Mathletics

Series F Student

Volume, Capacity and Mass

My name

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Series F – Volume, Capacity and Mass

Contents

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Volume and capacity – millilitres and litres

Capacity refers to the amount a container can hold and is usually associated with liquid.

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 **Express these amounts in litres:**

a 2 000 mL = ☐   **b** 1 500 mL = ☐

c 500 mL = ☐   **d** 5 000 mL = ☐

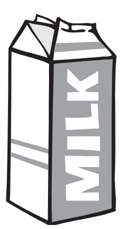
3 **Convert these amounts to millilitres:**

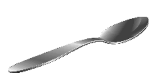
a 8 L = ☐   **b** 2.5 L = ☐

c 9.5 L = ☐   **d** 0.6 L = ☐

e 5.5 L = ☐   **f** 0.2 L = ☐

4 **Which unit would you use for measuring the capacity of each of these objects?**
Write L for litres or mL for millilitres:

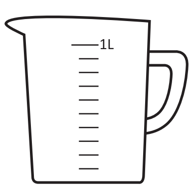


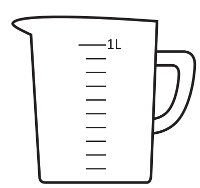


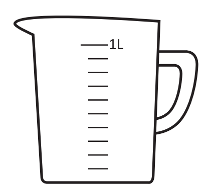



a 2 ______ **b** 5 ______ **c** 1 ______ **d** 300 ____ **e** 4 ______ **f** 250 ____

5 **Colour the jugs to show these quantities:**





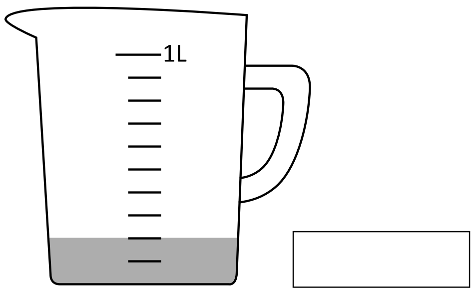


a half a litre **b** $\frac{1}{4}$ of a litre **c** $\frac{3}{4}$ of a litre **d** 900 mL

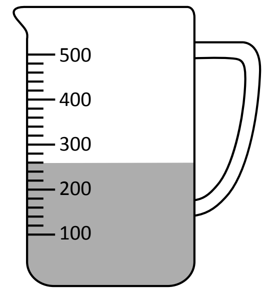
Volume and capacity – millilitres and litres

6 **Answer these problems to do with mixing drinks:**

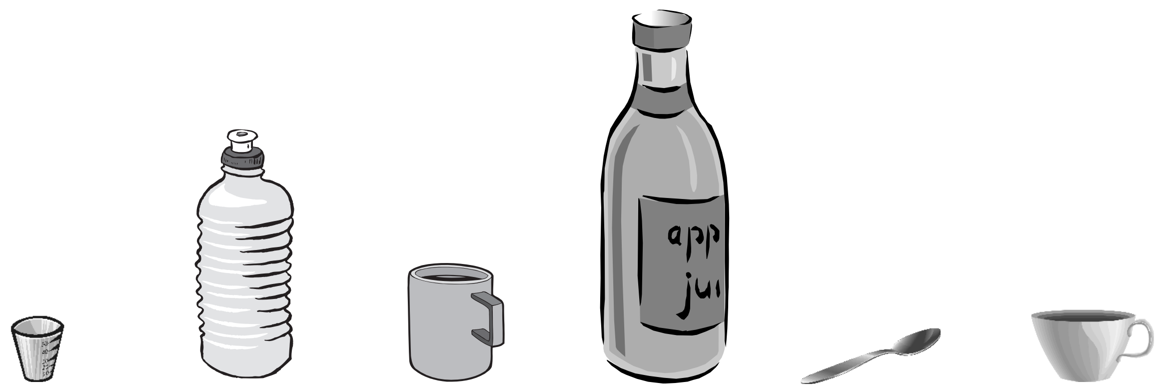
a Tyler has poured cordial syrup into this jug. How much water will he add to make 1 L of cordial drink?



b This jug contains some lemonade. Lucy pours in another 80 mL of lemonade. Draw a line to show the new amount of liquid in the jug.



