) 21:200
- (a) 0.18 (b) 0.225 (c) 2.25 (d) 0.01123
- (a) 10/ (b) ₹ 6375 (c) 300 kg (d) 75 km (e) 3 minutes 36 seconds (f) 13.5
- (a) 500 (b) 480 (c) 240 (d) 280 10. 33.33% 11. 20,000 12. Mukesh 13. 800 marks
- 400 candidates 15. ₹ 25714 16. ₹ 2,50,000 17. 8000 students

Exercise 8.2

- (a) ₹ 2175 (b) ₹ 1300 (c) ₹ 2510.75 (d) ₹ 114.75 2. (a) ₹ 800 (b) ₹ 2237 (c) ₹ 1395.5 (d) ₹ 746
- (a) Profit = ₹ 90 and Profit% = 20% (b) Selling Price = ₹ 2640 and Profit = ₹ 440
(c) Cost Price = ₹ 600 and Profit% = 10% (d) Cost Price = ₹ 150 and Profit% = 20% (e) Cost Price = ₹ 720 and Selling Price = ₹ 828
- SP = ₹ 15,600 5. ₹ 48 per dozen 6. ₹ 30000 7. ₹ 26000 8. 1.5% profit 9. 25%
- ₹ 5312.5 11. 58.33% 12. ₹ 1200 13. 3.57% 14. ₹ 675 15. (a) ₹ 15 per kg (b) ₹ 20 per kg

Exercise 8.3

- (a) Amount = ₹ 2016 and Time = 2 years (b) Amount = ₹ 6200 and Rate = 6% (c) Principal = ₹ 562.50 and Interest = ₹ 337.5
(d) Principal = ₹ 4000 and Time = 2.5 years 2. $P = ₹ 4000$ 3. $P = ₹ 21484.6$ 4. 16.67% 5. ₹ 312.5 6. 4 years
- 12.5% 8. $P = ₹ 4000$, $R = 5\%$ 9. $R = 12.5\%$, $A = ₹ 13500$ 10. $P = ₹ 6000$

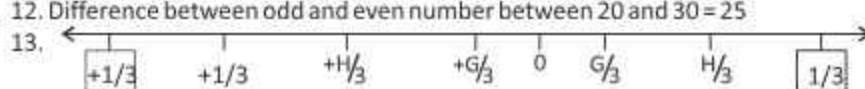
Exercise

- (a) (iii) (b) (iii) (c) (i) (d) (iv) (e) (ii) (f) (iii) (g) (iv) (h) (iii) 2. (a) 75% (b) 50%
(c) 62.5% (d) 25% 3. (a) ₹ 37.5 (b) 62/ (c) ₹ 128 km (d) 0.24 kg 4. Sehwaag - 266.66% 5. 11.1%
- 500 marks 7. 33.3% 8. Loss 4% 9. ₹ 1500 10. ₹ 200 11. Amount = ₹ 8000 12. 7 years
- Rate = 8% 14. $P = ₹ 6250$

Revision Test Paper-II

1. (iv) 2. (iii) 3. (iv) 4. (ii) 5. (iii) 6. (iii) 7. (iii) 8. (iv) 9. (i) 10. (iv)
1. trinomial 2. literal 3. balancing 4. continued 5. amount 6. factor 7. constant term
8. consequents 9. percentage 10. interest
1. T 2. T 3. T 4. F 5. F 6. F 7. T 8. F 9. F 10. T

Model Test Paper-I

- $64 \times (100 + 5) = (64 \times 100) + (64 \times 5) = 6720$ 2. $\frac{1}{4}$ 3. $\frac{2}{3}$ 4. 333.315 5. $\left(\frac{-3}{2}\right)^5$ 6. -11
- 14, 15, 16 8. ₹ 1000 9. 16000 10. 20% Profit 11. ₹ 1437.5
12. Difference between odd and even number between 20 and 30 = 25
13.  15. Do it yourself 16. $9x^4 - 7x^3 + 6x^2 - 12$ 17. $\frac{2}{7}$
18. (a) 0.83 (b) $0.\overline{285714}$ (c) 0.625 19. Profit 4.3% 20. 8 years 4 months 21. 300
22. (a) 240 (b) No 23. $\frac{-41}{63}$ 24. 41.6% profit
25. Value of first prize = 1050, value of second prize 875 and value of third prize = 700 26. 30, 120 27. Paid interest = ₹ 36000



