Mathletics

Series G Student

Volume, Capacity and Mass

My name

First edition printed 2009 in Australia.

A catalogue record for this book is available from 3P Learning Ltd.

ISBN 978-1-921861-07-9

Published 3P Learning Ltd

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Series G – Volume, Capacity and Mass

Contents

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Volume and capacity – metric and imperial

Most measurements used today in the UK (and in almost every country in the world apart from the USA) are metric, such as kilograms, metres and litres. They are based on the decimal number system, meaning that multiples of units are 10s, 100s or 1,000s. You will still come across some of the old 'imperial' units of measurement, though. Therefore, it's useful to know how to convert between metric and imperial units and back. Most of the equivalents below have been rounded to 1 decimal place.

	Imperial	to	Metric	Metric	to	Imperial
Mass:	1 ounce	=	28 g	1 gram	=	0.35 ounces
	1 pound (16 ounces)	=	0.45 kg	1 kilogram (1,000 g)	=	2.2 pounds
	1 stone (14 pounds)	=	6.4 kg	1 tonne (1,000 kg)	=	1.1 tons
	1 ton (2,000 pounds)	=	0.9 tonnes			
Capacity:	1 fluid ounce	=	30 ml	10 millilitres	=	0.3 fluid ounces
	1 pint (16 fluid ounces)	=	0.6 l	1 litre (1,000 ml)	=	2.1 pints

1 **Convert these measurements from imperial to metric or metric to imperial:**

a 2 pounds = ____ kilograms

b 7 tonnes = ____ tons

c 10 grams = ____ ounces

d 4 ounces = ____ grams

e 4 pints = ____ litres

f 8 tons = ____ tonnes

g 20 kilograms = ____ pounds

h 6 litres = ____ pints

2 **Selena wants to make two Victoria sponges. The recipe below is for one cake and is in imperial measurements. How much of each ingredient will she need in metric measurements for both cakes?**

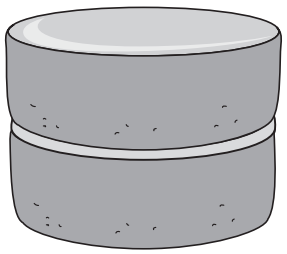
3 eggs ____ eggs

5 ounces (oz) self-raising flour ____ g self-raising flour

5 oz caster sugar ____ g caster sugar

8 oz butter ____ g butter

4 oz icing sugar ____ g icing sugar



Volume and capacity – millilitres and litres

Capacity refers to the amount a container can hold and is usually associated with liquid.
Common capacity measurements are millilitres and litres.

1,000 millilitres = 1 litre
1,000 ml = 1 l

1 **When we convert:**

a millilitres to litres, we [ ] by [1,000]

b litres to millilitres, we [ ] by [ ]

2 **Convert these amounts to litres:**

a 3,452 ml = [ ]

b 7,895 ml = [ ]

c 10,000 ml = [ ]

d 12,674 ml = [ ]

e 56,780 ml = [ ]

f 235 ml = [ ]

3 **Convert these amounts to millilitres:**

a 2.568 l = [ ]

b 3.999 l = [ ]

c 10.566 l = [ ]

d 1.78 l = [ ]

e 7.305 l = [ ]

f 0.35 l = [ ]

4 **Solve these word problems. They all involve conversion.**

a Omar was filling up a 3 l container with cordial. He only had a small 300 ml jug. How many times did he have to fill the jug to totally fill the container?

_____

b I poured 375 ml out of a 2 l milk container. How much was left? I then poured out another 375 ml. How much is left now?

_____

c How many 315 ml glasses can be filled from a 1.7 l jug? How much is left over?

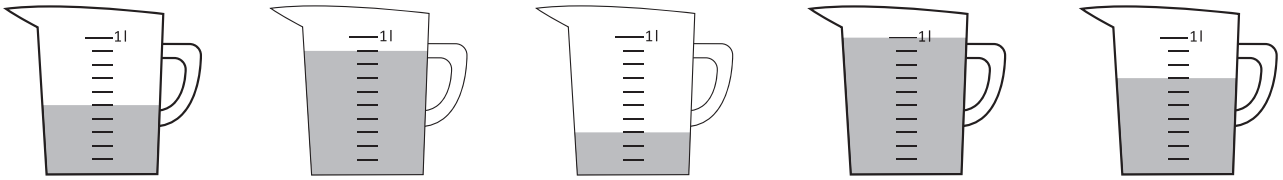
_____

d Paula is making a punch for her party. She uses 1.5 l of orange juice, 750 ml pineapple juice, 1.25 l of lemonade and 1.25 l of ginger ale. How much punch does she have altogether? How many 250 ml cups will she be able to fill?

