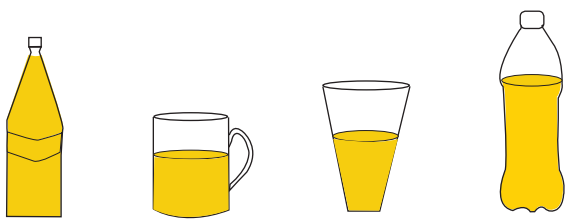
9 Liquid Measurements

By studying this lesson, you will be able to;

- determine the relationship between
  millilitres (ml) and cubic centimetres (cm^3),
  litres (l) and cubic centimetres (cm^3),
  litres(l) and cubic metres (m^3), as units which are used to measure liquid volumes, and
- solve problems involving units which are used to measure liquid volumes.

Volume and capacity

We know that the amount of space occupied by a solid or a liquid is known as its volume.
A solid has a definite shape and a definite volume. Although a liquid has a definite volume, it does not have a definite shape. A liquid always takes the shape of its container.
The below given pictures show 200 ml of drink in different shaped containers



When that quantity of drink is poured into the different shaped containers, even though the liquid takes the shape of the container, its volume of 200 ml remains unchanged. In the first picture, the container is completely filled with the 200 ml of drink. Therefore, the capacity of that container is 200 ml. The **capacity** of a container is the maximum volume that it can hold.

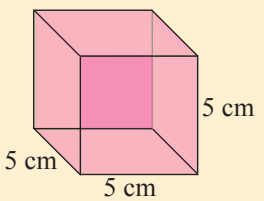
Do the following review exercise to recall the facts that you have learnt earlier in relation to volume and capacity.

Review Exercise

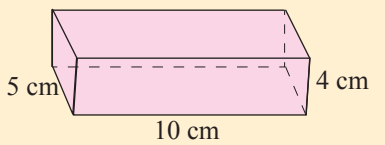
1. Complete the table given below using the fact that 1 *l* =1000 ml.

ml	*l* and ml		*l* (in decimal form)
	l	ml	
2500	2	500	2.5
.....	3	000	
3500	3		
.....	4	500	4.5
.....	0	500	
200			
50			
.....			3.25
.....	0	25	
.....			0.005

2. Complete the two tables given below based on the way the volumes of the cube and the cuboid in the figure have been calculated.



Volume = 5 cm × 5 cm × 5 cm = 125 cm^3



Volume = 10 cm × 5 cm × 4 cm = 200 cm^3

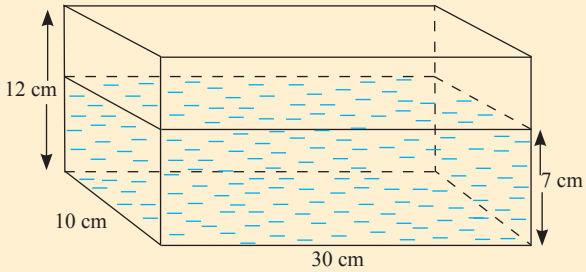
(i) Cube

The length of a side (cm)	Volume (cm^3)
2	.... × .... × .... = ...
4	
6	
7	
8	
10	
12	

(ii) Cuboid

Length (cm)	Width (cm)	Height (cm)	Volume (cm^3)
3	2	2	... × ... × ... = ...
5	3	4	
8	6	5	
10	5	10	
10	5	6	
12	10	8	
12	6	5	
15	8	10	
20	7	8	

3. The internal length, width and height of the container in the figure are 30 cm, 10 cm and 12 cm respectively. This container has been filled with water up to a height of 7 cm.



Determine the following.

i. The capacity of the container.

ii. The volume of water required to fill the whole container.

iii. The volume of water in the container, if the container is filled with water only up to a height of 7 cm.

iv. When the water level is 7 cm, if due to a leak it decreases to 5 cm within an hour, the volume of water that has leaked out during that hour.

