MATHEMATICS

Grade 7

Part - II

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The National Anthem of Sri Lanka

Sri Lanka Matha
Apa Sri Lanka Namo Namo Namo Namo Matha
Sundara siri barinee, surendi athi sobamana Lanka
Dhanya dhanaya neka mal palaturu piri jaya bhoomiya ramya
Apa hata sepa siri setha sadana jeewanaye matha
Piliganu mena apa bhakthi pooja Namo Namo Matha
Apa Sri Lanka Namo Namo Namo Namo Matha
Oba we apa vidya
Obamaya apa sathya
Oba we apa shakthi
Apa hada thula bhakthi
Oba apa aloke
Apage anuprane
Oba apa jeevana we
Apa mukthiya oba we
Nava jeevana demine, nithina apa pubudukaran matha
Gnana veerya vadawamina regena yanu mana jaya bhoomi kara
Eka mavakage daru kela bevina
Yamu yamu vee nopama
Prema vada sema bheda durerada
Namo, Namo Matha
Apa Sri Lanka Namo Namo Namo Namo Matha

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ஒரு தாய் மக்கள் நாமாவோம்
ஒன்றே நாம் வாழும் இல்லம்
நன்றே உடலில் ஓடும்
ஒன்றே நம் குருதி நிறம்

அதனால் சகோதரர் நாமாவோம்
ஒன்றாய் வாழும் வளரும் நாம்
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யாவரும் அன்பு கருணையுடன்
ஒற்றுமை சிறக்க வாழ்ந்திடுதல்
பொன்னும் மணியும் முத்துமல்ல - அதுவே
யான்று மழியாச் செல்வமன்றோ.

ஆனந்த சமரக்கோன்
கவிதையின் பெயர்ப்பு.

Being innovative, changing with right knowledge
Be a light to the country as well as to the world.

Message from the Hon. Minister of Education

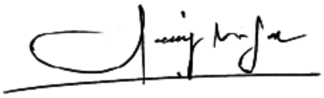
The past two decades have been significant in the world history due to changes that took place in technology. The present students face a lot of new challenges along with the rapid development of Information Technology, communication and other related fields. The manner of career opportunities are liable to change specifically in the near future. In such an environment, with a new technological and intellectual society, thousands of innovative career opportunities would be created. To win those challenges, it is the responsibility of the Sri Lankan Government and myself, as the Minister of Education, to empower you all.

This book is a product of free education. Your aim must be to use this book properly and acquire the necessary knowledge out of it. The government in turn is able to provide free textbooks to you, as a result of the commitment and labour of your parents and elders.

Since we have understood that the education is crucial in deciding the future of a country, the government has taken steps to change curriculum to suit the rapid changes of the technological world. Hence, you have to dedicate yourselves to become productive citizens. I believe that the knowledge this book provides will suffice your aim.

It is your duty to give a proper value to the money spent by the government on your education. Also you should understand that education determines your future. Make sure that you reach the optimum social stratum through education.

I congratulate you to enjoy the benefits of free education and bloom as an honoured citizen who takes the name of Sri Lanka to the world.



Akila Viraj Kariyawasam
Minister of Education

Foreword

The educational objectives of the contemporary world are becoming more complex along with the economic, social, cultural and technological development. The learning and teaching process too is changing in relation to human experiences, technological differences, research and new indices. Therefore, it is required to produce the textbook by including subject related information according to the objectives in the syllabus in order to maintain the teaching process by organizing learning experiences that suit to the learner needs. The textbook is not merely a learning tool for the learner. It is a blessing that contributes to obtain a higher education along with a development of conduct and attitudes, to develop values and to obtain learning experiences.

The government in its realization of the concept of free education has offered you all the textbooks from grades 1-11. I would like to remind you that you should make the maximum use of these textbooks and protect them well. I sincerely hope that this textbook would assist you to obtain the expertise to become a virtuous citizen with a complete personality who would be a valuable asset to the country.

I would like to bestow my sincere thanks on the members of the editorial and writer boards as well as on the staff of the Educational Publications Department who have strived to offer this textbook to you.

W. M. Jayantha Wickramanayaka,
Commissioner General of Educational Publications,
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2019.04.10

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Message of the Boards of Writers and Editors

This textbook has been compiled in accordance with the new syllabus which is to be implemented from 2016 for the use of grade seven students.

We made an effort to develop the attitude "We can master the subject of Mathematics well" in students.

In compiling this textbook, the necessity of developing the basic foundation of studying mathematical concepts in a formal manner was specially considered. This textbook is not just a learning tool which targets the tests held at school. It was compiled granting due consideration to it as a medium that develops logical thinking, correct vision and creativity in the child.

Furthermore, most of the activities, examples and exercises that are incorporated here are related to day to day experiences in order to establish mathematical concepts in the child. This will convince the child about the importance of mathematics in his or her daily life. Teachers who guide the children to utilize this textbook can prepare learning tools that suit the learning style and the level of the child based on the information provided here.

Learning outcomes are presented at the beginning of each lesson. A summary is provided at the end of each lesson to enable the child to revise the important facts relevant to the lesson. Furthermore, at the end of the set of lessons related to each term, a revision exercise has been provided to revise the tasks completed during that term.

Every child does not have the same capability in understanding mathematical concepts. Thus, it is necessary to direct the child from the known to the unknown according to his / her capabilities. We strongly believe that it can be carried out precisely by a professional teacher.

In the learning process, the child should be given ample time to think and practice problems on his or her own. Furthermore, opportunities should be given to practice Mathematics without restricting the child to just the theoretical knowledge provided by mathematics.

Our firm wish is that our children act as intelligent citizens who think logically by studying Mathematics with dedication.

Boards of Writers and Editors

Contents

13

Mass

By studying this lesson you will be able to

- identify milligramme as a unit used to measure masses,
- identify the relationship between the units gramme and milligramme,
- add and subtract masses expressed in grammes and milligrammes, and
- multiply and divide masses expressed in milligrammes, grammes, and kilogrammes by a whole number.

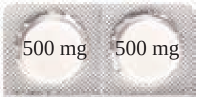
13.1 Units used to measure mass

You have learnt before that gramme and kilogramme are units used to measure masses. Now let us identify another unit which is used to measure masses.

The masses of the nutrients included in a 100 grammes packet of food for children, "Thriposha", are indicated as below.

Protein 20.0 g	Carbohydrate 61.9 g
Fat 7.8 g	Iron 18 mg

The mass of paracetamol in each of the paracetamol tablets shown in the figure is indicated as 500 mg.



Based on the above information, you will notice that in addition to kilogramme (kg) and gramme (g), the unit milligramme which is smaller than the other two units is also used to measure a mass more precisely. "Milligramme" is denoted by mg.

1 gramme is 1000 milligrammes. That is, 1 g = 1000 mg

13.2 The relationship between grammes and milligrammes

• Expressing a mass given in grammes in milligrammes

Now let us consider how a mass given in grammes is expressed in milligrammes.

$$\text{Since } 1\text{ g} = 1000\text{ mg},$$
$$2\text{ g} = 2 \times 1000\text{ mg} = 2000\text{ mg}$$
$$3\text{ g} = 3 \times 1000\text{ mg} = 3000\text{ mg}$$

Therefore, to express a mass given in grammes, in terms of milligrammes, the given number of grammes should be multiplied by 1000.

Example 1

Express 7.656 g in milligrammes.

$$7.656\text{ g} = 7.656 \times 1000\text{ mg}$$
$$= 7656\text{ mg}$$

Example 2

Express 2 g 650 mg in milligrammes.

$$2\text{ g } 650\text{ mg} = 2 \times 1000\text{ mg} + 650\text{ mg}$$
$$= 2000\text{ mg} + 650\text{ mg}$$
$$= 2650\text{ mg}$$

Example 3

Express 7.656 g in grammes and milligrammes.

$$7.656\text{ g} = 7\text{ g} + 0.656\text{ g}$$
$$= 7\text{ g} + 0.656 \times 1000\text{ mg}$$
$$= 7\text{ g} + 656\text{ mg}$$
$$= 7\text{ g } 656\text{ mg}$$

Example 4

Express $3\frac{1}{2}$ g in milligrammes.

$$3\frac{1}{2}\text{ g} = 3\text{ g} + \frac{1}{2}\text{ g}$$
$$= 3 \times 1000\text{ mg} + 500\text{ mg}$$
$$= 3000\text{ mg} + 500\text{ mg}$$
$$= 3500\text{ mg}$$

• Expressing a mass given in milligrammes in terms of grammes

Next let us consider how a mass given in milligrammes can be expressed in grammes.

$$\text{Since } 1000\text{ mg} = 1\text{ g},$$
$$2000\text{ mg} = \frac{2000}{1000}\text{ g} = 2\text{ g}$$
$$3000\text{ mg} = \frac{3000}{1000}\text{ g} = 3\text{ g}$$

Therefore, to express a mass given in milligrammes in terms of grammes, the given number of milligrammes should be divided by 1000.

Example 1

Express 2758 mg in grammes.

$2758 \text{ mg} = \frac{2758}{1000} \text{ g}$

$= 2.758 \text{ g}$

Example 2

Express 2225 mg in grammes and milligrammes.

$2225 \text{ mg} = 2000 \text{ mg} + 225 \text{ mg}$

$= \frac{2000}{1000} \text{ g} + 225 \text{ mg}$

$= 2 \text{ g} + 225 \text{ mg}$

$= 2 \text{ g } 225 \text{ mg}$

Accordingly, when an amount of 1000 mg or more, is expressed in terms of grammes and milligrammes, care should be taken to ensure that the amount of milligrammes written is less than 1000.

Example 3

Express 3 g 675 mg in grammes.

$3 \text{ g } 675 \text{ mg} = 3 \text{ g} + 675 \text{ mg}$

$= 3 \text{ g} + \frac{675}{1000} \text{ g}$

$= 3 \text{ g} + 0.675 \text{ g}$

$= 3.675 \text{ g}$

Exercise 13.1

(1) Fill in the blanks.

(i) 8 g 42 mg = 8 g + ... mg
= ...... mg + ... mg
= ...... mg

(ii) $3750 \text{ mg} = \frac{3750}{1000} \text{ g}$
= .... g

(iii) 1.275 g = 1 g + ... mg
= .... mg + ... mg
= .... mg

(iv) 1.275 g = 1.275 × .... mg
= .... mg

(2) Express the following masses in grammes.

(i) 1245 mg (ii) 1475 mg (iii) 2 g 875 mg (iv) 12 g 8 mg

(3) Express the following masses in milligrammes.

(i) 8 g (ii) 15 g (iii) 3 g 750 mg (iv) 2 g 75 mg

(v) 2.5 g (vi) 3.005 g (vii) 3.61 g (viii) $1\frac{3}{4}$ g

(4) Express each of the following masses in terms of grammes and milligrammes.

(i) 2350 mg (ii) 3.75 g (iii) 12.05 g (iv) 1.005 g

(5) Complete the following table.

g	g mg	mg
1.4 g	1 g 400 mg	1400 mg
3.65 g	....	....
5.005 g	....	....
....	1 g 975 mg	....
....	5 g 5 mg	....
....	....	6007 mg
....	....	12 535 mg

13.3 Addition of masses expressed in grammes and milligrammes

The mass of the chocolates in a box of mass 15 g 350 mg, is 750 g 800 mg. Let us find the total mass of the box of chocolates.
To do this, let us add the mass of the box and the mass of the chocolates.

Method I

	g	mg
	15	350
+	750	800
	766	150

Let us add the quantities in the milligrammes column.
350 mg + 800 mg = 1150 mg
1150 mg = 1000 mg + 150 mg
= 1 g + 150 mg
Let us write 150 mg in the milligrammes column.

Let us carry the 1 g to the grammes column and add the amounts in the grammes column.
1 g + 15 g + 750 g = 766 g
Let us write 766 g, in the grammes column.

Total mass of the box of chocolates is 766 g 150 mg.

Method II

Let us express each of the masses in grammes, and then simplify.

15 g 350 mg = 15.350 g
750 g 800 mg = 750.800 g
766.150 g = 766 g + 150 mg

	g
	15 . 350
+	750 . 800
	766 . 150

Exercise 13.2

(1) Simplify the following.

(i)

	g	mg
	250	170
+	35	630

(ii)

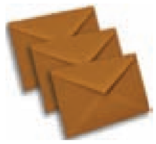
	g	mg
	15	150
	20	675
+	30	265

(iii) 10 g 255 mg + 5 g 805 mg

(iv) 150 g 750 mg + 50 g 360 mg

(2) The mass of the sweetmeats in a box of mass 19 g 750 mg, is 480 g 250 mg. Find the total mass of the box of sweetmeats.

(3) The masses of three letters received by a post office are 10 g 150 mg, 5 g 975 mg and 8 g 900 mg respectively. Show that the total mass of all three letters exceeds 25 g.



13.4 Subtraction of masses expressed in grammes and milligrammes

The total mass of a box of sweetmeats is 500 g 250 mg. The mass of the empty box is 100 g 750 mg. Accordingly, let us find the mass of the sweetmeats in the box.

To find the mass of the sweetmeats, the mass of the empty box needs to be subtracted from the total mass.

Method I

	g	mg
	500	250
−	100	750
	399	500

Since 750 mg cannot be subtracted from 250 mg, let us carry 1 g, that is 1000 mg, from the 500 g in the grammes column to the milligrammes column and add it to the 250 mg in the milligrammes column.
Then, 1000 mg + 250 mg = 1250 mg.
1250 mg − 750 mg = 500 mg
Let us write the 500 mg in the milligrammes column.

Let us subtract 100 g from the 499 g remaining in the grammes column.
Then, 499 g − 100 g = 399 g
Let us write the 399 g, in the grammes column.

The mass of the sweetmeats in the box is 399 g 500 mg.

Method II

Let us express each of the masses in grammes, and then simplify.

$$\begin{array}{r} \text{g} \\ 500\,.\,250 \\ -\ 100\,.\,750 \\ \hline 399\,.\,500 \\ \hline\hline \end{array}$$

500 g 250 mg = 500.250 g

100 g 750 mg = 100.750 g

399.500 g = 399 g 500 mg

The mass of the sweetmeats in the box is 399 g 500 mg.

Exercise 13.3

(1) Simplify the following.

(i)
$$\begin{array}{rrr} & \text{g} & \text{mg} \\ & 50 & 750 \\ - & 20 & 250 \\ \hline & & \\ \hline\hline \end{array}$$

(ii)
$$\begin{array}{rrr} & \text{g} & \text{mg} \\ & 150 & 200 \\ - & 75 & 300 \\ \hline & & \\ \hline\hline \end{array}$$

(iii) 250 g 550 mg – 150 g 105 mg

(iv) 60 g – 25 g 150 mg

(2) The total mass of a biscuit packet with biscuits is 210 g 150 mg. The mass of the empty packet is 2 g 300 mg. What is the mass of the biscuits in the biscuit packet?

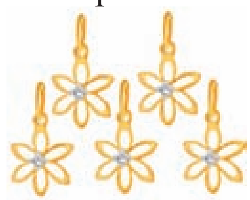
(3) When a certain amount was used from a quantity of margarine of mass 150 g, the remaining mass was 105 g 350 mg. Find the mass of the margarine that was used.

(4) A mass of 160 g 450 mg of gold was left over after making jewellery from a block of gold of mass 205 g 375 mg. Find the mass of the gold that was used to make the jewellery.

13.5 Multiplication of a mass by a whole number

➢ The mass of gold used to produce a particular pendent is 6 g 500 mg. Let us find the total mass of gold required to produce 5 such pendants.

To produce 5 pendants, 5 portions of gold of mass 6 g 500 mg each are required. Therefore, to find the total mass of gold that is required, 6 g 500 mg should be multiplied by 5.



Method I

Let us express 6 g 500 mg in milligrammes and then multiple by 5.

6 g 500 mg = 6500 mg

6500 mg × 5 = 32 500 mg

$$\begin{array}{r} \text{mg} \\ 6500 \\ \times 5 \\ \hline 32\ 500 \\ \hline\hline \end{array}$$

32 500 mg = 32 g 500 mg

That is, the total mass required to produce 5 pendants is 32 g 500 mg.

Method II

$$\begin{array}{ll} \text{g} & \text{mg} \\ 6 & 500 \\ & \times\ 5 \\ \hline 32 & 500 \\ \hline\hline \end{array}$$

First, let us multiply 500 mg by 5.
500 × 5 mg = 2500 mg
2500 mg = 2000 mg + 500 mg = 2 g + 500 mg
Let us write 500 mg in the milligrammes column.

Let us multiply 6 g by 5. 6 g × 5 = 30 g
Now let us add the 2 g obtained from the multiplication done in the milligrammes column, to 30 g.
30 g + 2 g = 32 g
Let us write 32 g in the grammes column.

➢ Let us simplify 5 kg 120 g × 12.

Method I

$$\begin{array}{lr} \text{kg} & \text{g} \\ 5 & 120 \\ & \times 12 \\ \hline 61 & 440 \\ \hline\hline \end{array}$$

First multiply 120 g by 12.
120 g × 12 = 1440 g = 1 kg 440 g
Let us multiply 5 kg, by 12.
5 kg × 12 = 60 kg
5 kg 120 g × 12 = 60 kg + 1 kg 440 g
= 60 kg +1 kg + 440 g
= 61 kg 440 g

5 kg 120 g × 12 = 61 kg 440 g

Method II

Let us express 5 kg 120 g in grammes and then multiply by 12.

5 kg 120 g = 5120 g

Let us multiply 5120 g by 12.

61 440 g = 61 kg 440 g

$$\begin{array}{r} \text{g} \\ 5120 \\ \times\ 12 \\ \hline 10240 \\ 5120 \\ \hline 61440 \\ \hline\hline \end{array}$$

Example 1

The mass of a lorry which transports goods is 2250 kg. It is loaded with 60 cement bags of mass 50 kg each. When entering an old bridge, the driver sees a notice which indicates that a mass greater than 5300 kg cannot be transported across the bridge. The mass of the driver and his assistant is 140 kg. Is this vehicle allowed to cross the bridge?

$$\begin{array}{rl} \text{Mass of vehicle} & = 2250 \text{ kg} \\ \text{Mass of cement} & = 50 \text{ kg} \times 60 = 3000 \text{ kg} \\ \text{Mass of two passengers} & = 140 \text{ kg} \\ \text{Therefore the total mass of the vehicle} & = 2250 \text{ kg} + 3000 \text{ kg} + 140 \text{ kg} \\ & = 5390 \text{ kg} \end{array}$$

Since the total mass of the vehicle is more than 5300 kg, it is not allowed to cross the bridge.

Exercise 13.4

(1) Simplify the following.

(i)
$$\begin{array}{rr} \text{g} & \text{mg} \\ 150 & 100 \\ & \times\ 5 \\ \hline \\ \hline\hline \end{array}$$

(ii)
$$\begin{array}{rr} \text{g} & \text{mg} \\ 175 & 375 \\ & \times\ 4 \\ \hline \\ \hline\hline \end{array}$$

(iii)
$$\begin{array}{lrr} & \text{kg} & \text{g} \\ & 12 & 100 \\ \times & & 8 \\ \hline \\ \hline\hline \end{array}$$

(iv)
$$\begin{array}{lrr} & \text{kg} & \text{g} \\ & 5 & 250 \\ \times & & 4 \\ \hline \\ \hline\hline \end{array}$$

(v) 12 g 150 mg × 12

(vi) 16 g 650 mg × 13

(vii) 10 kg 375 g × 15

(viii) 5 kg 650 g × 25

(2) Find the quantity of rice that needs to be purchased for a week for a household that requires 1 kg 750 g of rice daily.

(3) The mass of a certain type of biscuit is 3 g 750 mg. Packets containing 25 of these biscuits each are issued to the market. Find the total mass of the biscuits in one packet.

(4) Four gunny bags of mass 760 g each are filled with 40 kg of sugar per bag. Find the total mass of the 4 gunny bags filled with sugar.

(5) 20 incense sticks of mass 650 mg per stick are in a packet of mass 2 g.

(i) Find the mass of the incense sticks in one packet.
(ii) Find the total mass of one packet of incense sticks.
(iii) Find the total mass of 12 such packets.

13.6 Division of a mass by a whole number

➢ The mass of 5 tablets is 1 g 750 mg. Let us find the mass of one tablet. To do this, 1 g 750 mg should be divided by 5.

Method I

	g	mg
	0	350
5	1	750
	0	
	1 →	1000
		1750
		1750
		0000

Let us divide the gramme quantity first.
Since there are no 5s in 1, let us write '0' in the place where the answer is to be written in the grammes column and carry the remaining 1 g as 1000 mg to the milligrammes column.

Then let us find the amount of milligrammes in the milligrammes column.
1000 mg + 750 mg = 1750 mg
Let us divide 1750 mg by 5. 1750 mg ÷ 5 = 350 mg

The mass of one tablet is 350 mg.

Method II

Express 1 g 750 mg in milligrammes and then divide by 5.

	mg
	350
5	1750
	15
	25
	25
	00
	00
	00

1 g 750 mg = 1750 mg
1750 mg ÷ 5 = 350 mg

The mass of one tablet is 350 mg.

➢ A mass of 16 kg 200 g of sugar is stored in three bags in equal quantities. Let us find the mass of sugar in one of these bags.

To do this, 16 kg 200 g should be divided by 3.

Method I

	kg	g
	5	400
3	16	200
	15	
	1 →	1000
		1200
		1200
		0000

Let us divide 16 kg in the kilogrammes column by 3.
Let us carry the remaining 1 kg to the grammes column as 1000 g
Next let us find the amount of grammes in the grammes column
1000 g + 200 g = 1200 g
Let us divide 1200 g by 3.
1200 g ÷ 3 = 400 g

The mass of sugar in one bag is 5 kg 400 g.

Method II

Let us express 16 kg 200 g in grammes and divide by 3.

16 kg 200 g = 16 kg + 200 g
= 16 000 g + 200 g
= 16 200 g
16 200 g ÷ 3 = 5400 g

	g
	5400
3	16200
	15
	12
	12
	00
	00
	00
	00

The mass of sugar in one bag is 5 kg 400 g.

Example 1

A quantity of 19.2 kg of a particular type of sweetmeat is purchased and stored in equal quantities in 6 boxes. Find the mass of the sweetmeats contained in one box.

Mass of sweetmeats in 6 boxes = 19.2 kg
Mass of sweetmeats in one box = 19.2 kg ÷ 6
= 3.2 kg

	kg
	3.2
6	19.2
	18
	12
	12
	0

Exercise 13.5

(1) Simplify the following.

(i) 8 g 160 mg ÷ 8 (ii) 1 g 575 mg ÷ 3 (iii) 6 g 125 mg ÷ 5

(iv) 7 g 140 mg ÷ 3 (v) 10 g 400 mg ÷ 4

(2) Simplify the following.

(i) 4 kg 800 g ÷ 4 (ii) 4 kg 230 g ÷ 3 (iii) 8 kg 350 g ÷ 5

(iv) 12 kg 600 g ÷ 7

(3) A quantity of 1.6 kg of fertilizer from a quantity of 4 kg is used on a coconut plant. If the remaining amount is used on 8 orange plants in equal quantities, find the amount of fertilizer used on one orange plant in grammes.

(4) The mass of the biscuits in a biscuit packet is indicated as 75 g. If the packet contains 12 biscuits, find the mass of one biscuit.

(5) The total mass of 306 biscuits of the same type is 3 kg 978 g.

(i) Find the mass of one biscuit.

(ii) If these biscuits are put into packets such that each packet contains 34 biscuits, find the mass of the biscuits in one packet.

(iii) Find the total mass of the biscuits in 5 such packets.

13.7 Mass Estimation

The mass of an olive obtained from a stack of olive fruits is about 5 g. Estimate the total mass of 100 olives.

The total mass of 100 olives is approximately 5×100 g; that is, 500 g.

Exercise 13.6

(1) The mass of 10 nelli fruits obtained from a stack of fruits is 27 g 225 mg. Estimate the total mass of 100 nelli fruits.

(2) A household having only 4 adults and no children eat rice for all 3 meals in a day. An adult usually consumes 125 g of rice for breakfast, 100 g for lunch and 75 g for dinner.

(i) Estimate the amount of rice that is required for one adult of this household for one day.

(ii) Estimate the number of kilogrammes of rice that is required for this household for a week.

(iii) Estimate the amount of rice that is required for all 4 adults for a month.

(3) Information on the quantities of the nutrients included in a 100 g packet of "Thriposha" which is given to children with malnutrition is given below.

Protein 20.0 g　　Carbohydrate 61.9 g

Fat 7.8 g　　Iron 18 mg

If a child is given 50 g of 'Thriposha' per day, estimate the mass of each of the nutrients that can be expected to be consumed by a child in a month.

(i) Protein　　(ii) Fat

(iii) Iron　　(iv) Carbohydrate

Miscellaneous Exercise

(1) The amount of paracetamol in a paracetamol tablet is 375 mg. If the amount of paracetamol taken by an adult should be less than 2 g per day, what is the maximum number of tablets that an adult can take in a day?

(2) A mass of 100 g of cheese is issued to the market in a box of mass 2 g 500 mg. Find the mass of 100 such boxes of cheese.

(3) If 60 equal sized sesame balls are made from a mixture containing 500 g of sesame seeds and 250 g of jaggery, find the mass of one sesame ball in grammes and milligrammes.

(4) The total mass of a box containing 80 tea bags is 276 g. The mass of the empty box is 26 g. Find the mass of one tea bag and express it in grammes and milligrammes.

(5) When passengers flying oversees travel in a group, if the average mass of their bags does not exceed 30 kg, there are no extra charges for overweight bags. However, if the average mass of the bags exceeds 30 kg, then those with bags that exceed 30 kg have to pay overweight charges. The following are the masses of the bags of 5 passengers who are travelling in a group.

Hasintha - 20 kg 250 g   Mangala - 29 kg 750 g   Sithumini - 32 kg

Dileepa - 32 kg 150 g   Sashika - 28 kg 70 g

Based on the above information, show with reasons whether Dileepa and Sithumini have to pay overweight charges.

$$\text{Average mass of the bags} = \frac{\text{total mass of the bags of all the group members}}{\text{number of group members}}$$

Summary

- Milligramme (mg), gramme (g) and kilogramme (kg) are a few units used to measure mass.
  1 kg = 1000 g   1 g = 1000 mg
- To express a mass given in grammes, in terms of milligrammes, the given number of grammes should be multiplied by 1000.
- To express a mass given in milligrammes in terms of grammes, the given number of milligrammes should be divided by 1000.

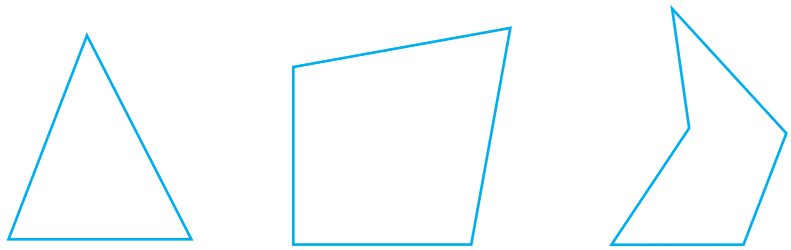
14

Rectilinear plane figures
(Part I)

By studying this lesson you will be able to
- identify what a polygon is and
- identify convex polygons, concave polygons and regular polygons.

14.1 Polygons

Consider each of the following plane figures.

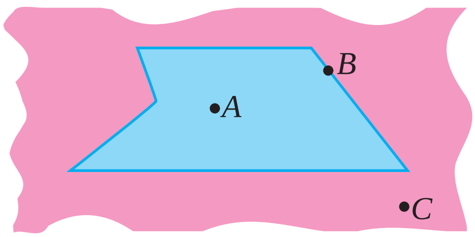


The above figures are all bounded by straight line segments. Furthermore, the straight line segments do not intersect each other in these plane figures, and only two straight line segments meet at each vertex point. Such plane figures are called **polygons**.

A closed plane figure bounded by three or more straight line segments is called a **polygon**.

Each of the line segments by which a given polygon is bounded is called a **side** of the polygon and each of the points at which two of these sides meet is called a **vertex** of the polygon.

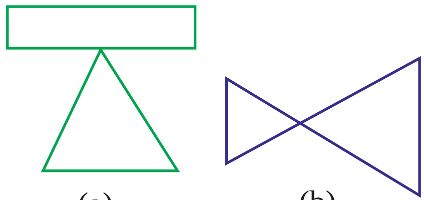
The region bounded by the straight line segments of a polygon (shaded blue) is called the interior region of the polygon, and the region outside (shaded pink) is called the exterior region of the polygon.



A is a point in the interior region of the polygon,
B is a point on the polygon and
C is a point in the exterior region of the polygon.

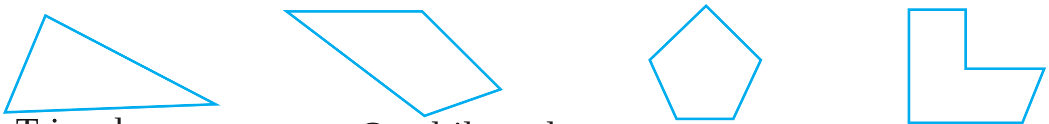
An angle in the interior region of a given polygon, between two sides which meet at a vertex is called an **angle** of the polygon.

Figure (a) shown here has three straight lines which meet at a particular point. Figure (b) has two straight lines which intersect at a point. Therefore, these plane figures are **not polygons**.



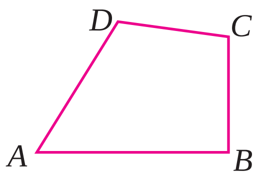
(a) (b)

A polygon should have at least three sides. Polygons with three sides are **triangles**. Polygons with 4 sides are **quadrilaterals**, polygons with 5 sides are **pentagons** and polygons with 6 sides are **hexagons**.



Triangle Quadrilateral Pentagon Hexagon

The vertices of a polygon are named using capital letters of the English alphabet. Then the polygon itself, the sides and the angles of the polygon can be named by using these letters.



- In the above given quadrilateral, the vertices have been named *A*, *B*, *C* and *D*. The quadrilateral is called *ABCD*.
- The sides of quadrilateral *ABCD* are *AB*, *BC*, *CD* and *DA*. In the same way, the sides can also be named *BA*, *CB*, *DC* and *AD*.
- The angles of quadrilateral *ABCD* are $A\hat{B}C$, $B\hat{C}D$, $C\hat{D}A$ and $D\hat{A}B$. In the same way, the angles can also be named $C\hat{B}A$, $D\hat{C}B$, $A\hat{D}C$ and $B\hat{A}D$. In a polygon, the number of sides and the number of angles are both equal to the number of vertices.

Exercise 14.1

(1) The way a polygon is named, based on the number of sides it has, is given in the following table.

Number of sides	Name of polygon	Number of angles	Number of vertices
3	Triangle		
4	Quadrilateral		
5	Pentagon		
6	Hexagon		
7	Heptagon		
8	Octagon		
9	Nonagon		
10	Decagon		

(i) Copy the table and complete the columns named "number of angles" and "number of vertices".

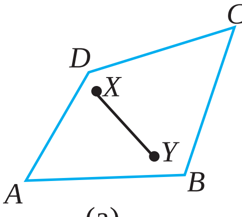
(ii) Draw a sketch of each type of polygon named in the above table. Name the vertices of each polygon you drew using capital letters of the English alphabet. Name the sides and the angles of each polygon.

(2) Cut 4 strips of paper of breadth around 5 cm. By folding each paper appropriately, make a triangle, a quadrilateral, a pentagon and a hexagon and cut each shape out. Paste these shapes in your book.

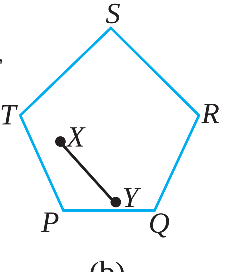
14.2 Convex polygons and Concave polygons

A quadrilateral *ABCD* and a pentagon *PQRST* are shown here.

- When joining any two points marked inside a polygon with a straight line, as shown in the figure, if the straight line, lies entirely inside the polygon, that is, it never goes outside the polygon, then that polygon is known as a **convex polygon**.



(a)

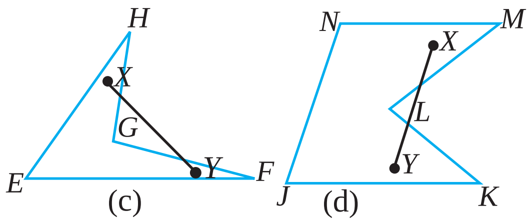


(b)

That is, the straight line joining any two points inside a convex polygon does not intersect the sides of the polygon.

A quadrilateral *EFGH* and a pentagon *JKLMN* are shown here.

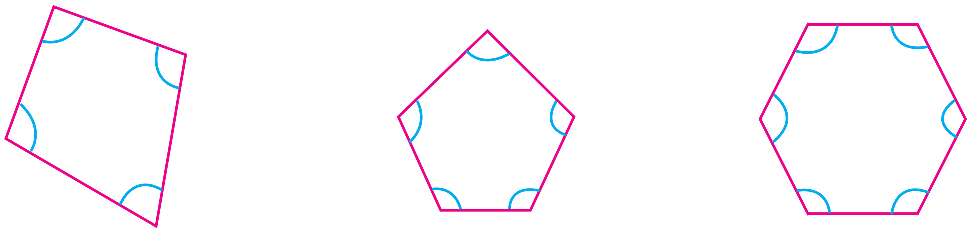
- If there are two points in the interior of a polygon such that the straight line joining these two points does not lie entirely inside the polygon, then that polygon is known as a **concave polygon**.



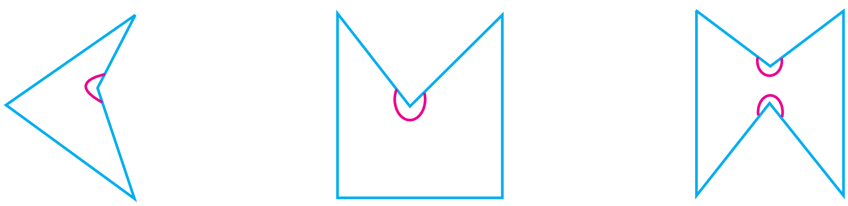
(c) (d)

  That is, in a concave polygon, there are two points inside the polygon such that the straight line which joins the two points intersects certain sides of the polygon.

No angle of a convex polygon is a reflex angle.



At least one angle of a concave polygon is a reflex angle.



- If no interior angle of a polygon is a reflex angle, then such a polygon is a convex polygon.
- If at least one interior angle of a polygon is a reflex angle, then such a polygon is a concave polygon.

Exercise 14.2

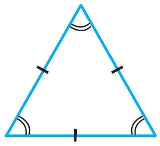
(1) Draw a concave polygon with 1 reflex angle, with 2 reflex angles and with 3 reflex angles. Name each polygon based on the number of sides.

(2) State two facts that distinguish a triangle from the other polygons.

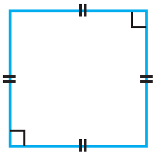
14.3 Regular polygons

A polygon with all sides equal in length and all angles equal in magnitude is called a **regular polygon.**

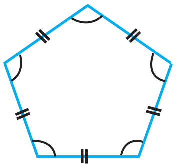
- A triangle with all three sides equal in length and all three angles equal in magnitude is a **regular triangle** or an **equilateral triangle**.



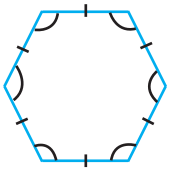
- A quadrilateral with all four sides equal in length and all four angles equal in magnitude is a **regular quadrilateral** or a **square**.



- A pentagon with all five sides equal in length and all five angles equal in magnitude is a **regular pentagon**.

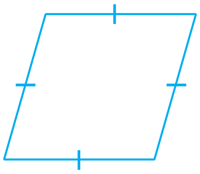


- A hexagon with all six sides equal in length and all six angles equal in magnitude is a **regular hexagon**.

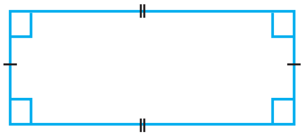


There are polygons with all sides equal in length, which are not regular polygons.

For example, in a rhombus, all four sides are equal in length, but all four angles are not equal in magnitude. Therefore a **rhombus is not a regular polygon.**



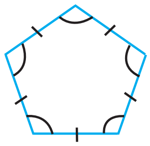
There are polygons with all angles equal in magnitude, which are not regular polygons.

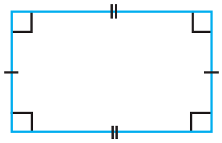


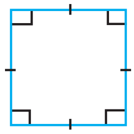
For example, in a rectangle, all four angles are equal in magnitude but all four sides need not be equal in length. Therefore, a **rectangle is not a regular polygon**.

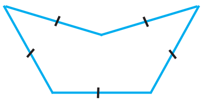
Exercise 14.3

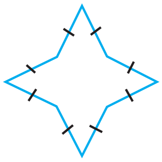
(1) Use the data in the below given polygons to complete the table.

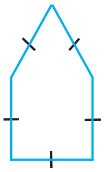

(a)

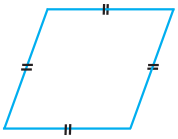

(b)


(c)


(d)


(e)


(f)


(g)

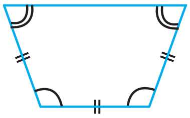

(h)

Figure	Convex / Concave	Is it regular?	If it is not regular, the reason
a			
b			
c			
d			
e			
f			
g			
h			

(2) Create various polygons by folding a piece of paper of length 50 cm and breadth 5 cm. Using a pen, draw straight lines along the folds. Name the polygons you obtain.