_____

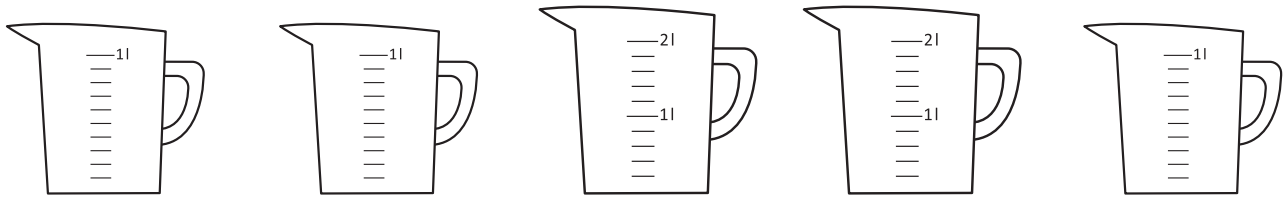
Volume and capacity – millilitres and litres

5 **How much liquid is in each jug? Answer in both litres and millilitres. The first one has been done for you.**



a 0.5 l = 500 ml **b** _____ l = _____ ml **c** _____ l = _____ ml **d** _____ l = _____ ml **e** _____ l = _____ ml

6 **Fill the jugs below to the amount shown:**



a 600 ml **b** 0.4 l **c** 1,800 ml **d** 1.6 l **e** 500 ml

These capacity measurements are useful to know: 1 teaspoon = 5 ml
1 cup = 250 ml

7 **Below is a recipe for the delicious summer drink, Lava Flow. The capacity measurements are expressed in cups or teaspoons. Express them in millilitres:**

Lava Flow

Ingredients (for one drink)

- $\frac{1}{2}$ cup of pineapple juice _____ ml
- $\frac{1}{2}$ cup of cream _____ ml
- $\frac{1}{2}$ a banana
- 3 teaspoons of coconut cream _____ ml
- 4 strawberries
- 1 cup ice _____ ml

Method

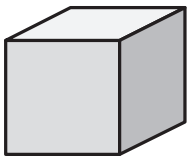
Blend all ingredients (except strawberries) until smooth. Put the strawberries in the bottom of a tall glass and add the blended mixture. Decorate with a drizzle of strawberry topping.

8 **If you were going to make this drink for your entire class, what amounts of each ingredient would you need to purchase? Use a calculator if you wish. What is the most effective unit in which to express the amounts?**

Volume and capacity – cubic centimetres and cubic metres

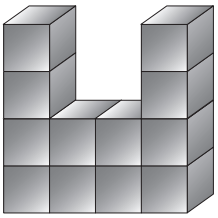
Remember that volume refers to the amount of space occupied by an object or substance. Commonly used volume measurements are the cubic centimetre and the cubic metre.

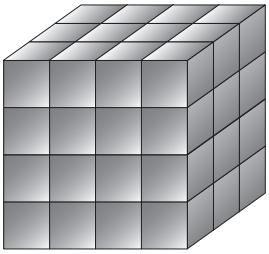
One cubic centimetre is 1 cm long, 1 cm wide and 1 cm high. The symbol we use for cubic cm is cm^3.
1 cm × 1 cm × 1 cm = 1 cm^3

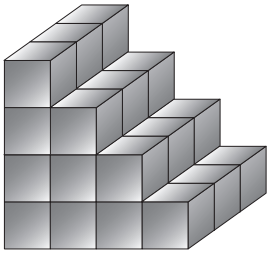


One cubic metre is 1 m long, 1 m wide and 1 m high. The symbol we use is m^3.
1 m × 1 m × 1 m = 1 m^3

1 **Find the volume of these shapes by counting the cubes. Each cube is 1 cm^3.**

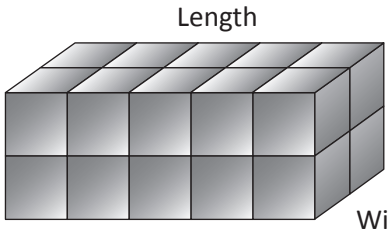






a Volume = _____ cm^3 **b** Volume = _____ cm^3 **c** Volume = _____ cm^3

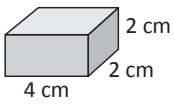
We can find out the volume of a rectangular prism or cube without counting each block. We just multiply the length by the width by the height.