9.1 The relationship between a cubic centimetre and a millilitre

A syringe used by doctors is given in the above figure. The amount of liquid medicine injected into a patient can be identified using the scale indicated on the syringe.

The units of measurement are indicated as cc/ ml.

cc means "**cubic centimetre**". It consists of the initial letters of these two words. A cubic centimetre is the volume of a cube of side length 1 cm.

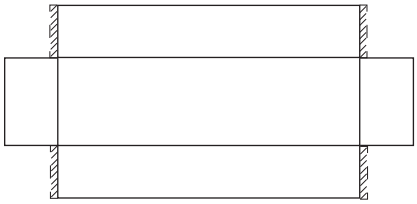
The back slash (/) means "or". It indicates that the amount of medicine can be expressed in terms of either cc or ml. The question which arises immediately is whether 1 cc is equal to 1 ml. In the metric system, 1 ml is defined such that it is equal to1 cc. Accordingly,

1 cubic centimetre = 1 millilitre

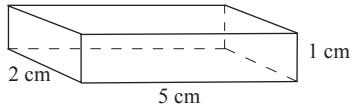
$$1 \text{ cm}^3 = 1 \text{ ml}$$

Do the following activity in order to study this fact further.

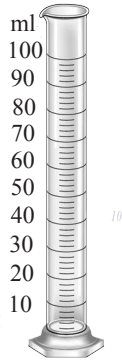
Activity



The net to construct the container



The cuboid shaped container of volume 10 cm^3



Measuring cylinder

- Construct a container of dimensions 5 cm × 2 cm × 1 cm using a net prepared from a thin plastic sheet as shown in the figure (paste the edges properly using sellotape or a suitable glue so that there is no water leakage).
- Obtain a measuring cylinder of capacity 100 ml from the laboratory.
- Draw the below given table in your exercise book.

Number of times water is poured from the cuboid shaped container into the measuring cylinder	The volume of water poured into the measuring cylinder	
	In cm^3 according to the cuboid shaped container	In ml according to the measuring cylinder
	10 20 30 40 50	

- Fill the cuboid shaped container completely with water and pour that water into the measuring cylinder.
- After pouring the water into the measuring cylinder, note down its reading.
- Repeat this process several times. Note down the reading on each occasion.
- Determine a relationship between the units of the volume of the container (cm^3) and the units (ml) marked on the measuring cylinder.

Based on the activity the following equalities are obtained.

$10\ cm^3 = 10\ ml$
$20\ cm^3 = 20\ ml$

Accordingly, it is clear that $1\ cm^3 = 1\ ml$.

This relationship can be used when solving problems related to liquid volumes in containers.

Example 1

A cuboid shaped glass container of length 20 cm, width 15 cm and height 10 cm is filled with a liquid medicine.

i. Find the volume of the container in cubic centimetres.
ii. What is the capacity of the container in litres?
iii. If the liquid in the container is to be stored in phials of capacity 50 ml each, find the number of phials required to store all the liquid in the container.

i. The volume of the container $= 20\ cm \times 15\ cm \times 10\ cm$
$= 3000\ cm^3$

ii. The capacity of the container $= 3000\ ml$
$= 3\ l$

iii. The total amount of liquid $= 3000\ ml$

The number of phials of capacity 50 ml each that are required $= 3000 \div 50$
$= 60$

Example 2

800 *l* of water is in a cuboid shaped concrete tank consisting of a base of length 2 m and width 1 m. Find the height to which the water is filled in the tank.

Let us construct an equation, assuming that the tank is filled up to a height of x cm, and by solving it find the height to which it is filled.

Let us first convert all the measurements into centimetres.

The length of the tank $= 2\ m = 200\ cm$
The width of the tank $= 1\ m = 100\ cm$

The volume of water in the tank if the water level is x cm $= 200$ cm $\times 100$ cm $\times x$ cm

$= 20\,000x$ cm^3

It is given that the volume of water in the tank is 800 l.