Summary

- A closed rectilinear plane figure consisting of three or more straight line segments is a polygon.
- No interior angle of a convex polygon is a reflex angle.
- At least one interior angle of a concave polygon is a reflex angle.
- A polygon with all sides equal in length and all angles equal in magnitude is called a regular polygon.

14

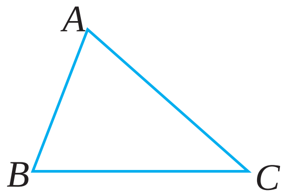
Rectilinear plane figures

(Part II)

By studying this lesson you will be able to
- identify acute angled triangles, right angled triangles and obtuse angled triangles, and
- identify equilateral triangles, isosceles triangles and scalene triangles.

14.4 Triangles

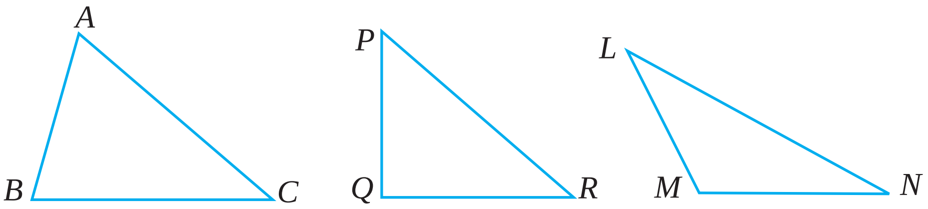
You have learnt that a polygon consisting of three straight line segments is a triangle. There are three angles and three sides in a triangle. These are called the elements of the triangle.



AB, BC and CA are the three sides of the triangle ABC. Furthermore, $A\hat{B}C$, $B\hat{C}A$ and $C\hat{A}B$ are the three angles of the triangle ABC.

Activity 1

Step 1 - Complete the table given below by naming the sides and the angles of each of the given triangles.

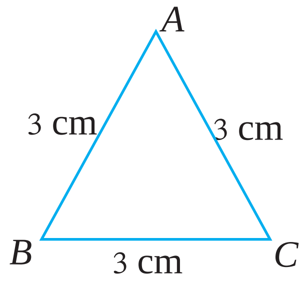


Triangle	Sides	Angles
ABC	AB, AC, BC,	$A\hat{B}C$, $B\hat{A}C$, $B\hat{C}A$,
PQR		
LMN		

14.5 Classification of triangles according to the length of the sides

• Equilateral triangles

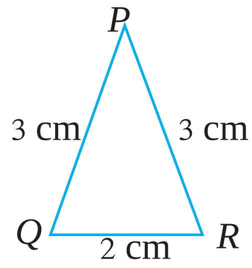
Each side of triangle ABC is of length 3 cm.
That is, $AB = BC = CA = 3$ cm.
All sides of triangle ABC are equal in length.



A triangle of which all three sides are equal in length is known as an **equilateral triangle**.

• Isosceles triangles

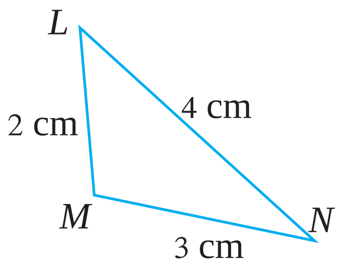
In triangle PQR, $PQ = PR = 3$ cm.
The other side which is QR is 2 cm in length. That is, PQ and PR are equal in length in triangle PQR.



A triangle of which two sides are equal in length is known as an **isosceles triangle.**

• Scalene triangles

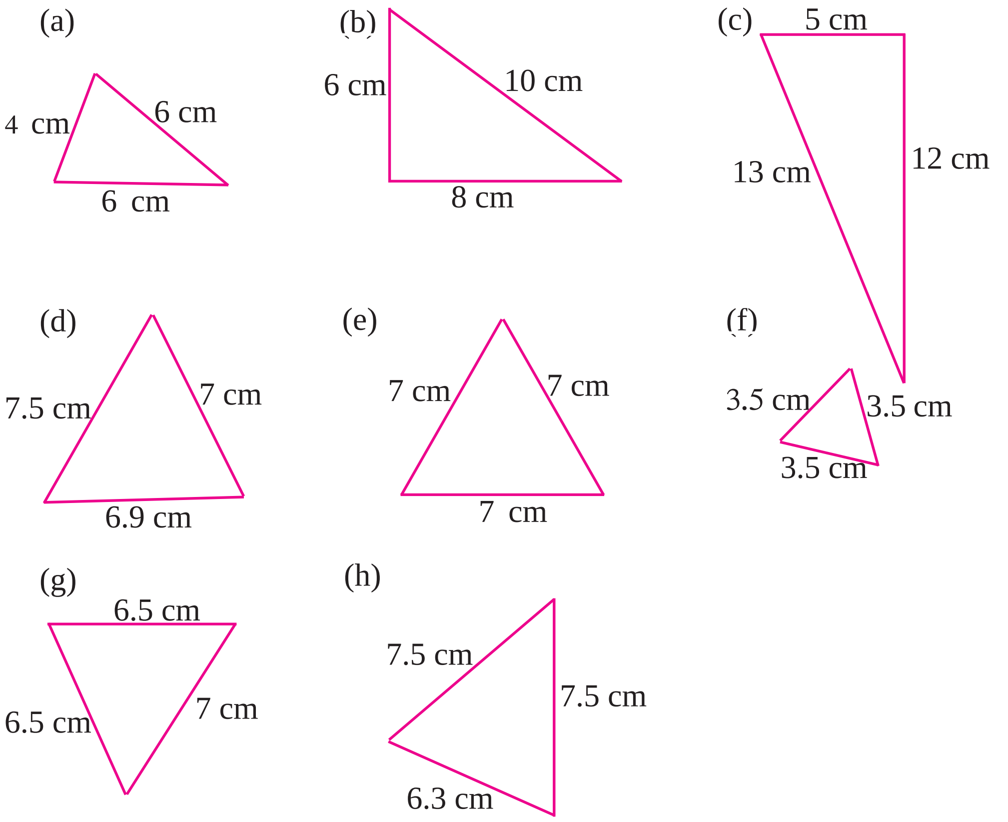
In triangle LMN, $LM = 2$ cm,
$MN = 3$ cm and $NL = 4$ cm.
That is, all sides of triangle LMN are of different lengths.



A triangle of which all three sides are unequal in length is known as a **scalene triangle.**

Exercise 14.4

(1) Examine the below given triangles and state whether each triangle is an equilateral triangle, an isosceles triangle or a scalene triangle.

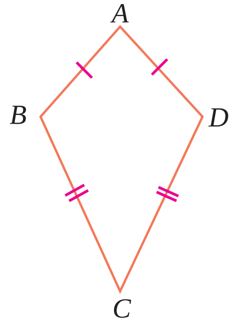


(2) Complete the table.

Length of each side of the triangle			Type of triangle based on the lengths of the sides
(cm)	(cm)	(cm)	
6	3	6	
4	4	4	
3	6	5	
5	6	8	

(3) "All equilateral triangles are isosceles triangles". Do you agree with this statement? Give reasons.

(4) A quadrilateral is shown in the figure. Name according to the lengths of the sides, the triangles that are obtained by



(i) joining only AC

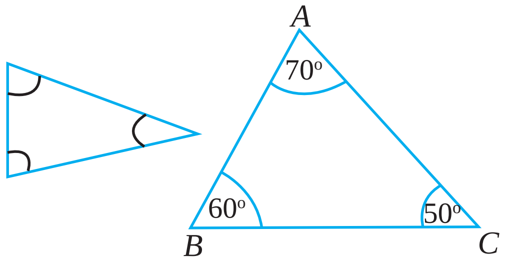
(ii) joining only BD

(5) By folding a rectangular shaped paper, create an equilateral triangle and an isosceles triangle, cut these triangles out, and paste them in your book.

14.6 Classification of triangles according to the angles

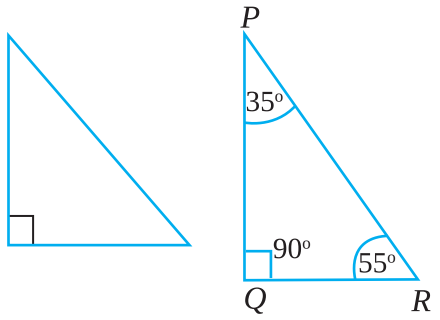
• Acute angled triangle

If all three angles of a triangle are acute angles, then the triangle is called an **acute angled triangle.**



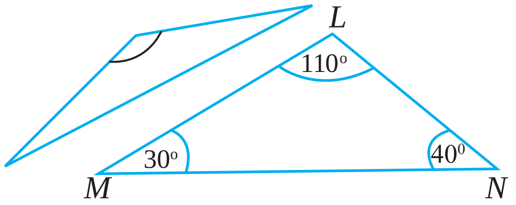
• Right angled triangle

If one angle of a triangle is a right angle, then the triangle is called a **right angled triangle**. The other two angles of a right angled triangle are acute angles.



• Obtuse angled triangle

If one angle of a triangle is an obtuse angle, then the triangle is called an **obtuse angled triangle.** The other two angles of an obtuse angled triangle are acute angles.

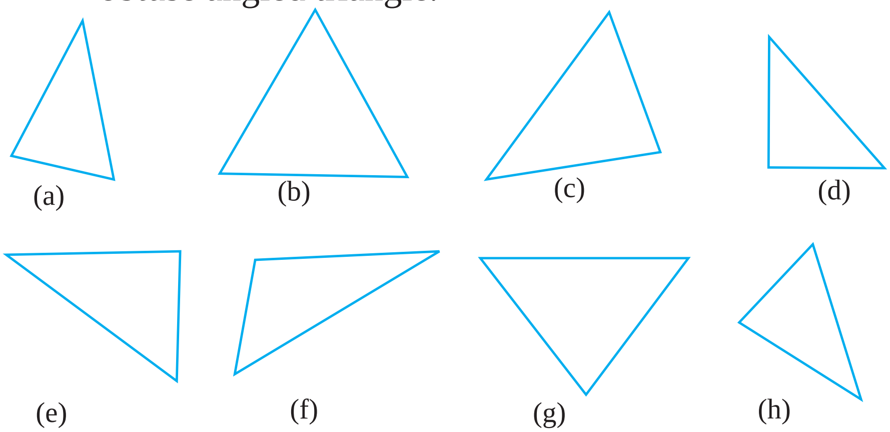


Activity 2

Step 1 - Obtain a right angled corner by folding a piece of paper.

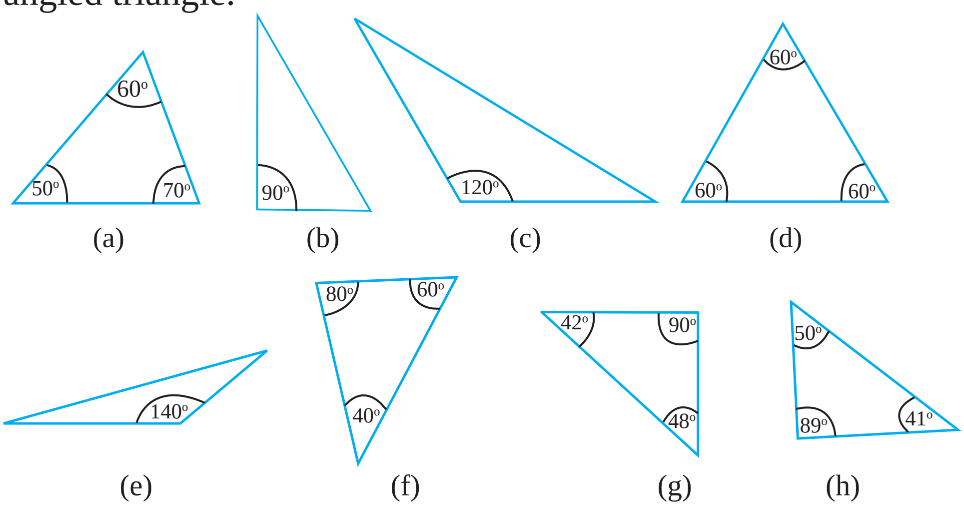
Step 2 - Using the right angled corner, compare the angles of the below given triangles.

Step 3 - Accordingly, write down for each of the triangles whether it is an acute angled triangle, a right angled triangle or an obtuse angled triangle.

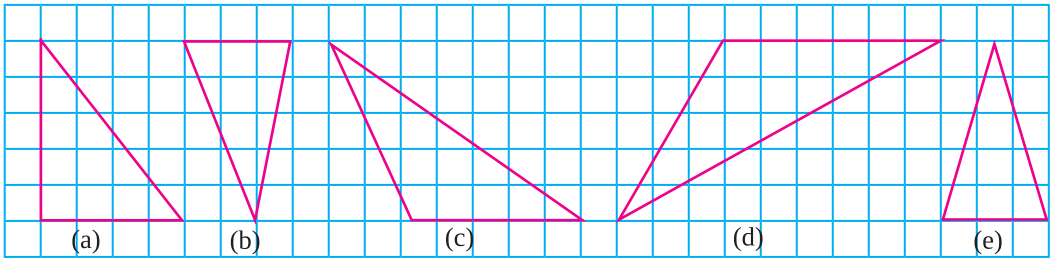


Exercise 14.5

(1) By considering the data in the below given triangles, classify each of them as an acute angled triangle, right angled triangle or an obtuse angled triangle.



(2) Classify each of the triangles given below, according to its angles.



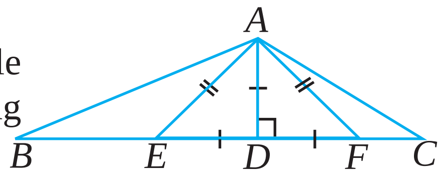
(3) Do the following by considering the given figure.

(i) Name 3 isosceles triangles.

(ii) Name 2 right angled triangles.

(iii) Name an obtuse angled triangle and a right angled triangle having AB as a side.

(iv) Name a scalene triangle.



(4) Do the following using the data in the figure.

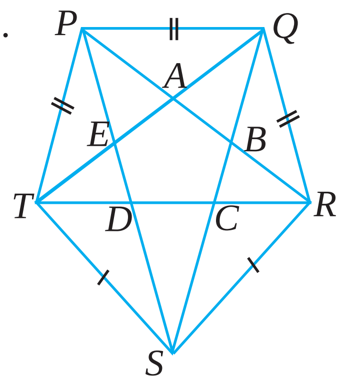
(i) Name 3 isosceles triangles.

(ii) Name 2 scalene triangles.

(iii) Name 2 convex pentagons.

(iv) Name 2 concave pentagons.

(v) Name a hexagon.



Summary

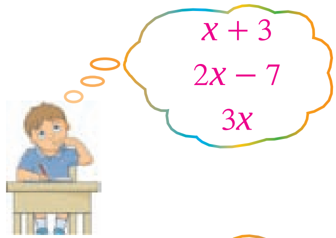
- If all three sides of a triangle are equal in length, then it is called an equilateral triangle.
- If any two sides of a triangle are equal in length, then it is called an isosceles triangle.
- If all three sides of a triangle are different in length, then it is called a scalene triangle.
- In a triangle, if all three angles are acute, then it is called an acute angled triangle.
- In a triangle, if one angle is a right angle, then it is called a right angled triangle.
- In a triangle if one angle is an obtuse angle, then it is called an obtuse angled triangle.

15 Equations and Formulae

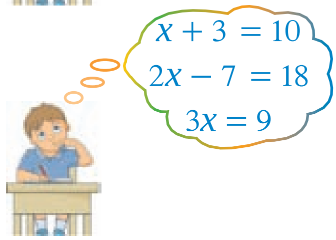
By studying this lesson you will be able to

- construct a simple equation in one unknown,
- solve simple equations,
- construct simple formulae, and
- find the value of any variable of a formula by substituting positive whole numbers for the other variables.

15.1 Constructing simple equations



You have learnt earlier to construct algebraic expressions by using algebraic symbols for unknown values, numbers for known values and operations.



When the value represented by an algebraic expression is equal to the value of a given number, it can be expressed as "algebraic expression = number".

When the value represented by an algebraic expression is equal to the value represented by another algebraic expression, it can be expressed as
"first algebraic expression = second algebraic expression".

Relationships of the above forms are called **equations**.

Consider the equations $x + 3 = 10$, $2x - 7 = 18$ and $3x = 9$. There is only one unknown in each of these equations. The index of the unknown in each equation is also 1.

An equation containing only one unknown of index one is called a **simple equation**.

In the equation $x + 5 = 8$, the value of the algebraic expression $x + 5$ on the left-hand side has been equated to 8 on the right-hand side.

An equation always contains the symbol "=". Apart from this, it also contains unknown terms, numbers and operations.

- A vendor had x mangoes. He bought another 24 mangoes. He now has a total of 114 mangoes. Let us express this information by an equation.

The number of mangoes the vendor had initially $= x$

The number of mangoes the vendor bought $= 24$

The total number of mangoes the vendor has now $= x + 24$

Moreover, since the total number of mangoes the vendor has now is 114,

$$x + 24 = 114$$

- "The price of a loaf of bread reduced by 4 rupees. The new price of a loaf of bread is 50 rupees." Let us express this by an equation.

Let us take the initial price of a loaf of bread as b rupees.

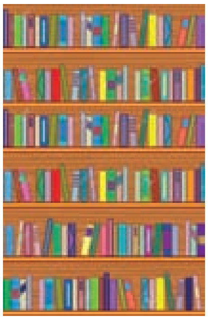
Since the price of a loaf of bread reduced by 4 rupees,

the new price of a loaf of bread $= b - 4$

Moreover, since the new price of a loaf of bread is 50 rupees,

$$b - 4 = 50$$

- Books have been placed on the shelves of a bookcase in a library such that each shelf contains x books. There are 6 shelves in the bookcase. After 10 of these books were issued to students, the number of books remaining in the bookcase reduced to 104. Let us express this information by an equation.



The total number of books that were on the 6 shelves $= 6x$

Number of books issued to students $= 10$

$\therefore$ the number of books remaining in the bookcase $= 6x - 10$

Moreover, since the number of books remaining is 104,

$$6x - 10 = 104$$

Example 1

When 13 is added to twice the value of a given number, the value that is obtained is 85. Represent this information by an equation.

Let us take the number as a.

Twice this number $= 2 \times a = 2a$

The number that is added $= 13$

The number that is obtained $= 2a + 13$

Moreover, since the number that is obtained is 85,

$$2a + 13 = 85$$

Example 2

In a certain year, a father was three times the age of his daughter on the day of her wedding. The girl's mother is 4 years younger to her father. That year, the mother's age was 62. By taking the age of the daughter on the day of her wedding as x years, construct an equation to represent this information.

Three times the age of the girl on the day of her wedding $= 3x$

$\therefore$ the father's age that year $= 3x$

The age of the mother who is four years younger to the father $= 3x - 4$

Moreover, since the mother's age that year was 62,

$$3x - 4 = 62$$

Exercise 15.1

(1) Each part, construct an equation to represent the information given in the statements.

(i) When 7 is added to the number represented by x, the value obtained is 20.

(ii) Nimal's present age is x years. In another 5 years he will be 18 years old.

(iii) When 12 is subtracted from the number represented by y, the value obtained is 27.

(iv) Saman received a salary of x rupees in January. The amount remaining from his salary after he had sent Rs 5000 to his mother was Rs 8000.

(v) When a number x is multiplied by 2, the value that is obtained is 34.

(vi) The amount spent on three pencils of the same type which cost p rupees each was 54 rupees.

(vii) The price of 1 kg of rice is r rupees. When 80 rupees is added to the price of 4 kg of rice, the value is 500 rupees.

(viii) The age of a father was three times the age of his son on the day of the son's wedding. The mother's age on this day was 60 years. The mother is 6 years younger to the father. Take the son's age to be x years.

(ix) Due to the price of a newspaper increasing by 10 rupees, its price is now 30 rupees.

(x) When a piece of cloth of length 70 cm is cut out, a piece of length 40 cm is left over.

(xi) 200 rupees was needed to purchase 5 mangosteens and one pineapple priced at 100 rupees.

(xii) When 12 is subtracted from five times a certain number, the value obtained is 98.

(xiii) When 4 is added to three times a certain number, the value obtained is 73.

(xiv) Sameera needed to buy a book worth 500 rupees. He saved an equal amount of money each day for 7 days. To purchase the book, he needed to add another 129 rupees to the amount he had saved.

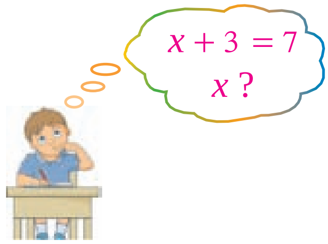
15.2 Solving simple equations

The equality symbol "=" in an equation expresses the fact that the value represented on the left-hand side of the symbol is equal to the value represented on the right-hand side.

What we mean by solving a simple equation is finding the value of the unknown term which satisfies the equation (that is, the value for which the equation holds true). This value is called the solution of the equation. A simple equation has only one solution.

For example, when 4 is substituted for x in the equation $x + 3 = 7$, the left-hand side of the equation is equal to the right-hand side.

Therefore, the solution to the equation $x + 3 = 7$ is $x = 4$.



• Solving simple equations using algebraic methods

You have learnt that the equality symbol "=" in an equation expresses the fact that the value on the left-hand side of this symbol is equal to the value on the right-hand side.

When solving simple equations, the value that the unknown should take for the left-hand side to be equal to the right-hand side of the equation can be found as follows.

➢ Let us find the value of the unknown which satisfies the equation $a + 8 = 10$.

When the same number is subtracted from the two sides of an equation, the new values that are obtained on the two sides are equal.

Let us subtract 8 from both sides of the equation $a + 8 = 10$.

$a + 8 - 8 = 10 - 8$ $\quad$ $(8 - 8 = 0)$

$\therefore a = 2$

➢ Let us find the value of the unknown which satisfies the equation $x - 7 = 10$.

In this equation, the value of $x - 7$ is equal to 10.

When the same number is added to the two sides of an equation, the new values that are obtained on the two sides are equal.

When 7 is added to the two sides of the equation $x - 7 = 10$, the left-hand side is equal to x and the right-hand side is equal to 17.

$x - 7 + 7 = 10 + 7$ $\quad$ $(-7 + 7 = 0)$

$\therefore x = 17$

- Let us solve the equation $5x = 10$.

When the two sides of an equation are divided by the same non-zero number, the new values that are obtained on the two sides are equal.

Let us divide both sides of the equation $5x = 10$ by 5.

$$\frac{5x}{5} = \frac{10}{5} \qquad \left(\frac{5}{5} = 1\right)$$

$$\therefore \; x = 2$$

When the value that is obtained is substituted for the unknown in the equation and simplified, if the same number is obtained on the two sides of the equation, then the accuracy of your answer is established.

Let us establish this, through the following examples.

Example 1

Solve $3y - 2 = 10$.

$$3y - 2 = 10$$

$$3y - 2 + 2 = 10 + 2 \quad \text{(let us add 2 to both sides)} \; (-2 + 2 = 0)$$

$$3y = 12$$

$$\frac{3y}{3} = \frac{12}{3} \quad \text{(let us divide both sides by 3)} \; \left(\frac{3}{3} = 1\right)$$

$$\therefore \; y = 4$$

Let us examine whether the solution $y = 4$ that you obtained is correct.

When $y = 4$,

Left-hand side $= 3y - 2$

$= 3 \times 4 - 2$

$= 12 - 2$

$= 10$

Right-hand side $= 10$

Therefore, left-hand side = right-hand side

Therefore, the solution $y = 4$ is correct.

Example 2

It costs 96 rupees to buy four books of the same price and 3 pencils priced at 8 rupees each. Find the price of a book.

Let us take the price of a book as x rupees.

Then the price of four books = $4x$ rupees

The price of 3 pencils, each priced at 8 rupees = 3×8 rupees = 24 rupees

Therefore, $4x + 24 = 96$

$$4x + 24 - 24 = 96 - 24$$

$$4x = 72$$

$$\frac{4x}{4} = \frac{72}{4}$$

$$x = 18$$

$\therefore$ the price of a book is 18 rupees.

Let us examine whether the solution $x = 18$ is correct.

When $x = 18$,

Left-hand side $= 4x + 24$

$= 4 \times 18 + 24 = 72 + 24 = 96$

Right-hand side $= 96$

That is, left-hand side = right-hand side

$\therefore$ the solution $x = 18$ is correct.

• Another method of solving simple equations

The inverse operations of the mathematical operations addition, subtraction, multiplication and division which we use in equations are respectively subtraction, addition, division and multiplication.

Another method of solving a simple equation of the above form is performing the inverse operations of the operations on the left-hand side, on the value on the right-hand side.

Let us solve the equation $3x + 7 = 10$.

The left-hand side of this equation is $3x + 7$.

The right-hand side is 10.

$$x \xrightarrow{\boxed{\times 3}} 3x \xrightarrow{\boxed{+7}} 3x+7 \qquad \text{(left-hand side)}$$

$$x \xleftarrow{\boxed{\div 3}} 3x \xleftarrow{\boxed{-7}} 3x+7$$

$$1 \xleftarrow{\boxed{\div 3}} 3 \xleftarrow{\boxed{-7}} 10 \qquad \text{(right-hand side)}$$

$\therefore\ x = 1$

Example 1

Solve $x - 7 = 10$.

$$x \xrightarrow{\boxed{-7}} x-7 \qquad \text{(left-hand side)}$$

$$\underset{17}{x} \xleftarrow{\boxed{+7}} \underset{10}{x-7} \qquad \text{(right-hand side)}$$

$\therefore\ x = 17$

Example 2

Solve $5\,x = 30$.

$$x \xrightarrow{\boxed{\times 5}} 5x \qquad \text{(left-hand side)}$$

$$\underset{6}{x} \xleftarrow{\boxed{\div 5}} \underset{30}{5x} \qquad \text{(right-hand side)}$$

$\therefore\ x = 6$

Example 3

Solve $3y - 2 = 10$.

$$y \xrightarrow{\boxed{\times 3}} 3y \xrightarrow{\boxed{-2}} 3y-2 \qquad \text{(left - hand side)}$$

$$\underset{4}{y} \xleftarrow{\boxed{\div 3}} \underset{12}{3y} \xleftarrow{\boxed{+2}} \underset{10}{3y-2} \qquad \text{(right-hand side)}$$

$\therefore\ y = 4$

Exercise 15.2

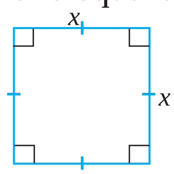
(1) Solve each of the following equations.

(i) $x + 6 = 7$ (ii) $x + 4 = 20$ (iii) $x - 5 = 14$ (iv) $x - 3 = 27$
(v) $6x = 48$ (vi) $7b = 56$ (vii) $2x + 5 = 9$ (viii) $8x + 7 = 79$
(ix) $7x - 5 = 51$ (x) $9x - 7 = 101$ (xi) $11x + 1 = 12$

(2) The price of a banana in a comb with 18 fruits is y rupees. If it costs 170 rupees to buy this comb of bananas and a pineapple priced at 80 rupees, find the value of y.

15.3 Formulae

Let us develop the relationship between the length of a side of a square and the perimeter of the square.



Let the length of a side of a square be x cm and the perimeter of the square be p cm.

Since the perimeter of a square is the sum of the lengths of the four sides of the square,

$p = x + x + x + x \;\; = 4\,x$

Equations such as the above are called **formulae**.

Here p is called the subject of the formula.

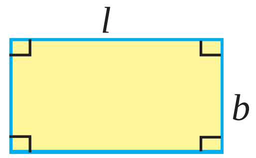
Accordingly, the relationship between the perimeter and the length of a square of length x units and perimeter p units is $p = 4x$.

This formula can be used to find the perimeter of any square of which the side length is known.

Since the units of the values on the two sides of a formula are the same, it is not necessary to state the units.

Formula for the perimeter of a rectangular lamina can also be developed as above.

Let the length of this rectangular lamina be l units, the breadth be b units and the perimeter be P in the same units.



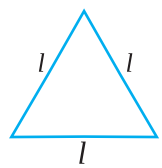
Then $P = l + b + l + b$

This can be written either as $P = 2l + 2b$ or $P = 2\,(l + b)$.

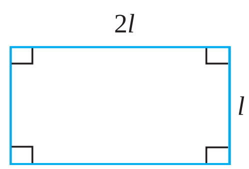
This formula can be used to find the perimeter of any rectangle of which the length and breadth are known.

Exercise 15.3

(1) The perimeter of an equilateral triangle of side length l units is P units. Construct a formula expressing the relationship between P and l.



(2) The breadth and the length of the given rectangle are l units and $2l$ units respectively. Construct a formula for its perimeter P in terms of l.



(3) The breadth of the rectangle in the figure is x cm. If the length is 10 cm more than the breadth and the perimeter is P in the same units, construct a formula expressing the relationship between P and x.

(4) There is a fixed charge of 100 rupees in the monthly electricity bill of a certain city. Apart from this, households that consume less than 100 units of electricity per month have to pay an additional amount of 8 rupees per unit consumed. If the monthly electricity bill of a consumer who uses n units (where $n < 100$) during a month is p rupees, construct a formula for p in terms of n.

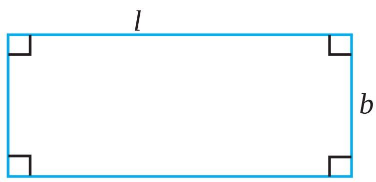
(5) A machine produces N milk packets during the first hour. Every hour thereafter, it produces n packets. If T packets are produced in t hours, construct a formula for T in terms of n, N and t.

15.4 Substituting numerical values for the variables in a formula

If the length, breadth and perimeter of a rectangle are l, b and P respectively, then $P = 2l + 2b$.

The length and the breadth of a certain rectangle are 13 cm and 7 cm respectively. Let us calculate its perimeter by using the above formula.

$$
\begin{aligned}
P &= 2l + 2b \\
l = 13 \text{ cm and } b &= 7 \text{ cm} \\
\text{Therefore, } P &= 2 \times 13 + 2 \times 7 \text{ cm} \\
&= 26 + 14 \text{ cm} \\
&= 40 \text{ cm}
\end{aligned}
$$



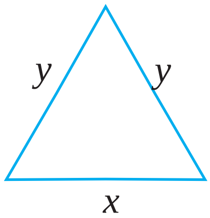
Exercise 15.4

(1) Find the value of N when $Q = 13$ and $D = 20$ in the formula $N = 18 + QD$.

(2) If the area of a square lamina of side length x units is A square units, a formula for A, in terms of x is $A = x^2$. Find the value of A when $x = 8$.

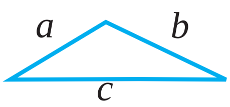
(3) (i) If the perimeter of the given triangle is P, develop a formula for P.

(ii) Find the value of P when x =16 cm and y = 12 cm.



(4) (i) If the perimeter of the given triangle is P, construct a formula for P.

(ii) Find the value of P when $a = 4$ cm, $b = 5$ cm and $c = 6$ cm.



(5) If the area of a rectangular lamina of length l units and breadth b units is A square units, the formula for A, in terms of l and b is $A = lb$. Find the value of A when $l = 6$ cm and $b = 3$ cm.

Summary

- The relationship that is obtained when two mathematical expressions, of which at least one is algebraic, are equated to each other is an equation.
- The solution of an equation is the value of the unknown for which the equation holds true.
- A relationship between several variables can be expressed as a formula.
- The value of the any variable of a formula can be found by substituting positive whole numbers for the other variables.

16 Length

By studying this lesson you will be able to

- add and subtract length measurements,
- multiply and divide length measurements by a whole number, and
- find the perimeter of a rectilinear plane figure.

16.1 Units of length

All the words, height, depth, width and thickness describe a certain length. You have already learnt that the units millimetre (mm), centimetre (cm), metre (m) and kilometre (km) are used to measure lengths. The relationships between these units are given below.

1 centimetre	=	10 millimetres
1metre	=	100 centimetres
1 kilometre	=	1000 metres

1 cm	=	10 mm
1 m	=	100 cm
1 km	=	1000 m

You have also learnt to convert a length given in a certain unit to another unit using the above relationships. Do the following review exercise to revise what you have learnt.

Review Exercise

(1) Fill in the blanks.

(i) 13 mm = 10 mm + ... mm
= ...... cm + ... mm
= 1.3 cm

(ii) 45 mm = ... cm ...... mm
= .... cm

(iii) 728 cm = ... m ...... cm
= .... m

(iv) 7075 m = ... km .... m
= .... km

(v) 305 mm = ... cm

(vi) 150 cm = ... m

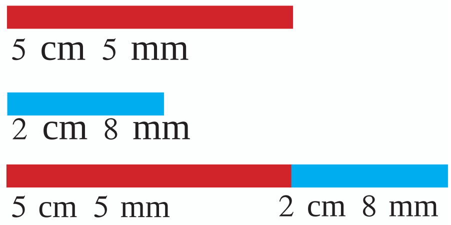
(vii) 1540 m = ... km

(viii) 5.3 cm = ... mm

(ix) 3.25m = ... cm

(x) 2.375 km = ... m

16.2 Addition of length measurements



The figure shows two ribbons, one red and the other blue. The red ribbon is of length 5 cm 5 mm. The blue ribbon is of length 2 cm 8 mm. The figure also shows the two ribbons pasted on a piece of paper such that one end of the blue ribbon touches one end of the red ribbon. Let us find the length of the pasted ribbon.

To do this we need to add the lengths of the two ribbons.

Method I

$$\begin{array}{rrr} & \text{cm} & \text{mm} \\ & 5 & 5 \\ + & 2 & 8 \\ \hline & 8 & 3 \\ \hline\hline \end{array}$$

Let us add the quantities in the millimetres column.
$5 \text{ mm} + 8 \text{ mm} = 13 \text{ mm}$
$13 \text{ mm} = 1 \text{ cm} + 3 \text{ mm}$
Let us write 3 mm in the millimetres column and carry the 1 cm to the centimetres column.
Then, $1 \text{ cm} + 5 \text{ cm} + 2 \text{ cm} = 8 \text{ cm}$
Let us write 8 cm in the centimetres column.

So, the total length is 8 cm and 3 mm.

Method II

Let us express each of the length measurements in centimetres, and then simplify.

$5 \text{ cm } 5 \text{ mm} = 5.5 \text{ cm}$

$2 \text{ cm } 8 \text{ mm} = 2.8 \text{ cm}$

$8.3 \text{ cm} = 8 \text{ cm } 3 \text{ mm}$

$$\begin{array}{rr} & \text{cm} \\ & 5.5 \\ + & 2.8 \\ \hline & 8.3 \\ \hline\hline \end{array}$$

- Let us simplify $5 \text{ m } 65 \text{ cm} + 15 \text{ m } 70 \text{ cm}$.

Method I

$$\begin{array}{rrr} & \text{m} & \text{cm} \\ & 5 & 65 \\ + & 15 & 70 \\ \hline & 21 & 35 \\ \hline\hline \end{array}$$

Let us add the quantities in the centimetres column.
$65 \text{ cm} + 70 \text{ cm} = 135 \text{ cm}$
$135 \text{ cm} = 1 \text{ m} + 35 \text{ cm}$
Let us write the 35 cm in the centimetres column and carry the 1 m to the metres column.
Then, $1 \text{ m} + 5 \text{ m} + 15 \text{ m} = 21 \text{ m}$
Let us write 21 m in the metres column.

Method II

Let us express each of the length measurements in metres, and then simplify.

5 m 65 cm = 5.65 m

15 m 70 cm = 15.70 m

21.35 m = 21 m 35 cm

m
5 . 65
+ 15 . 70
21 . 35

- Let us simplify 3 km 30 m + 980 m .

Method I

	km	m
	3	30
+		980
	4	10

Let us add the quantities in the metres column.
30 m + 980 m = 1010 m
1010 m = 1 km + 10 m
Let us write the 10 m in the metres column and carry the 1 km to the kilometres column.
3 km + 1 km = 4 km
Let us write the 4 km in the kilometres column.

Method II

Let us express each of the length measurements in kilometres, and then simplify.

3 km 30 m = 3.030 km

980 m = 0.980 km

4.010 km = 4 km 10 m

km
3 . 030
+ 0 . 980
4 . 010

Example 1

Simplify 12 m 70 cm + 8 m 5 cm + 15 m 80 cm.

Method I

	m	cm
	12	70
	8	05
+	15	80
	36	55

Method II

12 m 70 cm = 12.70 m

8 m 5 cm = 8.05 m

15 m 80 cm = 15.80 m

m
12 . 70
+ 8 . 05
15 . 80
36 . 55

36.55 m = 36 m 55 cm

Exercise 16.1

(1) Simplify the following.

(i)

	cm	mm
	5	6
+	12	3

(ii)

	cm	mm
	13	6
+	17	8

(iii)

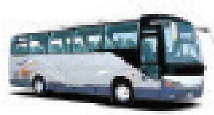
	m	cm
	4	35
+	7	80

(iv)

	km	m
	3	70
+	1	5

(v) 2 km 780 m + 1 km 530 m
(vi) 57 cm 8 mm + 8 cm 7 mm + 12 cm 7 mm
(vii) 8 m 53 cm + 7 m 75 cm + 4 m 2 cm
(viii) 1 km 730 m + 4 km 20 m + 950 m

(2) Nipuna travels 1 km and 370 m from his house to the bus halt by bicycle. From there he travels 5 km and 680 m to school by bus. Find the total distance Nipuna travels when going to school from his house.