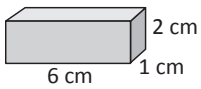
L × W × H = V
5 × 2 × 2 = 20 cm^3

2 **Use the formula L × W × H = V to find the volume of these prisms. You may use a calculator.**

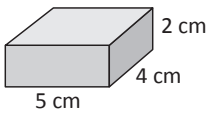
a



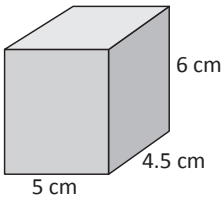
b



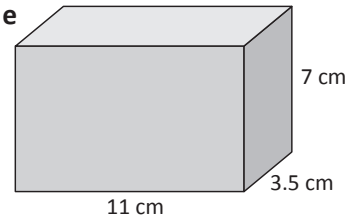
c



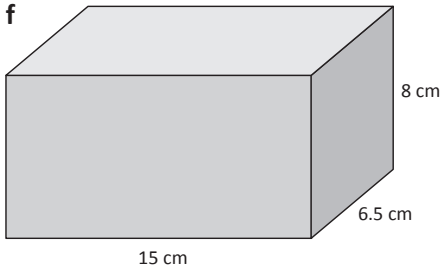
d



e



f

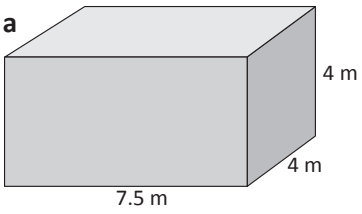


Shape	a	b	c	d	e	f
Volume						

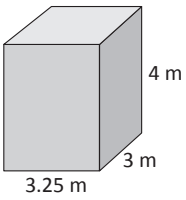
Volume and capacity – cubic centimetres and cubic metres

3 **Use the formula L × W × H = V to find the volume of these prisms.**

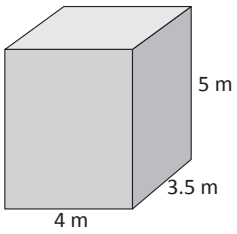
a



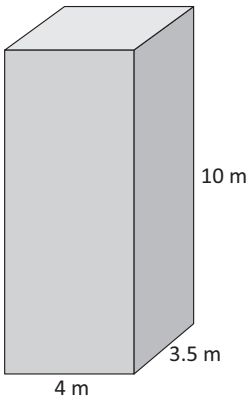
b



c



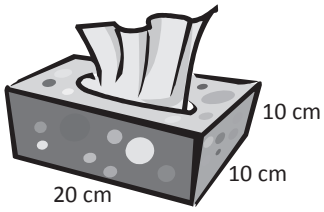
d



Shape	a	b	c	d
Volume				

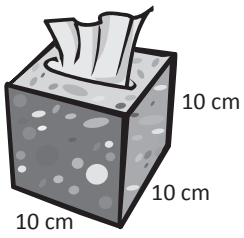
4 **Boxes of tissues are packed in cubic metre containers to be shipped to supermarkets. Use a calculator to work out how many of these boxes will fit into each container. You will first need to work out how many cubic centimetres are in a cubic metre.**

a



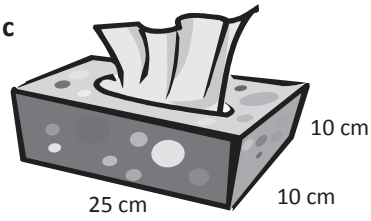
_____ boxes

b



_____ boxes

c



_____ boxes

5 **Work with a friend on this activity. You may either physically build the towers or choose to talk through the problem together. You are building towers using centicubes. One of you makes your first level with 4 rows of 3 blocks. The other person starts with 5 rows of 4 blocks. The first one has been done for you.**

a Fill in the table to show how the volume of the towers would increase as they grow.

b Your teacher says you can only have 200 cubes between you. You build the towers to the same height. How many levels could you each build?

_____

_____

_____

	Person 1	Person 2
1st level	*12* cm³	*20* cm³
2nd level	cm³	cm³
3rd level	cm³	cm³
4th level	cm³	cm³
5th level	cm³	cm³
6th level	cm³	cm³
7th level	cm³	cm³
8th level	cm³	cm³

Volume and capacity – displacement

Remember that volume is the amount of space occupied by an object or substance and capacity is the amount an object will hold.
Displacement is the amount of fluid that is pushed away when an object is placed in the fluid.
We can use displacement to calculate both volume and capacity.