Ch-9 Triangle and Its Properties

Exercise 10.1

- 20°, 60°, 100° 2. 360° 3. (a) $P = 65^\circ$, $P = 65^\circ$ (b) $P = 70^\circ$ (c) $P = 30^\circ$, $2P = 60^\circ$ (d) $P = 50^\circ$, $Y = 80^\circ$
(e) $y = 60^\circ$, $P = 70^\circ$ 4. (a) $a = 112^\circ$, $b = 147^\circ$
- (a) The sum of all angles of a triangle is equal to 180° . A triangle can not have two angles of 90° each. (b) Yes
(c) Scalene Triangle (d) Equilateral Triangle 6. (a) 58° , 58° and 64° 7. (a) Vertically opposites
(b) Alternate interior angles (c) Corresponding angles (d) Exterior angle (e) Interior angles (f) Right angles
- (a) An equilateral triangle have all three sides equal but an isosceles triangle have only 2 equal sides.
(b) An equilateral triangle have all three angles equal but an isosceles triangle have two angles equal.
- (a) $x = 66^\circ$ (b) $y = 92^\circ$ (c) $y = 22^\circ$ 10. 2 cm and 14 cm

Exercise 9.2

- 25 km 2. 25 cm 3. Perimeter = 68 cm. 4. Length of diagonal = 13 cm.
- Since $6^2 + 4.5^2 = 7.5^2$ (Pythagoras theorem) 6. $x = 115^\circ$, $y = 65^\circ$, $z = 25^\circ$

Revision Exercise

- (a) Three angles (b) 90° (c) $AB^2 + BC^2 = AC^2$ (d) Longest side (e) No (f) None of these (g) Less than 90°
- $y = 62^\circ$, $x = 148^\circ$ 3. (a) Possible Scalene (b) Possible, Scalene Triangle (c) Possible, Scalene Triangle
(d) Impossible (e) Possible, Scalene Triangle 4. (a) The sum of all angles of a triangle is equal to 180° .
(b) Do it yourself 5. third angle = 43° , acute angle, 6. 19°
- (a) A scalene triangle have all sides unequal but an isosceles triangle have two equal sides and one different.
(b) Do it yourself (c) $X = 60^\circ$, $Y = 70^\circ$ 8. (a) 40° , 60° , 80° (b) 107° (c) 152° (d) equilateral (e) 90° (f) 98m
(g) longest (h) greater 9. Do it yourself 10. $x = 70^\circ$, $y = 50^\circ$, $z = 60^\circ$ 11. Do it yourself
- 135° 13. $\angle P + \angle Q + \angle R + \angle S + \angle X + \angle T = 360^\circ$ 14. 6 cm and 16 cm 15. Do it yourself 16. $x = 120^\circ$, $y = 60^\circ$, $z = 70^\circ$

Ch-10 Perimeter and Area

Exercise 10.1

- 21.6 m 2. (a) 32 cm (b) 18 cm 3. (a) 18 cm (b) 27 cm (c) 36.9 cm 4. 37 m 5. 16.6 cm
- Length = 36m, Breath = 12 m 7. Length = 196cm, Breath = 147cm 8. 24m, 36m and 48m 9. Side = 21cm
- (a) 20cm (b) 38m (c) 30.4cm (d) 56m

Exercise 10.2

- (a) $120m^2$ (b) $45m^2$ (c) $90m^2$ (d) $58m^2$ 2. (a) $56.25m^2$ (b) $169m^2$ (c) $51.84m^2$ (d) $144m^2$ 3. $80cm^2$
- 16m 5. (a) $84m^2$ (b) $19.2m^2$ 6. $432m^2$ 7. $180m^2$ 8. 75m and 50m 9. $31cm^2$
- $F = 7cm^2$, $L = 5cm^2$, $M = 9cm^2$, $H = 7cm^2$ and $J = 6cm^2$, $T = 5cm^2$ 11. 32m 12. 72m