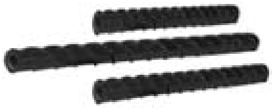


(3) A ribbon is cut into 3 pieces in order to make a wall hanging.

First piece	-	12 cm 8 mm
Second piece	-	8 cm 4 mm
Third piece	-	4 cm

In order to cut all the above pieces, what is the minimum length of the ribbon that is required?

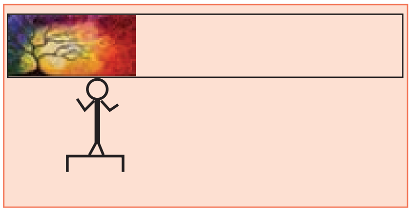
(4) There are three iron rods of the same type of length 1 m 23 cm, 2 m 9 cm and 1 m 73 cm respectively. A new rod can be made by selecting two of these rods and soldering them together without altering their original lengths.



(i) Find the length of the longest rod that can be made in this manner.
(ii) Find the length of the shortest rod that can be made in this manner.

16.3 Subtraction of lengths

- The length of a classroom wall is 5 m 50 cm. It has been decided to draw a picture along the top edge of the wall. On a particular day, the picture is drawn to a length of 1 m 80 cm. Let us find the remaining length of the wall on which the picture needs to be drawn.



To do this we need to subtract the length of the picture drawn from the length of the entire wall.

Method I

$$5\text{ m }50\text{ cm} = 5.50\text{ m}$$
$$1\text{ m }80\text{ cm} = 1.80\text{ m}$$
$$5\text{ m }50\text{ cm} - 1\text{ m }80\text{ cm} = 3.70\text{ m}$$
$$= 3\text{ m }70\text{ cm}$$

$$\begin{array}{r} \text{m} \\ 5\ .\ 50 \\ -\ \underline{1\ .\ 80} \\ \underline{\underline{3\ .\ 70}} \end{array}$$

So the length of the wall remaining on which the picture has to be drawn is 3 m 70 cm.

Method II

	m	cm
	5	50
–	1	80
	3	70

50 is less than 80. So let us carry over 1 m from the 5 m in the metres column to the centimetres column.
Then 4 m will remain in the metres column.
$100\text{ cm} + 50\text{ cm} = 150\text{ cm}$
$150\text{ cm} - 80\text{ cm} = 70\text{ cm}$
Let us write 70 cm in the centimetres column.
Now let us reduce 1 m from the 4 m in the metres column.
$4\text{ m} - 1\text{ m} = 3\text{ m}$
Let us write 3 m in the metres column.

So the length of the wall remaining on which the picture has to be drawn is 3 m 70 cm.

Example 1

A piece of length 7 cm 5 mm is cut from a ribbon of length 32 cm 3 mm. What is the length of the remaining piece of ribbon?

Let us simplify 32cm 3mm – 7 cm 5 mm.

Method I

	cm	mm
	32	3
–	7	5
	24	8

3 is less than 5. Let us carry over 1 cm from the 32 cm in the centimetres column to the millimetres column. Then there will be 31 cm remaining in the centimetres column.
$10\text{ mm} + 3\text{ mm} = 13\text{ mm}$
$13\text{ mm} - 5\text{ mm} = 8\text{ mm}$
Let us write 8 mm in the millimetres column.
From the remaining 31 cm in the centimetres column, let us subtract 7 cm.
$31\text{ cm} - 7\text{ cm} = 24\text{ cm}$

Method II

Let us express each of the length measurements in centimetres, and then simplify.

32 cm 3 mm $= 32.3$ cm

7 cm 5 mm $= 7.5$ cm

Length of the remaining piece of ribbon is 24.8 cm $= 24$ cm 8 mm

$$\begin{array}{r} \text{cm} \\ 32\,.\,3 \\ -\,7\,.\,5 \\ \hline 24\,.\,8 \\ \hline\hline \end{array}$$

Example 2

Simplify 6 km 50 m $-$ 2 km 700 m.

Method I

$$\begin{array}{rrr} & \text{km} & \text{m} \\ & 6 & 50 \\ - & 2 & 700 \\ \hline & 3 & 350 \\ \hline\hline \end{array}$$

50 is less than 700. Let us carry over 1 km from the 6 km in the kilometres column to the metres column.

1000 m + 50 m = 1050 m

1050 m − 700 m = 350 m

Let us write 350 m in the metres column. From the remaining 5 km, in the kilometres column, let us subtract 2 km.

5 km − 2 km = 3 km

Let us write 3 km in the kilometres column.

Method II

6 km 50 m $= 6.050$ km

2 km 700 m $= 2.700$ km

3.350 km $= 3$ km 350 m

$$\begin{array}{r} \text{km} \\ 6\,.\,050 \\ -\,2\,.\,700 \\ \hline 3\,.\,350 \\ \hline\hline \end{array}$$

Exercise 16.2

(1) Simplify.

(i) 10 cm 8 mm – 2 cm 5 mm

(ii) 15 cm 5 mm – 9 mm

(iii) 7 m 85 cm – 4 m 75 cm

(iv) 75 m 5 cm – 57 m 85 cm

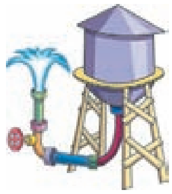
(v) 12 km 300 m – 8 km 500 m

(vi) 24 km 75 m – 15 km 350 m

(2) Ruvini is 1 m 35 cm tall. Gayani is 1 m 48 cm tall. By how many centimetres is Gayani taller than Ruvini?

(3) From a piece of cloth of length 35 m in a shop, a length of 20 m 80 cm was sold. Find the length of the remaining cloth.

(4) A water tank is 1 m 30 cm deep. Water is filled to a height of 80 cm in this tank. We want to fill the tank completely. To do this, what is the height the water that must be added now?



(5) A worker is assigned to dig a trench of length 15 m. On a particular day he digs a length of 3 m 40 cm. Find the length of the trench remaining for him to dig.

(6) During an inter house sports meet of a school, it was required to run a distance of 10 km for the marathon. Nisham participated in this event. After running a distance of 8 km 850 m, he was injured and could not complete the race. Find the remaining distance that Nisham should have run to complete the race.

16.4 Multiplication and division of measurements of length

- **Multiplication of a measurement of length by a whole number**

➢ A ribbon of length 1 m 80 cm is required to decorate a present. Let us find the length of ribbon required to decorate 8 presents.

To do this, we need a ribbon which is of length eight times that of the piece of ribbon that is required to decorate one present. So 1 m 80 cm must be multiplied by 8.

Method I

	m	cm
	1	80
$\times$		8
	14	40

80 cm $\times 8 = 640$ cm

Since 640 cm $= 6$ m 40 cm,

let us write the 40 cm in the centimetres column and carry the 6 m to the metres column.

1 m $\times 8 = 8$ m.

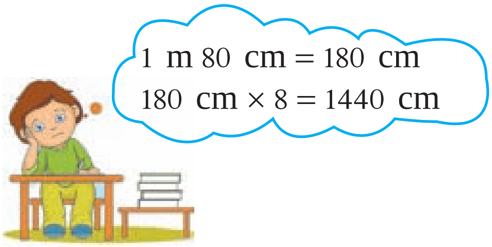
Let us add the 8 m to the 6 m.

8 m $+ 6$ m $= 14$ m

Let us write the 14 m, in the metres column.

Method II

Let us express 1 m 80 cm, in centimetres and then multiply by 8.



$$\begin{array}{r} \text{cm} \\ 180 \\ \times \quad 8 \\ \hline 1440 \\ \hline\hline \end{array}$$

Therefore the total length = 1440 cm = 14 m 40 cm

➢ Let us simplify 3 cm 7 mm × 5.

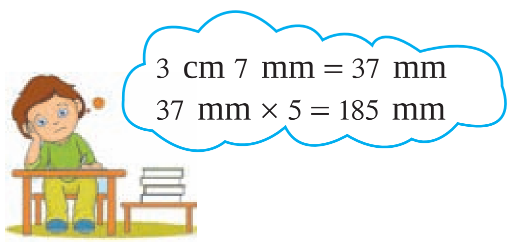
Method I

	cm	mm
	3	7
×		5
	18	5

7 mm × 5 = 35 mm
35 mm = 3 cm 5 mm
Let us write 5 mm in the millimetres column.
3 cm × 5 = 15 cm
Let us add the 3 cm to the 15 cm.
3 cm + 15 cm = 18 cm
Let us write 18 cm in the centimetres column.

Method II

Let us express 3 cm 7 mm, in millimetres and then multiply by 5.



$$\begin{array}{r} \text{mm} \\ 37 \\ \times \quad 5 \\ \hline 185 \\ \hline\hline \end{array}$$

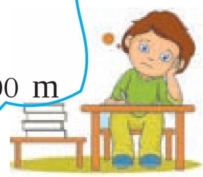
185 mm = 18 cm 5 mm
3 cm 7 mm × 5 = 18 cm 5 mm

➢ Let us simplify 3 km 175 m × 12.

Method I

km	m
3	175
×	12
38	100

Let us first multiply 175 m by 12.
175 m × 12 = 2100 m
= 2 km 100 m
Now let us multiply 3 km by 12.
3 km × 12 = 36 km
3 km 175 m × 12 = 36 km + 2 km 100 m
= 38 km 100 m



Method II

Let us express 3 km 175 m, in metres and then multiply by 12.

$$\begin{array}{r} 3175 \\ \times \quad 12 \\ \hline 6350 \\ 3175 \\ \hline 38100 \\ \hline \end{array}$$

3 km 175 m = 3175 m
3175 m × 12 = 38 100 m
38 100 m = 38 km 100 m
∴ 3 km 175 m × 12 = 38 km 100 m

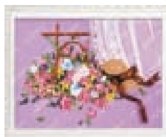
Exercise 16.3

(1) Simplify.

(i) 5 cm 2 mm × 5 (ii) 12 cm 7 mm × 5 (iii) 5 m 25 cm × 7
(iv) 2 m 50 cm × 15 (v) 35 km 7 m × 6 (vi) 2 km 450 m × 16

(2) Cloth of length 1 m 35 cm is required to sew a child's dress. Find the length of cloth required to sew 8 such dresses.

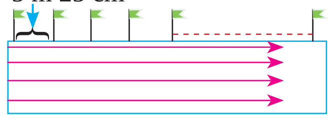
(3) Seven pieces of ribbon, each of length 12 cm 5 mm, are required to make a wall hanging. What is the minimum length of the ribbon needed to cut these seven pieces?



(4) In a play ground, the running tracks are straight as shown in the figure. Along the edge of the running track, flags are placed 5 m 25 cm apart as shown in the figure. There are 21 such flags.

(i) How many such 5 m 25 cm gaps are there along the row of flags?

(ii) Find the distance between the first and the 21st flag.



(5) Twelve tiles are stacked one on top of another. Each tile is of thickness 2 cm 4 mm. Find the height of the stack of tiles.

(6) To get to the second floor of a two storey house, it is necessary to climb 35 steps, each of height 15.75 cm.

 (i) Find how many centimetres above the first floor, the second floor is located.

 (ii) Express this height in metres.

• Division of a measurement of length by a whole number

Let us now study how to divide measurements of length by a whole number.

➢ Suppose we are given a wire of length 5 m 46 cm and cut it into 2 equal pieces. Let us find the length of one piece.

Here we need to divide the length of the wire by 2.

Method I

Let us express 5 m 46 cm in centimetres and then divide by 2.

$$
\begin{array}{r|l}
 & \overline{273\ \text{cm}} \\
2 & 546\ \text{cm} \\
 & \underline{4} \\
 & 14 \\
 & \underline{14} \\
 & \quad 6 \\
 & \quad \underline{6} \\
 & \quad 0
\end{array}
$$

5 m 46 cm = 546 cm

546 cm ÷ 2 = 273 cm

273 cm = 2 m 73 cm

So the length of one piece = 2 m 73 cm

Method II

$$
\begin{array}{r|l}
 & \overline{2\ \text{m} \quad 73\ \text{cm}} \\
2 & 5\ \text{m} \quad 46\ \text{cm} \\
 & \underline{4} \\
 & 1\ \text{m} \rightarrow \underline{100\ \text{cm}} \\
 & \qquad 146\ \text{cm} \\
 & \qquad \underline{146\ \text{cm}} \\
 & \qquad\ 00
\end{array}
$$

Let us divide the 5 m in the metres column by 2.
Let us carry the remainder which is 1 m to the centimetres column.
Then the number in the centimetres column is
100 cm + 46 cm = 146 cm.
146 cm ÷ 2 = 73 cm

So the length of one piece = 2 m 73 cm.

Example 1

Simplify 65 cm 7 mm $\div 9$.

$$\begin{array}{r|l} & \;\;73\text{ mm} \\ \hline 9 & 657\text{ mm} \\ & 63 \\ \hline & \;\;27\text{ mm} \\ & \;\;27\text{ mm} \\ \hline & \;\;00 \end{array}$$

Method I

Let us express 65 cm 7 mm, in millimetres and then divide by 9.

65 cm 7 mm $= 657$ mm

65 cm 7 mm $\div 9 = 73$ mm

$= 7$ cm 3 mm

Method II

$$\begin{array}{r|l} & 7\text{ cm } 3\text{ mm} \\ \hline 9 & 65\text{ cm } 7\text{ mm} \\ & 63 \\ \hline & \;\;2 \rightarrow 20\text{ mm} \\ & \;\;\;\;\;\;\;27\text{ mm} \\ & \;\;\;\;\;\;\;27\text{ mm} \\ \hline & \;\;\;\;\;\;\;00 \end{array}$$

Let us divide the 65 cm in the centimetres column by 9. Let us take the remaining 2 cm, to the millimetres column as 20 mm and find the amount in the millimetres column.

20 mm $+ 7$ mm $= 27$ mm

27 mm $\div 9 = 3$ mm

65 cm 7 mm $\div 9 = 7$ cm 3 mm

Example 2

Simplify 8 km 740 m $\div 5$.

$$\begin{array}{r|l} & 1748\text{ m} \\ \hline 5 & 8740\text{ m} \\ & 5 \\ \hline & 37 \\ & 35 \\ \hline & \;\;24 \\ & \;\;20 \\ \hline & \;\;\;\;40 \\ & \;\;\;\;40 \\ \hline & \;\;\;\;00 \end{array}$$

Method I

Let us express 8 km 740 m in metres and then divide by 5.

8 km 740 m $= 8740$ m

8740 m $\div 5 = 1748$ m

8 km 740 m $\div 5 = 1748$ m

$= 1$ km 748 m

Method II

$$\begin{array}{r|ll} & 1\text{ km} & 748\text{ m} \\ \hline 5 & 8\text{ km} & 740\text{ m} \\ & 5 & \\ \hline & 3 \rightarrow & 3000\text{ m} \\ & & 3740 \\ & & 35 \\ \hline & & \;\;24 \\ & & \;\;20 \\ \hline & & \;\;\;\;40 \\ & & \;\;\;\;40 \\ \hline & & \;\;\;\;00 \end{array}$$

Let us divide the 8 km in the kilometres column by 5.

Let us take the remaining 3 km, to the metres column as 3000 m. Then the amount in the metres column is

3000 m $+ 740$ m $= 3740$ m.

3740 m $\div 5 = 748$ m

8 km 740 m $\div 5 = 1$ km 748 m

Exercise 16.4

(1) Fill in the blanks.

(i)
```
        .... cm .... mm
   12 | 43 cm  2 mm
      | 36
      | .... → ....
              72 mm
              ....
              ....
```

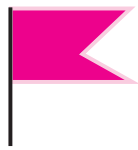
(ii) 43 cm 2 mm = ... mm
43 cm 2 mm ÷ 12 = ... mm ÷ 12
= .... mm
= .... cm .... mm

(2) Simplify the following.

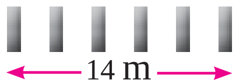
(i) 15 cm 6 mm ÷ 3 (ii) 96 cm 6 mm ÷ 7 (iii) 12 m 48 cm ÷ 8
(iv) 205 m 70 cm ÷ 10 (v) 8 km 40 m ÷ 3 (vi) 2 km 750 m ÷ 5

(3) If a wire of length 8 m is cut into 20 equal parts, find the length of one part.

(4) A piece of cloth of length 35 m was used to sew 25 flags of equal size for a festival. If the entire piece of cloth was used to sew the flags, then find the length of the material used to sew one flag.



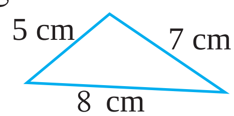
(5) A plot of land is of length 14 m. The figure shows how 6 concrete poles are placed along one side of the border of this plot of land. The gap between any two nearby poles is the same. Find the gap between two nearby poles.



(6) A quantity of 57.6 m of material was bought for costumes and distributed equally among 24 members of a band. Find the quantity of material one person received.

16.5 Perimeter

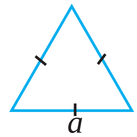
In grade 6 you learnt that the length around a closed plane figure is called its perimeter.
Let us find the perimeter of the triangle shown in the figure.



The sum of the lengths of all three sides of the triangle $\}$ = 8 cm + 7 cm + 5 cm
= 20 cm

Therefore the perimeter of the triangle = 20 cm

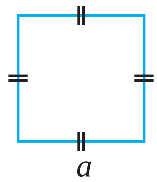
- **Perimeter of an equilateral triangle**



If the side length of an equilateral triangle is a units and the perimeter is p units, then

$$p = a + a + a$$
$$p = 3a$$

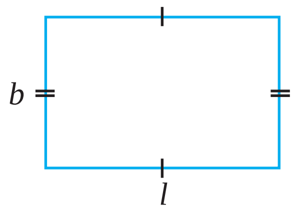
- **Perimeter of a square**



If the side length of a square is a units and the perimeter is p units, then

$$p = a + a + a + a$$
$$p = 4a$$

- **Perimeter of a rectangle**

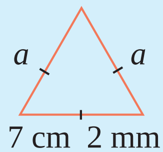


If in a rectangle, the length is l units, the width is b units and the perimeter is p units, then

$$p = l + b + l + b$$
$$p = 2l + 2b$$
or
$$p = 2\ (l + b)$$

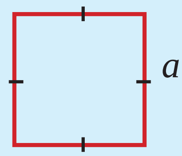
Example 1

The length of an equilateral triangle is 7 cm 2 mm. Find its perimeter.



Perimeter of the triangle $= 3a$
$= 3 \times (7 \text{ cm } 2 \text{ mm})$
$= 21 \text{ cm } 6 \text{ mm}$

Example 2



The perimeter of a square is 25 cm 6 mm. Find the length of a side.

If the length of a side is a units, then

the perimeter of the square $= 4a = 25 \text{ cm } 6 \text{ mm}$

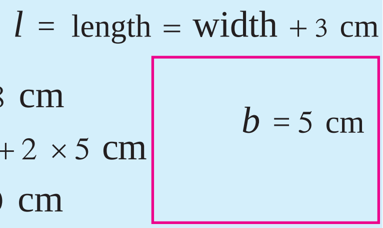
$\therefore$ the length of a side $= a = 25 \text{ cm } 6 \text{ mm} \div 4$

The length of a side is 6 cm 4 mm.

6 cm 4 mm
4 | 25 cm 6 mm
24
1 → 10 mm
16 mm
16 mm
00

Example 3

The length of a rectangle is 3 cm greater than its width. If the width is 5 cm, then find the perimeter.



The length of the rectangle = width + 3 cm

$= 5 \text{ cm} + 3 \text{ cm} = 8 \text{ cm}$

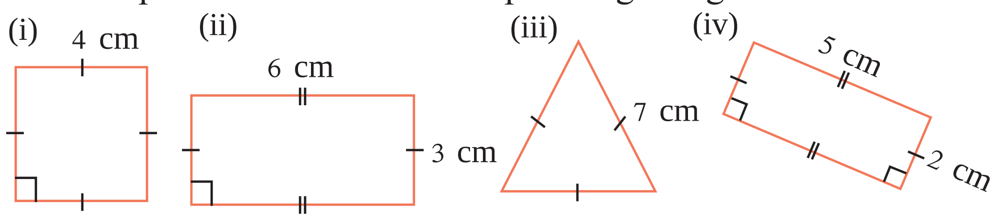
The perimeter of the rectangle $= 2l + 2b = 2 \times 8 + 2 \times 5$ cm

$= 16 + 10$ cm

$= 26$ cm

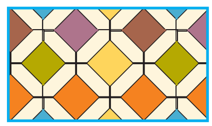
Exercise 16.5

(1) Find the perimeter of each of the plane figures given below.

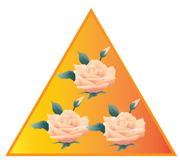


(2) (i) The figure denotes a square shaped stamp of side length 2.4 cm. Find the perimeter of the stamp.

(ii) Find the perimeter of the rectangular shaped tile of length 24 cm and breadth 5 cm shown in the figure.

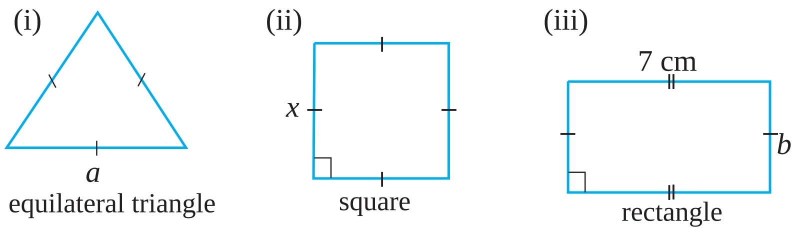


(iii) The perimeter of an equilateral triangle shaped wall hanging is 48 cm 6 mm. Find the length of a side.



(iv) The perimeter of a square shaped handkerchief is 40 cm. Find the length of a side.

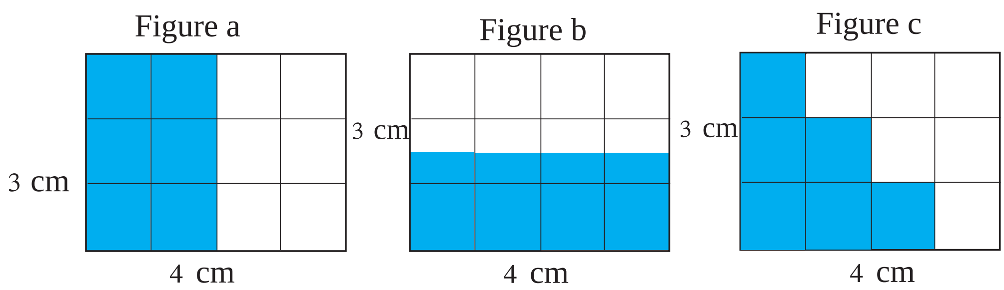
(3) The perimeter of each figure below is 24 cm. Find the values of a, x and b.



(4) (i) Find the perimeter of a square shaped plot of land of side length 50 m.

(ii) Find the total length of five strands of wire needed to build a fence around the above plot of land.

(5) Three rectangular shaped laminas are shown in the following figure. Each of them are of length 4 cm and width 3 cm. One half of each of these laminas is shaded.



(i) Find the perimeter of a rectangle of length 4 cm and width 3 cm

(ii) Find the perimeter of the shaded region of Figure a.

(iii) Find the perimeter of the shaded region of Figure b.

(iv) Find the perimeter of the shaded region of Figure c.

(v) If a rectangular sheet of paper is divided into two equal parts, will the perimeter of one of these parts be equal to half the perimeter of the rectangle?

Summary

- 10 mm = 1 cm   100 cm = 1 m   1000 m = 1 km
- If a side of an equilateral triangle is a, then its perimeter is $3a$.
- If a side of a square is a, then its perimeter is $4a$.
- If the length a rectangle is l and its width is b, then its perimeter is $2l + 2b$. That is $2\,(l + b)$.

Ponder

There are four iron rods of length 85 cm, 1m 23 cm, 2 m 9 cm and 1 m 73 cm respectively. Find the length of the longest and the shortest rod that can be made by soldering three of these rods together. Assume that the lengths of the rods do not change when they are soldered together.

17 Area

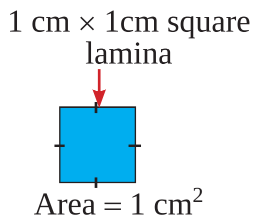
By studying this lesson you will be able to

- identify the units used to measure areas,
- find the areas of squares and rectangles using formulae,
- find areas of composite plane figures, and
- solve problems related to area

17.1 Area

You have learnt in grade 6 that the extent of a surface is called the area of that surface.

The area of a square lamina of side length 1 cm is used as the standard unit to measure areas. This is defined as one square centimetre and is denoted by 1 cm^2.



Two birthday cards are shown in the figure. The extent of the surface of each card is called the area of each picture.

(a)

(b)

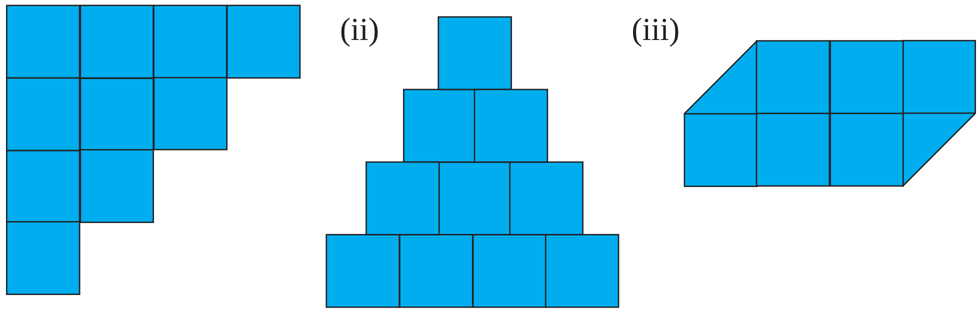
You can identify that the area of (b) is greater than the area of (a).

Do the following review exercise to recall the above facts which were learnt in Grade 6.

Review Exercise

(1) Considering the area of a small square to be 1 cm^2, find the area of each of the figures given below.

(i) (ii) (iii)

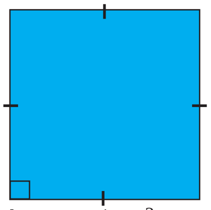


17.2 More on units used to measure areas

The unit 1 cm^2 is not sufficient to measure the areas of surfaces such as walls, parapet walls, the floor of a classroom and flower beds. Even the length measurements of such surfaces are obtained using metres and not centimetres.

Consider a square shaped portion of a floor of side length 1 m. It is too large to be drawn in a book. A reduced shape of such a surface is shown in the figure.

1 m ×1 m
square lamina



Area = 1 m^2

The area of a square lamina of side length 1 m is one square metre. This is denoted by 1 m^2.

The area of the square shaped portion of the floor shown in the figure is 1 m^2. Do the following activity to gain an understanding of the extent of a 1 m^2 surface area.

Activity 1

Step 1 - Get a few newspapers, a pair of scissors, a meter ruler or a measuring tape and some glue.

Step 2 - Paste the newspapers together appropriately and cut out a square lamina of side length 1 m.

Step 3 - Cut out another square lamina of side length 1 cm.

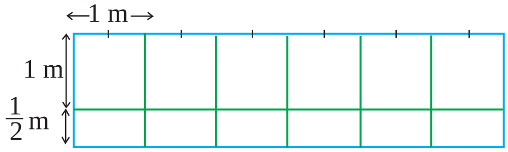
Step 4 - What is the area of each square lamina you cut out?

Step 5 - Can you easily identify how many times the area of the small square the area of the large square is?

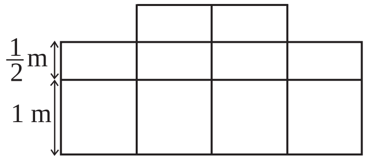
By doing the above activity you would have realized that a surface area of 1 m^2 is very large compared to a surface area of 1 cm^2.

Exercise 17.1

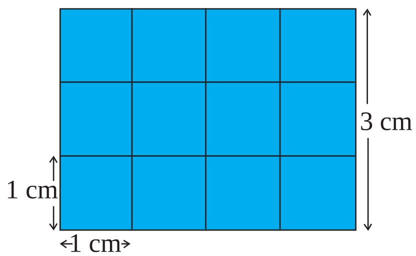
(1) The figure shows how the wall of a school has been divided into square shaped and rectangular shaped sections for paintings to be done on them. What is the total surface area allocated for paintings in square metres?



(2) What is the area of the figure shown here which is made out of equal sized squares and equal sized rectangles?



17.3 Formulae for the area of a square and the area of a rectangle



The rectangular lamina shown in the figure which is of length 4 cm and breadth 3 cm is divided into square laminas of side length 1 cm.

Since there are 12 small squares, the area of this rectangle is 12 cm^2. The length of this rectangle is 4 cm.

Number of squares in a row $= 4$

Number of rows $= 3$

$\therefore$ Total number of squares $= 4 \times 3$

$= 12$

$\therefore$ The area of the figure $= 12 \text{ cm}^2$

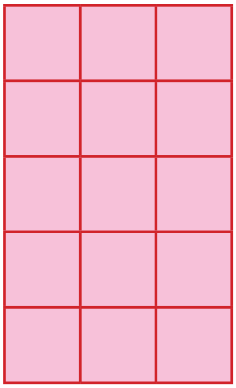
As the length of the rectangle is 4 cm and the breadth is 3 cm,

the area of the figure = (length $\times$ breadth) cm^2

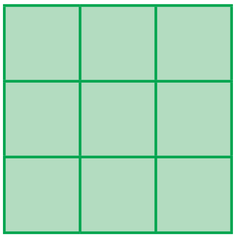
Based on the above explanation it is clear that the area of a rectangle can be found using its length and its breadth, without counting the squares of area 1cm^2. Do the following activity to establish this further.

Activity 2

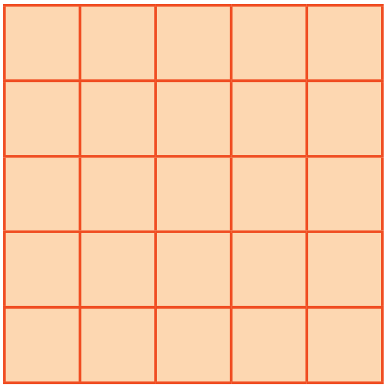
Consider the length of each side of a small square into which each of the shapes given below are divided, to be 1 cm. Copy and complete the table based on these shapes.



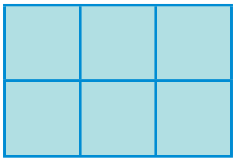
(a)



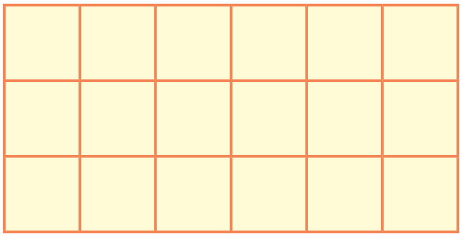
(b)



(c)



(d)



(e)

Figure	Number of squares in a row	Number of rows	Specific name of the figure	Total number of squares	Area	Area of the rectangle = length × breadth
a	3	5	Rectangle	$3 \times 5 = 15$	15 cm^2	3 cm × 5 cm = 15 cm^2
b	....	....	....	....	....	....
c	....	....	....	....	....	....
d	....	....	....	....	....	....
e	....	....	....	....	....	....

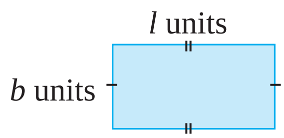
- **Formula for the area of a rectangle**

It is clear from this activity that the area of the rectangle obtained by counting the small squares can also be found using the length and the breadth of the rectangle.

Now let us obtain a formula for the area of a rectangle of length l units and breadth b units

The area of the rectangle = length × breadth

$\therefore$ The area of the rectangle = $l \times b$ square units

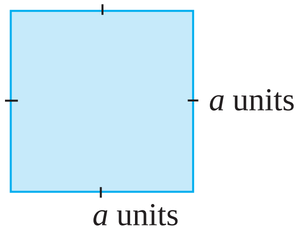


If the area of a rectangle of length l units and breadth b units is A square units, then $A = lb$.

- **Formula for the area of a square**

Let us similarly, obtain a formula for the area of a square.

$$\begin{aligned} \text{The area of the square} &= \text{length} \times \text{breadth} \\ &= a \times a = a^2 \\ \therefore \text{The area of the square} &= a^2 \text{ square units} \end{aligned}$$



If the area of a square of side length a units is A square units, then $A = a^2$

Example 1

Find the area of the rectangular wall hanging of length 12 cm and breadth 5 cm.

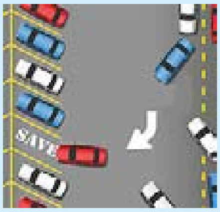
$\left.\begin{array}{r}\text{The area of a rectangle of length } l \text{ and} \\ \text{breadth } b\end{array}\right\} = lb$

$\therefore$ The area of the wall hanging $= 12 \times 5 \text{ cm}^2$

$= 60 \text{ cm}^2$

Example 2

The length of a side of a square shaped car park is 30 m. Find the area of the park.



The area of a square of side length $a = a^2$

$\left.\begin{array}{r}\therefore\text{The area of the car park of side length} \\ 30 \text{ m}\end{array}\right\} = 30 \times 30 \text{ m}^2$

$= 900 \text{ m}^2$

Example 3

The breadth of a rectangular plot of land of area equal to the area of another rectangular plot of land of length 12 m and breadth 3 m, is 4 m. Find the length of this plot of land.

The area of a rectangle of length l and breadth $b = lb$

$\left.\begin{array}{r}\text{The area of the rectangular plot of land of length} \\ 12 \text{ m and breadth } 3 \text{ m}\end{array}\right\} = 12 \times 3 \text{ m}^2$

$= 36 \text{ m}^2$

The length of the plot of land of breadth 4 m $= 36 \div 4$ m

$= 9$ m

Let us take the length of the rectangular plot of land as l.

$A = lb$

$36 = l \times 4$

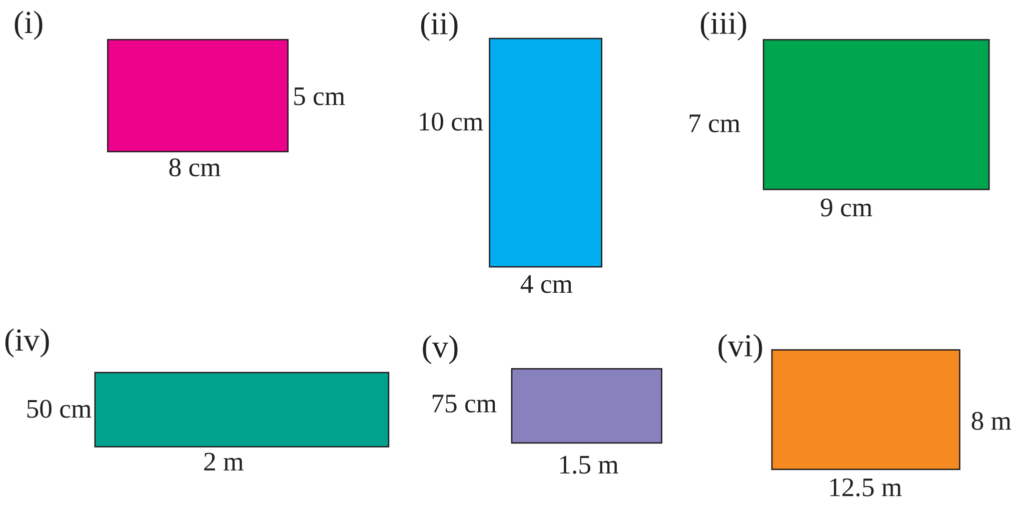
$4l = 36$

$l = \frac{36}{4} \text{ m} = 9 \text{ m}$

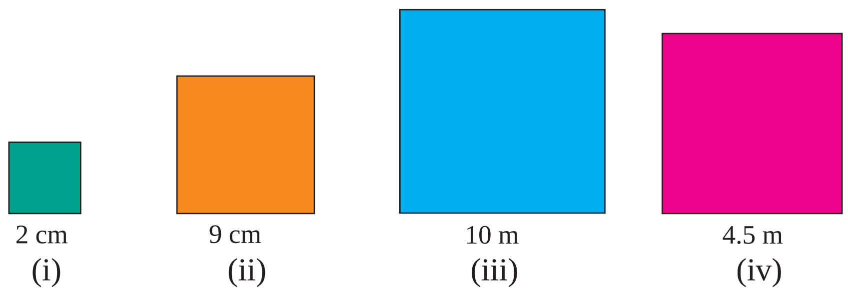
$\therefore$ the length of the plot of land is 9 m.

Exercise 17.2

(1) Find the area of each of the rectangular laminas given below.



(2) Find the area of each of the square laminas given below.



(3) The length of a rectangular plot of land is 9 m and its breadth is 4 m.

(i) Find the area of this plot of land.

(ii) Draw figures of two other plane shapes of the same area and mark the dimensions on the figure.

(4) The floor of a classroom takes the shape of a square of side length 10 m.

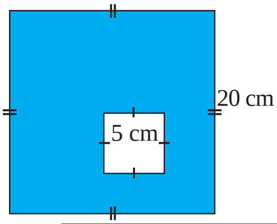
(i) Find the area of the floor of the classroom.

(ii) Another classroom which has the same area as the above classroom has a rectangular floor. If the breadth of the floor of this classroom is 5 m, find the length of the floor.

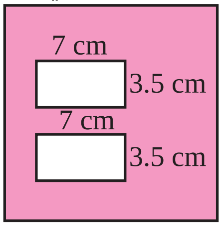
(5) The area of a flower bed is 36 m^2. An incomplete table containing the dimensions of several flower beds of the same area is given below. Copy and complete the table.