1 **Try this experiment to find out about displacement. You will need a jug, a lunchbox, a tray and a model made from 100 centicubes. Work with a friend or in a small group.**

1 Stand the lunchbox in the tray.

2 Fill the box to the top with water.

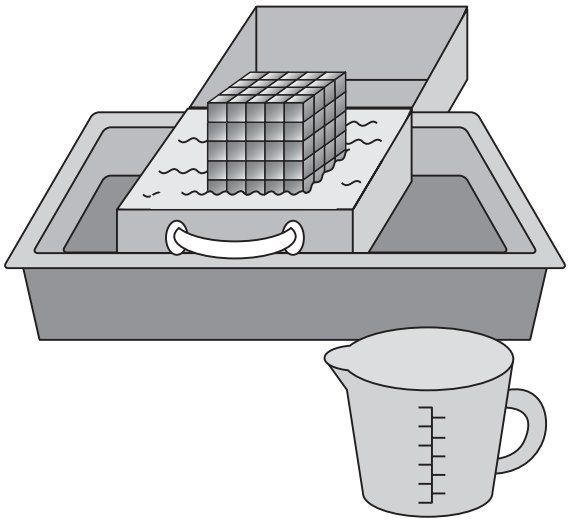
3 Carefully submerge the model in the water in the box.

4 Pour the water that overflowed into the tray into the measuring jug. How many ml equals 100 cm³?

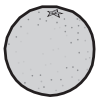
_____

Check your answer with that of two other groups.
Do they agree with you?

_____



2 **Now use the objects below (or something equivalent). Using displacement, find the volume and capacity of each object.**

Object	a 	b 	c 	d 	e 	f 	g 
Volume							
Capacity							

3 **Using what you now know about volume and displacement, how many millilitres of water would be displaced by objects with these volumes?**

a 100 cm³ = _____ ml **b** 250 cm³ = _____ ml **c** 500 cm³ = _____ ml

d 8 cm³ = _____ ml **e** 1,000 cm³ = _____ ml **f** 56 cm³ = _____ ml

g 86 cm³ = _____ ml **h** 4 300 cm³ = _____ ml **i** 1.9 cm³ = _____ ml

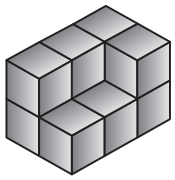
Volume and capacity – linking mass, capacity and volume

Do you remember the relationship between volume, mass and capacity?

$1\ cm^3 = 1\ ml = 1\ g$

1 **Calculate the volume, mass and capacity of these shapes by counting the cubes. Each cube is 1 cm^3.**

a

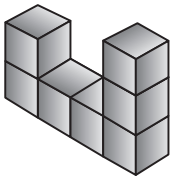


Volume = _____ cm^3

Capacity = _____ ml

Mass = _____ g

b

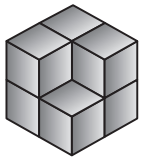


Volume = _____ cm^3

Capacity = _____ ml

Mass = _____ g

c

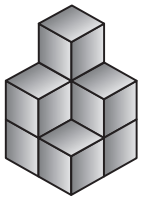


Volume = _____ cm^3

Capacity = _____ ml

Mass = _____ g

d

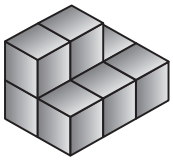


Volume = _____ cm^3

Capacity = _____ ml

Mass = _____ g

e

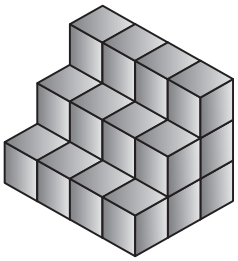


Volume = _____ cm^3

Capacity = _____ ml

Mass = _____ g

f



Volume = _____ cm^3

Capacity = _____ ml

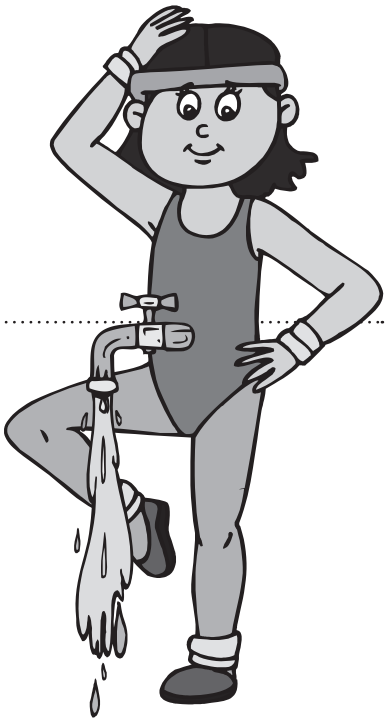
Mass = _____ g

2 **Seven tenths of the human body is water. Weigh yourself in kg then use a calculator to help you work out the answers to the following:**