$\therefore$ Volume of water in the tank $= 800\ l$

$= 800\,000$ ml

$= 800\,000$ cm^3

Since the volume of water represented above in two ways is equal,

$20\,000 \times x = 800\,000$

$$x = \frac{800\,000}{20\,000}$$

$= 40$

$\therefore$ The height of the water in the tank is 40 cm.

Exercise 9.1

1. Join each of the volumes in box A with the volume in box B which is equal to it.

A	B
1000 cm^3	25 ml
10 cm^3	25 l
3000 cm^3	1 l
1500 cm^3	10 ml
25000 cm^3	1.5 l
25 cm^3	3 l

2. The dimensions of several cuboid shaped containers are given in the following table. Complete this table.

Length (cm)	Width (cm)	Height (cm)	Capacity		
			cm^3	ml	l
20	10	5			
40	20	10			
35	12	10			
50	35	12			
40	35	25			
25	20	18			

3. A cuboid shaped tank of base area 240 cm^2 is filled up to a height of 12 cm with water. Find the volume of water in the tank in,

i. cubic centimetres **ii.** millilitres **iii.** litres

4. A cuboid shaped container has a square base of area 225 cm^2. An amount of 3.6 l of water has been filled into this container.

i. Find the height of the water in the container.

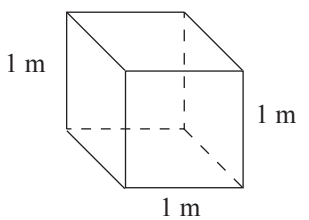
ii. If the height of the container is 24 cm, show that the water is filled to $\frac{2}{3}$ of its capacity.

5. Show that a barrel of capacity 15 l can be filled completely by pouring water 15 times using a completely filled cube shaped container of side length 10 cm.

9.2 The relationship between a litre and a cubic metre

The need for a unit which is larger than ml or l arises when it is necessary to measure large volumes of liquid such as the quantity of liquid in an oil tank or a swimming pool. In such instances a large unit called cubic metre is used.

In order to identify a cubic metre, let us calculate the capacity of a cube shaped container of side length 1 m.



The capacity of the container shown in the figure $= 1\text{ m} \times 1\text{ m} \times 1\text{ m} = 1\text{ m}^3$

However, since $1\text{ m} = 100\text{ cm}$,

the capacity of the container, $1\text{ m}^3 = 100\text{ cm} \times 100\text{ cm} \times 100\text{ cm}$

$= 1\,000\,000\text{ cm}^3$

$= 1\,000\,000$ ml (Since $1\text{ cm}^3 = 1$ ml)

$= \frac{1000\,000}{1000}\ l$ (Since 1000 ml = 1 l)

$= 1\,000\ l$

Accordingly,

one cubic metre is equal to 1000 *l*.

$1\ m^3 = 1000\ l$

Example 3

The internal length, width and height of a cuboid shaped tank in which water is stored for the daily use of a household are 1.5 m, 1 m and 1 m respectively.

(i) What is the capacity of the tank in litres?
(ii) If the residents use 300 *l* per day, for how many days will a completely filled tank be sufficient?

(i) The capacity of the tank $= 1.5\ m \times 1\ m \times 1\ m$
$= 1.5\ m^3$
$= 1\ 500\ l$ (Since $1\ m^3 = 1000\ l$)

(ii) The volume of water used per day $= 300\ l$
The volume of water in the tank $= 1\ 500\ l$
$\therefore$ The number of days for which the water is sufficient $= \frac{1\ 500}{300}$
$=$ five days

Exercise 9.2

1. Complete the table.

The inner dimensions of the cuboid shaped tank			The capacity of the tank	
Length (m)	Width (m)	Height (m)	m^3	*l*
2	2	1	.....	.....
2	1.5	1	.....	.....
1	1	0.5	.....	.....
4	1	.....	8	.....
.....	1.5	3.0	.....	9000
1	.....	1	1.5	.....