Length (m)	Breadth (m)	Area (m^2)	Shape of the flower bed	Perimeter of the flower bed
9	....	36	Rectangle	....
18	....	36	....	....
12	....	36	....	....
6	....	36	....	....

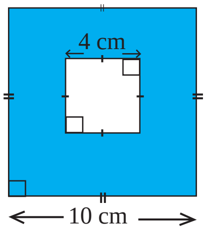
(6) The figure shows a shaded square shaped lamina of side length 20 cm within which a square shaped lamina of side length 5 cm has been shaded white. Find the area of the region shaded in blue in the figure.

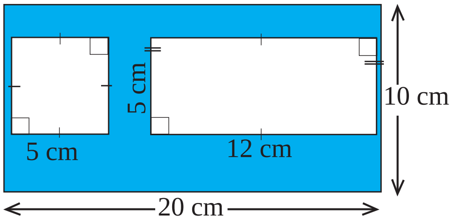


(7) Two rectangular shaped parts of length 7 cm and breadth 3.5 cm have been shaded in white in the square shaped piece of paper in the figure of area 616 cm^2. Find the area of the region shaded in pink.



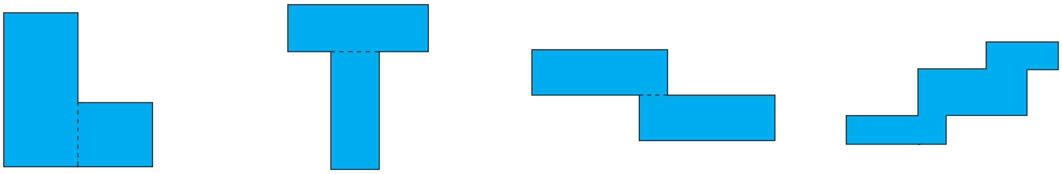
(8) Find the area of the shaded region in each of the following figures.





17.4 Areas of composite plane figures

Composite plane figures that can be divided into several rectangles are shown here.



Activity 3

Step 1 - From coloured paper, cut out the following shapes with the given dimensions.

- 3 rectangles of length 5 cm and breadth 4 cm
- 3 rectangles of length 6 cm and breadth 3 cm
- 3 rectangles of length 4 cm and breadth 1 cm
- 3 squares of side length 2 cm
- 3 squares of side length 3 cm

Step 2 - Find the area of each of the above plane figures and write it on the lamina.

Step 3 - Prepare 3 composite figures using 2 different laminas at a time and paste them in your exercise book.

Step 4 - Prepare another 3 composite figures using 3 different shapes at a time and paste them in your exercise book as well.

Step 5 - Find the areas of the pasted composite plane figures by considering the areas of the rectangles and squares prepared at the beginning of the activity, and write them next to the relevant composite figure.

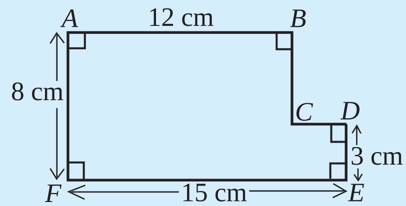
Step 6 - Write down the procedure of finding the area of a composite figure.

Based on the above activity, the procedure of finding the area of a composite plane figure can be expressed in 3 steps.

- Divide the composite figure into sections which are squares and of rectangles of which the area can be found.
- Find the area of each divided section.
- Find the sum of the areas.

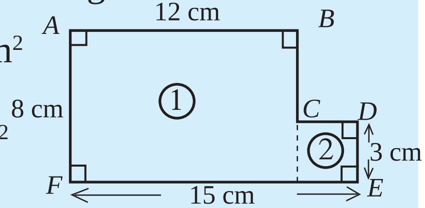
Example 1

Find the area of the figure *ABCDEF* based on the given measurements.



Method I

This figure can be divided into two sections as a rectangle of length 12 cm and breadth 8 cm and a square of side length 3 cm.



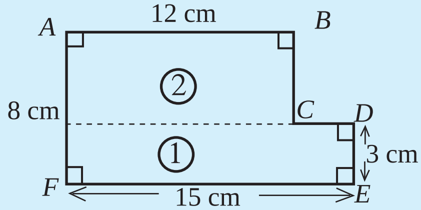
The area of rectangle 1 $= 12 \times 8\ \text{cm}^2$
$= 96\ \text{cm}^2$

The area of square 2 $= 3 \times 3\ \text{cm}^2$
$= 9\ \text{cm}^2$

$\therefore$ The area of the whole figure $= (96 + 9)\ \text{cm}^2$
$= 105\ \text{cm}^2$

Method II

The area of the above figure can also be found by dividing it into two rectangles, where one is of length 15 cm and breadth 3 cm and the other is of length 12 cm and breadth 5 cm.



The area of rectangle 1 $= 15 \times 3\ \text{cm}^2$
$= 45\ \text{cm}^2$

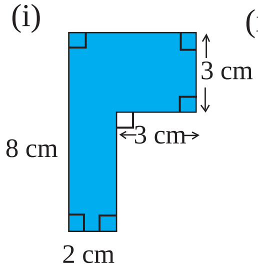
The area of rectangle 2 $= 12 \times 5\ \text{cm}^2$
$= 60\ \text{cm}^2$

$\therefore$ The area of the whole figure $= 45 + 60\ \text{cm}^2$
$= 105\ \text{cm}^2$

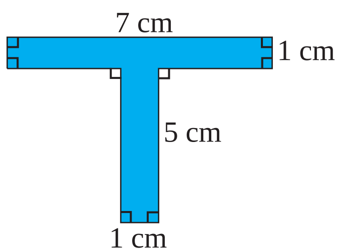
Exercise 17.3

(1) Several composite figures that can be separated into rectangles are shown here. Copy the given figures in your exercise book and find the area of each figure.

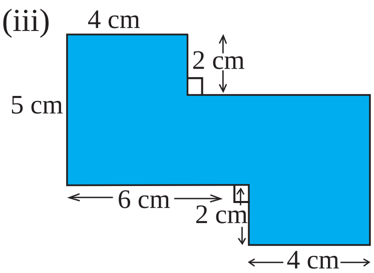
(i)



(ii)



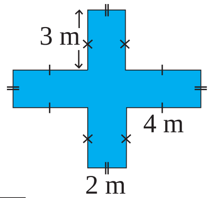
(iii)



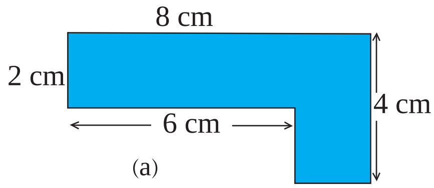
(2) Find the

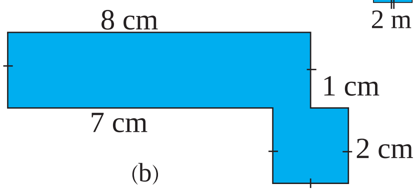
(i) area and

(ii) perimeter of the given figure.



(3)





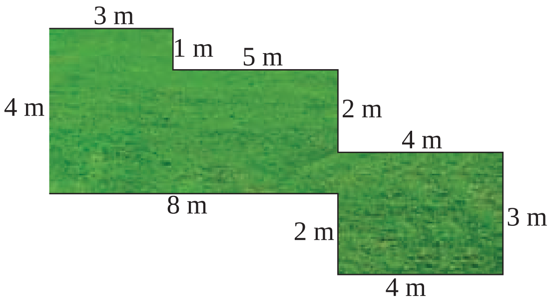
(i) Find the area of figure (a) and figure (b) separately.

(ii) Is the area of figure (a) equal to the area of figure (b)?

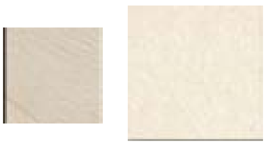
(iii) Find the perimeter of figure (a) and figure (b) separately.

(iv) Is the perimeter of figure (a) equal to the perimeter of figure (b)?

(4) Find the area of the plot of land given in the figure.



(5) It is proposed to lay tiles on a rectangular floor of length 6 m and breadth $4\frac{1}{2}$ m. It is required to select a suitable tile from a square tile of side length 30 cm and a square tile of side length 40 cm. The tiles are to be laid such that the edges of the tiles are parallel to the walls.

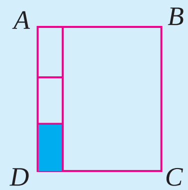


(i) Write down which tile you will select to avoid any wastage. Explain the reason for your selection.

(ii) Find the number of tiles that are required based on your selection.

17.5 Estimation of the areas of plane figures

Example 1



The area of the shaded region in the figure is 6 cm^2. Estimate the area of the rectangle *ABCD*.

Area of a thin strip = 6×3 cm^2 = 18 cm^2

There are about 5 thin strips.

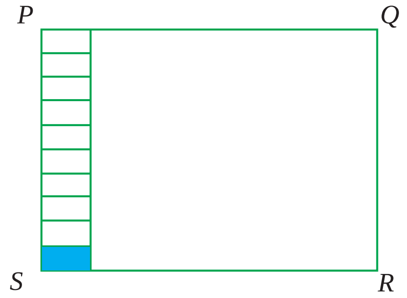
The area of 5 strips $= 18 \times 5 \text{ cm}^2$

$= 90 \text{ cm}^2$

$\therefore$ The area of the rectangle $ABCD$ is approximately $= 90 \text{ cm}^2$

Exercise 17.4

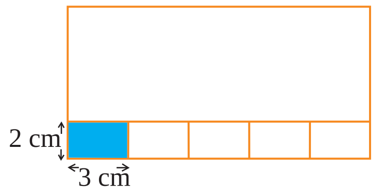
(1) $PQRS$ is a rectangle. The area of the shaded region in the figure is 120 cm^2. Find an approximate value for the area of the rectangular lamina $PQRS$.



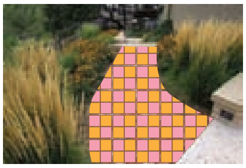
(2) Based on the information given in the figure,

(i) find the area of the shaded region.

(ii) estimate the area of the whole figure.



(3) It is required to lay concrete bricks along a straight road of breadth 4 m to a distance of 100 m. The top surface of a concrete brick is square shaped of side length 40 cm. Estimate the minimum number of concrete bricks required to pave the whole road.



Summary

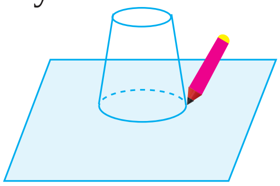
- Square centimetre (cm^2) and square metre (m^2) are two units used to measure areas.
- The area of a rectangle of length l units and breadth b units is lb square units.
- The area of a square of side length a units is a^2 square units.

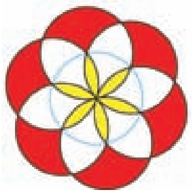
18 Circles

By studying this lesson you will be able to
- draw circles by handling a pair of compasses accurately,
- identify what the centre, radius and diameter of a circle are, and
- create circle designs using a pair of compasses.

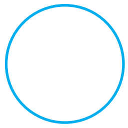
18.1 Drawing Circles

You are already capable of drawing circles and creating circle designs using different objects with circular shapes. Observe the figures given below to recall what you have learnt earlier on this subject.

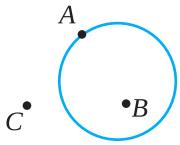




A figure drawn using a tumbler is shown here. You have learnt that the entire curved line of the figure is called a circle.



In this figure, A is a point on the circle, B is a point inside the circle and C is a point outside the circle.



When circles are drawn using various objects, the size of each circle drawn depends on the size of the circular shape of the object used to draw the circle. Therefore the above method is not suitable to draw a circle of the size of your choice. Let us investigate other methods of drawing circles without using objects with circular shapes. Let us do Activity 1.

Activity 1

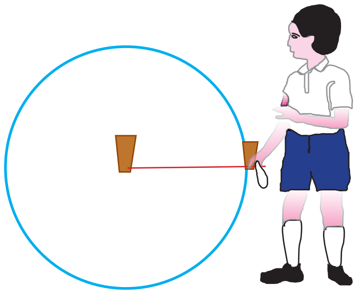
Get two sticks and a thread.

Step 1 - Fix one stick in the middle of a flat sandy land and tie a thread of a particular length to the stick as shown in the figure.

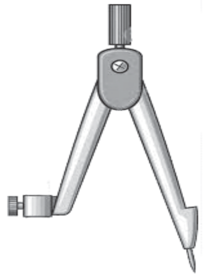
Step 2 - Tie the other end of the thread to another stick.

Step 3 - Mark a curved line on the sand by keeping one end of the second stick in contact with the sandy land while moving right around the stick fixed in the middle of the flat land, ensuring that the thread is tightly stretched at all times.

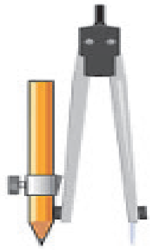
Step 4 - Repeat the above activity several times using threads of different lengths.



You will realize that the size of the circle depends on the length of the thread that is used.



There is a tool called "**a pair of compasses**" in the mathematical instruments box which can be used instead of the two sticks and the piece of thread, to do the above activity. Different lengths can be obtained using a pair of compasses, as was achieved above by using pieces of thread of different lengths.



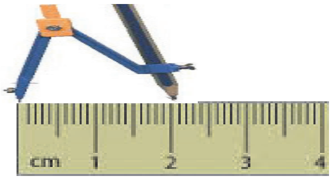
Now let us do the above activity using the pair of compasses. When you are preparing the pair of compasses, it is convenient to use a short pencil. The pencil should be fixed such that the point of the pencil and the point of the pair of compasses are at the same level when the pair of compasses is fully compressed.

Activity 2

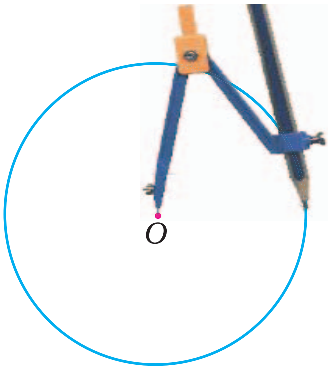
Get a pair of compasses with a correctly fixed pencil, a ruler and a white paper.

Step 1 - Mark a point called O towards the centre of the white paper.

Step 2 - Adjust the pair of compasses such that the distance between the pencil point and the point of the pair of compasses is 2 cm.



Step 3 - Keep the point of the pair of compasses fixed at O and draw a curved line on the piece of paper by moving the pencil point one whole round about the point O, while ensuring that the distance between the pencil point and the point of the pair of compasses remains unchanged. You will see that a circle is drawn around point O.



Step 4 - Construct several other circles by changing the distance between the point of the pair of compasses and the pencil point.

Exercise 18.1

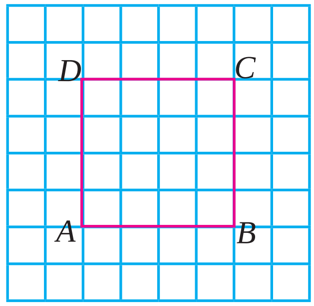
(1) Draw a circle by keeping a distance of 4 cm between the point of the pair of compasses and the pencil point.

(2) Mark a point O on a clean sheet of paper. Keep the point of the pair of compasses on point O and draw 3 circles by changing the distance between the point of the pair of compasses and the pencil point.

(3) (i) Draw a straight line segment AB of length 3 cm.

(ii) Keep the point of the pair of compasses at point A and extend it until the pencil point reaches point B. Now draw the circle which goes around point A.

(iii) Keep the point of the pair of compasses on point *B* and extend it until the pencil point reaches point *A*. Now draw the circle which goes around point *B*.

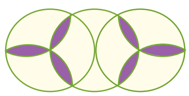


(4) (i) Draw a square *ABCD* in your square ruled exercise book by taking the length of 4 squares of your exercise book as the length of a side of the square.

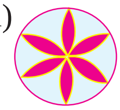
(ii) Take the distance between the point of the pair of compasses and the pencil point to be the length of 2 squares of your exercise book and draw 4 circles around the points *A*, *B*, *C* and *D*.

(5) Several circle designs created by using a pair of compasses and a pencil are shown below. Create these designs or some other circle designs using a pair of compasses and a pencil.

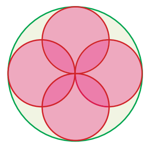
(i)



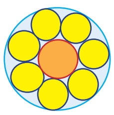
(ii)



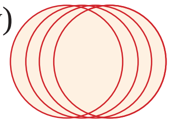
(iii)



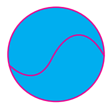
(iv)



(v)



(vi)

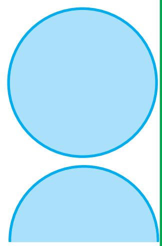


(6) Create a design suitable for a wall hanging by drawing circles using a pair of compasses and a pencil.

18.2 Centre, radius and diameter of a circle

• The centre of a circle

Activity 3



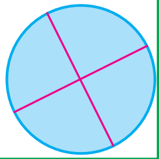
Step 1 - Draw a circle on a piece of paper using a pair of compasses and a pencil.

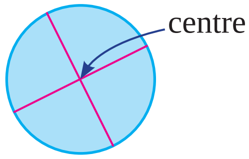
Step 2 - Cut along the circle and separate out the circular lamina.

Step 3 - Fold the circular lamina into two equal parts.

Step 4 - Open out the folded lamina and fold it again into two equal parts along another line.

Step 5 - Open out the folded lamina again and mark the fold lines in a dark colour using a ruler.





Observe how the two fold lines intersect each other. You will notice that the point of intersection of the fold lines and the point at which the point of the pair of compasses was kept while drawing the circle are the same. This point is called the **centre** of the circle.

• The radius of a circle

Activity 4

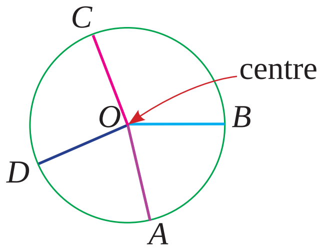
Step 1 - Draw a circle on a piece of paper using a pair of compasses and a pencil.

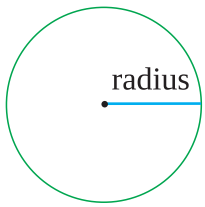
Step 2 - Mark the centre of the circle as O.

Step 3 - Mark several points on the circle and name them as A, B, C and D.

Step 4 - Join each of these points to the centre.

Step 5 - Using a ruler, measure the lengths of the straight line segments that were obtained in step 4.





You will notice that the lengths of these straight line segments are all equal to each other and identical to the distance between the points of the pair of compasses and the pencil that was used to draw the circle. Accordingly, the distance from the center of a circle to any point on the circle is the same constant value.

The straight line segment joining the center of a circle to a point on the circle is called **a radius** of the circle. The term ‘radius’ is also used for the length of the radius.

• The diameter of a circle

Activity 5

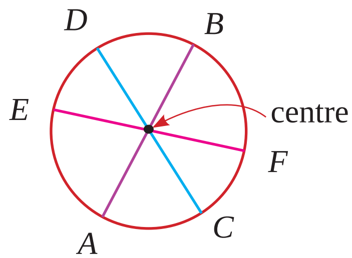
Step 1 - Draw a circle on a piece of paper using a pair of compasses and a pencil.

Step 2 - Mark the centre of the circle as O.

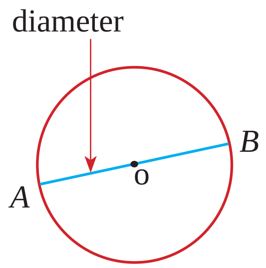
Step 3 - Draw a straight line segment through the point O using the ruler, and name the intersecting points of the straight line segment and the circle as A and B.

Step 4 - Measure the length of the straight line segment AB using the ruler.

Step 5 - Draw several such straight line segments by changing the position of the ruler. Observe that the lengths of all these straight line segments are equal.



A straight line segment joining two points on a circle, which passes through the centre of the circle, is called **a diameter** of the circle. The term ‘diameter’ is also used for the length of a diameter.



According to this figure, AB is a diameter and OA and OB are radii of the circle.

$AB = OA + OB$

Further, $OA = OB$ (radii of the circle)

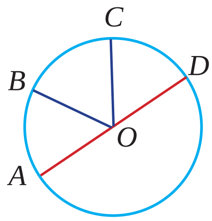
$AB = OA + OA$

That is, $AB = 2\,OA$

The diameter of a circle is twice its radius.

Exercise 18.2

(1) Do the following for the circle shown in the figure.



(i) Name the centre of the circle.

(ii) Name the radii.

(iii) Name a diameter.

(2) (i) Draw a circle of radius 4 cm.

(ii) Name the centre of the circle as O and a point on the circle as X.

(iii) Produce XO until it meets the circle again at Y.

(iv) Write down the name used to define XY. Measure the length of XY and write it down.

(3) Draw a straight line segment AB such that $AB = 3$ cm. Draw two circles of radius 3 cm each, taking the points A and B as the two centres.

(i) Name the points of intersection of the two circles as P and Q.

(ii) Measure the lengths of AP and BP.

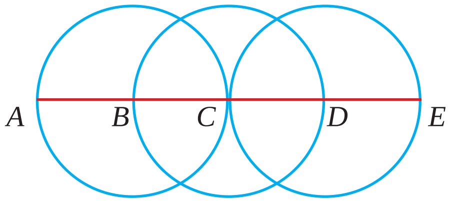
(iii) Join PA and produce it until it meets the circle with centre A again at R.

(iv) What name is used to define the straight line segment PR?

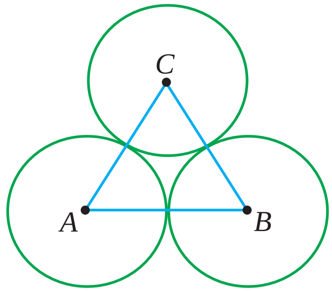
(4) B, C and D are the centres of the circles shown in the figure. The radii of all three circles are equal. Here $AE = 10$ cm.

(i) Find the length of AC.

(ii) Find the radius of each circle.



(5) ABC is an equilateral triangle. The perimeter of the triangle ABC is 12 cm. Three circles of equal radii and centres A, B and C respectively have been drawn as shown in the figure.



(i) Calculate the length of the side AC.

(ii) Calculate the radius of the circle with centre A.

(iii) Calculate the diameter of the circle with centre B.

(6) (i) Draw a circle of radius 3 cm. Name its centre O.

(ii) Mark a point on the circle and name it A.

(iii) Draw a circle of radius 3 cm with A as its centre. Mark one of the intersecting points of this circle and the first circle as B.

(iv) Draw a circle of radius 3 cm with B as the centre.

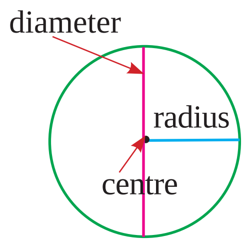
(v) Similarly, draw another 4 circles such that the centres of these circles all lie on the first circle and the radius of each circle is 3 cm.

(vi) Do all the circles with centres that lie on the first circle pass through O?

(7) (i) Draw a straight line segment AB of length 4 cm. Draw a circle such that AB is a diameter.

(ii) Draw two circles having A and B as their centres and AB the radius of each circle.

Summary



- A straight line segment joining the centre of a circle to a point on the circle is called a radius of the circle.
- A straight line segment joining two points on a circle, which passes through the centre of the circle, is called a diameter of the circle.
- The diameter of a circle is twice its radius.

Ponder

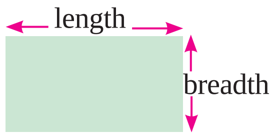
(1) Get a rectangular piece of paper and draw the largest possible circle that can be drawn on that piece of paper using a pair of compasses.

Volume

By studying this lesson you will be able to

- identify what volume means,
- identify the different units used to measure volume, and
- find the volume of a cube and a cuboid.

19.1 Identifying what volume means



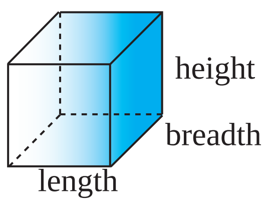
You have learnt that area is the extent of a plane surface.
Now let us see what volume is.

Let us consider the following objects.

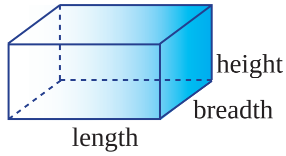
Each of the above objects occupies a certain amount of space. This space is called the **volume** of the object.

Now let us consider a cube and a cuboid.

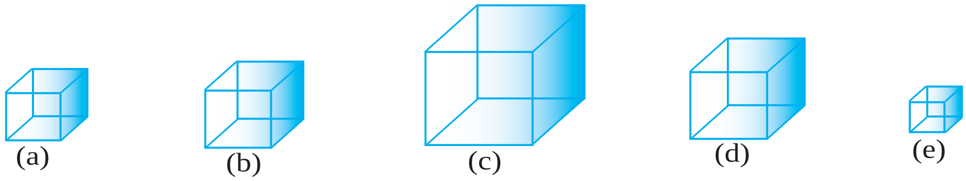
A cube consists of 6 equal square shaped faces. It has 12 edges of equal length. As shown in the figure, the length, breadth and height of a cube are equal.



A cuboid consists of three pairs of rectangular plane surfaces; each pair being equal. It has three sets of 4 edges of equal length; totalling 12 edges. As shown in the figure, the length, breadth and height can be different to each other.



The following figure depicts five cubes.



When these cubes are arranged in ascending order of their volumes we obtain *e*, *a*, *b*, *d*, *c*.

Activity 1

Step 1 - Collect at least 4 solid cube or cuboid shaped objects.

Step 2 - See whether you can arrange them in increasing order of their volumes.

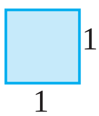
Step 3 - Inquire from your teacher whether the order in which you arranged the objects is correct.

19.2 Measuring the volume of solid objects using arbitrary units

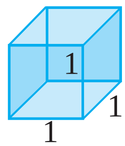
By comparing the amount of space occupied by a die with the amount of space occupied by a brick, we can easily say that the volume of the brick is greater than the volume of the die.

However, it is difficult to compare the volumes of objects such as statues and logs which are of different shapes by just observing them. Therefore let us consider the units that are used to measure volumes.

A straight line segment of length 1 unit



A square of area 1 square unit

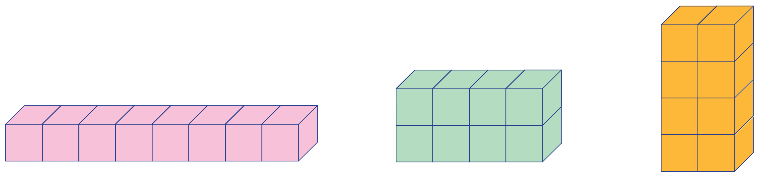


A cube of volume 1 cubic unit

The unit to measure area is 1 square unit which is the area of a square of side length 1 unit.

The unit to measure volume is 1 cubic unit which is the volume of a cube of side length 1 unit.

The following figure depicts a few cuboids that have been created using 8 identical cubes. Now let us find the volume of each of these cuboids.



(a) (b) (c)

Let us take the volume of a small cube to be 1 cubic unit. Then,

since there are 8 cubes in figure (a), the volume of the cuboid in figure (a) is 8 cubic units,

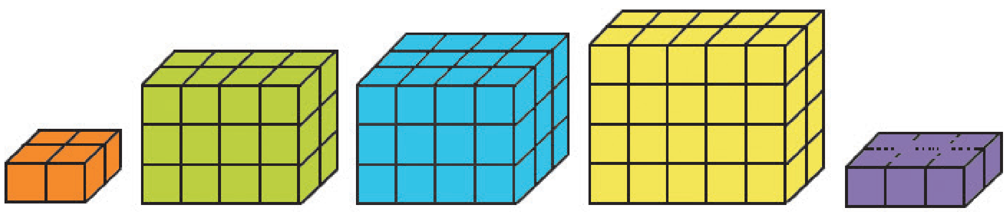
since there are 8 cubes in figure (b), the volume of the cuboid in figure (b) is 8 cubic units, and

since there are 8 cubes in figure (c), the volume of the cuboid in figure (c) is 8 cubic units.

Although the length, breadth and height of these cuboids take different values, their volumes are all equal.

Exercise 19.1

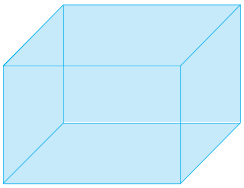
(1) Find the volume of each of the solid objects in the given figure by counting the number of small cubes each object contains. Consider the volume of a small cube to be 1 cubic unit.

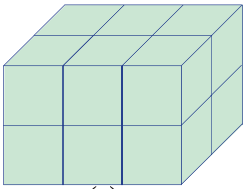


(a) (b) (c) (d) (e)

• More on measuring the volume of solid objects using arbitrary units

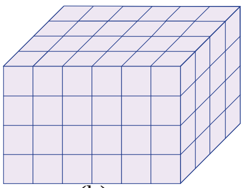
Consider how the volume of the cuboid shown below has been found.





(a)

Here the cuboid has been divided into 12 smaller cubes of side length 1 unit. Let us take the volume of one small cube to be 1 cubic unit. Then the volume of the cuboid is 12 cubic units.



(b)

Here the cuboid has been divided into 96 small cubes of side length 1 unit. Let us take the volume of one small cube to be 1 cubic unit. Then the volume of this cuboid is 96 cubic units.

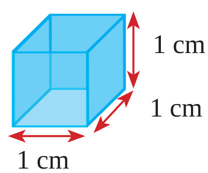
Understand that the volume of the small cube that we used as our unit to measure volume is different in the above two cases. Accordingly, two different numerical values were obtained for the volume of the cuboid.

As indicated above, an arbitrary unit can be used to measure the volume of a solid object. It is important to mention the unit that was used when writing the volume of an object, as the numerical value depends on the unit used, as seen above.

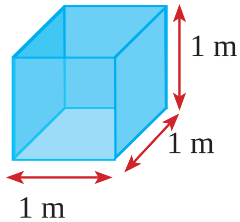
19.3 Standard units used to measure volume

We obtained different numerical values for the volume of a solid object, which depended on the unit that was used. To avoid this variance, standard units are used to measure volumes.

The volume of a cube of side length 1 cm is used as the standard unit of volume. It is defined as 1 cubic centimetre and written as 1 cm^3.

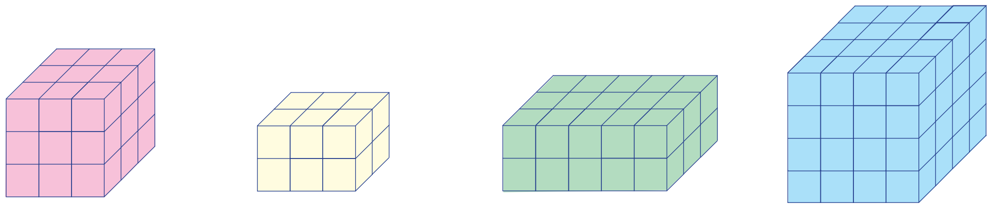


The volume of a cube of side length 1 metre is used as the unit to measure larger volumes. Its volume is 1 cubic metre. One cubic metre is written as 1 m^3.



Exercise 19.2

(1) Find the volume of each of the following solid objects in cubic centimetres. Consider the volume of a small cube to be 1 cm^3.



(a) (b) (c) (d)

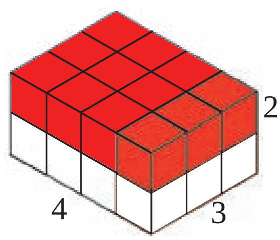
19.4 Another method of finding the volume of a cube or a cuboid

Let us consider an easier method of finding the volume of a cube and a cuboid.

- **The volume of a cuboid**

A cuboid of length 4 units, breadth 3 units and height 2 units is shown here.

The portion highlighted in red consists of 12 cubes of volume 1 cubic unit each.

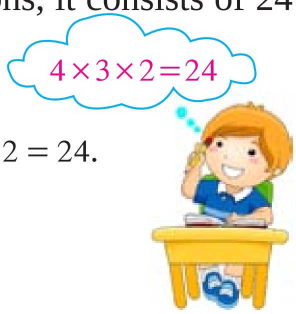


$4 \times 3 = 12$

Since the whole cuboid consists of two such portions, it consists of 24 cubes of volume 1 cubic unit each.

$12 \times 2 = 24$

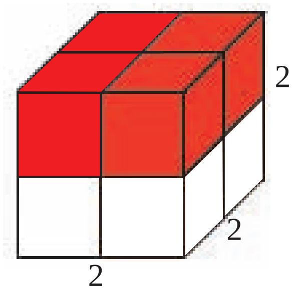
Therefore, the volume of the whole cuboid $= 4 \times 3 \times 2 = 24$.



Volume of a cuboid = length × breadth × height

• The volume of a cube

A cube of side length 2 units is shown here.



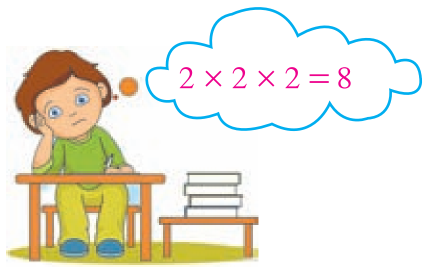
The portion highlighted in red consists of 4 cubes of volume 1 cubic unit each.

$2 \times 2 = 4$

Since the whole cube consists of two such portions, it consists of 8 cubes of volume 1 cubic unit each.

$4 \times 2 = 8$

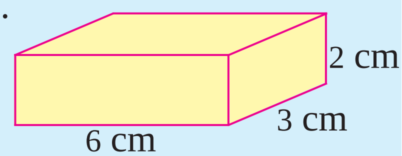
Therefore,
the volume of the whole cube of side length 2 units $= 2 \times 2 \times 2 = 8$



Volume of the cube = length × breadth × height
= side length × side length × side length
= $(\text{side length})^3$

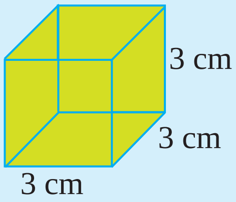
Example 1

Find the volume of the cuboid in the figure.



Length of the cuboid = 6 cm
Breadth of the cuboid = 3 cm
Height of the cuboid = 2 cm
Volume of the cuboid = length × breadth × height
= 6 cm × 3 cm × 2 cm
= 36 cm^3

Example 2

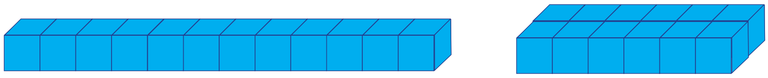


Find the volume of the cube in the figure.

Volume of the cube = length × breadth × height
= 3 cm × 3 cm × 3 cm
= 27 cm^3

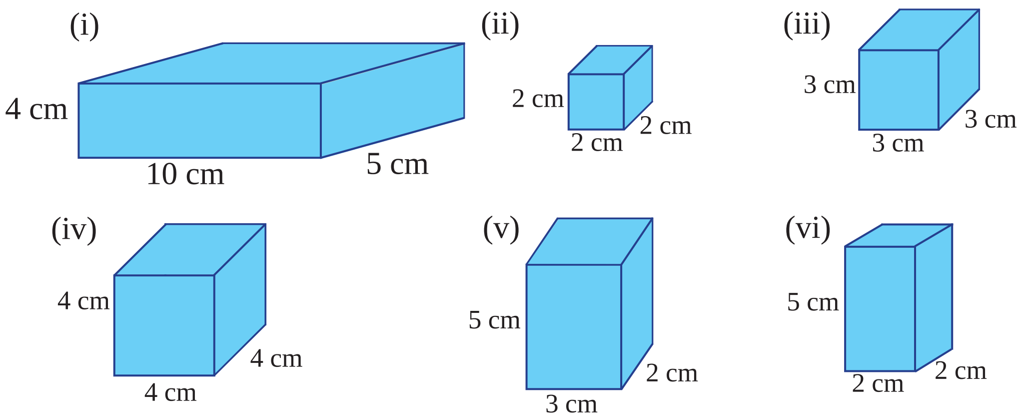
Exercise 19.3

(1) The following figure depicts two cuboids that have been formed using 12 cubes of volume 1 cm^3 each.



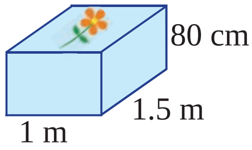
(i) Find the volume of each cuboid.
(ii) Find the length, breadth and height of each cuboid.
(iii) Write the length, breadth and height of another cuboid of volume 12 cm^3.

(2) Calculate the volume of each of the following solids.



(3) The volume of a cuboid shaped box is 60 cm^3. The length and breadth of the box are respectively 6 cm and 2 cm. Calculate its height.

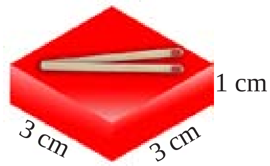
(4) The length, breadth and height of a cuboid shaped container are 1.5 m, 1 m and 80 cm respectively.



(i) Find the height of the container in centimetres.

(ii) Find the volume of the container in cubic centimetres.

(5) The figure shows a matchbox of length, breadth and height equal to 3 cm, 3 cm and 1 cm respectively.



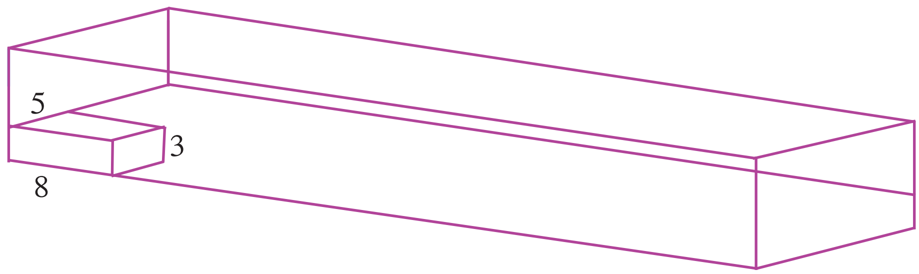
(i) Find the volume of this matchbox.