7 **Look at the pictures, then answer the questions below:**

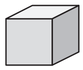


50 mL　　600 mL　　300 mL　　1 L　　5 mL　　200 mL

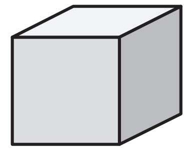
	True or False
a The mug holds the same amount of liquid as six full medicine cups.	
b The tea cup needs to be filled 3 times to equal a full water bottle.	
c The medicine cup holds 10 times more liquid than the spoon.	
d More than 2 L of liquid is needed to fill the water bottle three times.	
e The water bottle holds half as much as the juice bottle.	
f The mug holds half as much as the water bottle.	
g The juice bottle holds the same amount of liquid as four tea cups.	
h The tea cup holds one tenth the amount the juice bottle holds.	

Volume and capacity – cubic centimetres and cubic metres

Volume is 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.
$1\text{ cm} \times 1\text{ cm} \times 1\text{ cm} = 1\text{ cm}^3$



One cubic metre is 1 m long, 1 m wide and 1 m high. The symbol we use is m^3.
$1\text{ m} \times 1\text{ m} \times 1\text{ m} = 1\text{ m}^3$

1 **For this activity you will need 48 centicubes or centimetre blocks. Work with a friend and record your answers in the table as you go:**

a Use all 48 cubes to make a block 4 cubes wide and 4 cubes high. Before you begin, predict how long you think it will be. How long is it? Record your answer in the table below.

b Now use all 48 cubes to make a block 12 cubes long. Before you begin, predict how wide and high it will be. How wide and high is it?

____

c Can you make a block that is still 12 cubes long, but is a different height and width?

____

d Take turns choosing a length between 1 and 48. The other person tries to make a cube with that length. If it can be done, add it to the table. If not, list it to the right of the table. Why do you think these lengths won't work?

____

e Can you see a pattern in your results?

____

f Now for each row, put a multiplication symbol between the width and height and then the height and length. Put an equals sign between the length and number of cubes. Do the number sentences work? If so, you have worked out the formula for volume: **length × width × height = volume**

____

Width	Height	Length	Number of Cubes
			48
			48
			48
			48
			48
			48

Lengths that won't work:

____

____

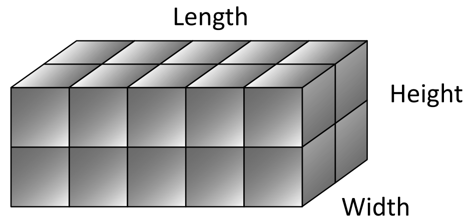
____

____

____

Volume and capacity – cubic centimetres and cubic metres

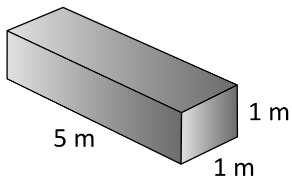
To find out the volume of an object without counting each block, we can multiply the length by the width by the height.



$L \times W \times H = V$
$5 \times 2 \times 2 = 20 \text{ cm}^3$

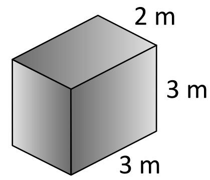
2 **Using the formula L × W × H = V, calculate the volume of these boxes:**

a



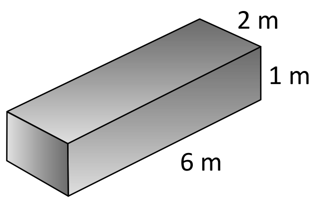
☐ × ☐ × ☐ = ☐

b



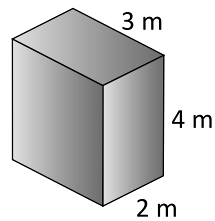
☐ × ☐ × ☐ = ☐

c



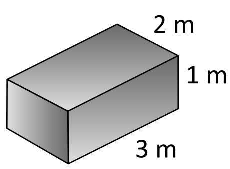
☐ × ☐ × ☐ = ☐

d



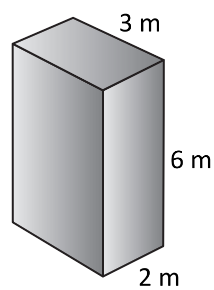
☐ × ☐ × ☐ = ☐

e



☐ × ☐ × ☐ = ☐

f



☐ × ☐ × ☐ = ☐

3 **Would you measure the volume of these objects in the given units? If not, suggest a better choice:**