2. The length, width and depth of a swimming pool are 50 m, 25 m and 3 m respectively.

i. Find the capacity of the swimming pool

ii. If the swimming pool is filled with water up to a height of 1.2 m, what is the volume of water in the swimming pool in litres?

iii. How much more water is required to fill the swimming pool completely?

3. A bowser of capacity 6.5 m^3 is filled completely with oil. This bowser is supposed to distribute 850 *l* of oil each to 8 filling stations. Is the oil in the bowser sufficient for all 8 filling stations? Give reasons for your answer.

4. A person requires on average 150 *l* of water daily. If a cuboid shaped tank of length $1\frac{1}{2}$ m, width 1 m and height 1 m is completely filled with water, for how many people in total will this quantity of water be sufficient for a day?

5. The length of an interior side of a cube shaped tank is 1 m. The tank is completely filled with water. When a tap from which the water in the tank is discharged is opened, water flows out from the tank at a constant rate of 50 *l* per minute. Determine how long after the tap is opened the tank becomes empty, if the water flows out at this constant rate.

Miscellaneous Exercise

1. The capacity of a large drink bottle is 1.5 *l*. It is expected to serve a quantity of 150 ml of this drink in small glasses to each of the guests at a party. If there are 225 guests at the party, find the minimum number of large drink bottles needed to serve all the guests.

2. Household storage tanks of capacity 500 *l*, 1000 *l* and 2000 *l* are available for sale. The head of a family of 5 members intends to buy one of these tanks to store water for their household use. If each family member requires a maximum of 150 *l* per day and 200 *l* of water is required each day for other household chores. Determine which tank best suits his requirements, if the head of the family intends to fill the tank only once a day,

Summary

Summary

- 1 cm^3 = 1 ml
- 1 m^3 = 1000 *l*

Revision Exercise – First term.

Part – I

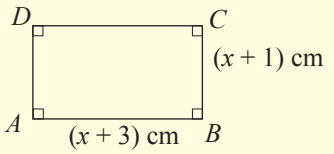
1. Write the general term of the number pattern 5, 8, 11, 14, …, with a common difference.

2. Fill in the blank: $10011_{\text{two}} - \ldots\ldots_{\text{two}} = 0011_{\text{two}}$.

3. The value of $\frac{1}{3}$ of a certain amount of money is Rs 800. What is the value of $\frac{3}{4}$ of that amount of money?

4. If a profit of Rs 300 is earned by selling an item for Rs 1500, what is the profit percentage?

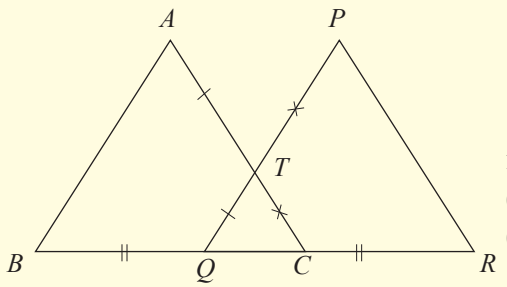
5.



Express the area of the rectangle $ABCD$ in terms of x.

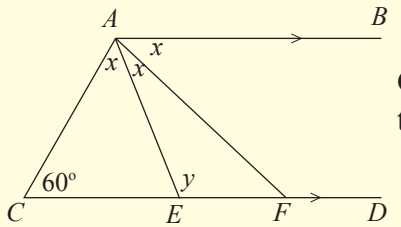
6. Factorize $2x^2 - x - 6$

7.



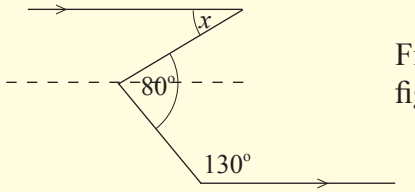
Show using axioms and the information in the figure that,
(i) $AC = PQ$ and
(ii) $BC = QR$.

8.

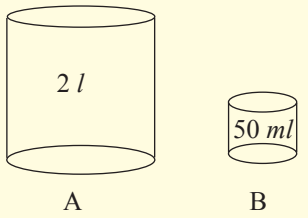


Given that the lines AB and CD are parallel, find the value of y.