(ii) There are three layers, each consisting of 4 matchboxes in a package containing 12 of these matchboxes. Find the length, breadth and height of this package.

(iii) Show that the volume of this package is 108 cm^3.

19.5 Estimation of Volume

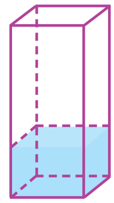
The length, breadth and height of a cake of soap are 8 cm, 5 cm and 3 cm respectively. The maximum number of cakes of soap that can be packed in the given box is 92. Estimate the volume of the box.



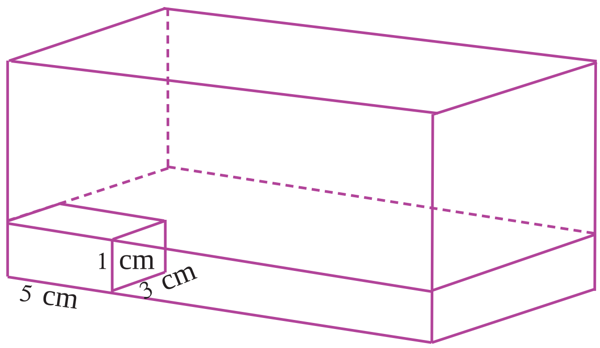
The volume of a cake of soap is approximately $8 \times 5 \times 3$ cm^3; that is, 120 cm^3. Therefore, the volume of the box is approximately 120×92 cm^3, that is, 11 040 cm^3.

Exercise 19.4

(1) The volume of the shaded cuboid portion in the figure is 16 cm^3. Estimate the volume of the whole cuboid.



(2) The length, breadth and height of a matchbox are 5 cm, 3 cm and 1 cm respectively. Matchboxes are packed in the box as shown in the figure. Estimate the volume of the box.



Summary

- The volume of a solid is the amount of space it occupies.
- Arbitrary units can be used to measure volumes. When stating the volume, the units used should also be mentioned.
- A cube of side length 1 cm is used as the standard unit of volume.
- Cubic centimetre (cm^3) and cubic metre (m^3) are two units that are used to measure volumes.
- The volume of a cuboid of length, breadth and height equal to a, b and c units respectively is $a \times b \times c$ cubic units.
- The volume of a cube of side length a units = a^3 cubic units.

20 Liquid Measurements

By studying this lesson you will be able to

- multiply liquid quantities expressed in millilitres and litres by a whole number and
- divide liquid quantities expressed in millilitres and litres by a whole number.

20.1 Units used to measure liquid quantities

There are occasions when you have to purchase liquid types such as milk, coconut oil and syrups. You have already learnt in grade 6, that millilitre and litre are two units that are used to measure liquid quantities. A quantity of one litre of a liquid is equal to a quantity of 1000 millilitres of that liquid.

$$1\ l = 1000\ \text{ml}$$

To express a liquid quantity in millilitres, which is given in litres, the quantity given in litres should be multiplied by 1000.

To express a liquid quantity in litres, which is given in millilitres, the quantity given in millilitres should be divided by 1000.

Do the following exercise to revise your grade 6 knowledge.

Review Exercise

(1) (i) Express 6 l in millilitres.

(ii) Express 7 l 300 ml in millilitres.

(iii) Express 3758 ml in litres and millilitres.

(iv) Express 10 065 ml in litres and millilitres.

(2) Simplify.

(i) l	ml	(ii) l	ml	(iii) l	ml	(iv) l	ml
7	250	3	50	6	50	3	45
+ 4	350	+ 7	975	– 3	875	– 2	165

(3) Find out how much of drink can be prepared by adding 1 l 250 ml of fruit juice to 2 l 650 ml of water, and express this amount in litres and millilitres.

(4) There was 10 l 750 ml of water in a bucket. Geetha watered plants with a quantity of 5 l 850 ml of water from the bucket. How much of water is remaining in the bucket now?

20.2 Multiplication of liquid quantities expressed in millilitres and litres by a whole number

➢ Binuli drinks a 200 ml glass of *kola kenda* daily. Let us find out how much *kola kenda* she drinks in 4 days.

Amount of *kola kenda* consumed per day = 200 ml
Amount of *kola kenda* consumed in 4 days = 200 ml × 4
= 800 ml

➢ 1 l 750 ml of fuel is required to operate a generator for one hour. Let us find the amount of fuel required to operate the generator for 3 hours.

Method I

1 l 750 ml = 1750 ml
1750 ml × 3 = 5250 ml
5250 ml = 5 l 250 ml

$$\begin{array}{r} \text{ml} \\ 1750 \\ \times \quad 3 \\ \hline 5250 \\ \hline\hline \end{array}$$

Method II

1 l 750 ml = 1.750 l
1.75 l × 3 = 5.25 l
5.25 l = 5 l 250 ml

$$\begin{array}{r} 1.75 \\ \times \quad 3 \\ \hline 5.25 \\ \hline\hline \end{array}$$

Method III

l	ml
1	750
$\times$	3
5	250

Let us multiply the 750 ml in the millilitres column by 3.

750 ml $\times$ 3 = 2250 ml

2250 ml = 2000 ml + 250 ml = 2 l 250 ml

Let us write 250 ml in the millilitres column and carry the 2 l to the litres column.

Let us multiply the amount of litres in the litres column by 3.

1 l $\times$ 3 = 3 l. Now let us add the 2 l we carried from the millilitres column.

3 l + 2 l = 5 l

Finally let us write 5 l in the litres column.

Exercise 20.1

(1) Multiply.

(i)

l	ml
4	25
$\times$	5

(ii)

l	ml
2	350
$\times$	4

(iii) 5 l 750 ml $\times$ 13

(iv) 8 l 575 ml $\times$ 15

(2) Multiply the liquid quantities given below by the given number and express the answer in litres and millilitres.

(i) 250 ml $\times$ 5 (ii) 515 ml $\times$ 7 (iii) 750 ml $\times$ 16

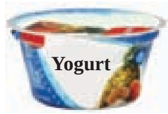
(3) A bottle contains 375 ml of drink. Express the total amount of drink in 6 such bottles in litres and millilitres.

(4) A cordial bottle contains 1 l 750 ml of cordial. How much of cordial is there in 6 such bottles?

(5) A house without electricity requires 1 l 650 ml of kerosene oil per day. Find the amount of kerosene oil required by that house for a week.

(6) 2 l 225 ml of diesel is required to operate a generator for one hour. Find the amount of diesel required to operate the generator for 8 hours.

(7) 50 ml of milk is used to produce one cup of yoghurt. Find the total amount of milk required to produce 150 such cups of yoghurt.



(8) A bucket used for bathing can be filled completely with 5 *l* 650 ml of water. If a person pours water from this bucket (completely filled) 60 times whenever he bathes, find how much of water he uses on each occasion that he bathes.

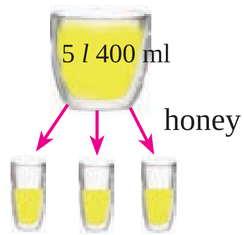
(9) A 540 *l* water tank is filled with water. Due to a crack in a pipe, water leaks out at a speed of 6 *l* 750 ml per minute.

(i) What is the total amount of water that leaks during 8 minutes?

(ii) Show that the tank will be empty if the leakage continues for 80 minutes.

20.3 Division of liquid quantities expressed in millilitres and litres by a whole number

➢ The total amount of honey collected from a honeycomb is 5 *l* 400 ml. If this amount is divided equally among 3 people, how much of honey will one person receive?



Amount of honey received by one person = 5 *l* 400 ml ÷ 3

Method I

5 *l* 400 ml = 5400 ml
5400 ml ÷ 3 = 1800 ml
5 *l* 400 ml ÷ 3 = 1800 ml
= 1 *l* 800 ml

$$\begin{array}{r|l} & \text{1800 ml} \\ \hline 3 & \text{5400 ml} \\ & \underline{3} \\ & 24 \\ & \underline{24} \\ & \quad 00 \\ & \quad \underline{00} \\ & \quad 00 \end{array}$$

Method II

$$
\begin{array}{r|rr}
 & l & \text{ml} \\
 & 1 & 800 \\ \cline{2-3}
3 & 5 & 400 \\
 & \underline{3} & \\
 & 2 \rightarrow & \underline{2000} \\
 & & 2400 \\
 & & \underline{2400} \\
 & & \underline{\underline{0000}}
\end{array}
$$

When 5 *l* is divided by 3, the remainder is 2 *l*.
When this remainder of 2 *l* is taken to the millilitres column, it is 2000 ml.

2 *l* = 2000 ml
When 2000 ml is added to 400 ml we get 2400 ml.
2400 ml ÷ 3 = 800 ml

One person receives 1 *l* 800 ml of honey.

Exercise 20.2

(1) Evaluate the following.

(i) 750 ml ÷ 3	(ii) 9 *l* 750 ml ÷ 3	(iii) 2 *l* 200 ml ÷ 5
(iv) 4 *l* 50 ml ÷ 3	(v) 18 *l* 900 ml ÷ 6	(vi) 13 *l* 50 ml ÷ 3

(2) The 45 000 litres of fuel in a bowser is issued in equal amounts to six filling stations. Find the amount issued to one filling station.

(3) 10 *l* 728 ml of milk is poured in equal quantities into 12 pots for curdling. Find how much of milk is poured into one pot.

(4) A motor vehicle requires 1 *l* 560 ml of fuel to travel a distance of 24 km. Find how much fuel it requires to travel a distance of 1 km.

(5) If 4 *l* 50 ml of a drink is poured equally into 9 glasses, how many milliliters of drink will one glass contain?

(6) A quantity of 1 *l* 950 ml of a perfume is put into 30 small bottles in equal amounts and issued to the market. What quantity of perfume is there in one bottle in millilitres?

(7) When the drink prepared by mixing 1.54 *l* of fruit juice with 1.7 *l* of water is poured in equal amounts into 12 tumblers, how many litres of drink will one tumbler contain?

(8) A soft drink manufacturing company produces 800 bottles of drink of regular size in a day. If the total amount of drink produced in a day is 300 *l*, how much drink is included in one bottle?

Miscellaneous Exercise

(1) An Ayurvedic syrup is issued to the market in 80 bottles containing 750 ml of syrup in a day.

- (i) Find the total volume of syrup issued in a day.
- (ii) A customer uses a bottle of syrup he purchased for 30 days. He drinks an equal amount twice a day.
  - (a) Find the amount of syrup he consumes in a day.
  - (b) Find the amount of syrup he consumes on each occasion.
- (iii) If the daily production of syrup is increased to 86 *l* 250 ml, how many bottles can be issued in a day?

(2) A motor vehicle can be driven 16 km on one litre of fuel. A person spends 1.5 *l* of fuel daily to go to office and return home.

- (i) Find the total distance travelled by the vehicle in a day.
- (ii) Find the amount of fuel required by him for 22 working days.
- (iii) If the total distance he travelled during a certain month is 480 km, find the total number of litres of fuel that was consumed during that month.

Summary

- 1 *l* = 1000 ml
- To express a liquid quantity in litres, which is given in millilitres, the quantity given in millilitres should be divided by 1000.
- To express a liquid quantity in millilitres, which is given in litres, the quantity given in litres should be multiplied by 1000.

Revision Exercise - 2

(1) (i) Find the value of 6.785×1000.

(ii) Simplify $3\frac{1}{3} - 1\frac{1}{4}$.

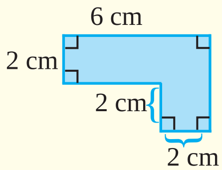
(iii) Find the value of $2a + 5$, if $a = 4$.

(iv) Express 5.075 g, in grammes and milligrammes.

(v) Solve $2x + 5 = 7$.

(vi) Simplify 96 cm 6 mm $\div 7$.

(vii) Find the area of the given figure.

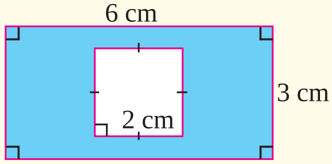


(viii) Find the volume of a cube of side length 5 cm.

(ix) Write $1\frac{5}{7}$ as an improper fraction.

(x) Write $\frac{17}{5}$ as a mixed number.

(xi) Find the area of the shaded region.



(xii) Find the side length of a square land of perimeter 22 m.

(xiii) Find the breadth of a rectangular land of area 24 m^2 and length 8 m.

(2) (a) Fill in the blanks using $<$ or $>$ appropriately.

(i) $\frac{3}{4}$ ..... $\frac{1}{4}$ (ii) $\frac{1}{4}$ ..... $\frac{5}{12}$ (iii) $3\frac{5}{8}$ ..... $3\frac{1}{3}$

(b) Simplify the following.

(i) $3\frac{5}{12} + \frac{7}{12}$ (ii) $2\frac{2}{7} + \frac{9}{14}$ (iii) $2\frac{5}{8} - 1\frac{1}{8}$ (iv) $3\frac{7}{8} - 2\frac{2}{3}$

(c) Dileepa and Sithumina sat for a multiple choice question paper. From the total number of questions, Dileepa answered $\frac{5}{8}$ correctly and Sithumina answered $\frac{3}{4}$ correctly. Who answered more questions correctly? Give reasons for your answer.

(d) In a test, Rahuman received 0.36 of the total marks and Rahuldev received $\frac{9}{25}$ of the total marks. Show that Rahuman and Rahuldev received the same amount of marks.

(3) (a) Convert the following fractions and mixed numbers into decimals.

(i) $\frac{648}{1000}$ (ii) $\frac{6}{20}$ (iii) $\frac{7}{8}$ (iv) $2\frac{1}{4}$

(b) Simplify.

(i) 0.875×100 (ii) 3.25×6 (iii) 0.005×22

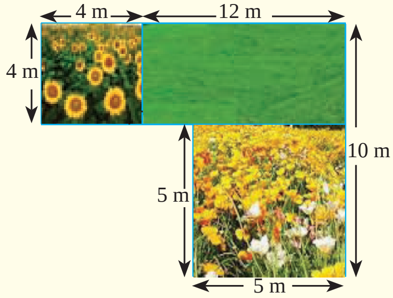
(iv) $127.5 \div 10$ (v) 24.68×8 (vi) $13.75 \div 1000$

(4) The given figure shows a home garden.

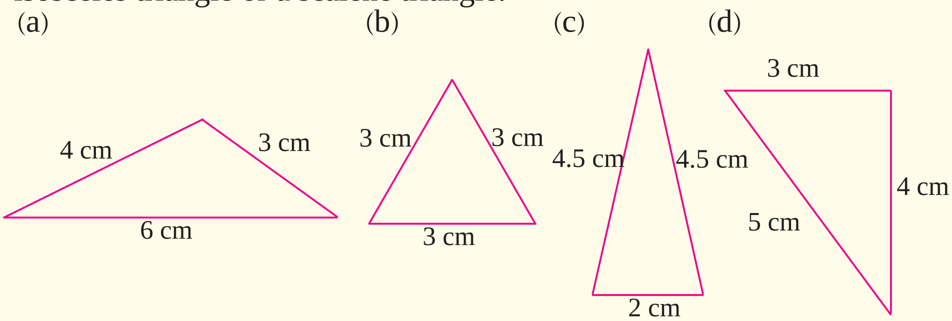
(i) Find the perimeter of the garden.

(ii) Find the area of the garden where flowers are grown.

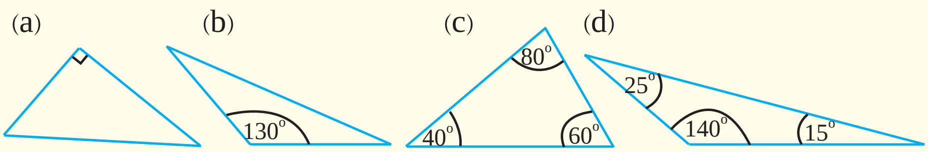
(iii) Find the total area of the garden.



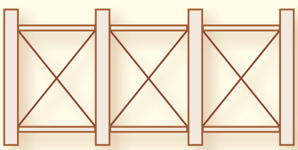
(5) (i) Each of the following triangles state whether it is an equilateral triangle, an isosceles triangle or a scalene triangle.



(ii) Each of the following triangles state whether it is an acute angled triangle, a right angled triangle or an obtuse angled triangle.



(6) The gate shown in the figure has 4 vertical posts. Each is of height 1.75 m.

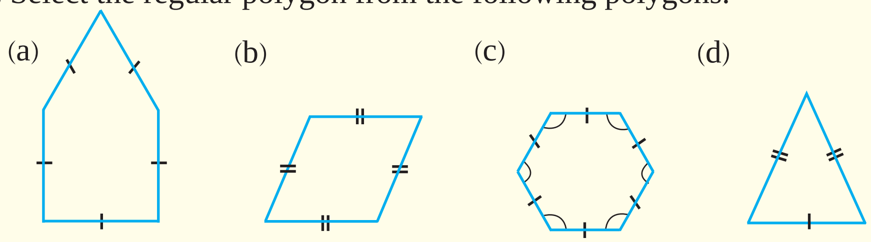


(i) If the posts are made from a metal pipe, find the total length of the pipe.

(ii) The total length of the metal bar used to cut the 6 horizontal bars was 8.4 m. Find the length of one horizontal bar.

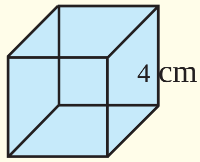
(7) (a) (i) Draw a concave polygon with 1 reflex angle and 6 sides.

(ii) Select the regular polygon from the following polygons.



(8) (a) (i) Find the volume of the given cube.

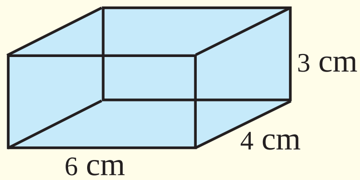
(ii) Calculate the volume of a cube of length twice the length of the above given cube.



(b) A cuboid is shown in the figure.

(i) Find the volume of this cuboid.

(ii) What is the height of a cuboid of volume 96 cm^3, if its length and breadth are the same as those of the cuboid shown in the figure?



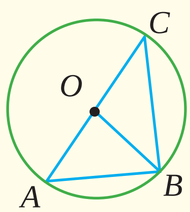
(9) *O* is the centre of the circle in the figure. *AC* is a straight line.

(i) What is the special name given to *AC* ?

(ii) What is the special name given to the length *OB* ?

(iii) Name two isosceles triangles in the figure.

(iv) If *AB* = 6 cm, *BC* = 8 cm and the radius of the circle is 5 cm, find the perimeter of each of the triangles *OBC*, *AOB* and *ACB*.



(10) Information on the quantities of milk bought by three households during a week from a milkman is given below.

(i) Household *A* buys 1*l* 500 ml of milk per day on all seven days of the week. Find the total quantity of milk that household *A* buys during a week.

(ii) Household *B* buys the same amount of milk on each of the seven days of a week. The total amount of milk household *B* buys during a week is 12 *l* 250 ml. Find the amount of milk household *B* buys per day.

(iii) Find the total quantity of milk bought during a week by household *C*, if 7 *l* 500 ml of milk in total is bought during the five week days and 2 *l* 750 ml of milk in total is bought on Saturday and Sunday.

(iv) During the school holidays, the milkman is asked to deliver 250 ml more milk per week than the normal amount he delivers. If an equal amount of milk is delivered each day, find the amount he delivers to household *C* per day during the holidays.

(11) A certain brand of biscuits is introduced to the market in packets.

(i) The mass of a biscuit is 8 g 250 mg. If a packet contains 25 biscuits, find the total mass of the biscuits in a packet.

(ii) The mass of the empty packet is 760 mg. Find the total mass of a packet of biscuits.

(iii) 12 such packets of biscuits are packed in a box of mass 40 g, and such boxes containing packets of biscuits are distributed to wholesale dealers. Find the total mass of one such box that is bought by a wholesale dealer.

(12) (a) (i) Solve $9x + 7 = 97$.

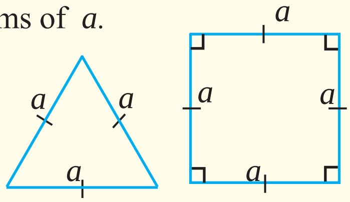
(ii) When Nimal gave Rs. 200 to buy 8 books, he received a balance of Rs. 40. Construct an equation using this information, by taking the price of a book to be Rs. x. Find the price of a book.

(b) The figure shows two frames in the shape of rectilinear plane figures, which have been made using ekels of equal length. The length of one ekel is a cm.

(i) Find the perimeter of the first figure in terms of a.

(ii) Find the perimeter of the second figure in terms of a.

(iii) If the total length of the ekels used to make these two frames is 42 cm, construct an equation in terms of a. Solve it and find the value of a.



(i) (ii)

(13) The cost of printing the cover of a certain book is Rs. y while the cost of printing a page of the book is Rs. p.

(i) If the book has 45 pages, and it costs Rs. c to print one copy of it, construct a formula for c in terms of p and y.

(ii) If the cost of printing the book is Rs. 115, and the cost of printing the cover is Rs. 25, find in rupees, the cost p of printing a page of this book.

(14) Two athletes train on two days of the week. The distances run on the two days are given below.

Day	Shanuka	Kavindu
Monday	2 km 800 m	1 km 200 m
Tuesday	4 km 400 m	3 km 800 m

(i) Who runs a longer distance during the training period of two days?

(ii) How much further does Shanuka run on Tuesday than on Monday?

(iii) On Tuesday, how much further does Shanuka run than Kavindu?

(iv) What is the total distance run by Shanuka during 4 weeks of such training?

21

Ratios

By studying this lesson you will be able to
- divide a quantity in a given ratio,
- find the total value or the values of the other terms when the value of a term of a ratio is given, and
- apply knowledge on ratios in practical situations.

21.1 Ratios and Equivalent Ratios

You have learnt in grade six that a ratio is a numerical relationship between two or more quantities expressed in similar units.

Let us focus on a few instances in daily life where ratios are applied.

A label pasted on a bottle of fruit juice recommends that, two parts juice be mixed with three parts water.

Fruit juice Water

Therefore, to make a consumable drink from the bottled juice, one can mix 2 litres of juice with 3 litres of water.

We say that the fruit drink is made using juice and water in the ratio 2:3.

The mixed quantities (in litres) of juice and water are expressed by the ratio 2:3. This is read as 'two-to-three' or 'two-is-to-three'. The numbers 2 and 3 are called the **terms of the ratio**.

When we write a ratio, it is essential to write the terms in the correct order – that is, the order in which we mention the quantities. In the above example, we wrote juice first and water second. The same order is followed for the terms – we write 2 as the first term of the ratio and 3 as the second term.

When the terms of a given ratio are multiplied by the same positive whole number, we get an **equivalent ratio**.

That is, $1 : 3 = 2 : 6 = 3 : 9 = 4 : 12 = 5 : 15.$

Now let us consider an example where three items are mixed.

A concrete mixture is made by mixing together cement, sand and granite.

The ratio in which cement, sand and granite are mixed to prepare this concrete mixture is written as 1 : 3 : 4. It is read '1 to 3 to 4' or '1 is to 3 is to 4'. Here, 1, 3 and 4 are the terms of the ratio.

Let us multiply each term of the ratio 1 : 3 : 4 by 2.
Then we get the ratio 2 : 6 : 8. The ratio 2 : 6 : 8 is equivalent to the ratio 1 : 3 : 4.

A ratio should be written such that its terms are whole numbers that cannot be simplified further.

If the terms of a given ratio are whole numbers, and if the highest common factor of the terms is 1, then the ratio is said to be in the simplest form.

When the terms of a ratio are whole numbers, to write the ratio in its simplest form,

- check whether the terms have common factors.
- if the terms have common factors, then divide each term of the ratio by the highest common factor of the terms.

Example 1

Write a ratio equivalent to $4 : 1 : 6$.
Multiplying the terms in the ratio by 3 we obtain,

$$4 : 1 : 6 = 4 \times 3 : 1 \times 3 : 6 \times 3$$
$$= 12 : 3 : 18$$

Example 2

Express the ratio $8 : 4 : 12$ in its simplest form.
The HCF of the terms 8, 4 and 12 is 4. Dividing the terms of the ratio by 4 we obtain,

$$8 : 4 : 12 = 8 \div 4 : 4 \div 4 : 12 \div 4$$
$$= 2 : 1 : 3$$

Example 3

The sides of a triangle are 8 cm, 6 cm 5 mm and 50 mm. Find the ratio of the lengths of the sides of the triangle and express it in the simplest form.
Let us express the lengths in similar units.
8 cm = 80 mm, 6 cm 5 mm = 65 mm, 50 mm
The ratio of the lengths of the sides = 80 : 65 : 50
The ratio of the lengths of the sides in the simplest form } = 16 : 13 : 10

Exercise 21.1

(1) Write down the ratio for each of the following examples, and express it in the simplest form.
   (i) The number of boys in a class is 20 and the number of girls is 25.
   (ii) The price of a pen is Rs. 15, the price of a pencil is Rs. 10 and the price of an eraser is Rs. 5.
   (iii) The ingredients for a cake are 1 kg flour, 500 g sugar and 500 g margarine.
   (iv) The price of a mandarin is Rs. p, the price of an orange is Rs. q and the price of an apple is Rs r.

(2) For each of the following ratios, write down two equivalent ratios.
   (i) 2 : 3 (ii) 6 : 5 : 7 (iii) 1 : 4 : 5

(3) Express each of the following ratios in its simplest form.
   (i) 12 : 18 (ii) 28 : 70 : 42 (iii) 25 : 100 : 125

(4) The sides of a triangle are 7 cm, 50 mm and 6 cm 5 mm. Find the ratio of the lengths of the sides and express it in the simplest form.

21.2 Dividing in a ratio

• Dividing a given quantity in a ratio

There are instances in day-to-day life when people need to divide items among themselves. On some occasions, this is done in equal amounts, while on other occasions it is done in unequal amounts.
At the beginning of this lesson, we discussed about mixing juice and water in the ratio 2:3.

Five units of fruit drink are made by mixing 2 parts juice with 3 parts water.

The ingredients of this drink are juice and water.

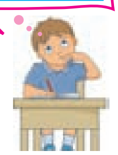
Since the **number of parts of juice is 2** and the **number of parts of water is 3**, the number of parts of drink is 5.

Let us find the amount of each ingredient in the drink, if 10 litres of the drink were made.

$$\begin{aligned}
\text{Ratio of juice to water} &= 2:3 \\
\text{Total number of parts} &= 2+3 \\
&= 5 \\
\text{Volume of five parts} &= 10\ l \\
\text{Volume of one part} &= \frac{10}{5}\ l \\
&= 2\ l \\
\text{Parts of juice} &= 2 \\
\text{Volume of juice} &= 2\ l \times 2 \\
&= 4\ l \\
\text{Parts of water} &= 3 \\
\text{Volume of water} &= 2\ l \times 3 \\
&= 6\ l
\end{aligned}$$

Juice : Water
2 : 3

Number of parts	Volume
5	10
2	?
3	?



Note
When using this method, problem solving is facilitated by writing the given ratio in its simplest form and then finding the total number of parts relevant to it.

Example 1

Cement, sand and granite in a concrete mixture are in the ratio $1:3:4$. Find the quantities of cement, sand and granite in 16 cubic metres of concrete.

Ratio of cement to sand to granite $= 1:3:4$

Total number of parts $= 1+3+4 = 8$

Size of 8 parts $= 16\ \text{m}^3$

Size of a single part $= \frac{16}{8}\ \text{m}^3 = 2\ \text{m}^3$

Number of parts of cement $= 1$

Quantity of cement $= 1 \times 2\ \text{m}^3 = 2\ \text{m}^3$

Number of parts of sand $= 3$

Quantity of sand $= 3 \times 2\ \text{m}^3 = 6\ \text{m}^3$

Number of parts of granite $= 4$

Quantity of granite $= 4 \times 2\ \text{m}^3 = 8\ \text{m}^3$

Example 2

The ingredients to make 3 kg of cake are butter, sugar and flour, mixed in the ratio 1 : 2 : 3. Find the mass of each ingredient in the cake.

Ratio of butter to sugar to flour $= 1:2:3$

Total number of parts $= 1+2+3 = 6$

Total mass of the 6 parts of cake mixture $= 3$ kg

Mass of a single part $= \frac{3}{6}$ kg

$= \frac{3000}{6}\ \text{g} = 500\ \text{g}$

Parts of butter $= 1$

Mass of butter $= 1 \times 500\ \text{g} = 500\ \text{g}$

Parts of flour $= 3$

Mass of flour $= 3 \times 500\ \text{g} = 1500\ \text{g}$

$= 1$ kg 500 g

Parts of sugar $= 2$

Mass of sugar $= 2 \times 500\ \text{g}$

$= 1000\ \text{g} = 1$ kg

Example 3

Nadaraja and Mohommad made a profit of Rs. 7000 from their small business. They decide to divide the profit in the ratio 3 : 4, which is the ratio in which they invested in the business. Find how much of the profit each person receives.

$$\left.\begin{array}{r}\text{The ratio in which the profit is}\\ \text{divided between Nadaraja and Mohommad}\end{array}\right\} = 3 : 4$$

$$\begin{aligned}
\text{Total number of parts} &= 3 + 4 = 7\\
\text{Total profit} &= \text{Rs. } 7000\\
\text{Value of a single part} &= \text{Rs. } \frac{7000}{7}\\
&= \text{Rs. } 1000\\
\text{Number of parts Nadaraja receives} &= 3\\
\text{Value of profit Nadaraja receives} &= \text{Rs. } 1000 \times 3\\
&= \text{Rs. } 3000\\
\text{Number of parts Mohommad receives} &= 4\\
\text{Value of profit Mohommad receives} &= \text{Rs. } 1000 \times 4\\
&= \text{Rs. } 4000
\end{aligned}$$

Exercise 21.2

(1) Rs. 1500 was divided between Sumudu and Kumudu in the ratio 2 : 3. Find the amount each received.

(2) Copper is added to gold in gold jewellery, such that the ratio of copper to gold is 1 : 11. Find the mass of gold and copper needed to make a necklace of mass 60 grammes.

(3) The ratio of boys to girls in a school is 5 : 4. If the total number of students in the school is 1800, find the number of boys and the number of girls there are in the school.

(4) A land owner divides his land of 1800 m^2 between his son and his daughter in the ratio 5:3. How much of the land does the son receive?

(5) Rice flour, sugar and coconut are mixed in the ratio 4 : 3: 1 to prepare a certain sweetmeat mixture. Find the mass of each ingredient in 2 kg of the sweetmeat.

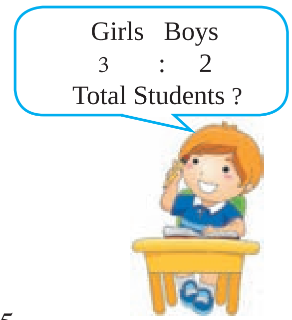
(6) A high nutrient food item is made of green gram, soya and rice mixed in the ratio 2 : 1 : 3. Compute the amount of rice in a 840 g packet of this food item.

(7) The ratio of the high-school students enrolled in the science, technology and arts streams in a school is 3 : 5 : 7. If the total number of high-school students in the school is 600, how many students are enrolled in the arts stream?

(8) The ratio of length to breadth of a rectangular playground is 3 : 2. If its perimeter is 600 m, find its length and its breadth.

• Calculating the total amount, when the amount of one item in a ratio is given

The ratio of girls to boys in a class is 3 : 2. If the number of girls in the class is 24, let us find how many students there are in total in the class.



Ratio of girls to boys $= 3 : 2$

Number of parts of girls in the class $= 3$

Number of girls $= 24$

Since the number of students in 3 parts is 24,

the number of students in one part $= \frac{24}{3} = 8$

Total number of parts $= 3 + 2 = 5$

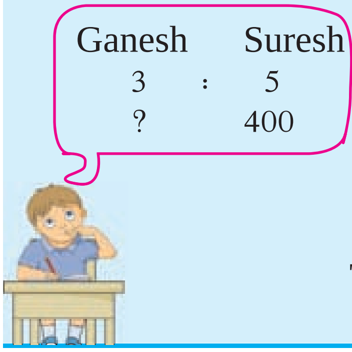
Total number of students $= 8 \times 5$

$= 40$

Example 1

A sum of money was divided between Ganesh and Suresh in the ratio 3 : 5. Suresh received Rs. 400. What was the total amount that was divided between the two of them?

The ratio in which the money was divided between Ganesh and Suresh $\}$ = 3 : 5



Parts for Suresh = 5

Amount received by Suresh = Rs. 400

Therefore, the value of 5 parts = Rs. 400

Value of one part = Rs. 400 ÷ 5

= Rs. 80

Number of parts = 3 + 5 = 8

Total amount that was divided = Rs. 80 × 8

= Rs. 640

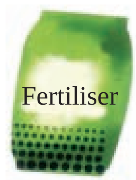
Exercise 21.3

(1) Sugar and flour were mixed in the ratio 3 : 5 to prepare a mixture for a sweetmeat. If the mass of sugar used was 750 g, find the total mass of the sweetmeat mixture.

(2) Sirimal rides a bike from his house to the bus halt and then takes a bus when he travels to school. The ratio of the distance he travels by bike to the distance he travels by bus is 2 : 7. If the distance he travels by bus is 14 km, what is the distance to the school from his house?

(3) A fruit drink is made using water and orange juice in the ratio 5 : 7. If the quantity of orange juice used is 350 ml, what is the total volume of the fruit drink that is made?

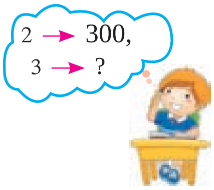
(4) The ratio of Nitrogen to Phosphorus to Potassium in a fertiliser is 5 : 2 : 1. If the mass of Phosphorus in a bag of this fertiliser is 250 g, what is the total mass of the bag?



(5) When making a mixture of plaster, the ratio in which cement, lime and sand are mixed is 2:3:5. If the quantity of lime in a mixture of plaster is 6 pans, what is the total quantity of the mixture, measured in pans?

- **When the amount related to one term in a ratio is given, determining the other amounts**

The ratio in which a sum of money was divided between Siyam and Kandan is 2 : 3. If Siyam received Rs. 300, let us find how much money Kandan received.



Ratio in which the money was divided between Siyam and Kandan $\}$ = 2 : 3

Parts Siyam received = 2

Money Siyam received = Rs.300

Since two parts is worth Rs. 300,

the value of one part = Rs. $300 \div 2$

= Rs. 150

Parts Kandan received = 3

Money Kandan received = Rs. 150×3

= Rs. 450

Example 1

The ratio in which cement, sand and granite are mixed in order to prepare a concrete mixture is 2 : 3 : 4. Let us find the quantities of cement and granite that should be mixed with 9 pans of sand and the total amount of concrete mixture that is made.

Parts of sand = 3

Pans of sand = 9

Quantity of sand in one part $= \frac{9}{3}$ pans = 3 pans

Parts of cement = 2

$\therefore$ quantity of cement $= 3 \times 2$ pans = 6 pans

Parts of granite = 4

$\therefore$ quantity of granite $= 3 \times 4$ pans = 12 pans

Total number of parts $= 2 + 3 + 4 = 9$

Quantity of concrete mixture $= 3 \times 9$ pans = 27 pans

Exercise 21.4

(1) Sesame balls are made by mixing sesame and jaggery in the ratio 5 : 4. How much jaggery is required to make sesame balls, if 500 g of sesame is used?

(2) The ratio of female workers to male workers in an office is 3 : 2. If there are 18 female workers, find the number of male workers.

(3) Tea and milk are mixed in the ratio 2 : 5 when making milk tea. How many millilitres of tea should be used to make milk tea, if 100 ml of milk is used?

(4) Mr. Perera's savings to expenditure ratio is 3:7. If his savings during a certain month was Rs. 6000, how much money did he spend that month?

(5) An alloy is made by mixing masses of zinc and copper in the ratio 2:5.

   (i) If the mass of zinc in a sample of this alloy is 6 kg, what is the mass of copper?

   (ii) If the mass of copper in a sample of this alloy is 10 kg, what is the mass of zinc?

   (iii) Find the mass of copper in 28 kg of the alloy.

   (iv) If the mass of zinc in a sample of this alloy is 2 kg, what is the mass of the sample?

Miscellaneous Exercise

(1) Silver and copper were mixed in the ratio 2 : 3 to make a statue. If the mass of the statue is 1425 g, find the mass of silver in the statue.

(2) Kamalini, Nimal and Tharaka divided several veralu (olives) among themselves in the ratio 1 : 3 : 5. If Tharaka received 15 veralu, how many veralu did Kamalini receive? Find also the number of veralu that Nimal received.

(3) The ratio of Sinhalese to Tamils to Muslims in a certain city is 5 : 4 : 3. If the total population in the city is 7200, find how many Sinhalese there are in the city.

Summary

- Multiplying (or dividing) the terms of a given ratio by a fixed number gives an equivalent ratio.
- If all the terms of a ratio are whole numbers and their HCF is one, the ratio is said to be in its simplest form.
- The total number of parts of a ratio is the sum of the terms of the ratio. The number of parts of each item is the term in the ratio associated with that item.