a swimming pool – cm^3 ______________________

b brick – cm^3 ______________________

c suitcase – cm^3 ______________________

d restaurant – cm^3 ______________________

e pencil case – cm^3 ______________________

f lunch box – cm^3 ______________________

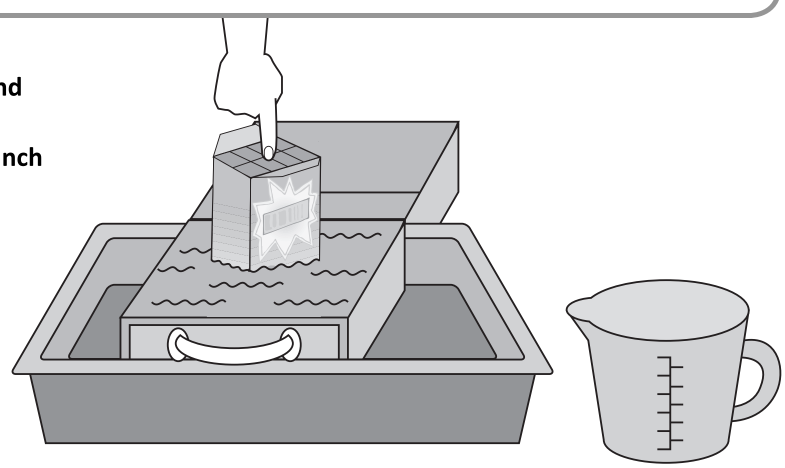
g remote control – cm^3 ______________________

h classroom – cm^3 ______________________

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.
We can use displacement to calculate both volume and capacity. Displacement is the amount of fluid that is pushed away when an object is placed in the fluid.

1 **Try this experiment. Work with a friend or in a small group. You'll need the following equipment: a juice box, a lunch box, a measuring jug, a tote tray and some centicubes.**



a Look at the capacity of your juice box. How many mL does it hold?

____

b Knowing what you do about the relationship between volume and capacity, what do you think is the volume of the juice box? Write down your estimate.

____

c Drink your juice and then carefully cut off the lid of the juice box. Rinse the box out. Now fill the juice box with centicubes. Make sure you keep count as you go. What is the volume? Is it the same as your estimate? If not, why do you think this is?

____

d Place your lunch box in the tote tray and carefully fill the lunch box to the very top with water. Gently submerge your juice box filled with centicubes into the lunchbox. Make sure it is fully submerged. Water should overflow.

e Take the juice box out of the lunch box and carefully take the lunch box out of the tray. Pour the water that overflowed into the tray into the measuring jug. How much water overflowed?

____

f Was it close to the capacity you found in question **a**?

____

2 **Use your measuring equipment and your knowledge of the relationship between volume and capacity to see if you can find a rock with a volume of 50 cm³.**

a How much water will it displace? _______________

b What size rock do you think you will be looking for? _______________

c Once you have found one, was it smaller or larger than you imagined? _______________

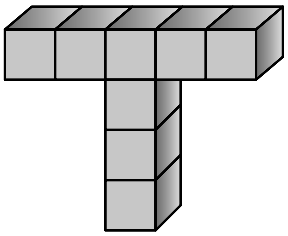
Volume and capacity – displacement

We can see the connection between volume and capacity:

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

3 **Calculate the volume (cm^3) and capacity (mL) from these models made from centicubes:**