9. Find the values of b and c if $(x + 4)(x - 3) = x^2 + bx + c$.

10. 

Find the value of x using the information in the figure.

11. 

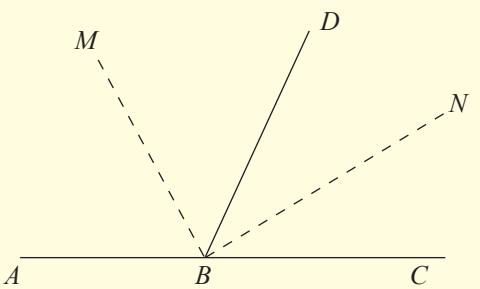
How many times should water be poured into the container A of capacity $2l$ from the completely filled container B of capacity 50 ml to fill $\frac{3}{4}$.

12. brokerage fee of 3% is charged when a land is sold. If the land owner received 27 lakhs in rupees after the brokerage fee was paid, find the price at which the land was sold.

13. What is the fraction by which $1\frac{3}{4}$ has to be multiplied to obtain $3\frac{3}{4}$?

14.
$$\begin{array}{r} 1101_{\text{two}} \\ +\ 1111_{\text{two}} \\ \hline \ldots\ldots\ldots\ldots \\ -\ \ 101_{\text{two}} \\ \hline \ldots\ldots\ldots\ldots \\ \hline\hline \end{array}$$

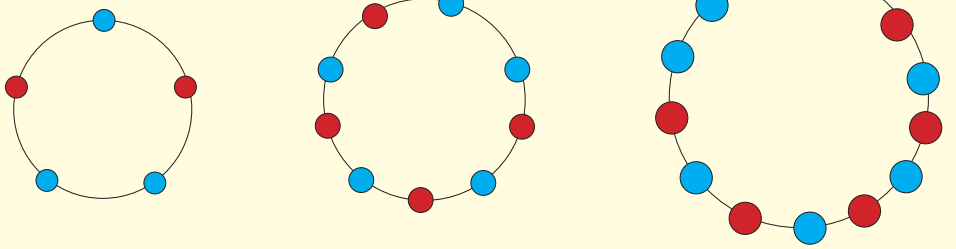
Fill in the blanks.

15. 

The bisectors of $A\hat{B}D$ and $D\hat{B}C$ are BM and BN respectively. Find the value $A\hat{B}M + C\hat{B}N$, if $A\hat{B}C$ is a straight line.

Part II

1.



1. Adecoration is madeby preparing circles of various sizes and placing red and blue bulbs in a pattern with a common difference such that the first three arrangements contain 3, 5, 7 blue bulbs and 2, 4, 6 red bulbs respectively as shown in the figure.

   (i) Write the number of blue bulbs and the number of red bulbs in the 4th and 5th arrangements.

   (ii) Identify the patterns of the number of blue bulbs and the number of red bulbs in the arrangements and construct two expressions in n for the number of bulbs of each colour in the nth arrangement.

   (iii) Find an expression for the total number of bulbs inthe nth arrangement, using the expressions in (ii) above.

   (iv) Find the number of blue bulbs and the number of red bulbs in the 10th arrangement using the expressions in (ii) above.

   (v) Which arrangement is prepared using a total of 61 bulbs? Find the number of blue bulbs in that arrangement.

2. (a) Simplify.

i. $\dfrac{2\frac{1}{5}+\frac{1}{2}}{\frac{3}{10}}$

ii. $(1\frac{1}{8} \text{ of } 1\frac{1}{3}) \div 2\frac{1}{2}$

(b) **i.** $\frac{1}{4}$ th of a certain land contains mango trees. What fraction of the total land is the remaining portion of land?

ii. If $\frac{1}{3}$ of the remaining land contains banana trees, express the portion of land in which banana trees are grown as a fraction of the whole land.

iii. In what fraction of the total land are the mango trees and banana trees grown?

iv. If the area of the portion in which these trees are not grown is 3 hectares, what is the total area of the land?