a How much of your mass is water? _____

b What is the capacity of this water? _____

c What is the volume of this water? _____



3 **If you could drain yourself of all the water (not a good idea), what kind and size of container would be suitable and why?**

_____

_____

_____

Measuring mud

investigate

Getting ready

In this activity you are going to use what you know about the relationship between mass and volume to calculate the volume of the water in mud. You will need a cup, some newspaper and a scale.

Work with a partner. This experiment may take a day or so to complete and is probably best done outside.

What to do

Collect a cupful of mud or damp soil. Make sure the mud is not too sloppy. Find its mass by weighing it. How will you do this? Perhaps you could weigh the empty cup and then subtract the weight of the cup.

Now spread out your mud onto sheets of newspaper and leave it to dry in the sun. It may help to place weights on the paper or tape it down. You may also need to label your experiment so it doesn't get accidentally cleaned up!

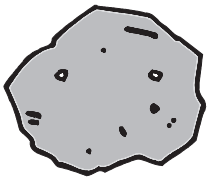
Once your mud has dried, carefully collect it and measure its mass. Remember to use the same cup. Why do you need to do this?

What was the volume of water in the mud?

How do you know?

What to do next

Find a rock that has the same volume as the lost water. How will you do this? How will you know that it has the same volume?



Water, water, everywhere … investigate

Getting ready

This activity could come in handy should you ever be stranded in the forest somewhere! You will need a rubbish bag, some string and a measuring jug. Work in a small group.

You are going to predict, collect and measure the amount of water a tree branch loses through transpiration (evaporation) over the period of a day. It is best to begin the experiment as early in the day as possible and to collect the water as late in the day as you can. Choose a nice sunny day for your experiment. A bit of a breeze will help too.

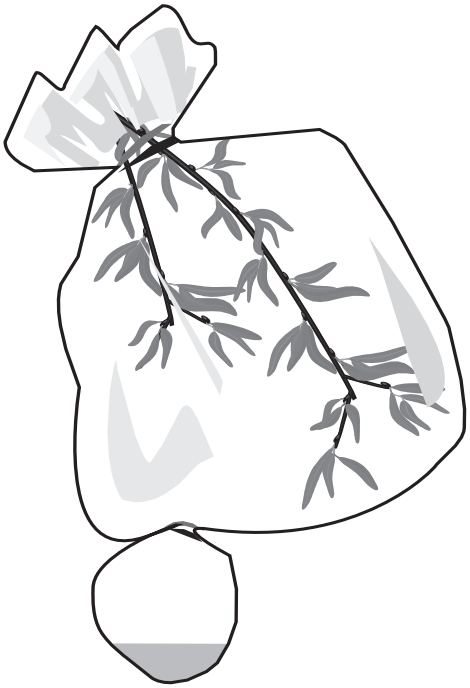
What to do

Choose a nice leafy tree branch. How much water do you think you will be able to collect from it? Write down your predictions.

Put your bag over your selected branch and tie it off. Now, make a pouch at the bottom of the bag and tie that off too.

Leave the bag over the day and come back to collect the water as late as you can.

Cut the pouch and carefully drain the water into a measuring jug. What is the capacity of the water you have collected?



What to do next

Compare your results with the results of other groups. Do they differ? Why?

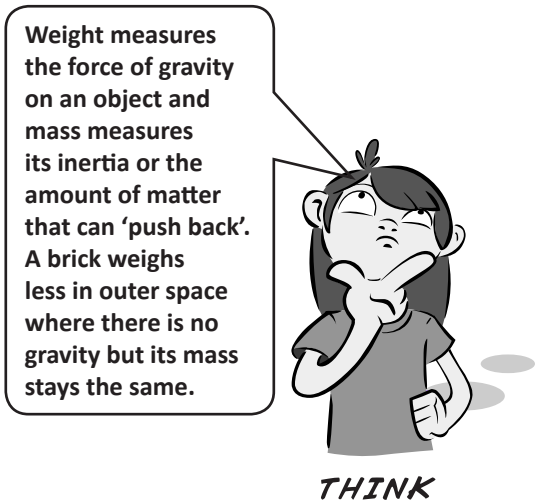
Repeat your experiment on another day using the same branch. Are your results different to those of the original experiment? What was different about the two days?