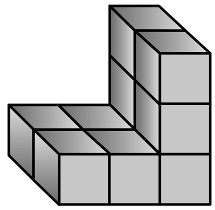
a



Volume = ______ cm^3

Capacity = ______ mL

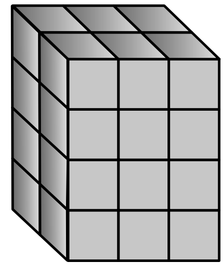
b



Volume = ______ cm^3

Capacity = ______ mL

c

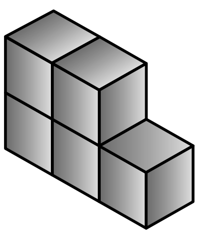


Volume = ______ cm^3

Capacity = ______ mL

4 **Wandu, the work experience girl, has made these shapes out of centicubes. She has written their capacity underneath them. Is she right? Check her thinking.**

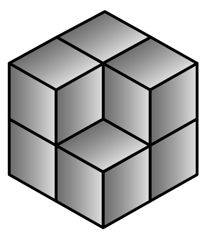
a



5 mL

Is she right? ________________

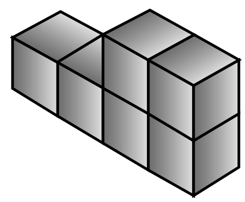
b



6 mL

Is she right? ________________

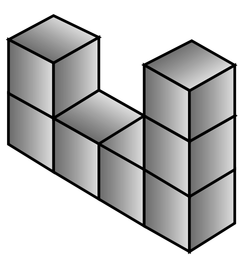
c



6 mL

Is she right? ________________

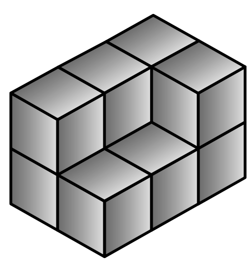
d



7 mL

Is she right? ________________

e



12 mL

Is she right? ________________

Getting ready

You have 4 teenage brothers who drink milk like it's going out of fashion.

To save money, your parents have bought a cow. To their delight, Maisie produces a lot of milk. They have now asked you and a friend to design a 4 litre milk bottle or carton that will fit in the fridge door compartment to hold all that milk.

You will need paper or cardboard, a ruler, scissors, tape, glue, stapler and any other supplies you think may be useful.

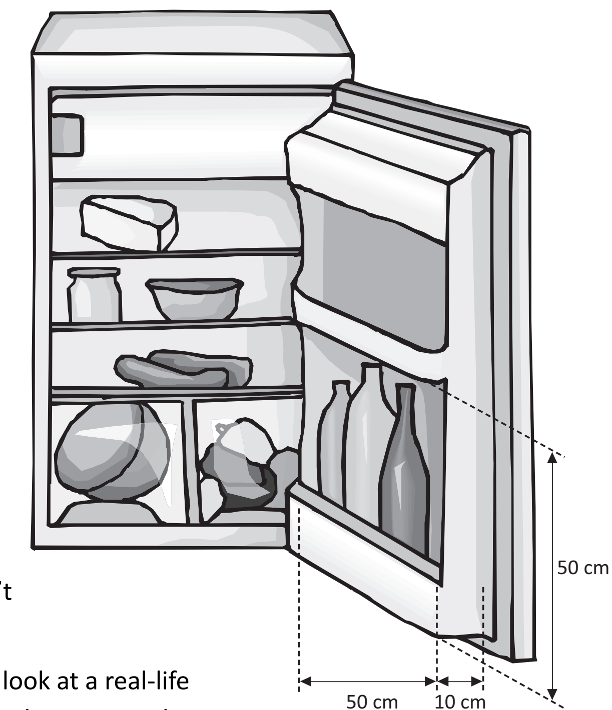
What to do

Using the following fridge door measurements, work with a friend to design and then construct a milk carton.

Look carefully at the dimensions of the compartment on the diagram.

You'll need to think carefully about the relationship between volume and capacity.

Sketch your design and then construct your carton. This is a design prototype so it doesn't actually have to hold the milk!



When planning, it may help to look at a real-life fridge door compartment. Next time you are in the supermarket, look at all the different types of cartons there are.

What to do next

Take your carton to a fridge and test it out. Does it work?