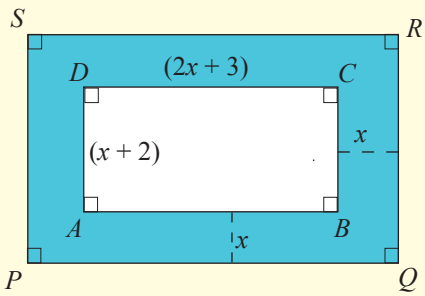
3. (a) The selling price of an item which was bought for Rs 8000 was marked keeping aprofit of 25%. A discount of 10% was given when the item was purchased outright. Find the profit percentage earned by the seller.

(b) A person marks the price of an item to earn a profit of 15%. If its price had been marked to earn a profit of 20%, an extra Rs 200 could have been earned. Find the purchase price and the marked price of the item.

4. (a) Find the value of each of the following expressions when $a = -2$ and $b = 3$.

i. $2a + 3b$ **ii.** $b - 2a$ **iii.** $\frac{a}{3} - \frac{b}{2}$

(b) a



The rectangle *ABCD* in the figure represents picture. Its length is $(2x+3)$ cm and its breadth is $(x + 2)$ cm.

i. Obtain an expression in terms of x for the area of *ABCD*.

ii. he shaded part in the figure represents a band of breadth x cm which is pasted bordering *ABCD*. Find an expression for the area of the rectangle *PQRS* and express the area of the shaded part in terms of x using the expression found in (i) above too.

iii. Calculate the area of the shaded part if $x = 3$ cm.

(c) Factorize the following expressions.

i. $5x^2 + 12y^2 - 4xy - 15xy$

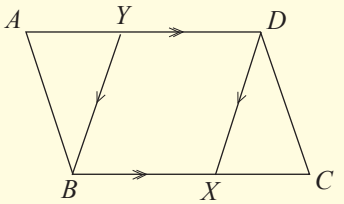
ii. $6(x-1) + 3x - 3$

iii. $t^2 - 8t + 15$

iv. $3k^2 - 12k$

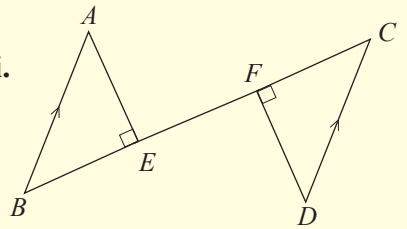
5. (a) Obtain the following results using axioms and the information in the figure.

i.



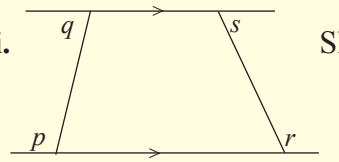
Show that $A\hat{Y}B = D\hat{X}C$.

ii.



Show that $B\hat{A}E = F\hat{D}C$.

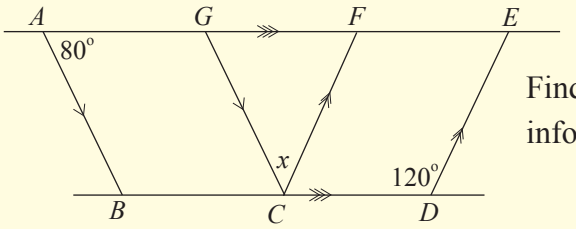
iii.



Show that $\hat{p} - \hat{s} = \hat{r} - \hat{q}$.

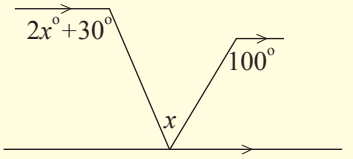
(b)

i.