Mass – grams

Mass measures how much matter is in an object. We usually measure this by finding out what the object weighs. Mass and weight are slightly different but we often use weight terms when we are talking about day to day mass measurements.
Common measurements are grams (g), kilograms (kg) and tonnes (t).
There are 1,000 g in each kilogram and 1,000 kg in a tonne.

1 **This activity will help you get a feel for different masses. You'll need the objects in the table, a set of scales or a balance scale and some small masses (10 g, 50 g, or 100 g). Estimate, then measure the mass:**

Item	Estimate	Mass
scissors		
glue stick		
calculator		
lunch box (full)		
lunch box (empty)		
pencil case (full)		
pencil case (empty)		



2 **Estimate and then measure how many of each of these objects are needed to balance 10 grams.**

	Centicubes	5p coins	Drawing pins
Estimate			
Measure			

3 **Use your answers in question 1 to place the 7 items on the line in order of their individual mass.**

4 **Write each mass in grams, kilograms and grams, and as a decimal.**

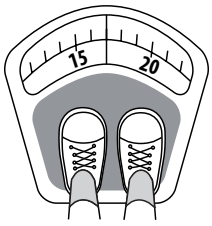
Grams	1,000 g			350 g		
Kilograms and grams		2 kg 700 g			5 kg 50 g	
Decimal notation			7.125 kg			3.2 kg

Mass – grams and kilograms

1 **Five children measured their mass.**

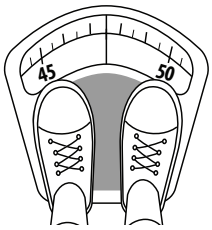
a Use decimal notation to write the masses in kilograms as shown on the scales:

Minh



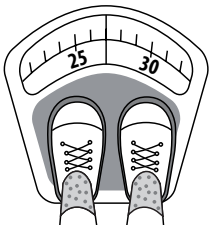
kg

Ben



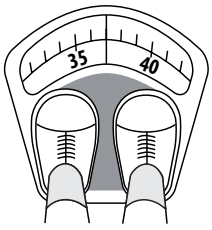
kg

Heba



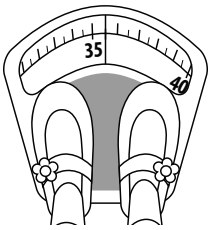
kg

Sara



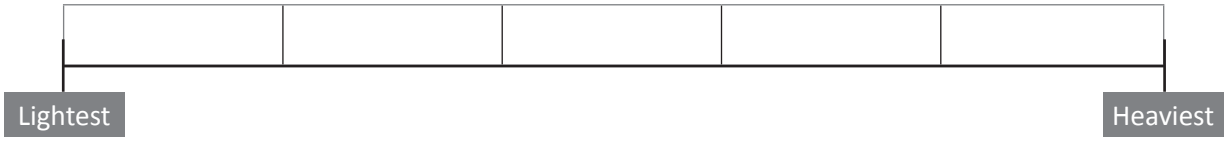
kg

Yasmin



kg

b Now order the children from lightest to heaviest.



2 **A regular packet of cereal has a mass of 540 g. An average serving is 45 g. Answer these questions without a calculator.**

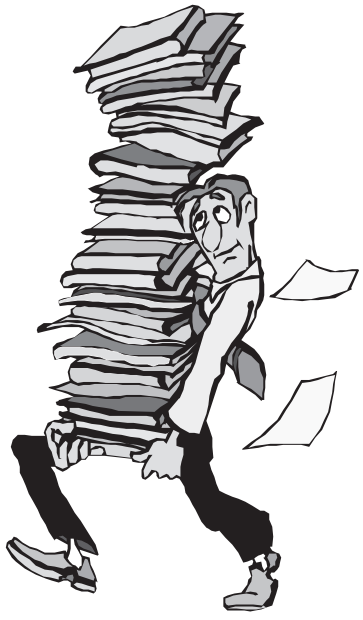
a How many average servings are there in one packet? _____

b There are four people in Michaela's family. Each has an average serve per day. How many days will the box last? _____

c The largest sized box has a mass of 720 g. How long will this box last her family? _____

d Michaela's family is going camping for 2 weeks. They need to take all their food with them. They want to take exactly the right amount of cereal. How many boxes of each size will they need to take? _____

3 **There are 28 students in Mr Brown's class. Being the dedicated and hardworking teacher that he is, he lugs their books home to mark each week.**



a Each maths book has a mass of 550 g. He puts them all in a tray which has a mass of 345 g. What is the total mass he will carry to his car?