Think outside the box — create

Getting ready

In this activity you are going to create different shaped lidless boxes using the same sized piece of paper.

You will need 3 sheets of cm squared paper, a ruler, scissors and some tape.

You are going to calculate the volume of each box.

What to do

Box 1:

Cut a 12 cm square piece of paper.

Make your first box by cutting one square out from each corner. Fold up the sides and tape the box together. What is the volume of the box? ______________

Box 2:

Cut out another 12 cm square piece of paper. This time, cut out 2 cm × 2 cm squares in each corner. Fold up the sides and tape that box together.

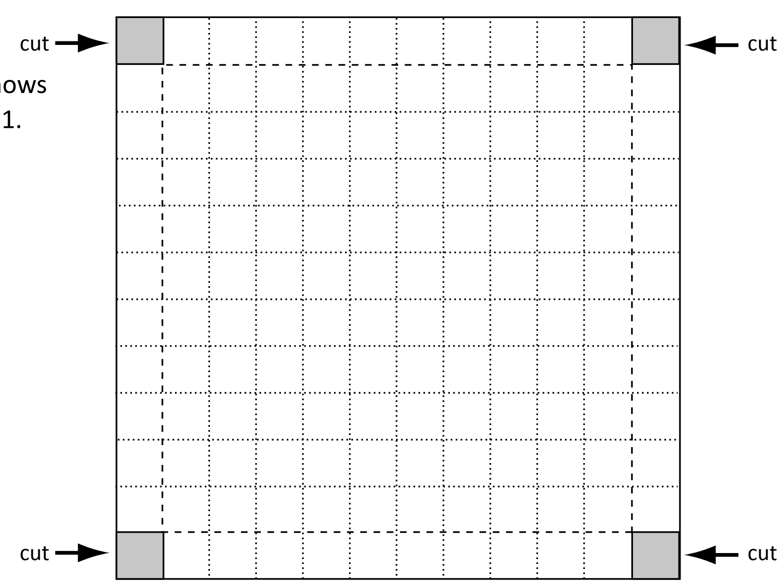
Put the two boxes side by side. Do you think they have the same volume? Does one box look bigger than the other?
Calculate the volume of the 2nd box. Was your prediction correct? ______________

Box 3:

Take a third piece of paper and this time, cut out 3 cm × 3 cm corners.
How does this change the look and the volume of the box? ______________

Make a table of your results.

This diagram shows how to cut box 1.



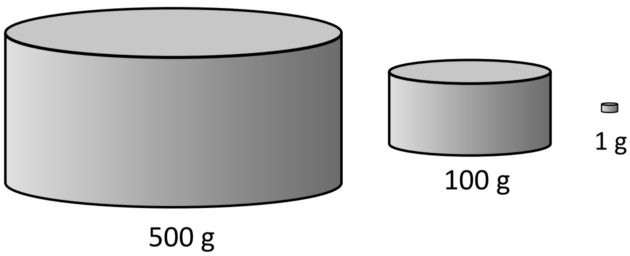
What to do next

Choose some different sized paper squares and repeat the process. What patterns do you find? Can you make volume predictions without actually making the boxes?

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 1000 g in a kilogram and 1000 kg in a tonne.

Before you begin this activity, make sure you get a feel for each of these weights.
Your teacher will get you some of these weights to explore:



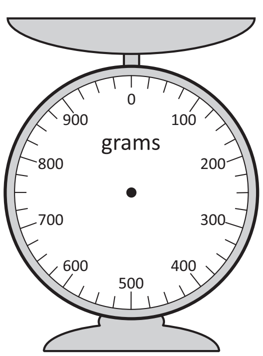
Weight measures the force of gravity on an object and mass measures its inertia or the amount of matter that can 'push back'. A brick weighs less in outer space where there is no gravity but its mass stays the same.

1 **Choose 5 different objects to estimate and measure. Fill in the table below.**

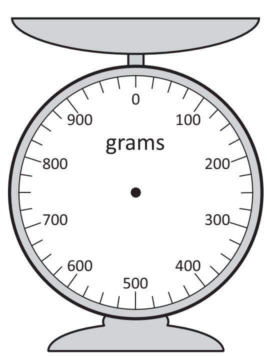
Object	Estimate	Mass

At home, go through your pantry or fridge and find some objects that weigh either 250 grams, 500 grams or 1000 grams. Can you get a sense of what each of these masses feels like?