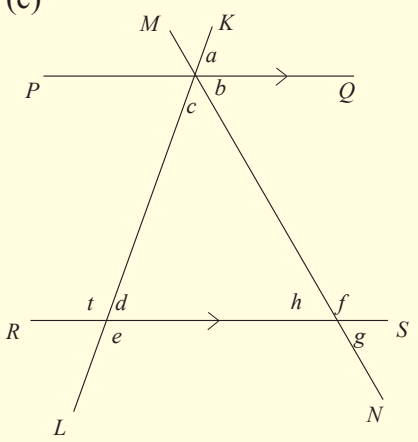
Find the value of x using the information in the figure.

ii.



Find the value of x using the information in the figure.

(c)



The parallel lines PQ and RS are intersected by the transversals MN and KL. Answer the following questions using the information in the figure.

i. Write all the instances where the sum of the given angles is 180^{o}.

ii. Write the pairs of allied angles in the figure.

iii. Providing reasons, write all the angles which are equal to each other.

iv. Is $\hat{a} + \hat{e} = 180^{o}$? Explain your answer.

v. Using axioms, show that $t - f = h - d$.

vi. Find the values of all the angles indicated by lowercase letters if $e = 140^{o}$, $f = 110^{o}$.

6. The length, breadth and height of a water tank are 2m, 1.5m and 1m respectively.

i. Express the capacity of the tank in liters.

ii. If the daily water requirement of a person is 150 l, how much water is required daily for 4 people?

iii. For how many days will the water in this tank be sufficient for4 people if it is full?

iv. If water is supplied to the tank at a rate of 100 l per minute, how much time is needed to fill thetank if it is empty?

v. On a day when the tank is filled to its capacity, 900 l of water leaks out due to a fault in the delivery pipeline. Find the height of the remaining water.

Glossary

A

Addition	එකතු කිරීම	கூட்டல்
Allied angles	මිත්‍ර කෝණ	நேயக்கோணங்கள்
Algebraic expressions	වීජීය ප්‍රකාශන	அட்சரகணிதக் கோவைகள்
Algebraic term	වීජීය පදය	அட்சரகணித உறுப்பு
Alternate angles	ඒකාන්තර කෝණ	ஒன்றுவிட்டகோணங்கள்

B

Base	පාදය	அடி
Binary numbers	ද්වීමය සංඛ්‍යා	துவித எண்கள்
Brackets	වරහන්	அடைப்பு
Broker	තැරැව්කරුවා	தரகர்

C

Capacity	ධාරිතාව	கொள்ளளவு
Commission	කොමිස්	தரகு (கமிஷன்)
Common factors	පොදු සාධක	பொதுக்காரணிகள்
Converse	විලෝමය	மறுதலை
Conversion	පරිවර්තනය	மாற்றல்
Corresponding angles	අනුරූප කෝණ	ஒத்தகோணங்கள்

D

Difference of terms	පද අතර වෙනස	உறுப்புக்களுக்கிடையேயானவித்தியாசம்
Discount	වට්ටම	கழிவு

F

First term	පළමුවන පදය	முதலாம் உறுப்பு
Fractions	භාග	பின்ன ங்கள்

G

General term	සාධාරණ පදය	பொது உறுப்பு

I

integers	නිඛිල	நிறைவெண்கள்

L

Loss	අලාභය	நட்டம்

M

Marked Price	ලකුණු කළ මිල	குறித்த விலை

N

Number sequence	සංඛ්‍යා අනුක්‍රම	எண் தொடரி

P

Place Value	ස්ථානීය අගය	இடப்பெறுமானம்
Power	බලය	வலு
Profit	ලාභය	இலாபம்

S

Sciencetific notation	විද්‍යාත්මක අංකනය	விஞ்ஞானமுறைக் குறிப்பீடு
Selling Price	විකුණුම් මිල	விற்றவிலை
Subtraction	අඩු කිරීම	கழித்தல்

T

Theorem	ප්‍රමේයය	தேற்றம்

V

Vertically opposite angles	ප්‍රතිමුඛ කෝණ	குத்தெதிர்க்கோணங்கள்
Volume	පරිමාව	கனவளவு

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