  For example, a concrete mixture in which cement, sand and granite are mixed in the ratio 3 : 6 : 8 has 3 parts of cement, 6 parts of sand and 8 parts of granite. Thus, the total number of parts is 17.
- When ingredients are mixed in a given ratio, if the amount of one ingredient or the total amount is known, it is possible to find the amount of a single part, by dividing the known amount by the relevant number of parts. Thereby the individual amounts of the other ingredients and the total amount can be determined.

22 Percentages

By studying this lesson you will be able to,

- identify a percentage,
- use the symbol %, to indicate an amount as a fraction of 100, and
- write a fraction with denominator equal to a factor of 100, as a percentage.

22.1 Introduction to the concept of percentage

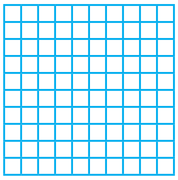
Some advertisements taken from a newspaper and a leaflet are shown below.

In all these advertisements the symbol 1 % appears after a number. % is known as the **percentage sign**. The percentage sign is used in various instances.

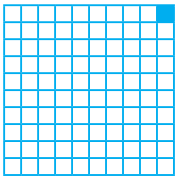
5% of the eggs in the basket are rotten. This means that 5 eggs out of 100 eggs are rotten. The ratio of the number of rotten eggs to the number of eggs in the basket is 5:100.

The yield from paddy seeds is 3500%. Accordingly, when you plant 100 paddy seeds you will get a yield of 3500. Therefore the ratio of the yield to the amount of seeds planted is 3500 : 100.

Let us study percentages using a 10×10 square grid.

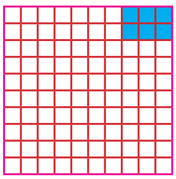
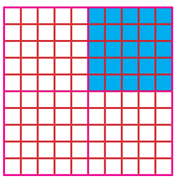
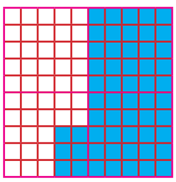
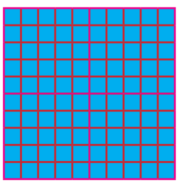


The region of the 10×10 square grid is taken as 1 unit.



Considering it as one unit, the grid is divided into 100 small squares. Of these squares, exactly one is coloured. That is, $\frac{1}{100}$ of the entire grid is coloured. As a percentage, this is 1%. This is read as "**one percent**". This indicates a portion of a unit as a percentage.

The below given table is prepared by taking the initial number of squares as 100.

Figure	Coloured part	As a fraction	As a decimal number	As a percentage
	6 of the 100 squares	$\frac{6}{100}$	0.06	6%
	25 of the 100 squares	$\frac{25}{100}$	0.25	25%
	56 of the 100 squares	$\frac{56}{100}$	0.56	56%
	100 of the 100 squares	$\frac{100}{100}$	1.00	100%

Exercise 22.1

(1) Write the percentages given in words using the percentage sign.

(i) Two percent (ii) Twenty percent

(iii) Hundred percent (iv) Hundred and seventy five percent

(v) Twelve and a half percent (vi) Thirty point five percent

(2) Write down how each of the percentages given below is read.

(i) 25 % (ii) 180 % (iii) 7.5 %

(3) Write the percentage corresponding to each of the following fractions of a unit.

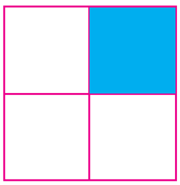
(i) $\frac{9}{100}$ (ii) $\frac{30}{100}$ (iii) $\frac{100}{100}$ (iv) $\frac{105}{100}$

(4) Write the fraction corresponding to each of the percentages given below.

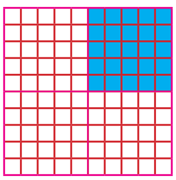
(i) 33 % (ii) 100 % (iii) 85 % (iv) 1 %

22.2 More on representing fractions as percentages

Let us now consider a fraction which does not have 100 as the denominator. Let us learn to write it as a percentage.



Observe this figure. We see that $\frac{1}{4}$ of the whole figure is coloured.



This figure has been divided into 100 equal sized squares. Here $\frac{25}{100}$ of the whole figure is coloured. That is 25% of the whole figure is coloured.

See that the coloured parts of both figures are the same. So $\frac{1}{4} = \frac{25}{100}$.
That is $\frac{1}{4} = 25\%$.

Thus, a given fraction can be written as an equivalent fraction with 100 as the denominator. Then we can represent the given fraction as a percentage.

Example 1

Write $\frac{3}{10}$ as a percentage.

As $100 \div 10 = 10$, let us multiply the denominator and the numerator by 10.

$$\frac{3}{10} = \frac{3 \times 10}{10 \times 10} = \frac{30}{100} = 30\%$$

Example 2

Write $\frac{5}{4}$ as a percentage.

As $100 \div 4 = 25$, let us multiply the denominator and the numerator of $\frac{5}{4}$ by 25.

$$\frac{5}{4} = \frac{5 \times 25}{4 \times 25} = \frac{125}{100} = 125\%$$

Example 3

Write 3 as a percentage.

$$3 = \frac{3}{1} = \frac{3 \times 100}{1 \times 100} = \frac{300}{100} = 300\%$$

Example 4

Write $2\frac{1}{2}$ as a percentage.

$$2\frac{1}{2} = \frac{5}{2} = \frac{5 \times 50}{2 \times 50} = \frac{250}{100} = 250\%$$

Example 5

Of the 25 students in a class, 13 are girls. Represent the number of girls, as a percentage of all the students in the class.

The number of girls, as a fraction of all the students in the class is $\frac{13}{25}$.

$$\frac{13}{25} = \frac{13 \times 4}{25 \times 4} = \frac{52}{100} = 52\%$$

$\therefore$ the number of girls, as a percentage of all the students in the class is 52%.

Exercise 22.2

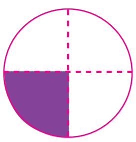
(1) Write each of the fractions given below as a percentage.

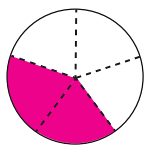
(i) $\frac{3}{4}$ (ii) $\frac{1}{10}$ (iii) $\frac{15}{20}$ (iv) $\frac{3}{2}$ (v) $\frac{13}{10}$ (vi) $1\frac{2}{5}$ (vii) $1\frac{7}{20}$

(2) For each of the figures given below, write the shaded part as a fraction of the whole figure. Indicate this as a percentage.

(i) 

(ii) 

(iii) 

(iv) 

(3) The total marks given for an assignment was 25. Prathapa got 21 for this assignment.
   (i) Write her marks as a fraction of the total marks.
   (ii) Write her marks as a percentage of the total marks.

(4) A children's society has 20 members. Only 17 members attended a meeting on a certain day.
   (i) Write the number that attended the meeting that day as a fraction of the total number of members.
   (ii) Write the above fraction as a percentage.

(5) The same Mathematics test paper was given to both Class A and Class B of grade 7. Malinda who was in Class A got 22 marks out of 25 for the test, while Suresh who was in Class B, got 18 marks out of 20.
   (i) Express the marks Malinda got, as a percentage of the total marks.
   (ii) Express the marks Suresh got, as a percentage of the total marks.
   (iii) Of the two, who has shown more mathematical ability at the test?

(6) A vendor bought 50 mangoes, of which 8 were spoilt.
   (i) Express the number of spoilt mangoes as a percentage of the total number of mangoes.
   (ii) Express the number of good mangoes as a percentage of the total number of mangoes.

(7) 20 students attended an eye clinic. Of them, 5 had problems with their eye sight. Of all the students who came to the clinic find the percentage of students who didn’t have problems with their eye sight.

(8) Last year, Mr. Perera's salary was 50 000 rupees per month. This year his salary has increased to 65 000 rupees per month. Find the increment as a percentage of last year’s monthly salary.

(9) You can harvest 5 kg of ginger from 1 kg of ginger. Express the harvest as a percentage of the ginger that is planted.

(10) For every 100 bean seeds that are planted from a packet, 85 germinate. Write the percentage of germinating seeds.

22.3 Representing decimal numbers as percentages

We have already learnt how to represent a decimal number as a fraction. Recalling what was learnt earlier, let us consider how a decimal number is represented as a percentage.

Activity 1

Copy the table given below in your exercise book and fill in the blanks.

Decimal number	The number as a fraction	The number as a fraction having 100 as the denominator	The number as a percentage of the original amount
0.5	$\frac{5}{10}$	$\frac{5 \times 10}{10 \times 10} = \frac{50}{100}$	50%
2.3	$\frac{23}{10}$	....	....
0.25	$\frac{25}{100}$	....	25%
1.75	....	....	....

A given decimal number with one or two decimal places can be represented as a percentage, by first representing it as a fraction having 100 as the denominator.

➢ **This can also be done by multiplying the given decimal number or fraction by 100 and placing the % symbol in the answer.**

- Let us represent 0.5 as a percentage.
  Let us multiply 0.5 by 100 and then place the % symbol in the answer.
  $0.5 \times 100 = 50$
  $\therefore$ 50% is 0.5 represented as a percentage.

- Let us represent 0.25 as a percentage.
  0.25 represented as a percentage is 0.25×100 %; that is, 25%.

Example 1

Let us represent 1.08 as a percentage.

1.08 represented as a percentage is 1.08×100 % ; that is, 108%.

Exercise 22.3

(1) Write each of the given decimal numbers as a fraction. Then write it as a percentage.

(i) 0.3 (ii) 0.5 (iii) 0.1 (iv) 0.33
(v) 0.45 (vi) 0.03 (vii) 0.08 (viii) 0.01

(2) Multiply each of the given decimal numbers and fractions by 100, and represent it as a percentage of the original amount.

(i) 0.7 (ii) $\frac{2}{5}$ (iii) 0.65 (iv) $\frac{3}{4}$
(v) 0.08 (vi) 0.05 (vii) 1.5 (viii) 1.25

(3) A person spends $\frac{2}{5}$ of his monthly income on his children's education and 0.25 of his monthly income on food items.

(i) Express the amount he spends on his children's education as a percentage of his income.

(ii) Express the amount he spends on food items as a percentage of his monthly income.

(iii) For which of the above two needs does he spend the greater portion of his monthly income?

(4) Kamal had to pay a certain amount of money to an institution. He pays $\frac{1}{4}$ in January, 23% in February and 0.52 of the amount in March.

(i) Express the amount of money he pays in January and March as a percentage of the total amount he had to pay.

(ii) Now compare your answers and decide in which month he has paid the most.

Summary

- When amounts which are parts of 100 are written with the percentage symbol %, we say that they are written as percentages.
- A given fraction or decimal number can be written as a percentage, by first writing it as a fraction having 100 as the denominator.
- A given decimal number can be represented as a percentage by multiplying it by 100 and placing the % symbol in the answer.

23

Cartesian Plane

By studying this lesson you will be able to
- identify what a Cartesian plane is,
- identify a point on a Cartesian plane by its coordinates, and
- plot a point on a Cartesian plane when its coordinates are given.

23.1 Identifying a location

The locations of several students seated in a classroom are shown in the figure. Let us describe the location of each of the students.

Location of several students

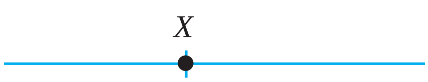
Location		Name of the student
Column	Row	
3	3	Nimal
2	2	Sesath
3	2	Mala
2	3	Mayuri

Mayuri's location is in the 3rd row of the 2nd column.
You may observe, as indicated in the table, that the location of each of the students in the classroom can be indicated exactly, in a similar manner.

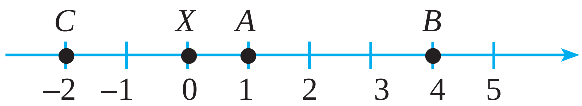
Now let us see how the location of a point can be determined with respect to a fixed point.

• Location of a point with respect to a fixed point

A fixed point on a straight line is indicated as X.



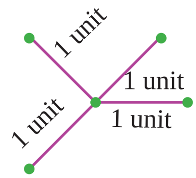
Considering point X as 0 (zero), number the straight line as a number line. Now, with respect to the point X, we can represent any point on the line by a number.



Accordingly, with respect to the point X, the positions of the points A, B and C can be represented by the numbers 1, 4 and -2 respectively.

Points A and B are located to the right of point X, at a distance of 1 unit and 4 units respectively from X. Point C is located to the left of point X, at a distance of 2 units from X.

There are many points on a plane which are at a distance of 1 unit from a fixed point on the plane. Therefore, it is not possible to exactly determine the location of a point at a distance of 1 unit from a particular point on a plane, using only one number line.

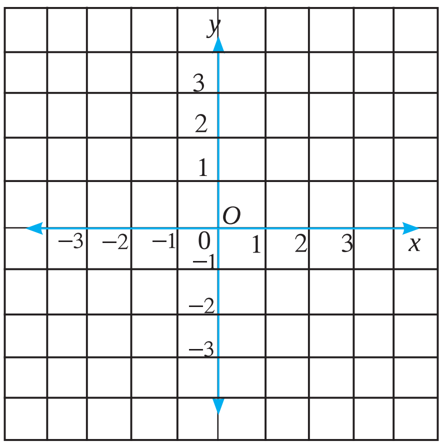


In 1637, Rene Descartes (1596 AD – 1650 AD) of French origin presented a method of representing the exact location of a point on a plane using a grid. Such a grid is called a **Cartesian plane.**


Rene Descartes

23.2 Cartesian plane

A Cartesian plane is shown in the figure.

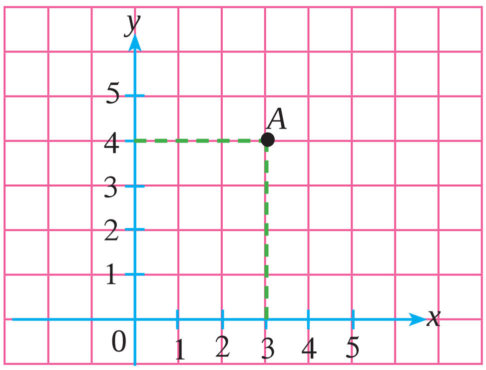


- O is a fixed point on this Cartesian plane.
- Here, two number lines intersect perpendicularly at point O.
- The number zero of each number line is positioned at point O. It is called the **origin**.
- As indicated in the figure, one number line is called the ***x*-axis** and the other number line is called the ***y*-axis**.
- Any point on the plane can be exactly identified by two numbers based on point O.
- These two numbers are called the **coordinates** of that point.

23.3 Identifying a point on a Cartesian plane by its coordinates

A is a point on the given Cartesian plane.

Let us see how the point A on the Cartesian plane can be exactly identified by two numbers.



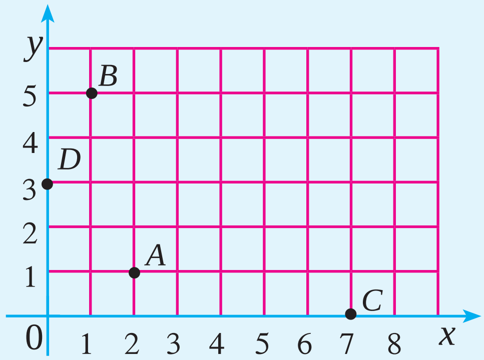
The line drawn from point A which is perpendicular to the x - axis, meets the x - axis at 3. The line drawn from point A which is perpendicular to the y - axis, meets the y-axis at 4.

Accordingly, the x - coordinate of the point A is defined as 3 and the y - coordinate of A is defined as 4. The coordinates of A are written as (3, 4) by writing the x - coordinate first and the y-coordinate second, within brackets. This is written in short as $A(3,4)$.

Accordingly, the coordinates of the origin O are (0, 0).

Example 1

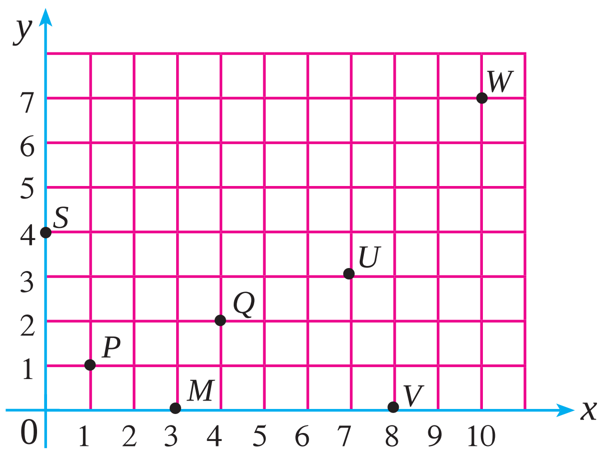
Write down the coordinates of the points on the given cartesian plane as ordered pairs.



Point	*x* - coordinate	*y* - coordinate	Coordinates
A	2	1	(2,1)
B	1	5	(1,5)
C	7	0	(7,0)
D	0	3	(0,3)

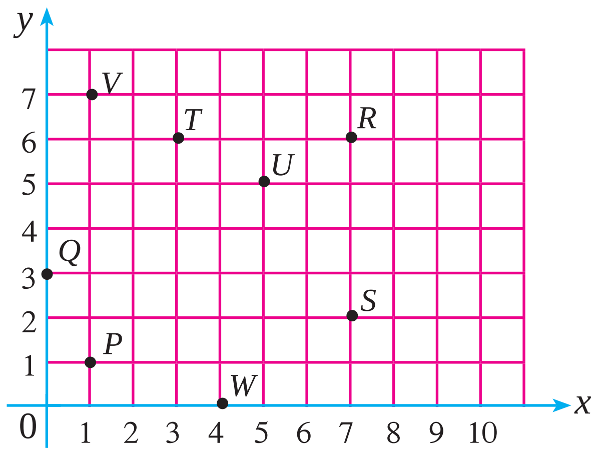
Exercise 23.1

(1) Copy the given table in your book and complete it based on the coordinates of the points represented on the Cartesian plane.

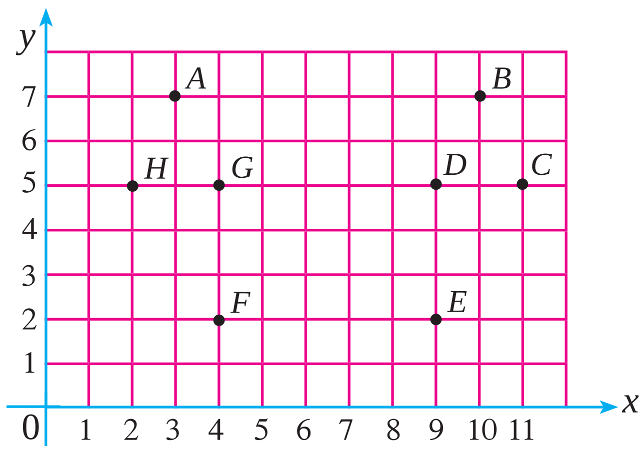


Point	x - coordinate	y - coordinate	Coordinates	Name of the point with its coordinates
P	1	1	(1,1)	P (1,1)
Q				
S				
V				
U				
W				
M				

(2) Write down the coordinates of the points on the given Cartesian plane.



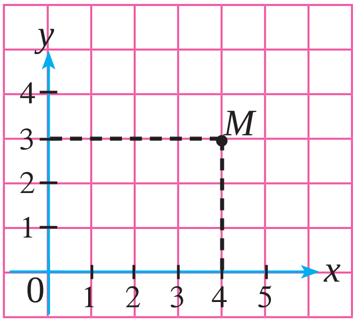
(3) Write down the coordinates of the points on the given Cartesian plane.



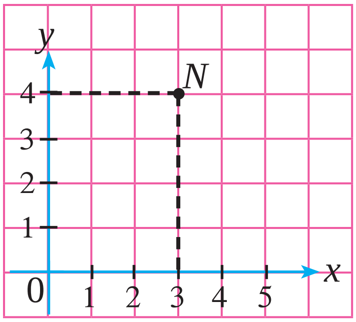
23.4 Plotting points on a Cartesian plane

Let us see how the point M (4, 3) is plotted on a cartesian plane. From the origin O, move 4 units to the right along the x - axis, and from there, move 3 units upwards parallel to the y - axis and then mark M.

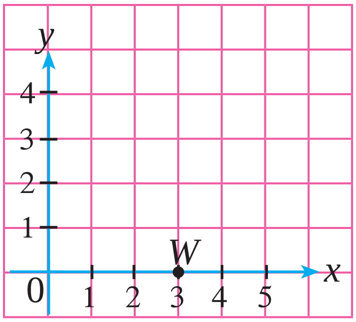
(i) Plotting the point M (4,3)



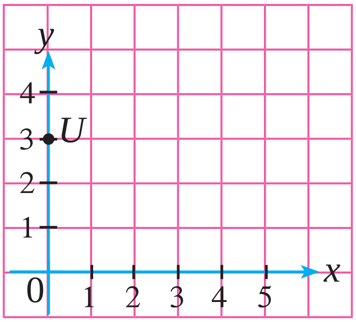
(ii) Plotting the point N (3,4)



(iii) Plotting the point W (3,0)



(iv) Plotting the point U (0,3)



- The coordinates of a point with y - coordinate zero, i.e., a point on the x - axis, is of the form (x, 0).
- The coordinates of a point with x - coordinate zero, i.e., a point on the y - axis, is of the form (0, y).
- The coordinates of the point with the x and y - coordinates both equal to zero is (0, 0). This point is the origin.

Exercise 23.2

(1) Draw a suitable Cartesian plane and plot the following points.

A (2, 5), B (4, 3), C (2, 1), D (0, 6), E (3, 6), F (7, 0)

(2) Plot the following points on a Cartesian plane and join them with straight line segments in the order of the letters and return to the starting point.

(i) A (1, 7), B (2, 1), C (5, 5), D (8, 1), E (9, 7)

(ii) A (5, 1), B (5, 3), C (0, 5), D (0, 6), E (5, 4), F (5, 5), G (10, 5), H (10, 1)

(iii) A (1, 4), B (0, 4), C (0, 7), D (1, 7), E (1, 6), F (7, 6), G (7, 7), H (10, 7), I (10, 4), J (7, 4), K (7, 5), L (1, 5)

(3) Shanuka says that "the vertices of a square are positioned at P (2, 2), Q (2, 7), R (7, 7), S (7, 2)". Plot these points on a cartesian plane and verify the validity of the above statement.

(4) Draw a Cartesian plane and plot four points such that the x - coordinate and y - coordinate values of each point are equal to each other. Write down the coordinates of the four points.

(5) (i) Plot the points given below on a Cartesian plane and join them in the order of the letters with straight line segments.

A (4, 1), B (4, 2), C (4, 3), D (4, 4)

(ii) Extend the line that is obtained.

(iii) Write the coordinates of two other points on this line.

(6) (i) Plot the points given below on a Cartesian plane and join them in the order of the letters with straight line segments.

P (2, 3), Q (4, 3), R (6, 3), S (7, 3)

(ii) Extend the line that is obtained.

(iii) Write the coordinates of two other points on this line.

Summary

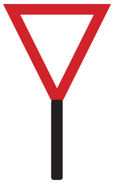
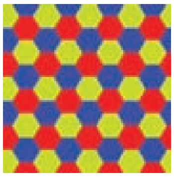
- Any point on a Cartesian plane can be denoted by an ordered pair (x, y).
- The number denoted by x is called the x - coordinate and the number denoted by y is called the y - coordinate of the point (x, y).

24 Construction of Rectilinear Plane Figures

By studying this lesson you will be able to
- construct a straight line segment of given length,
- construct an equilateral triangle of given side length, and
- construct a hexagon by means of an equilateral triangle or a circle.

24.1 Constructions

The following figure presents examples of equilateral triangles and regular hexagons that can be observed around us.

Equilateral triangles and regular hexagons are two types of convex polygons that are important in geometry.

In geometry, it is necessary to draw as well as construct plane figures. When a plane figure is being drawn, it is done according to the given data, without paying much attention to the measurements. However, when a plane figure is being constructed, attention needs to be paid to the measurements, and a figure of the correct size should be constructed according to the given data.

Geometrical constructions are done with a pair of compasses and a straight edge.

When it is necessary to measure lengths and angles, then the appropriate measuring instruments need to be used.

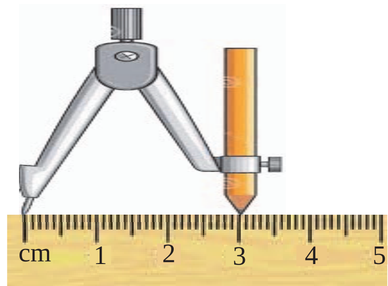
24.2 Construction of a straight line segment

You have learnt earlier that a straight line segment is a portion of a straight line.

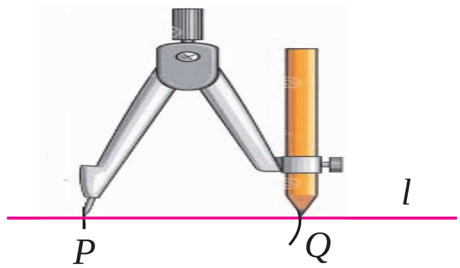
Now let us construct the straight line segment PQ of length 3 cm.

Step 1 - Draw a straight line using a ruler. Name it l. Mark a point on the straight line l and name it P.

Step 2 - Place the pair of compasses on the ruler and set it so that the point of the pair of compasses and the pencil point are at a distance of 3 cm apart.



Step 3 - Place the point of the pair of compasses on the point P and mark a point on the line which is 3 cm from P and name it Q.



Step 4 - Write "3 cm" between the two points P and Q.

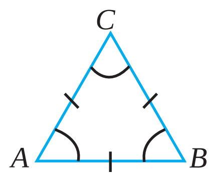
Now you have constructed a straight line segment PQ of length 3 cm. To indicate that the length of this straight line segment is 3 cm, we write PQ = 3 cm.

➤ Construct straight line segments of the lengths given below.

(i) $AB = 7$ cm (ii) $XY = 7.8$ cm

24.3 Construction of an equilateral triangle

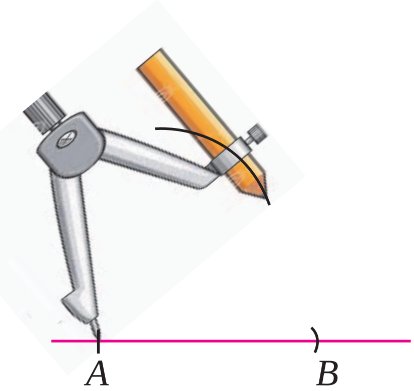
You have learnt earlier that an equilateral triangle is a triangle with sides which are equal in length and angles which are equal in magnitude.



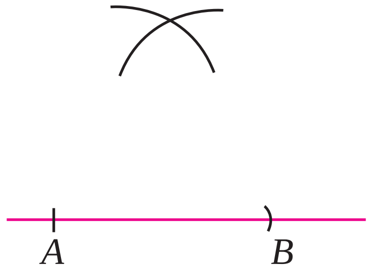
Let us construct an equilateral triangle of side length 3 cm.

Step 1 - Construct a straight line segment *AB* of length 3 cm using a pair of compasses and a ruler.

Step 2 - Set the pair of compasses so that the point of the pair of compasses and the pencil point are at a distance of 3 cm apart. Place the point of the pair of compasses on the point *A* and construct an arc as shown in the figure.

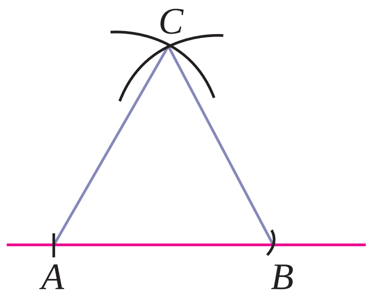


Step 3 - Place the point of the pair of compasses at the point *B* and construct another arc such that it intersects the first arc. If the arcs do not intersect, place the point of the pair of compasses at *A* and lengthen the initial arc.



Name the point of intersection of the two arcs as *C*.

Step 4 - Join *AC* and *BC*.



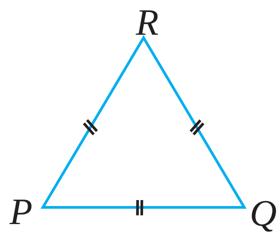
Then you will obtain the equilateral triangle *ABC* of side length 3 cm.

➤ (i) Construct two equilateral triangles of side length 4 cm and 5.7 cm.
(ii) Measure the angles of the above two triangles that you constructed.

Exercise 24.1

(1) Construct the straight line segment LM of length 6 cm using a straight edge and a pair of compasses.

(2) Draw the straight line l and construct the straight line segment PQ of length 7.5 cm on it.



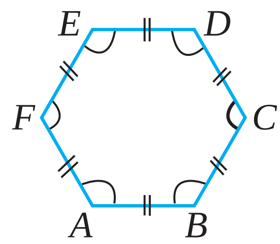
(3) (i) Construct the equilateral triangle PQR in the figure. Measure and write down the magnitude of the angle PQR.

(ii) Mark the mid points of the sides of the triangle PQR and name them X, Y and Z. Draw the triangle XYZ.

(4) (i) Cut out 6 equilateral triangles, each of side length 3 cm, from different coloured paper.

(ii) Mark a point O on a piece of paper and paste the triangles on this paper such that one vertex of each triangle coincides with O and adjacent triangles have a side which touches one side of each triangle next to it. What is the shape of the figure you obtain by doing this?

24.4 Constructing a regular hexagon



In the figure is a regular hexagon $ABCDEF$. A hexagon is a closed convex polygon bounded by 6 straight line segments. In a regular hexagon,

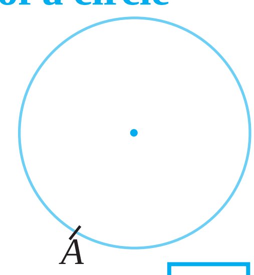
- the sides are of equal length
- the angles are of equal magnitude

Now let us see how a regular hexagon is constructed.

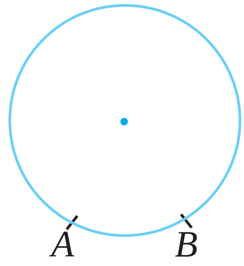
• Constructing a regular hexagon by means of a circle

Step 1 - Construct a circle of radius 1.5 cm using a pair of compasses.

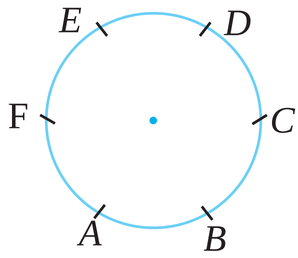
Step 2 - Mark a point A on this circle.



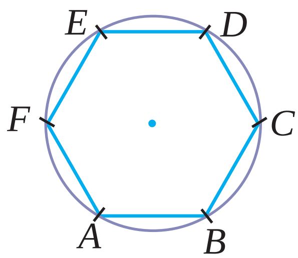
Step 3 - Set the pair of compasses so that the point of the pair of compasses and the pencil point are at a distance of 1.5 cm apart. Place the point of the pair of compasses on point *A*, draw an arc which intersects the circle and name this point *B*.



Step 4 - Similarly, place the point of the pair of compasses on the point *B* and mark the point *C*. Now, place the point on *C* and mark the point *D*, place the point on *D* and mark the point *E* and finally place the point on *E* and mark the point *F*.



Step 5 - Join the points *A*, *B*, *C*, *D*, *E* and *F* respectively.



You have now constructed the regular hexagon *ABCDEF* of side length 1.5 cm. By measuring the angles of the regular hexagon establish the fact that they are of equal magnitude.

➤ Construct a regular hexagon of side length 3.5 cm by following the above steps.

• Constructing a regular hexagon using an equilateral triangle

Step 1 - Construct the equilateral triangle *ABC* of side length 4 cm.
Step 2 - Construct the equilateral triangle *BCD* by taking *BC* as a side.
Step 3 - Construct the equilateral triangle *CDE* by taking *CD* as a side.
Step 4 - Construct the equilateral triangle *CEF* by taking *CE* as a side.
Step 5 - Construct the equilateral triangle *CFG* by taking *CF* as a side.
Step 6 - Join *A* and *G*.

Then you will obtain the regular hexagon *ABDEFG* of side length 4 cm. A regular hexagon of any side length can be constructed in the above manner.

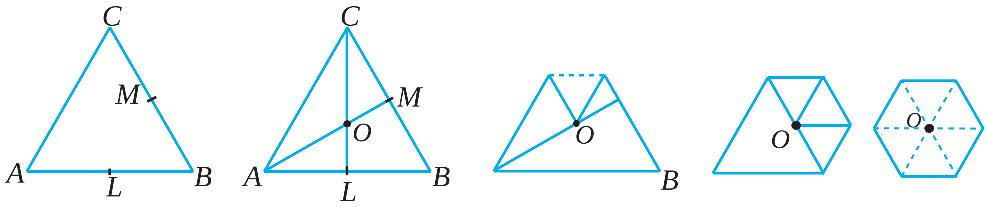
➤ Construct a regular hexagon of side length 3 cm.

Activity 1

Step 1 - Construct the equilateral triangle *ABC* of side length 3 cm on a piece of paper.

Step 2 - Mark the midpoint of *AB* as *L* and the midpoint of *BC* as *M*.

Step 3 - Join *MA* and *LC*. Name the point of intersection of *LC* and *MA* as *O*. Cut out the triangular lamina *ABC*.



Step 4 - Fold the triangle such that each vertex coincides with *O*. The figure that is obtained by doing this is a regular hexagon.

Step 5 - Measure the length of a side of the regular hexagon.

- The length of a side of the regular hexagon is 1 cm.
- That is, the length of a side of the original equilateral triangle is 3 times the length of a side of the regular hexagon.

➤ Construct a regular hexagon of side length 3 cm by following the above steps.

Exercise 24.2

(1) (i) Construct the circle of radius 5 cm and centre *O*.

(ii) Construct the regular hexagon *ABCDEF* of side length 5 cm with its vertices on the above circle.

(iii) Join *OA*, *OB*, *OC*, *OD*, *OE* and *OF*. How many triangles do you get? Are they all equilateral triangles?

(2) Construct a regular hexagon of side length 6 cm.

(3) (i) Construct a straight line segment *AB* of length 5 cm.
(ii) Create two equilateral triangles, each of which has *AB* as a side.

(4) (i) Construct a circle of radius 4 cm.
(ii) Construct a regular hexagon with its vertices on the above circle.
(iii) By producing three sides of the hexagon obtain an equilateral triangle.

(5) (i) Construct a circle of radius 5 cm.
(ii) Construct a regular hexagon with its vertices on the above circle.
(iii) Construct three equilateral triangles on three sides of the hexagon, leaving out a side of the hexagon between two triangles.
(iv) What is the shape of the total figure?

Summary

- The construction of an equilateral triangle can be done in four steps.
  - Construct a straight line segment.
  - Taking the same length as the straight line segment onto the pair of compasses, construct an arc placing the point of the pair of compasses at one end of the line segment.
  - Construct an arc from the other end point, using the same length as above, such that it intersects the earlier arc.
  - Join the intersection point to the end points of the straight line segment.
- A regular hexagon can be constructed by performing the following steps.
  - Construct a circle.
  - Divide the circle into 6 equal parts by intersecting the circle with arcs of the same length as the radius of the circle.
  - Join the points of intersection.

25

Solids

By studying this lesson you will be able to

- prepare models of a square pyramid and a triangular prism,
- draw the net of a square pyramid and a triangular prism on a square ruled paper, and
- know Euler's relationship for the above solids by considering the number of edges, vertices and faces of these solids.

25.1 Introduction of Solids

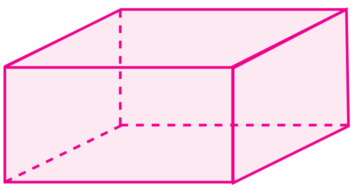

A die

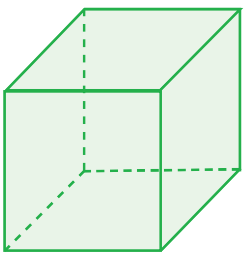

A brick

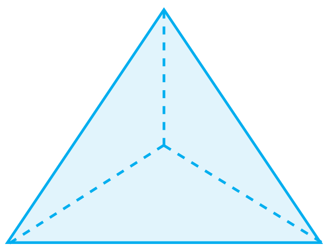

A putt


A concrete post

You have learnt that an object such as a die, an iron ball or a concrete pillar, which has a specific shape and which occupies a certain amount of space is called a solid object. You have also learnt in grade 6 that the surfaces of solid objects can be plane surfaces or curved surfaces.


A cuboid


A cube


A regular tetrahedron

Do the review exercise to recall the facts you have learnt about solids.

Review Exercise

(1) (i) Write down the number of faces, edges and vertices of a cuboid.
(ii) Draw a net that can be used to construct a cuboid.

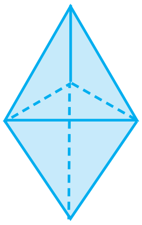
(2) (i) What is the shape of a face of a cube?
(ii) Draw a net that can be used to construct a cube.

(3) Write down the number of faces, edges and vertices of a regular tetrahedron.

(4) (i) Draw the shape of a face of a regular tetrahedron.
(ii) Draw a net that can be used to make a regular tetrahedron.

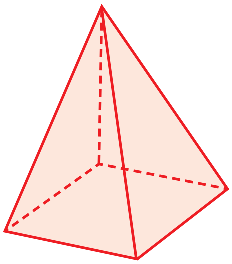
(5) Below is the figure of a solid object constructed by pasting two faces of two identical regular tetrahedrons, one on the other.

(i) How many faces are there in this solid?
(ii) How many edges are there in this solid?
(iii) How many vertices are there in this solid?



25.2 Square pyramid

Tombs of the Pharaohs who ruled in Egypt were built in this shape. They are called pyramids.