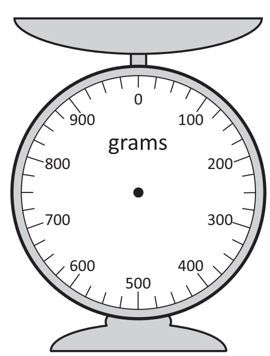
2 **Draw the item on the scale and the arrow to show the mass:**



250 grams of macaroni



675 grams of chocolate buttons



950 grams of rice

3 **Work out which cereal is the best value for money by calculating how much each would cost per kilo. Use the table below. 'Great Grains' is done for you.**

	Weight	Cost per kilogram
Great Grains	$3.60 for 250 g	$3.60 × 4 = $14.40
Munch Muesli		
Fruity Flakes		

You should already know this fact:

1 millilitre (mL) of water has a mass of 1 gram (g)

4 **Use the information to fill in the blanks in these statements:**

a 20 mL = ______ g

b 12 mL = ______ g

c 75 mL = ______ g

d 100 mL = ______ g

e 40 mL = ______ g

f 155 mL = ______ g

g ______ mL = 20 g

h ______ mL = 45 g

5 **This section has already been completed. Check the thinking:**

a 150 mL = 150 g

b 25 mL = 250 g

c 500 mL = 500 g

d 10 mL = 10 g

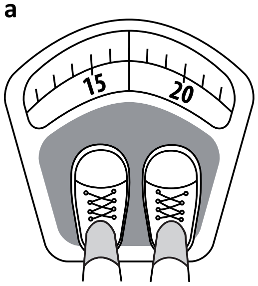
e 300 mL = 30 g

f 2 L = 200 g

Mass – kilograms

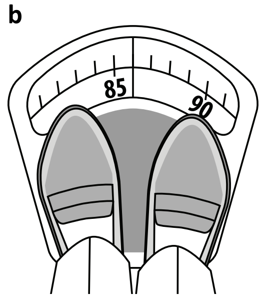
1 **How much does each person weigh?**

a



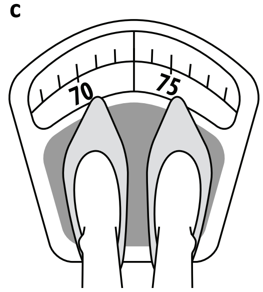
Mass = ☐ kg

b



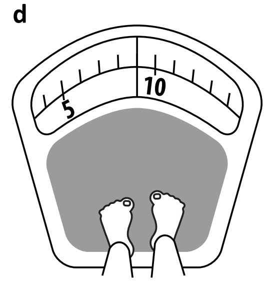
Mass = ☐ kg

c



Mass = ☐ kg

d

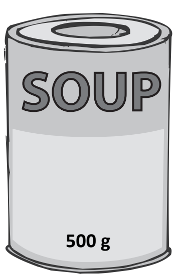


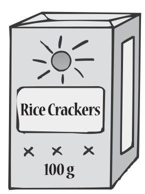
Mass = ☐ kg

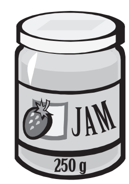
2 **Complete this table by writing each mass in grams and as a decimal. Remember to include the units of measurement:**

Decimal Notation	Grams	Kilograms and Grams
		4 kg 250 g
	1 800 g	
3.75 kg		

3 **Workers at a factory pack cartons that hold a net mass of 4 kg. Calculate the quantity of each item that can be packed per carton:**







a How many tins of soup can be packed into one carton? ____________

b How many boxes of rice crackers can be packed into one carton? ____________

c How many bars of chocolate can be packed into a carton? ____________

d How many jars of jam can be packed into one carton? ____________

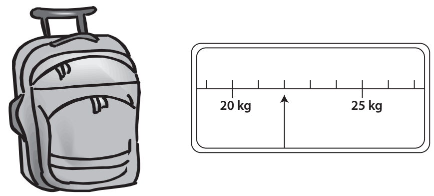
e Would a carton containing 2 tins of soup and 10 jars of jam exceed the net mass? ____________