Exercise 10.3

- (a) $111m^2$ (b) $225m^2$ 2. $445m^2$ 3. ₹1462.5 4. $4875m^2$ 5. ₹4608 6. ₹90900 7. ₹1472.5 8. $824m^2$
- (a) $200cm^2$ (b) $56m^2$

Exercise 10.4

- (a) 176cm (b) 22cm (c) 66m (d) 26.4cm 2. (a) 22m (b) 13.2cm (c) 264m (d) 44m 3. $7546m^2$
- $616cm^2$ 5. $3758.86m^2$ 6. $182.5m^2$ 7. $638m^2$ 8. $1386m^2$ 9. $990cm^2$ 10. (a) $119m^2$ (b) $192.5m^2$

Exercise

- (a) (iii) (b) (ii) (c) (i) (d) (iv) (e) (ii) (f) (ii) (g) (iv) (h) (iii) 2. Length = 42.5m, Breath = 17m
- 36m, 24m and 24m 4. 56m 5. Rahul, 270m 6. $12500m^2$ 7. 98m 8. $4608m^2$
- Base 91m, altitude = 52m 10. ₹ 1120 11. $411m^2$ 12. $3500m^2$ 13. 5280m 14. (a) $70.56m^2$ (b) $154cm^2$ (c) $81.44cm^2$

Revision Test Paper-III

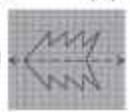
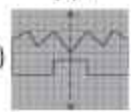
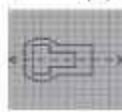
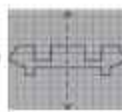
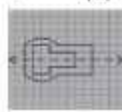
- (ii) 2. (i) 3. (iii) 4. (ii) 5. (iii) 6. (ii) 7. (iv) 8. (ii) 9. (iv) 10. (iv)
1. one angle 2. line of 3. infinite 4. sum 5. 17 6. isosceles triangle 7. 60° 8. greater
9. 0 10. symmetric
1. T 2. T 3. F 4. F 5. T 6. T 7. T 8. T 9. F 10. T

Ch-11 Symmetry

Exercise 11.1

- (a) 2 (b) infinite (c) Four (4) (d) 4 (e) 3 (f) 5 (g) No (h) 2 (i) 6 (j) 1
(k) 1 (l) 1 2. Do it yourself
- A B C D E H M, O T U V W X Y 4. (a) F (b) F (c) T (d) T (e) T

Exercise 11.2

- Do it yourself 2.  3.  4. (a)  (b)  (c)  (d)  (e) 

Exercise 11.3

- Do it yourself 2. (a) 3 (b) 4 (c) 2 3. (a) Octagon (b) Hexagon (c) Square (d) Equilateral triangle



4. A (4, -10), B (0, 0) 5. (a) (-2, -3) (b) (5, -4) (c) (-4, 2) (d) (5, 3) 6. (a) (2, -3) (b) (5, 4) (c) (-2, -4) (d) (-4, 6) 7. Do it yourself

Exercise

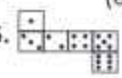
1. (a) $P' \leftrightarrow (-3, -8)$ (b) eight (c) One point of rotation (d) rhombus (e) get inverted (f) reflection
(g) 2 (h) None of these 2.  3. 
4. (a) (7, 6) (b) (18, 12) (c) (-6, -20) (d) (-7, -21) (e) (0, 4) (f) (11, -8)
5. (a) (-6, -18) (b) (4, 9) (c) (7, -2) (d) (-10, 5) (e) (7, 0) (f) (0, -11)
6. (a) F (b) T (c) T (d) T (e) F (f) T (g) T (h) F (i) T (j) T 7. Do it yourself

Ch-12 Representing 3-D in 2-D

Exercise 12.1

1. (a) Cylinder (b) Sphere (c) Sphere (d) Cylinder (e) Cuboid (f) Cuboid (g) Prism (h) Pyramid
2. Do it yourself 3. Do it yourself 4. (a) 0 (b) 0 (c) 8 (d) 1 (e) 5 vertices

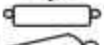
Exercise 12.2

1. Do it yourself 2. (a) blank (b) 0 (c) \$ (d) * (e) * and 0 (f) \$ (g) M and E
(h) $M \rightarrow E, O \rightarrow *, \$$ blank 3. Do it yourself 4. (c) 5. 