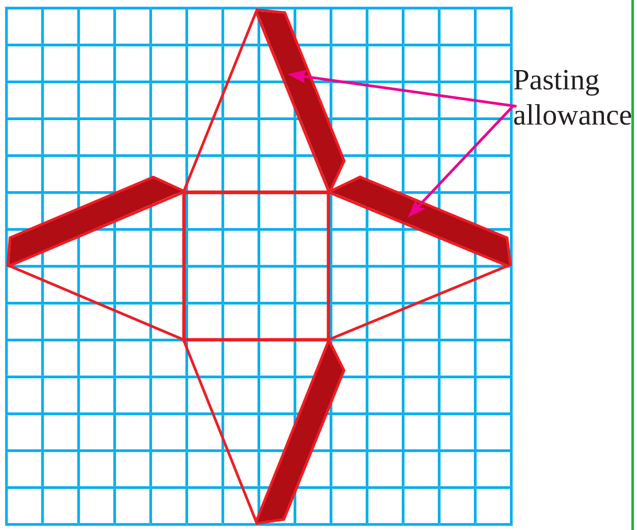


A solid object with a square base and four equal triangular faces is called a **square pyramid**. The figure illustrates a square pyramid.

Let us identify the characteristics of a square pyramid by engaging in the following activity.

Activity 1

Step 1- Draw the given figure on a square ruled paper. Cut out the figure that you drew and either copy it or paste it on a thick piece of paper such as a Bristol board.

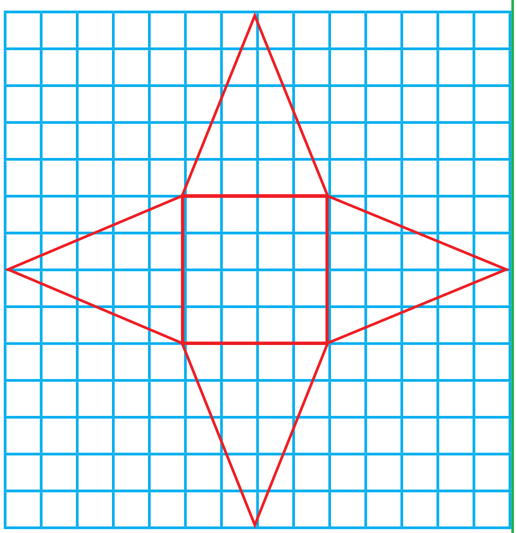


Step 2 - Cut out the figure drawn or pasted on the Bristol board and prepare a model of a square pyramid by folding along the edges and pasting along the pasting allowances.

Step 3 - Based on the model you prepared, find the number of faces, edges and vertices of a square pyramid. Examine the specific features of the model.

Step 4 - Write down the specific features you identified in your exercise book.

Step 5 - Measure and write down the lengths of the edges of the model.



The figure you obtain by removing the pasting allowances of the above figure which was used to prepare a model of a square pyramid, is called the "**net of the square pyramid**".

The object you prepared during the above activity is a model of a square pyramid.

Features you can identify in a square pyramid

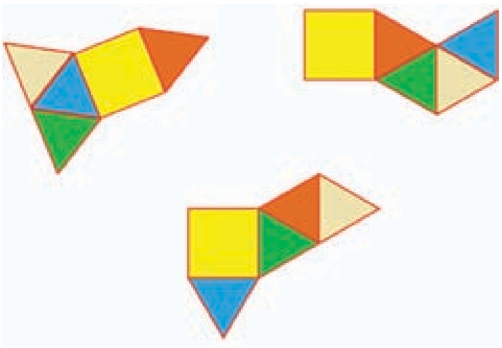
- There are 5 faces in a square pyramid.
- One face has a square shape.
- The other 4 faces take the shape of equal triangles.
- There are 5 vertices in a square pyramid.
- There are 8 edges in a square pyramid. All are straight edges.

Activity 2

(1) Draw each shape given in the figure on a square ruled paper.

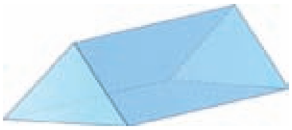
(2) Cut out each shape, fold along the edges and paste them using sellotape.

(3) What is the name of each of the solids you get?



25.3 Triangular Prism

A figure of a kaleidoscope which is an object through which a pattern of multiple images can be observed is given here. It is made out of 3 rectangular plane mirrors.

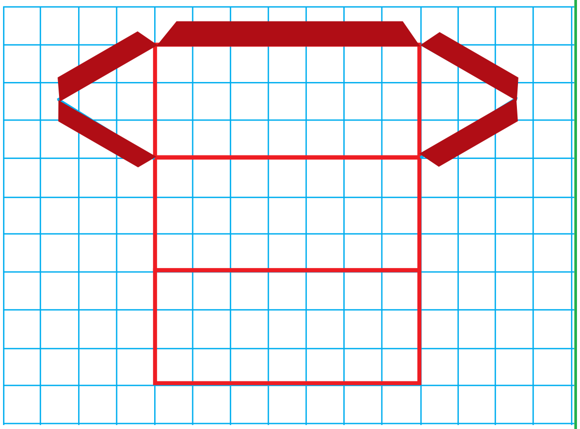


A solid object which has 3 rectangular plane faces and two triangular faces is called a "**triangular prism**".

Let us identify the characteristics of a triangular prism by engaging in the following activity.

Activity 3

Step 1 - Draw the given figure on a square ruled paper. Cut out the figure that you drew and either copy it or paste it on a thick piece of paper such as a Bristol board.

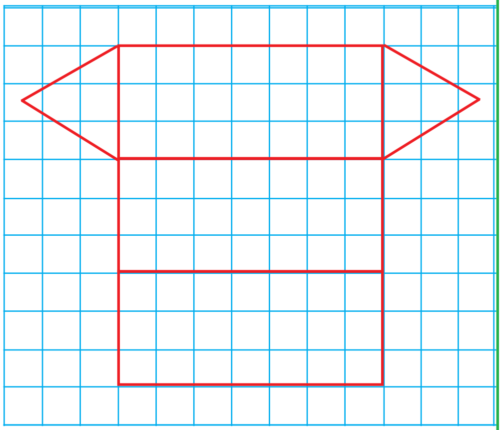


Step 2 - Cut out the figure drawn or pasted on the Bristol board and prepare a model of a triangular prism by folding along the edges and pasting along the pasting allowances.

Step 3 - Based on the model you prepared, find the number of faces, edges and vertices of a triangular prism. Examine other specific features of the model.

Step 4 - Write down the specific features you identified in your exercise book.

The figure you obtain by removing the pasting allowances of the above figure which was used to prepare a model of a triangular prism, is called the "**net of the triangular prism**".



Features you can identify in a triangular prism

- There are 5 faces in a triangular prism.
- There are 2 triangular shaped faces in a triangular prism. They are equal in size and shape.
- The other 3 faces of a triangular prism are of rectangular shape.
- There are 9 edges in a triangular prism. All are straight edges.
- There are 6 vertices in a triangular prism.

Exercise 25.1

(1) Write down the number of faces, edges and vertices of a square pyramid.

(2) Construct two square pyramids of equal measurements using Bristol board.

(i) Paste together the square faces of the two pyramids you constructed.

(ii) Write down the number of faces, edges and vertices of the solid object you obtained in the above step.

(3) Draw the figure of another net which can be used to prepare a square pyramid.

(4) Write down the number of faces, edges and vertices of a triangular prism.

(5) Write down the number of faces, edges and vertices of the solid you obtain by overlapping and pasting together two equal rectangular faces of two identical triangular prisms.

(6) Draw different nets that can be used to construct a triangular prism.

25.4 Euler's Relationship

Fill in the blanks in the table given below based on the solids you studied in grade 6 and by observing the solids you constructed in activities 1 and 3.

Solid	Number of vertices (V)	Number of faces (F)	Sum of the number of vertices and the number of faces $(V+F)$	Number of edges (E)
Cube	8	6	$8+6=14$	12
Cuboid	....	....	....	....
Regular tetrahedron	....	....	....	....
Square pyramid	....	....	....	....
Triangular prism	....	....	....	....

After completing the table, turn your attention to the $(V+F)$ column and the"E" column. With regard to the above solids, notice that the values in the $(V+F)$ column are always greater by 2 than the values in the"E" column.

Accordingly, for the above solids, the sum of the number of faces and the number of vertices is equal to the value obtained by adding 2 to the number of edges.

Number of Vertices + Number of Faces = Number of Edges + 2

$$V + F = E + 2$$

The above relationship which is true for solids with plane faces only, was first presented in the 18th century by a Swiss mathematician called "Leonhard Euler" who lived in Switzerland. Therefore this relationship was later called Euler's formula.

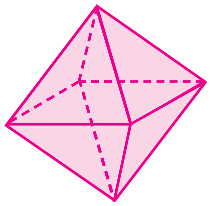
Exercise 25.2

(1) A certain solid has 6 faces and 8 vertices. Find the number of edges of the solid using Euler's relationship.

(2) If a certain solid has 8 edges and 5 faces, find the number of vertices of the solid.

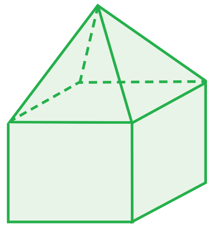
(3) Verify Euler's relationship for a triangular prism, by considering the number of faces, vertices and edges it has.

(4) A solid constructed by coinciding and pasting the square faces of two identical square pyramids is shown in the figure.

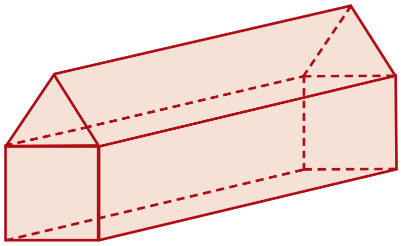


(i) Find the number of edges, faces and vertices of this solid.

(ii) Show that the above values satisfy Euler's relationship.



(5) A solid constructed by combining a cube and a square pyramid is shown in the figure. Find the number of edges, faces and vertices of the solid and check whether they satisfy Euler's relationship.



(6) The solid shown in the figure has been constructed using a cuboid and a triangular prism. Validate Euler's relationship for this solid.

(7) Construct a cube and 6 square pyramids with bases that are equal to a face of the cube. Construct a composite solid by pasting the square faces of the 6 pyramids on the six faces of the cube.

(i) How many edges, faces and vertices are there in the composite solid?

(ii) Do these values agree with Euler's relationship?

Summary

- A solid that consists of a square base and 4 identical triangular faces having a common vertex is called a square pyramid.
- A square pyramid consists of 8 edges, 5 faces and 5 vertices.
- A solid with 3 rectangular faces and 2 parallel triangular faces is called a triangular prism.
- A triangular prism consists of 9 edges, 5 faces and 6 vertices.
- If a solid has E number of edges, F number of faces and V number of vertices, $V + F = E + 2$ denotes Euler's relationship.

26

Data Representation and Interpretation

By studying this lesson you will be able to

- represent data in column/bar graphs and multiple column graphs and
- interpret data represented in column graphs and multiple column graphs

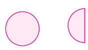
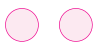
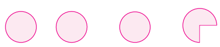
26.1 Column/Bar Graphs

Let us consider briefly what you learnt in Grade 6 about representing data in tables and pie-charts.

The given table provides information on how 39 employees of a certain office travel to work. The employees have been divided into four groups based on their mode of transport. Each group is called a category.

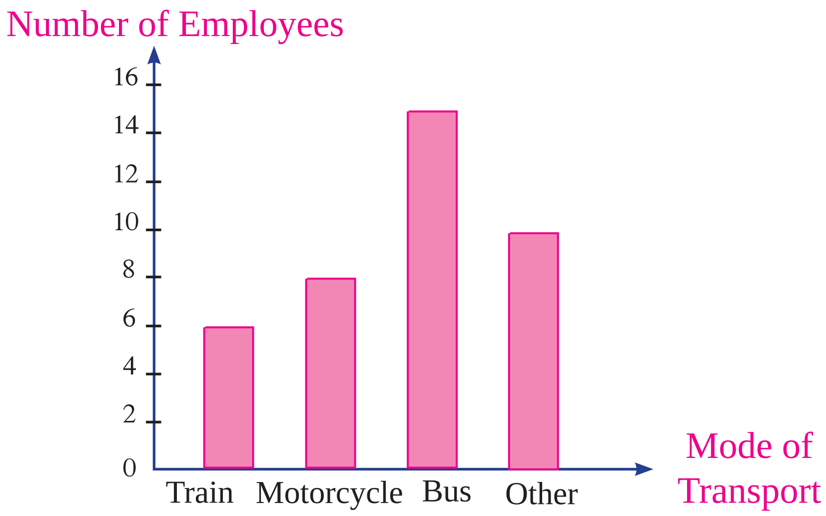
Mode of Transport	Number of Employees
Train	6
Motorcycle	8
Bus	15
Other	10

Let us represent this information in a picture graph. Let us represent 4 employees by . Accordingly, two employees are represented by half a circular shape , three employees are represented by three quarter of a circular shape and one employee is represented by a quarter of a circular shape .

Mode of Transport	Number of Employees
Train	
Motorcycle	
Bus	
Other	

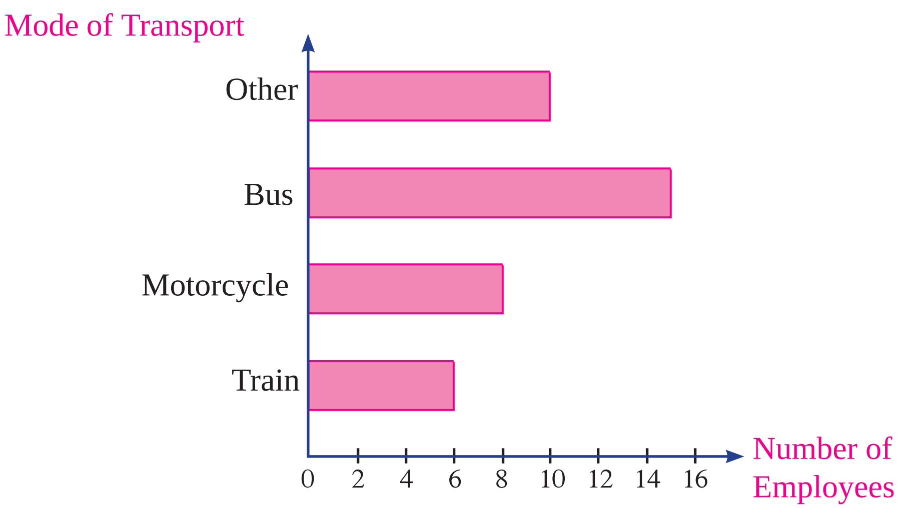
 Represents four employees

Let us represent this information using columns of equal width instead of pictures. Then a graph of the following form is obtained.



Graphs of the above form are called **column graphs**. These columns are of equal width and the gaps between the columns too are equal in size. The height of each column is equal to the number (amount) corresponding to the given category.

This information can also be represented by horizontal bars. Then the graph of the following form is obtained.

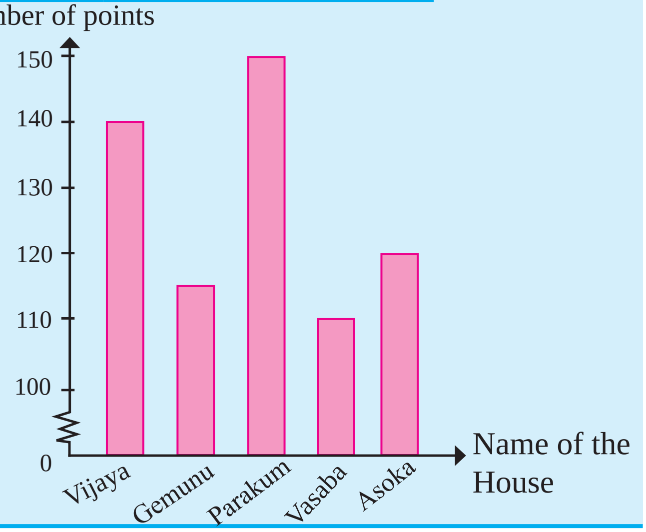


Example 1

The total points gained by each of the houses at the 2015 annual sports meet of a school with more than 5000 students are given in the following table. Represent this information in a column graph.

Name of the House	Total number of points
Vijaya	140
Gemunu	115
Parakum	150
Vasaba	110
Asoka	120

To indicate that the distance between 0 and 100 along the vertical axis in the column graph, which represents the total number of points, is less than what is should be, the symbol ≸ is used.

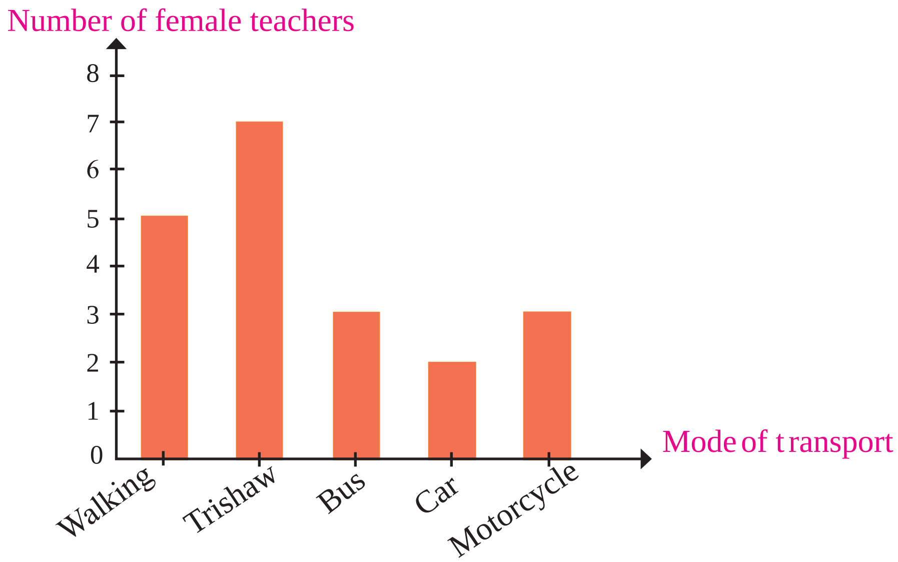


26.2 Multiple Column Graphs

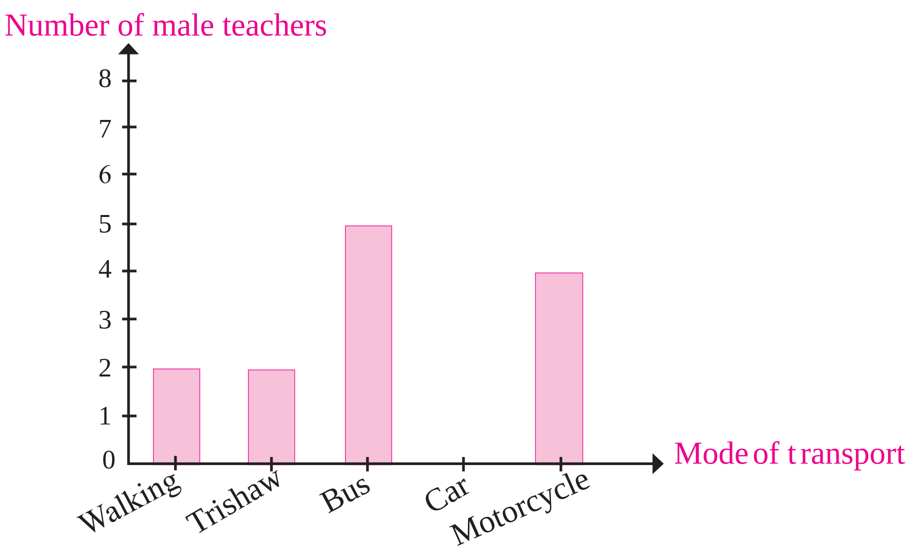
The following table provides information on how the teachers of a certain Maha Vidyalaya in a rural area travel to school. The teachers have been separated into five categories, and each category has been further divided into two subcategories named Male and Female.

Mode of Transport	Teacher	
	Female	Male
Walking	5	2
Trishaw	7	2
Bus	3	5
Car	2	0
Motorcycle	3	4

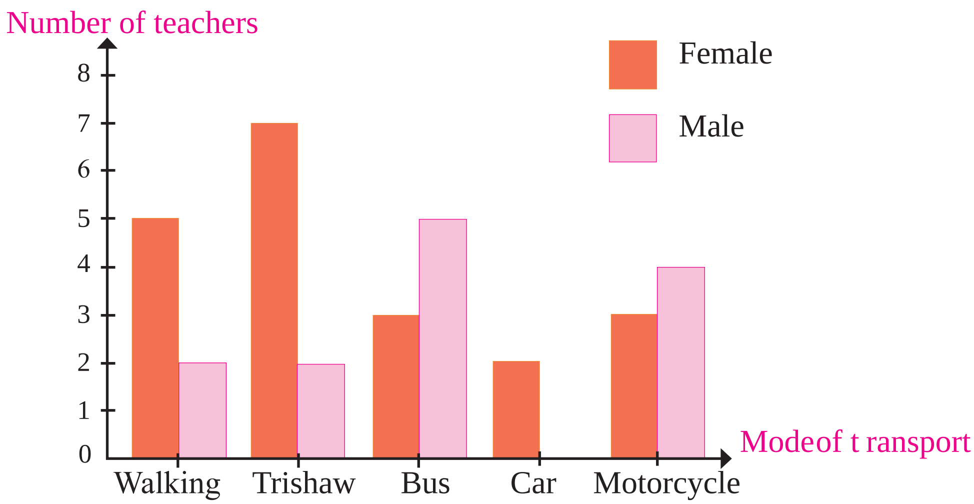
Information on how the female teachers travel to school is represented in the following column graph.



Information on how the male teachers travel to school is represented in the following column graph.



Information on how all the teachers travel to school is represented in the following multiple column graph.



In this graph too the columns are of equal width. The columns corresponding to the subcategories of each category have been drawn such that they border each other. Such graphs are called **multiple column graphs**.

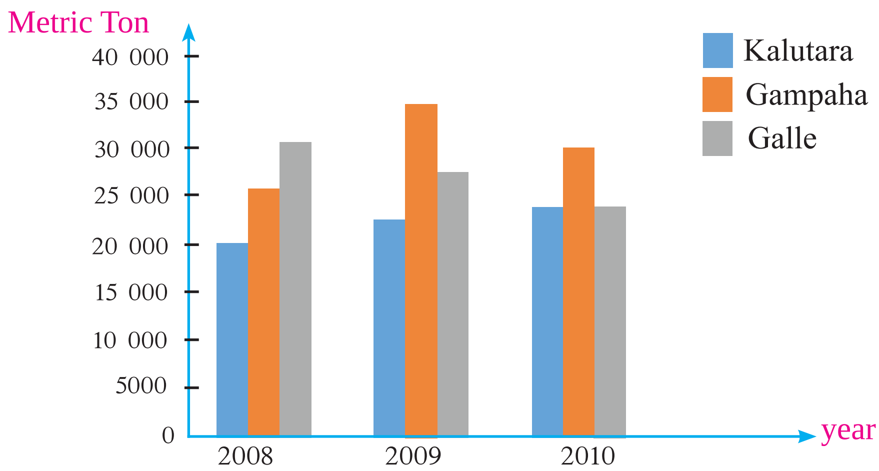
In the above example, the first two graphs have been drawn to provide an explanation. When drawing such graphs, represent all the information in one graph as in the third graph.

By representing the information by a multiple column graph, the information can be compared more easily.

26.3 Interpretation of Data

Now let us extract information from column graphs and multiple column graphs.

The following graph provides information on the paddy production during the Yala season in the districts of Gampaha, Kalutara and Galle.



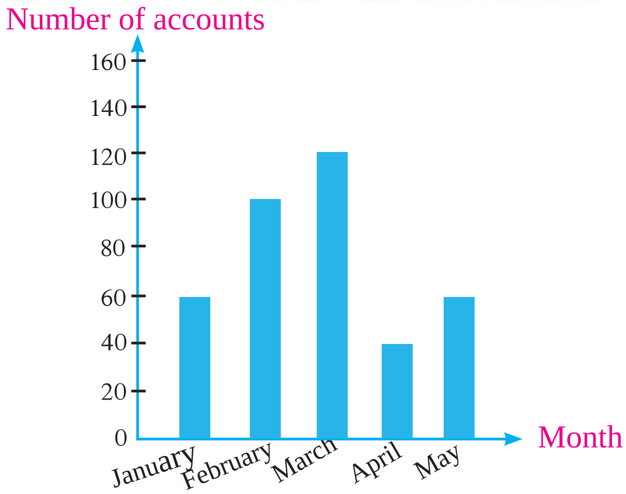
Let us carefully observe the above graph.

- It is a multiple column graph.
- During the Yala season, in the Gampaha district, the paddy production was highest in the year 2009 and lowest in the year 2008.
- The paddy production in the Kalutara district gradually increased during the period 2008 – 2010.
- The paddy production in the Galle district gradually decreased during the period 2008 – 2010.
- The paddy production in the year 2008 in all three districts was 75 000 metric tons.

Several conclusions that were drawn from the graph have been given above.

Exercise 26.1

(1) The following graph represents information on the savings accounts that were opened during the first five months of a year at a branch of a certain bank.



(i) In which month has the most number of savings accounts been opened?

(ii) In which month has the least number of savings accounts been opened?

(iii) In which two months have an equal number of savings accounts been opened?

(iv) How many savings account holders opened their accounts in the month of January?

(v) How many savings account holders in total opened accounts during the period from January to March?

(vi) How many more people had opened accounts in March than in April?

(2) A table with information on the number of coconuts that were plucked from a certain estate during the year 2014 is given below.

Month	**Coconut Yield (To the nearest 10 fruits)**
January	200
March	280
May	200
July	400
September	250
November	150

Represent this information by a column graph and answer the following questions based on the graph.

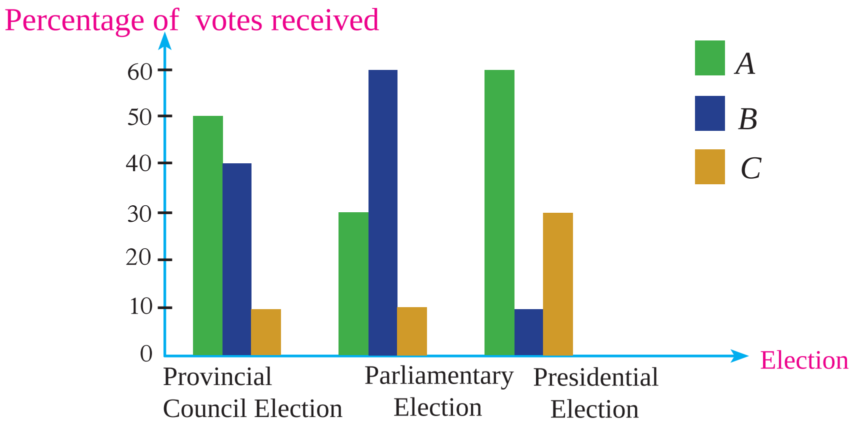
(i) Name the month with the highest yield.

(ii) In which month was the yield the lowest?

(iii) Write down the two months in which the yields were the same.

(iv) Is it easier to extract information from the table or from the column graph?

(3) The following graph represents information on the percentage of votes received by three political parties from the total votes cast during the three most recently held elections in a certain electoral district.



(a) Answer the following questions based on the above multiple column graph.

(i) Which party has received the most number of votes in the Provincial Council Election?

(ii) Which party has succeeded in increasing their percentage of votes from the Provincial Council Election to the Parliamentary Election?

(iii) In which election has the political party A received the highest percentage of votes?

(iv) Which party has received a lesser percentage of votes in the Presidential Election than in the Parliamentary Election?

(v) Which party received the highest percentage of votes in the Parliamentary Election?

(b) Draw another multiple column graph to represent the above information with the horizontal axis denoting the percentage of votes received by the three parties *A*, *B* and *C* and the vertical axis representing the three elections.

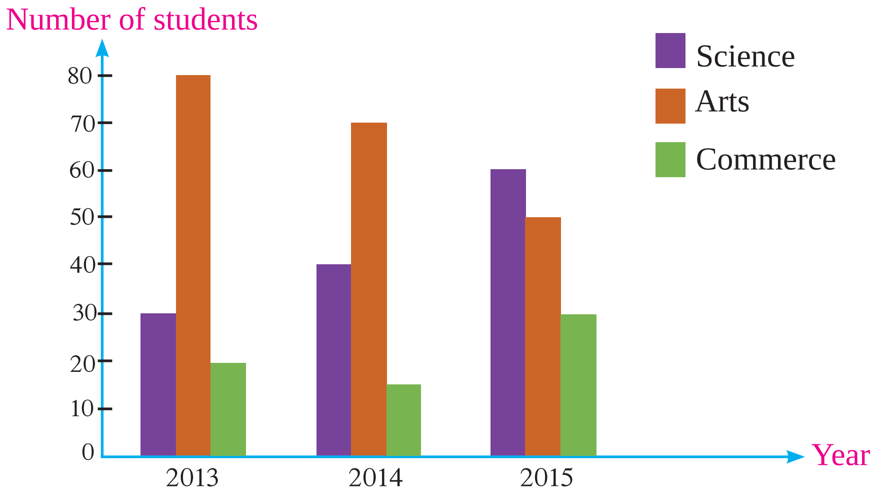
(4) A table prepared by the sports teacher of a certain school on the types of sports that students in grades 6 – 11 participate in is given below. Each grade has 100 students. (Assume that students who participate in one type of sport do not participate in the other type).

Grade	Number of Students	
	Indoor sports	Outdoor sports
6	10	90
7	35	65
8	15	85
9	15	85
10	40	60
11	45	55

Represent the information in the above table by a suitable multiple column graph and answer the following questions.

(i) Students of which grade participate in outdoor sports the most?
(ii) Which grade has the most number of students participating in indoor sports?
(iii) Which grade has the least number of students participating in outdoor sports?
(iv) Which grade has the greatest difference between the number of students who participate in outdoor sports and the number of students who participate in indoor sports?

(5) The following multiple column graph provides information on the number of students who entered the different A'level subject streams at a certain school during three successive years.



(i) Which stream shows a gradual increase in the number of students entering the stream?

(ii) Which stream shows a gradual decrease in the number of students entering the stream?

(iii) In which year has the greatest number of students joined the A'level classes of this school?

(iv) If all the students who joined the A'level class in 2013 sat the examination in 2015, how many students in total faced the A'level examination in 2015 from this school?

Summary

- When data has been represented in a column graph or a multiple column graph, it can be interpreted, and information can be compared by considering the heights of the columns of the graph.

27 Scale Diagrams

By studying this lesson you will be able to

- identify scale diagrams, and
- draw scale diagrams and calculate actual measurements using the scale.

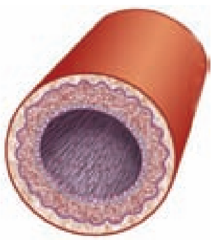
27.1 Scale Diagrams

When the shapes of various objects in the environment are being drawn, it is most often difficult to draw them to the actual measurements of the shape. In such situations, the shape is drawn by decreasing or increasing the measurements by a common ratio depending on the size of the shape.

Since the figure is drawn by increasing or decreasing all the measurements by a common ratio, the shape of the figure will be exactly the same as the original shape and only the size will be different. Figures drawn in this manner are called **scale diagrams**. A few such scale diagrams are shown below.

The plan of the floor area of a house; size has been decreased

The map of Sri Lanka; size has been decreased



The cross section of a blood vessel; size has been increased

27.2 The Scale of a Scale Diagram

Suppose you want to draw a scale diagram of a flower bed of length 6 m and breadth 2 m in your book. You need to first select a suitable scale.

Suppose 1 cm in the scale diagram represents a length of 1 m of the flower bed.

Since 1 m equals 100 cm, a length of 1 cm in the scale diagram represents 100 cm of actual length. As the same unit has been used, this can be expressed as a ratio as 1:100. This ratio is considered as **the scale** of the scale diagram.

Based on the selected scale, a scale diagram of the flower bed can be drawn, with the actual length of the flower bed which is 6 m represented by 6 cm and the actual breadth which is 2 m represented by 2 cm in the scale diagram.

2 cm

6 cm

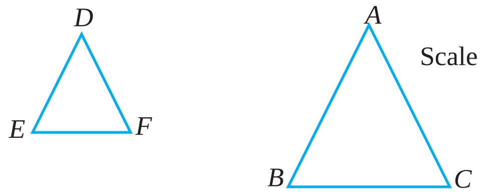
Scale 1: 100

The scale written as 1:100 in the figure expresses the fact that an actual length of 100 cm is represented by 1 cm in the scale diagram.

Observe carefully how the scales of various scale diagrams are indicated.

The scale diagram of the given triangle has been drawn to the scale 2:1.

Actual triangle



Scale diagram

Scale 2 : 1

Example 1

Express as a ratio, the scale of a scale diagram where 200 cm is represented by 1cm.

Since the same unit has been used, the scale can be expressed as a ratio as 1:200.

Example 2

Express as a ratio, the scale of a scale diagram where 9 m is represented by 2 cm.

$$\begin{aligned} \text{Length represented by } 2 \text{ cm} &= 9 \text{ m} \\ \text{Length represented by } 2 \text{ cm} &= 900 \text{ cm} \\ \text{Length represented by } 1 \text{ cm} &= 900 \div 2 \text{ cm} \\ &= 450 \text{ cm} \end{aligned}$$

The scale is $1 : 450$

Example 3

Express as a ratio, the scale of a scale diagram where 2 mm is represented by 1 cm.

$$\begin{aligned} \text{Length represented by } 1\text{cm} &= 2 \text{ mm} \\ \text{Length represented by } 10 \text{ mm} &= 2 \text{ mm} \end{aligned}$$

The scale is $10 : 2$ or $5 : 1$

This scale is used to magnify a small object.

Exercise 27.1

(1) Express the scale as a ratio in each of the following cases.

(i) Representing 20 cm by 1 cm
(ii) Representing 8 m by 2 cm
(iii) Representing 1 m by 4 cm
(iv) Representing 1 mm by 5 cm
(v) Representing 6 mm by 3 cm

27.3 Drawing scale diagrams

Let us gain an understanding of scale diagrams by considering the following examples.

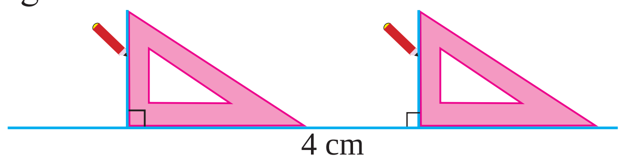
Let us draw a scale diagram of the blackboard in the classroom.

- The blackboard is rectangular in shape.
- Its length is 4 m and its breadth is 1 m.
- Let us consider that 1 m is represented by 1 cm as the scale. That means the scale is 1:100.
- So the scale diagram should be a rectangle of length 4 cm and breadth 1 cm.
- Let us mark the measurements in a sketch.

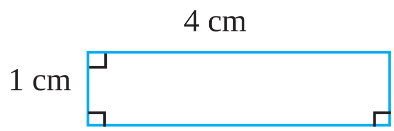
Follow the given steps to draw the scale diagram with this length and breadth.

Step 1 - Draw a straight line segment of length 4 cm using the ruler and the pencil.

Step 2 - Draw two perpendiculars of length 1 cm each at the two ends of the straight line segment using the set square as shown in the figure.



Step 3 - Complete the rectangle by joining the end points of the two perpendiculars.



Exercise 27.2

(1) The length of a hall in a particular school is 20 m and the width (breadth) is 8 m.

(i) Select a suitable scale to draw the floor plan of the hall and write it as a ratio.

(ii) Draw a scale diagram of the floor plan of the hall.

(2) The side length of a square shaped land is 24 m. Draw a scale diagram of the land using the scale 1:600.

(3) The length of a rectangular building is 30 m and the width is 18 m.

(i) Select a suitable scale to draw the scale diagram of the floor of the building.

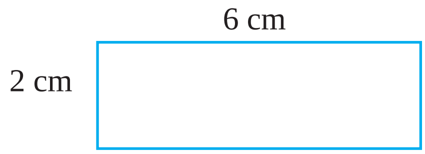
(ii) Draw the scale diagram of the floor of the building using the selected scale.

27.4 Obtaining actual measurements from scale diagrams

Let us see how the actual measurements can be obtained from a given scale diagram by considering a few examples.

A scale diagram of a land drawn to the scale 1:500 is shown in the figure. Let us find;

(i) the actual length of the land,
(ii) the actual width of the land,
(iii) the actual area of the land.



The scale 1:500 indicates that 500 cm or 5m of the actual length of the land is represented by 1 cm in the scale diagram.

Therefore;

(i) the actual length of the land $= 6 \times 5 \text{ m} = 30 \text{ m}$
(ii) the actual width of the land $= 2 \times 5 \text{ m} = 10 \text{ m}$
(iii) the actual area of the land $= \text{length} \times \text{width} = 30 \times 10 \text{ m}^2$
$= 300 \text{ m}^2$

Example 1

A square shaped land is drawn to the scale 1: 400. The side length of the scale drawing is 2.5 cm. Calculate the side length of the land.

1 : 400 means that 400 cm or 4 m is represented by 1 cm in the scale diagram.

Therefore, side length of the land $= 2.5 \times 4 \text{ m}$
$= 10 \text{ m}$

Example 2

What length in a scale diagram drawn to the scale 1: 10 000 represents an actual length of 1 km?