Mass – kilograms

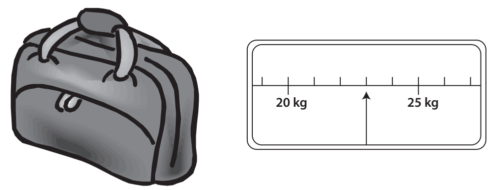
Airline	Checked luggage allowance	Excess luggage fee per kg
Pacific Airways	23 kg	$15
Continental Air	20 kg	$14
Budgetways	20 kg	$12
National Airlines	25 kg	$18

4 **Use the information above to answer these questions. Record your answers in the table below.**

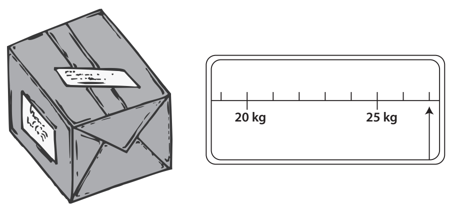
a This is Kim's bag. She is travelling with Budgetways. Will she pay a fee for excess luggage?



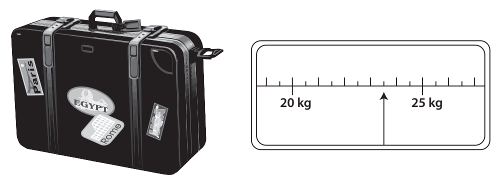
b This is Juan's suitcase. If he is flying with Continental Air will he pay a fee for excess luggage?



c This is Steve's parcel. Will he pay an excess luggage fee if he is flying with National Airlines?



d This is Lisa's suitcase. Her airline is Pacific Airways. Will she pay an excess luggage fee?



	Passenger	Airline	Luggage weight (kg)	Amount over	Excess luggage fee ($)
a	Kim	Budgetways			
b	Juan	Continental Air			
c	Steve	National Airlines			
d	Lisa	Pacific Airways			

5 **Answer the following problems to do with luggage allowance:**

a Mr and Mrs Chan are travelling with an airline that has a luggage allowance of 23 kg per person. Their bags weigh 10 kg, 11 kg, 12 kg and 15 kg. Will they pay an excess luggage fee?

____

b Sara has a parcel that weighs 9.5 kg and a bag that weighs 10.2 kg. If her airline has a luggage allowance of 20 kg, will she pay an excess fee?

____

c Bob is flying with an airline that has a checked luggage allowance of 23 kg and a carry-on luggage allowance of 7 kg. His suitcase weighs 28.5 kg and his carry-on luggage weighs 1 kg. How many kilograms should he move from his suitcase to his carry-on luggage to avoid paying an excess fee?

____

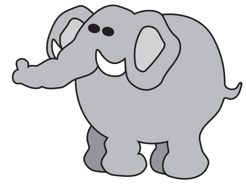
Mass – tonnes

Tonnes are used to measure large objects.

1 tonne = 1 000 kilograms

1 t = 1 000 kg

1 tonne



3 tonnes

1 **Convert these measurements to kilograms (kg):**

a 4 t = ______ **b** 5 t = ______ **c** 2 t = ______

d 8 t = ______ **e** 3 t = ______ **f** 3.5 t = ______

g 20 t = ______ **h** 15 t = ______ **i** 25 t = ______

j 45 t = ______ **k** 50 t = ______ **l** 80 t = ______

2 **Convert these amounts to tonnes (t):**

a 1 000 kg = ______ **b** 5 000 kg = ______ **c** 4 000 kg = ______

d 8 000 kg = ______ **e** 6 000 kg = ______ **f** 2 000 kg = ______

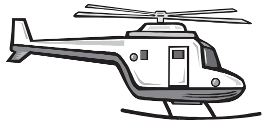
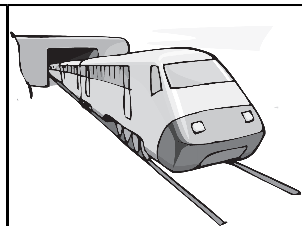
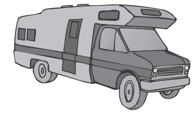
g 9 000 kg = ______ **h** 10 000 kg = ______ **i** 15 000 kg = ______

j 50 000 kg = ______ **k** 25 000 kg = ______ **l** 65 000 kg = ______

3 **Without using a calculator, convert these quantities from kilograms to tonnes. Check your answers with a calculator when you have finished.**