_____

b Last week he took home the spelling books in the same tray. The total mass was 9.445 kg. What was the mass of each spelling book?

_____

c Next week, the football starts again. There goes the marking. Mr Brown will now be sitting in the grandstand munching crisps and cheering on the Mighty Blues. If he consumes four 375 g bags of crisps in a particularly tense game, how much does he eat?

_____

Mass – mass and capacity

What is the mass of 1 millilitre of water?

1 **Try this experiment to find out about the mass of water. You will need a measuring cup or jug, some balance scales and some weights.**

1 Measure the mass of the measuring cup.

2 Pour 50 ml of water into the cup.

3 Measure the mass of the cup and water.

4 Calculate the mass of the water by subtracting the mass of the cup.

5 Repeat for 100 ml, 250 ml, 500 ml and 1 l and record your results.

Amount of water	50 ml	100 ml	250 ml	500 ml	1 l
Mass					

a What have you discovered? 1 ml of water = _____ gram.

b Why did you need to subtract the mass of the cup?

_____

2 **Without measuring, can you now calculate the mass of these amounts of water?**

a 150 ml = _____ g **b** 467 ml = _____ g **c** 1.5 l = _____ kg

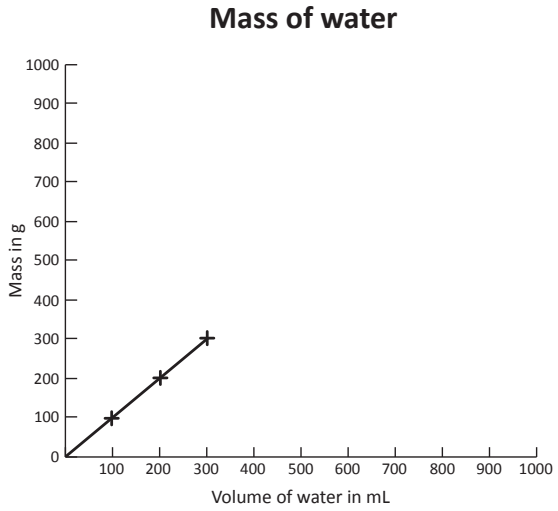
d 980 ml = _____ kg **e** 2.75 l = _____ kg **f** 8.45 l = _____ g

3 **Ben poured the same amount of water into five different containers. He then measured the mass of each of them. All the clues you need are in the table.**

Container	A	B	C	D	E
Mass of container filled with water	365 g	678 g	458 g	1 kg	1.3 g
Mass of container	15 g				

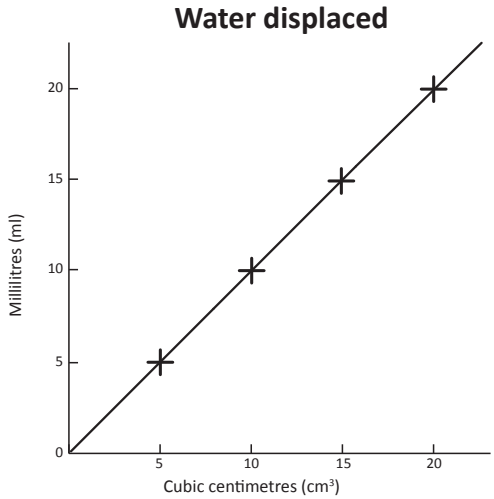
4 **Sean's teacher asked him to conduct an experiment to find out more about the mass of water.**

a He started to draw this graph and table. Complete both for him:



Volume of water	Mass of water
100 ml	100 g
200 ml	200 g
300 ml	300 g
500 ml	
600 ml	
800 ml	
1,000 ml	

b Sean then decided to see what would happen when he submerged centicubes in the water. This graph shows how much water was displaced as he did this. Use the graph to complete the table:



Cubic centimetres	Water displaced
10 cm^3	
20 cm^3	
	5 ml
	14 ml
50 cm^3	
	100 ml
850 cm^3	

c Use the information Sean discovered to complete the following table:

Volume (cm^3)	500 cm^3					7 cm^3
Capacity (ml)			25 ml		1,200 ml	
Mass (g)		350 g		1 kg		

5 **Try this experiment. You'll need 10 centicubes, plasticine, a measuring cup and a tap. Push the centicubes gently but fully into the plasticine, then carefully remove them. Now, fill the holes with water. Finally, measure the amount of water.**

a How much water was used? _____

b Was it the amount you expected? If not, why do you think it is different?