1:10 000 means that 10 000 cm is represented by 1 cm in the scale diagram.
$10\ 000 \text{ cm} = 100 \text{ m} = 0.1 \text{ km}$
That is, 0.1 km is represented by 1 cm in the scale diagram.
$\therefore$ 1 km is represented by 10 cm in the scale diagram.

Exercise 27.3

(1) In a map drawn to the scale 1:200,

(i) find the actual length represented by 3 cm.

(ii) find the actual length represented by 5 cm.

(iii) what length in the map represents an actual length of 8 m?

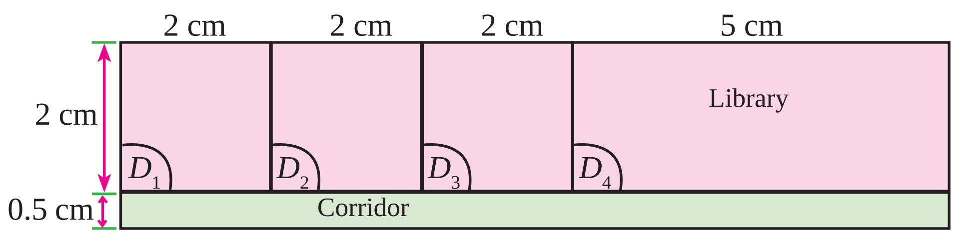
(2) In a map drawn to the scale 1:200 000,

(i) what is the actual distance between two cities indicated by a distance of 7 cm?

(ii) what length in the map represents a distance of 1 km?

(iii) If the distance from Colombo to Balangoda along the A4 road is 142 km, what is the distance between the two cities in the map?

(3) A scale diagram of the ground floor of a multi-storey building in a school is shown below. The floor plan consists of 3 classrooms, a library and a corridor. The scale is 1:200.



(i) Find the actual length and width of a classroom in metres.

(ii) Find the actual area of a classroom.

(iii) Find the actual area of the library.

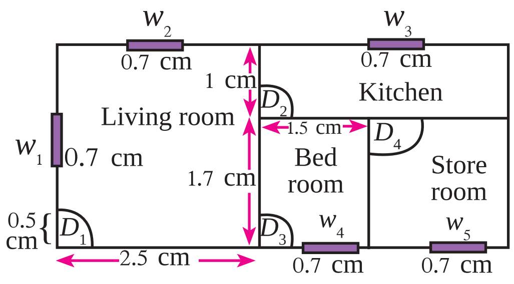
(iv) Find the actual area of the corridor.

(4) The floor plan of a house is shown in the figure. The scale is 1:200.

(i) Find the actual width of the door D_1.

(ii) Find the actual length of the window w_1.

(iii) Find the actual length and width of the bedroom and hence find the area of the bedroom.



(iv) Find the area of the living room.

(v) It is proposed to lay tiles in the living room. Estimate the number of square tiles of side length 50 cm required for this purpose.

Summary

- When a scale diagram of a shape is being drawn, it has to be done by decreasing or increasing the measurements by a common ratio, depending on the size of the shape.
- The ratio of a unit length to the actual length represented by a unit length in a scale diagram is considered as the scale of the scale diagram.

28

Tessellation

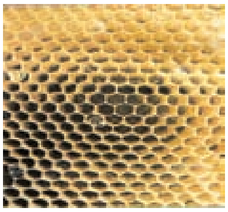
By studying this lesson you will be able to

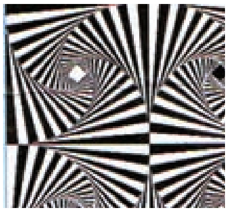
- understand what tessellation is,
- identify pure tessellations and semi pure tessellations, and
- create tessellations.

28.1 Introducing Tessellation

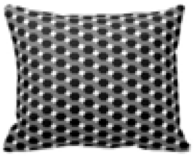
Figures of surfaces which are attractive due to a certain shape occurring repeatedly in an organized manner are given below. Each of these creations enhances the beauty of the environment.

The fact that the shape that recurs is of one size and the shapes are organized in a pattern without any gaps in between them reveals the wonder of nature. Let us consider such creations further.





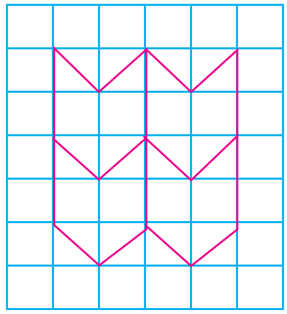
We have seen how bricks and tiles have been laid in attractive designs on the floors, roofs and courtyards of places of worship. Moreover, most bed spreads and clothes have beautiful designs on them. Several such designs are shown below. See whether you can identify the shapes in them.



Tessellation is the process of creating a design consisting of the repeated use of one or more shapes, closely fitted together without gaps or overlaps, on a plane surface.

Based on this description, we can identify the creations in the above figures as tessellations.

Activity 1



Step 1 - Create a design by repeatedly drawing the shape in this figure on a page in your square ruled exercise book.

Step 2 - Colour your design appropriately and make it an attractive work of art.

On completing the above activity you would have ended up with a very attractive tessellation.

28.2 Pure Tessellation

Activity 2

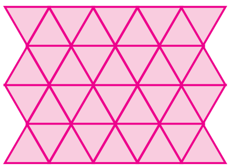


Figure 1

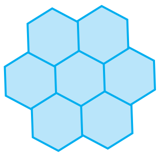


Figure 2

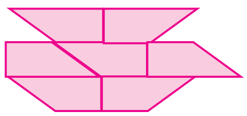


Figure 3

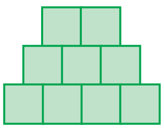


Figure 4

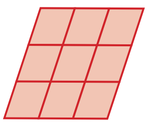


Figure 5

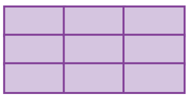


Figure 6

Figures of several tessellations that have been created using various shapes are given above. Copy the table given below and complete it after carefully observing the above tessellations.

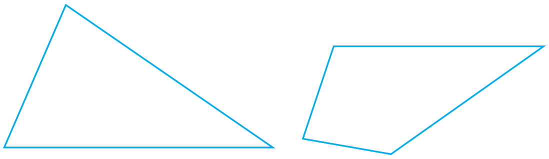
Figure	Sketch of the shape
1	
2	
3	
4	
5	
6	

From the above activity it is clear that tessellation can be done using various shapes.

Tessellation that is done using just one shape is called pure tessellation.

According to this, all the tessellations considered in the above activity are pure tessellations.

Activity 3



Step 1 - Copy the triangle in the figure and cut out 10 triangular laminas of the same size using coloured paper.

Step 2 - By using the cut out laminas, create a pure tessellation and paste it on a page of your exercise book.

Step 3 - Copy the given quadrilateral and create a pure tessellation as above, and paste it on a page of your exercise book.

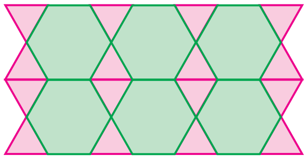
Exercise 28.1

(1) Write down two facts that need to be considered when creating a tessellation.

(2) What is a pure tessellation?

(3) Create a pure tessellation by using any shape you like and paste it on your exercise book.

28.3 Semi pure tessellation

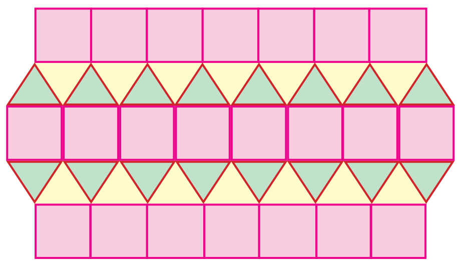


The above figure shows two tessellations that have been created using different shapes. Examine and see whether you can identify the shapes in the two figures.

Tessellation that is done using two or more different shapes is called semi pure tessellation.

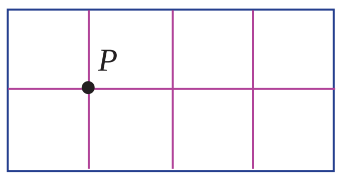
Activity 4

The figure shows a tessellation that has been created using triangles and quadrilaterals.



Create another tessellation using triangles and quadrilaterals and paste it in your exercise book.

The figure shows a tessellation that has been created using squares. A point at which vertices of several of these squares meet has been marked as P. As depicted in the figure, the angles of four squares are around the point P. Let us consider the sum of the angles around the point P.



The magnitude of an interior angle of the square $= 90^{\circ}$

$\therefore$ the sum of the angles around the point $P = 90^{\circ} \times 4 = 360^{\circ}$

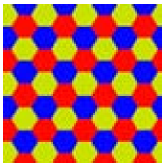
We can similarly show that the sum of the angles around any point is equal to 360°.

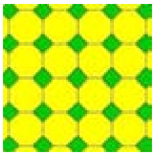
The sum of the angles around a vertex point of a tessellation created using rectilinear plane figures is 360°.

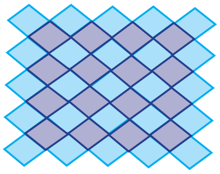
Accordingly, the shapes that are selected to create a tessellation should be such that the angle of 360° around a point can be covered by them without gaps and overlaps.

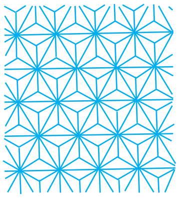
Exercise 28.2

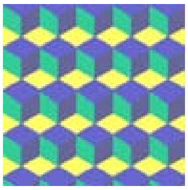
(1) For each of the following tessellations, write down with reasons whether it is a pure tessellation or a semi pure tessellation.

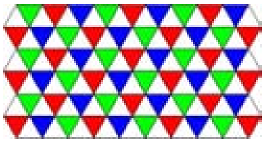

(i)

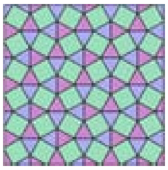

(ii)


(iii)

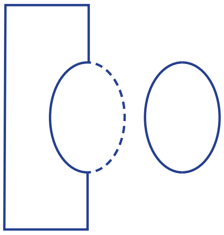

(iv)

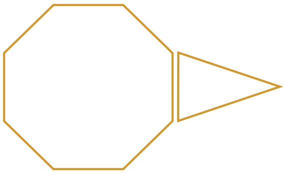

(v)

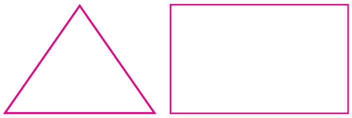

(vi)


(vii)

(2) From the following, select the pairs of shapes that can be used to create semi pure tessellations.


(a)

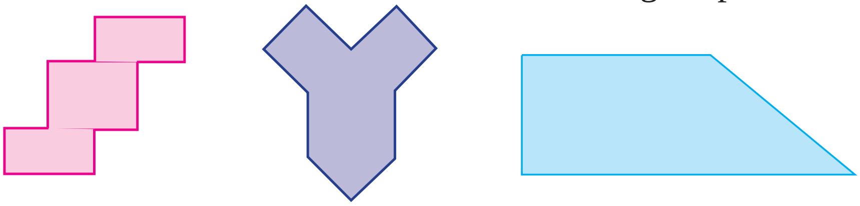

(b)


(c)

Activity 5

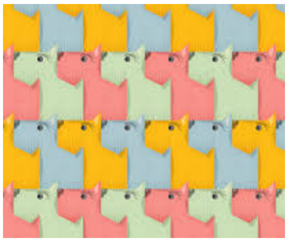
(1) Create a semi pure tessellation using two or more shapes that you like, and paste it in your exercise book.

(2) Create tessellations with each of the following shapes.



28. 4 Creating tessellation designs



Activity 6

Step 1 - Cut out a rectangular shaped lamina.

Step 2 - On the lamina that you cut out, draw any shape that you like as shown in Figure 1. Now cut and separate out the shape you drew.

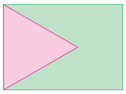


Figure 1

Step 3 - Paste the two parts that you obtained in Step 2 on a piece of cardboard as shown in Figure 2.

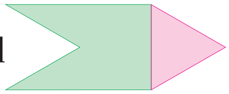
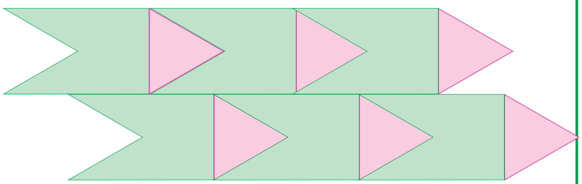


Figure 2

Step 4 - Using the net that you prepared in Step 3, cut out laminas using coloured paper and create a tessellation design.



- Following the steps of activity 6 above, create various attractive tessellation designs using different nets and display them.

Summary

- Tessellation is the process of creating a design consisting of the repeated use of one or more shapes, closely fitted together without gaps or overlaps, on a plane surface.
- Tessellation done using just one shape is called pure tessellation.
- Tessellation done using two or more shapes is called semi pure tessellation.

29 Likelihood of an Event Occurring

By studying this lesson you will be able to

- identify the events that definitely occur, the events that definitely do not occur and the event that occur randomly and
- describe the outcomes of an experiment.

29.1 Events

Let us consider the following events.

1. A stone which is lifted and released, falling downwards
2. The sun rising from the West
3. A tossed coin landing heads up
4. The next page turned in a Mathematics book being a whole numbered page
5. The cricketer getting out in the next ball
6. Appearance of the moon on a new-moon day
7. The sun rising tomorrow
8. Rain occurring this afternoon
9. A heavy stone floating on water
10. A train leaving at the scheduled time

Now let us divide these events into the following three types; the events that definitely occur, the events that definitely do not occur and the events which we cannot be certain will occur or not.

We know that the events 1, 4 and 7 will definitely occur. We also know that the events 2, 6 and 9 will definitely not occur. If we consider event 3, we cannot say for certain that a tossed coin will land heads up. Likewise it is not certain whether the events 5, 8 and 10 will occur or not.

So, the events we come across are of three types. They are, events that definitely occur, events that definitely do not occur and events that we cannot be certain will occur or not. The events which we cannot be certain will occur or not are called **random events**.

Activity 1

Write 2 examples each of random events, events that definitely occur and events that definitely do not occur.

Discuss your answers with the others in the class.

Exercise 29.1

(1) Write down whether each of the events given below, is an event which definitely occurs, an event which definitely does not occur or a random event.

(a) Of the two competing football teams A and B, team A winning the game

(b) When a red regular cube is tossed, the side that lands up being red

(c) A ball taken out of a bag which contains only 5 white balls, being a black ball

(d) The next passenger getting down from a bus being a woman

(e) When a regular cube with each of its six sides marked with one of 1, 2, 3, 4, 5 and 6 is rolled, the side with 5 turning up

(f) A stone thrown at a Mango tree with fruits, hitting a Mango

(g) A piece of wood placed on water, floating

(h) The youngest participant in a 100 m race for those under thirteen winning the race

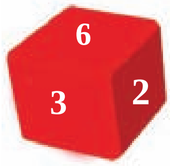
(i) Chathuri being a student who obtains more than 75 marks for Mathematics in the grade 7 year end examination

(2) In a school having 700 students, a prefect is chosen by the votes of all the students. Aravinda and Suranga have been proposed for this position.

(i) Find the least number of votes that Aravinda must get if he is to become the prefect.

(ii) Will a prefect always be elected through this method?

(3) The faces of a die are numbered 1, 2, 3, 4, 5 and 6. The die is rolled once. Write down whether each of the events given below is an event which will definitely occur, an event which will definitely not occur or a random event.



(i) Obtaining 8
(ii) Obtaining an even number
(iii) Obtaining 4
(iv) Obtaining a number which is less than 7

29.2 Experiments and Outcomes

The event, "the first commuter getting down from the bus is a woman" is a random event. This is because the first commuter getting down from the bus can be either a woman or a man. Before someone gets down from the bus, we cannot be certain which of these two events will occur. The experiment here is "observing whether the first commuter getting down from the bus is a woman or a man". The outcome will be either "the commuter is a woman" or "the commuter is a man".

For the event of "a stone which is lifted and released falling downwards" the relevant experiment is "observing a stone which is lifted and released". The outcome is "the stone falling downwards".

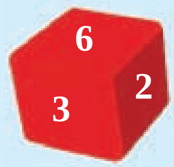
Furthermore, in experiments such as observing whether the sun rises from the East and observing whether a stone lifted and released falls downwards, the outcomes are definitely known before the experiment is conducted.

Let us consider the event of "a tossed coin landing tails up". In this case we cannot be certain whether heads or tails will land up. So the event is a random event. Here, the experiment is "observing the side that lands up when a coin is tossed". The outcome will be either "heads landing up" or "tails landing up".

Let us consider the event of "rain occurring this afternoon". This is a random event. The experiment is "observing whether it rains this afternoon". The outcome will be either "raining this afternoon" or "not raining this afternoon".

Example 1

The faces of a die are numbered 1, 2, 3, 4, 5 and 6. The die is rolled once and the number on the face that turns upward is observed. Write the set of outcomes of this experiment.



getting 1, getting 2, getting 3, getting 4, getting 5 and getting 6.

Exercise 29.2

(1) Write down the experiments and corresponding outcomes for each of the events in a, b, c, d and e under Exercise 29.1 (1).

29.3 The likelihood of obtaining each of the possible outcomes of an experiment

Let us examine the nature of each of the experiments given below.

- The faces of a regular die are numbered 1, 2, 3, 4, 5 and 6. The die is rolled once and the number on the face that turns upward is observed.

The outcomes of this experiment are getting 1, getting 2, getting 3, getting 4, getting 5 and getting 6. If each of these outcomes is equally likely to occur, then the die used in this experiment is called a "fair die" or an "unbiased die".

- A coin is tossed once and the side that lands up is observed.

The outcomes of this experiment are getting head and getting tail. If either one of these outcomes is equally likely to occur, then the coin used in this experiment is called “a fair coin “or an “unbiased coin”

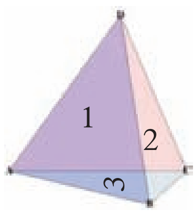
- A coin with one side made of aluminum and the other side of copper, where the quantities of aluminum and copper used are equal, is tossed once and the side that lands up is observed.

The outcomes of this experiment are “the aluminum side lands up” and “the copper side lands up”. Since the density of copper is more than the density of aluminum, the likelihood of the aluminum side landing up is greater than the likelihood of the copper side landing up. Therefore this is not a fair coin.

- A coconut shell similar to the one in the figure is tossed once and the side that lands up is observed.

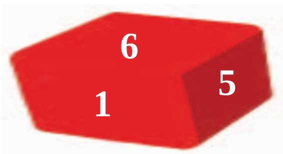
The outcomes of this experiment are “the shell lands up and “the shell lands down. Although there are only two outcomes, the likelihood of landing with the shell up is greater than the likelihood of landing with the shell down. Therefore, the coconut shell is not an unbiased object.

- The faces of a regular tetrahedron are numbered 1, 2, 3 and 4. The tetrahedron is rolled once and the number on the face that turns downward is observed.



The outcomes of this experiment are getting 1, getting 2, getting 3 and getting 4. If each of these is equally likely to occur, then this regular tetrahedron is a fair one.

- The faces of a cuboid are numbered 1, 2, 3, 4, 5 and 6. The cuboid is rolled once and the number on the face that turns upward is observed.



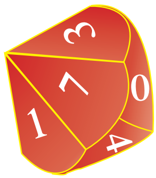
The outcomes of this experiment are getting 1, getting 2, getting 3, getting 4, getting 5 and getting 6. The areas of the faces of the cuboid are not the same. It is more likely for the cuboid to land with a face having the greatest area downwards. Therefore, of the six outcomes, certain events are more likely to occur than the others. So the cuboid is not a "fair object".

If each of the outcomes of an experiment is equally likely to occur, then the object used in the experiment is called a fair or an unbiased object.

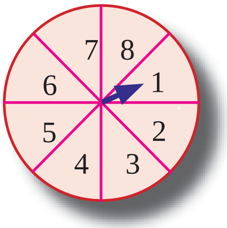
Exercise 29.3

(1) For each experiment below, write the set of outcomes and write down whether the experiment is carried out using a biased object or an unbiased object.

(i) The top in the figure, with its faces marked from 0 to 9 is spun and the face that touches the ground when it stops spinning is observed.



(ii) The figure shows a circular disc divided into 8 equal parts. The parts are numbered 1 to 8. One end of the indicator is fixed to the center and the other end is rotated. The number of the portion where the indicator stops is observed.



(2) Consider the figure below. Each circular disc is made to rotate around its centre. When the discs stop rotating, the colour indicated by the arrow head is observed. Explain whether each of the discs used in this experiment is fair or not.

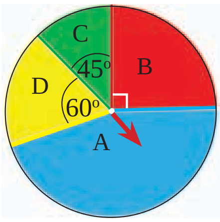


Figure 1

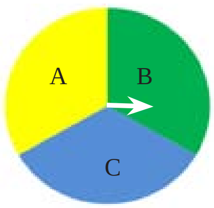


Figure 2

(3) Write two examples of experiments which are done using fair objects.

Summary

- The events which occur in our environment fall into one of the following three types. The events which definitely occur, the events which definitely do not occur and random events.
- The events that can occur in an experiment are called the outcomes of the experiment.
- If an experiment is carried out using an object, the object is considered to be an unbiased object (fair object) if all the outcomes of the experiment are equally likely and it is considered to be a biased object if the outcomes are not equally likely.

Revision Exercise 3

(1) (i) Write down a ratio equivalent to $2:8:5$.

(ii) Write down the number of faces, edges and vertices of a square pyramid.

(iii) Write down $1\frac{2}{5}$ as a decimal number.

(iv) Find the value of $64 - 125 \div 5$.

(v) Solve $2x + 8 = 16$.

(vi) Write down the ratio $14:49:35$ in its simplest form.

(vii) Find the highest common factor and least common multiple of 63 and 42.

(viii) Construct the straight line segment *AB* of length 6 cm.

(ix) Construct a circle of radius 4 cm.

(x) Write down the number of faces, edges and vertices in a triangular prism.

(xi) Write down all possible outcomes of the experiment of rolling an unbiased cubic die which has its six sides marked 1, 2, 3, 4, 5 and 6.

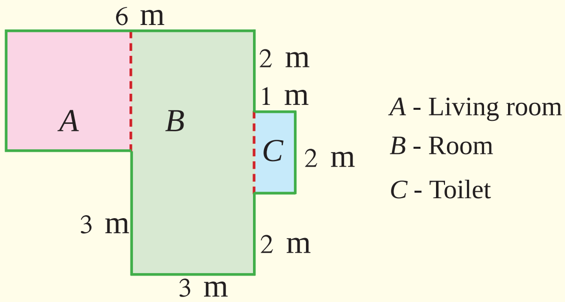
(xii) The length and width of a rectangular land drawn to the scale $1:200$ are 7 cm and 2.5 cm respectively. Find the actual length and width of the land.

(xiii) In a nutritious instant food packet, green gram, soya and rice are mixed in the ratio $1:1:3$. Find the amount of rice that is included in one such 100 g food packet.

(xiv) Write down Euler's relationship.

(xv) Construct an equilateral triangle of side length 8 cm. Name it *ABC*.

(2) The floor plan of a restroom in a tourist inn is shown below.



(i) The living room is square shaped. What is the length of a side of this room?

(ii) Find the area of the living room.

(iii) Find the area of the room.

(iv) Find the area of the toilet.

(v) Find the total perimeter of the restroom.

(vi) It is required to tile the floor of the room with $50 \text{ cm} \times 50 \text{ cm}$ square tiles. Find the number of tiles that can be laid in a widthwise row and the number of tiles that can be laid in a lengthwise row. Thereby, obtain the total number of tiles that is required for this purpose.

(vii) Draw a scale diagram of this floor plan using the scale 1 : 100.

(viii) What is the ratio of the length of the room to that of the toilet?

(3) (a) It has been decided to recruit male and female workers to a newly opened garment factory in the ratio 4 : 9.

(i) If the total number of workers that are to be recruited is 260, find separately, the number of male and female workers that are to be recruited.

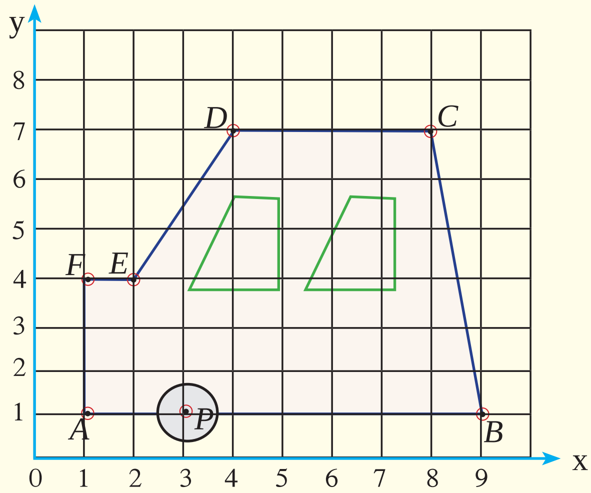
(ii) The ratio of the monthly salary of a male worker to that of a female worker is 5 : 4. If the monthly salary of a female worker is Rs 24 000, find the monthly salary of a male worker.

(4) 25 contestants participated in the 1st round of a poetry recitation competition. 12 contestants qualified for the 2nd round.

(i) Express the number of contestants who qualified for the 2nd round as a fraction of the total number of contestants.

(ii) Express the number of contestants who qualified for the 2nd round as a percentage of the total number of contestants.

(5) An incomplete figure of a motor car which has been drawn in a Cartesian plane is shown here.



(i) Draw this diagram in a Cartesian plane.

(ii) Which point is represented by the ordered pair (4,7)?

(iii) Write down the coordinates of the points *A*, *P*, *B*, *C*, D, *E* and *F* as ordered pairs.

(iv) If the coordinates of the centre of the back wheel is (7, 1), mark this centre and draw the wheel.

(6) (i) Construct a circle of radius 6 cm.

(ii) Construct a regular hexagon with its vertices on this circle.

(iii) Construct an equilateral triangle on each side of the hexagon, external to it.

(iv) Find the perimeter of one of the two largest triangles that you get when you complete the above step.

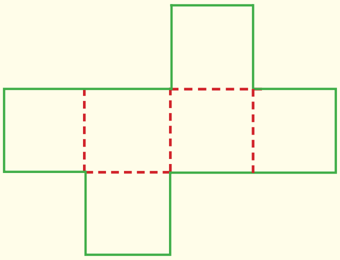
(v) What is the shape you get when you connect the vertices of the 6 equilateral triangles that do not lie on the original hexagon?

(7) (i) 5 m is represented by 1 cm in a scale diagram. Express this scale as a ratio.

(ii) Find the actual length of a house which is represented by 8 cm in a scale diagram drawn to the scale 1: 200.

(iii) The length of a school building is 20 m and its width is 6 m. Draw a scale diagram of this building using the scale 1 : 100.

(8) A net of a solid object is shown here. There are 6 equal squares of side length 6 cm.



(i) Write down the name of the solid that can be constructed by folding along the dotted lines.

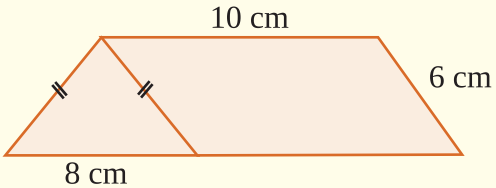
(ii) Considering the number of vertices, edges and faces of this solid object, show that Euler's relationship is satisfied by these values.

(iii) Obtain the total surface area of the solid by finding the area of each face.

(iv) Find the length of an edge of a solid of the same shape whose total surface area is 384 cm^2.

(v) Show that the volume of that solid is 512 cm^3.

(9) A prism is shown in the figure. The triangular faces are isosceles.



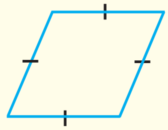
(i) Draw the 3 rectangular faces of the prism separately and mark their dimensions.

(ii) Find the area of each of these faces separately.

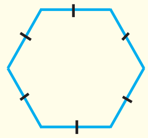
(iii) There are 10 edges and 6 vertices in a solid with plane faces. Find the number of faces that the solid has using Euler's relationship.

(10) (i) From the following plane shapes, select the ones that can be used for pure tessellation.

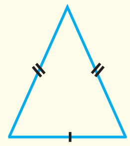
(a)



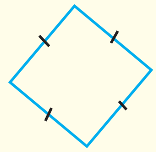
(b)



(c)

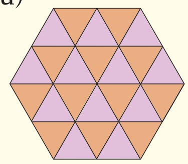


(d)

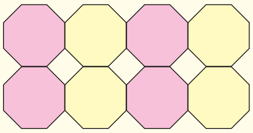


(ii) Select and separately write down the pure tessellations and the semi pure tessellation.

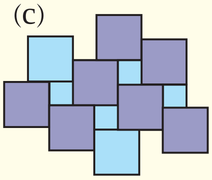
(a)



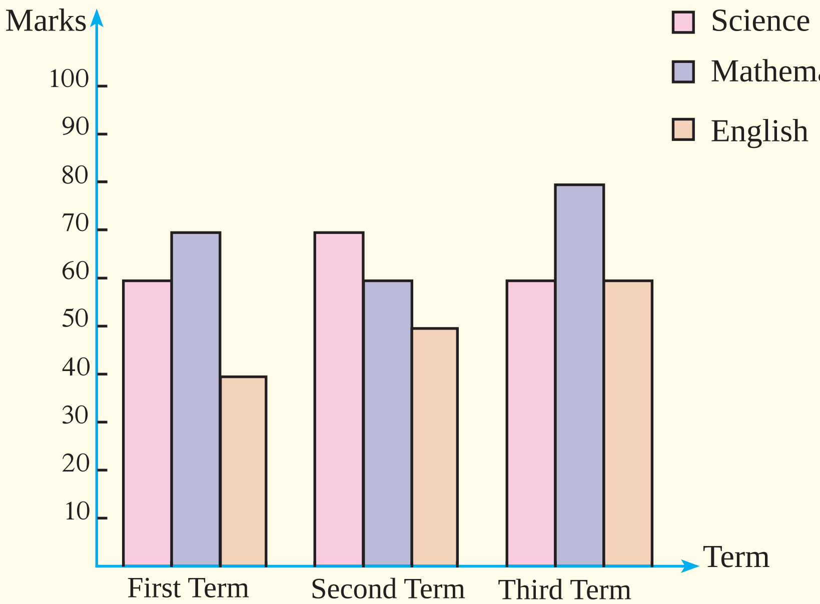
(b)



(c)



(11) The marks obtained by a student during 3 terms for Mathematics, Science and English are shown in the multiple column graph.



(i) Which subject shows a continuous increase in the marks?

(ii) For which subject has the student obtained identical marks in two terms?

(iii) By how many marks has the total marks obtained in the 3rd term for all 3 subjects increased when compared with the total marks obtained in the 1st term for all 3 subjects?

(12) If each employee is provided with 7.5 metres of material to sew uniforms, calculate the number of metres of material that is required for 12 employees.

(13) If the thickness of a DVD is 2.3 mm, find the thickness of a package consisting of 5 such DVDs.

Lesson Sequence

Content	Number of Periods	Competency levels
First Term		
1. Bilateral Symmetry	05	25.1
2. Sets	05	30.1
3. Mathematical Operations on Whole Numbers	04	1.1
4. Factors and Multiples	11	1.3, 1.4
5. Indices	06	6.1
6. Time	05	12.1
7. Parallel Straight Lines	03	27.1
8. Directed Numbers	06	1.2
9. Angles	07	21.1, 21.2
	52	
Second Term		
10. Fractions	10	3.1
11. Decimals	05	3.2
12. Algebraic Expressions	06	14.1, 14.2
13. Mass	06	9.1
14. Rectilinear Plane Figures	06	23.1, 23.2
15. Equations and Formulae	08	17.1, 19.1
16. Length	08	7.1, 7.2
17. Area	06	8.1
18. Circles	04	24.1
19. Volume	05	10.1
20. Liquid Measurements	04	11.1
	68	
Third Term		
21. Ratios	05	4.1
22. Percentages	05	5.1
23. Cartesian Plane	05	20.1
24. Construction of Plane Figures	05	27.2
25. Solids	05	22.1, 22.2
26. Data Representation and Interpretation	08	28.1, 29.1
27. Scale Diagrams	06	13.1
28. Tessellation	05	26.1
29. Likelihood of an Event Occurring	06	31.1, 31.2
	50	
Total	170	

Glossary

Acute - angled triangle	සුළු කෝණී ත්‍රිකෝණය	கூர்ங்கோண முக்கோணி
Area	වර්ගඵලය	பரப்பளவு
Biased	නැඹුරු	சமநேர்தகவற்ற
Category	ප්‍රවර්ග	வகைகுறி
Centre	කේන්ද්‍රය	மையம
Circle	වෘත්තය	வட்டம்
Closed plane figures	සංවෘත තලරූප	மூடிய தளவுரு
Column graph/ bar graph	තීර ප්‍රස්තාර	சலாகை வரைபு
Compound plane figures	සංයුක්ත තලරූප	கூட்டுத் தளவுருக்கள
Concave polygon	අවතල බහු-අස්‍රය	குழிவுப் பல்கோணி
Construction	නිර්මාණය	அமைப்பு
Convex polygon	උත්තල බහු-අස්‍රය	குவிவுப் பல்கோணி
Cartesian plane	කාටීසීය තලය	தெக்காட்டின் தளம்
Coordinates of a point	ලක්ෂ්‍යයක ඛණ්ඩාංක	புள்ளியொன்றின் ஆள்கூறுகள
Cube	ඝනකය	சதுரமுகி
Cuboid	ඝනකාභය	கனவுரு
Data	දත්ත	தரவுகள்
Desired units	අභිමත ඒකක	எதேச்சை அலகுகள்
Diameter	විෂ්කම්භය	விட்டம
Edge	දාරය	விளிம்பு
Equilateral triangle	සමපාද ත්‍රිකෝණය	சமபக்க முக்கோணி
Equilateral triangle	සමපාද ත්‍රිකෝණය	சமபக்க முக்கோணி
Euler’s relationship	ඔයිලර්ගේ සම්බන්ධතාව	ஒயிலரின் தொடர்பு
Event	සිද්ධි	நிகழ்ச்சி
Experiment	පරීක්ෂණ	பரிசோதனை
Face	මුහුණත	முகம்
Formula	සූත්‍රය	சூத்திரம்
Information	තොරතුරු	தகவல்கள
Isosceles triangle	සමද්විපාද ත්‍රිකෝණය	இருசமபக்க முக்கோணி
Length	දිග	நீளம்
Line segment	සරල රේඛා ඛණ්ඩය	நேர்கோட்டுத் துண்டம்
Liquid measurements	ද්‍රව මිනුම්	திரவ அளவீடுகள்
Multiple-column graph	බහු තීර ප්‍රස්තාර	கூட்டுச் சலாகை வரைபு
Obtuse - angled triangle	මහා කෝණී ත්‍රිකෝණය	விரிகோண முக்கோணி
Occurrence	සිදු වීම	நிகழ்வு ∴ நேர்கை
Origin	මූල ලක්ෂ්‍යය	உற்பத்தி

Pair of compasses	කවකටුව	கவராயம்
Percentage	ප්‍රතිශතය	சதவீதம்
Perimeter	පරිමිතිය	சுற்றளவு
Polygon	බහු අස්‍රය	பல்கோணி
Prism	ප්‍රිස්මය	அரியம்
Probability	සම්භාවිතාව	நிகழ்தகவு
Pure tessellation	ශුද්ධ ටෙසලාකරණය	தூய தெசலாக்கம
Pyramid	පිරමීඩය	கூம்பகம்
Radius	අරය	ஆரை
Random event	අහඹු සිදුවීම්	எழுமாற்று நிகழ்வு
Ratio	අනුපාතය	விகிதம்
Rectangle	සෘජුකෝණාස්‍රය	செவ்வகம்
Regular hexagon	සවිධි ෂඩස්‍රය	ஒழுங்கான அறுகோணி
Regular polygon	සවිධි බහු-අස්‍රය	ஒழுங்கான பல்கோணி
Right angled triangle	සෘජු කෝණී ත්‍රිකෝණය	செங்கோண முக்கோணி
Scale	පරිමාණය	அளவிடை
Scale diagram	පරිමාණ රූප	அளவிடை ப்படம்
Scalene triangle	විෂම ත්‍රිකෝණය	சமனில்பக்க முக்கோணி
Semi - pure tessellation	අර්ධ ශුද්ධ ටෙසලාකරණය	அரைத் தூய தெசலாக்கம
Shapes	හැඩතල	வடிவங்கள்
Solids	ඝන වස්තු	திண்மங்கள்
Square	සමචතුරස්‍රය	சதுரம்
Square pyramid	සමචතුරස්‍ර පිරමීඩය	சதுரக் கூம்பகம்
Standard units	සම්මත ඒකක	நியம அலகுகள்
Straight edge	සරල දාරය	நேர் விளிம்பு
Tessellation	ටෙසලාකරණය	தெசலாக்கம்
Triangle	ත්‍රිකෝණය	முக்கோணி
Triangular prism	ත්‍රිකෝණ ප්‍රිස්මය	முக்கோண அரியம்
Unbiased	නොනැඹුරු	சமநேர்தகவுடைய
Units	ඒකක	அலகுகள்
Vertex	ශීර්ෂය	உச்சி
Volume	පරිමාව	கனவளவு
x - axis	x අක්ෂය	ஒ அச்சு
y - axis	y අක්ෂය	ல அச்சு
x - coordinate	x - ඛණ්ඩාංකය	ஒ ஆள்கூறு
y - coordinate	y - ඛණ්ඩාංකය	ல ஆள்கூறு