Kilograms	2 546	8 500	3 019	5 854	10 298	28 131	55 750
Tonnes	2.546						

Mass – tonnes

 Helicopter: 3.2 t	 Train: 42 t	 Truck: 35 t	 Campervan: 3.5 t
 Four-wheel Drive: 2 t	 Bus: 14 t	 Car: 1 t	 Boat: 20 t

4 **What is the difference between the mass of each pair of vehicles? Complete the first 3 problems. Now find a friend and take turns giving each other a pair of vehicle masses to calculate:**

	Vehicle 1	Vehicle 2	Difference in Tonnes
a	Helicopter	Four-wheel drive	
b	Train	Truck	
c	Boat	Bus	
d			
e			
f			
g			

5 **Answer these word problems:**

a A 5-tonne truck can carry a load of 5 tonnes. How many 5-tonne trucks are needed to deliver 65 tonnes of steel to a building site? ______________________________

b How many tonnes of sand can be transported if a 9-tonne truck makes 8 trips? ______________________________

c There are 64 passengers on a bus. If the average weight of a passenger is 60 kilograms, what is the total weight of the passengers in tonnes? ______________________________

d A forklift is carrying a box that weighs 2.4 tonnes and a box that weighs 1.8 tonnes. If the forklift's maximum load is 5 tonnes, should another 1.8 tonne box be added? ______________________________

Spuds and carrots solve

Getting ready

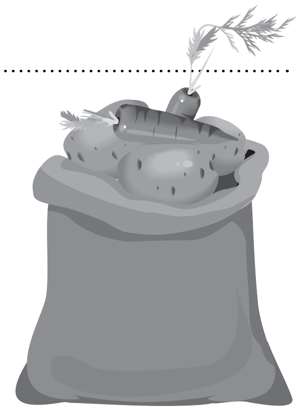
You have a job at a fancy restaurant but the chef is not happy with a mixup you made with the guacamole the other night – who knew wasabi paste could look so much like avocado? He now has you scrubbing out the bins with a toothbrush. You will not be freed from this task until you solve the following problem:

What to do

There is a bag filled with potatoes and carrots. It weighs 1 kilogram. There is an equal number of carrots and potatoes in the bag.

The potatoes each weigh 140 grams. The carrots are all identical and each weigh less than half that amount.

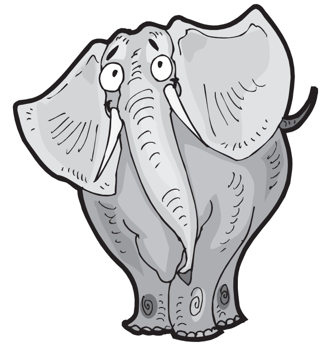
How many spuds are in the bag? How many carrots?



What to do next

What about if the potatoes weighed 260 g each and the carrots remain the same weight? (There will no longer be an identical amount of carrots and potatoes in the bag.)

Getting ready



It's a slow day at the zoo and five zoo keepers are standing around the elephant enclosure, shooting the breeze. They start arguing about the weight of Gertie, their favourite elephant. All five make a prediction. All are wrong, which is fortunate as the losers were going to have to dress up as a boy band and perform for the lunch crowds.

What to do

Your job is to find out Gertie's actual weight using the following clues:

The guesses were: 4 050 kg

4 070 kg

4 120 kg

4 130 kg

4 160 kg

Remember all of these guesses were wrong. However, only two guesses were more than 30 kg out and those two were out by 70 kg and 90 kg.

How much does Gertie weigh?