_____

The chocolate challenge

solve

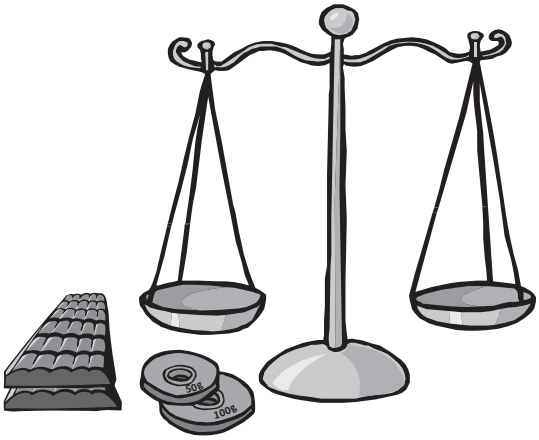
Getting ready

This word problem requires you to calculate the weight of two identical chocolate bars.

Work with a friend to solve it. You only need a pencil, paper and your brains.

What to do

You have two identical chocolate bars. You also have a set of balance scales and two weights, one measuring 100 g and the other measuring 50 g.



If you place one of the chocolate bars on one side of the balance scales, it is balanced by both weights and $\frac{1}{3}$ of the other chocolate bar.

How heavy is each chocolate bar?

What to do next

Could you write a similar problem for a friend? Use a 200 g weight, a 100 g weight and 2 identical objects in your problem.

Cupcake creation

solve

Getting ready

This word problem requires you to work out how many cupcakes you could make if you had a specifed amount of ingredients.

You can work alone or with a friend.

What to do

Read the recipe (on the right) for cupcakes:

This recipe makes 12 cupcakes.

How many cupcakes could you make if you had:

Ingredients

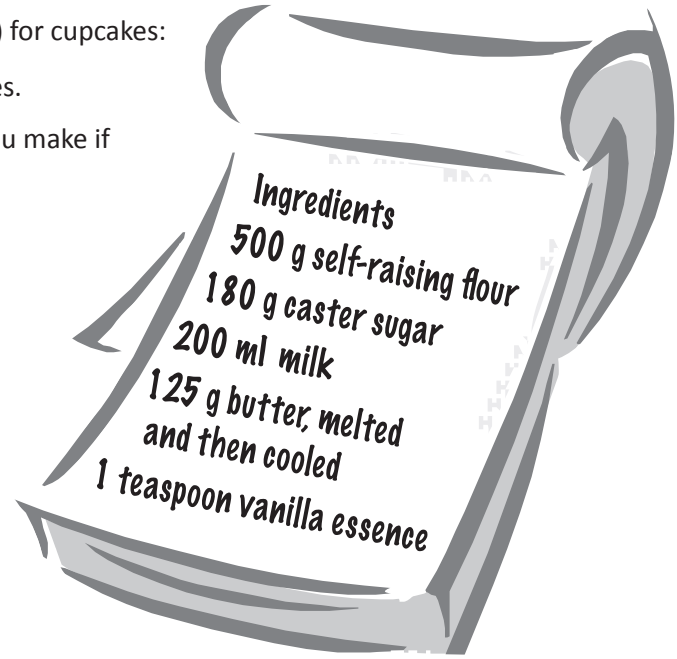
3 kg self-raising flour

720 g caster sugar

1 l milk

600 g butter

5 teaspoons vanilla essence



What to do next

Here is the method. Maybe you could make these at home.

Method

1. *Preheat the oven to 200°C and grease a 12 cup muffin tin.*
2. *Sift the flour and add the caster sugar.*
3. *Make a hole in the centre of the mix and add milk, butter, vanilla and eggs.*
4. *Mix gently and when combined, spoon into the muffin tin.*
5. *Bake for 12–15 minutes. Let cakes cool in the tin for 5 minutes before transferring to a wire rack to cool.*
6. *Once cold, ice using 10 tablespoons of icing sugar mixed with 1 tablespoon hot water and food colouring.*
7. *Decorate with sprinkles.*