Exercise 12.3

1. Do it yourself 2. Do it yourself 3. Do it yourself 4. Do it yourself

Exercise

1. (a) pyramid (b) none of these (c) on a squared paper (d) circle (e) $V + F - E = 2$
(f) polyhedrons (g) rectangles (h) edge (i) tetrahedron
2. (a) Vertices - A, B, C, D, P, Q, R, S (b) Curve face (c) Vertices - L, M, N, R, S, T
Faces - ABCD, PQRS, ABQP, SRCD, ADSP, BCRQ Plane faces No edge Faces - LMN, RST, LMRS, LNST, MNTR
Edges - AB, BC, CD, AD, PQ, QR, RS, SP, AP, DS, BQ, CR Edges - LM, LN, MN, LS, SR, MR, NT, ST, RT
3. Do it yourself 4. (a) Horizontally $\rightarrow$ Circle (b) Horizontally $\rightarrow$ Square 7. (a) 
Vertically $\rightarrow$ Rectangle (b) Vertically $\rightarrow$ Square (b) 
(c) Horizontally $\rightarrow$ Triangle (d) Horizontally $\rightarrow$ Triangle (c) 
Vertically $\rightarrow$ Circle (d) Vertically $\rightarrow$ Quadrilateral (d) 
5. (a) 4 and 6 (b) 1 (c) 6 (d) 5 6. (a) cone (b) tetrahedron (c) cube (d) volleyball
8. 2 cylinders, height 16 cm and 12 cm 9. Do it yourself 10. (a) F (b) T (c) F (d) T (e) T (f) F
(g) T (h) T (i) F (j) T

Ch-13 Data Handling

Exercise 13.1

1. Mean = $\frac{80+150+16+46}{4} = \frac{292}{4} = 73$ Readers 2. Median = 45.5, Mode = 46, Range = 23
3. Range = 32 Mean = 98.9 Median = 96 Mode = 90 & 96 4. Mean of first five odd number = 5 5. The value of x = 62

Exercise 13.2

1. (a) April (b) 400 (c) June (d) May 2. Do it yourself 3. (a) 4000 biscuits (b) 2003-04
(c) 2006-07 4. Do it yourself

Exercise

1. (a) (ii) (b) (iii) (c) (iv) 2. 6 hours 3. 294 4. 3 5. Do it yourself

Revision Test Paper-IV

- A. 1. (iv) 2. (iii) 3. (ii) 4. (i) 5. (iii) 6. (iii) 7. (i) 8. (ii) 9. (iv) 10. (ii)
B. 1. 4 2. Statistics 3. concentric 4. congruent 5. 3 6. Perimeter 7. Radius
8. 4 x side 9. Area 10. $\pi (R^2 - r^2)$
C. 1. F 2. F 3. T 4. T 5. T 6. F 7. T 8. F 9. F 10. T

Model Test Paper-II

- A. 1. 21.7 cm 2. 65° 3. Do it yourself 4. Edges = 12; Faces = 6; Vertices = 8
5. AB; PO; BC; OR; AC; PR, $\angle A = \angle P$; $\angle B = \angle O$, $\angle C = \angle R$ 6. Do it yourself
7. 128 m 8. 101.4 9. 3872 m 10. 8 cm² 11. $\angle AOY = 70^\circ$
B. 12. 40°, 35°, 105° 13. 17 m 14. Do it yourself 15. Do it yourself 16. Solve yourself 17. Do it yourself 18. 280 m²
19. Mean = 113.8, Median = 117, Mode = 117 20. x = 20, Equilateral Triangle 21. Base = 44 m, height = 33 m
C. 22. Do it yourself 23. 180°, 360°, order = 2, 2 24. 41 cm 25. 450 m² 26. Do it yourself 27. ₹ 61563.25
28. Do it yourself

