Your teacher may watch to see if you can:

- work collaboratively with others in a group.

Aim

To describe some forces and their effects.

Method

Apparatus

- wooden block
- masses
- sandpaper
- force meter
- string
- large beaker of water
- objects to weigh

A Put a mass on top of the wooden block and use the force meter to drag the block along a smooth part of the bench. Write down the reading on the force meter.

B Now drag the block along the sandpaper and write down the reading on the force meter.

C Use the force meter to weigh the two objects. Write down their weights.

D Now weigh them again, with the objects in water. Write down their weights.

Recording your results

1 Draw a table like this to record your results.

	Dragging wooden block		Weighing objects in air		Weighing objects in water	
	Bench	Sandpaper	Object A	Object B	Object A	Object B
Force meter reading (N)						

Considering your results

2 Describe the forces on the wooden block when it is:

a resting on the bench

b being pulled along the bench.

3 Explain why the force needed to pull the block along the bench changed when you pulled it along a different surface.

4 Describe the forces on an object being weighed with a force meter. Include forces on the spring inside the force meter.

5 **a** Describe the forces on an object floating in water.

b Explain why the force meter reading is zero when you weigh an object that is floating in water.

6 **a** Describe the forces on an object that sinks in water.

b Explain why the force meter reading is different when you weigh an object in air and in water.

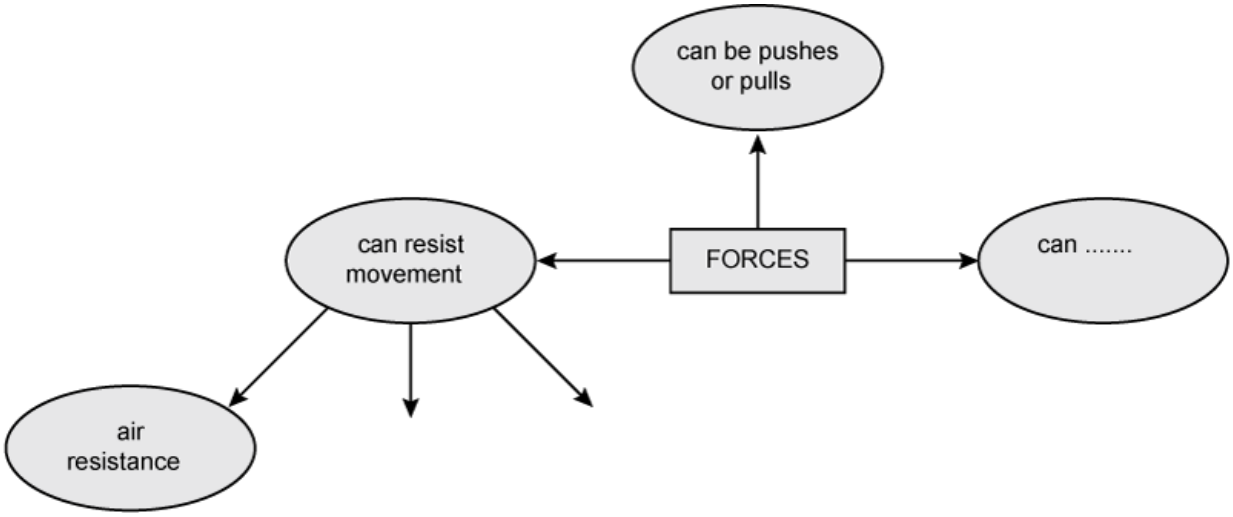
S1 Draw a concept map to show what you know about forces.

1 Cut out the cards at the bottom of the page and arrange them on a blank piece of paper to make a concept map. You can add more words of your own if you need to, and use some words more than once.

2 Draw lines to connect the words and phrases.

3 Look at the statements in the grey 'I can…' box, and make sure you have covered them in your concept map. Add more words and links if you need to.

4 You could start your concept map like this, or you can make your own arrangement of words.



FORCES	can be pushes or pulls	can resist movement
can affect floating and sinking	weight	friction
direction	drag	size
water resistance	vector	unbalanced
subtract	arrow	balanced
air resistance	resultant	add together

E1 A diver is using a 'diver propulsion vehicle' that is producing a forwards force of 100 N, and she is also producing a forwards force of 30 N from her flippers. Other forces on her are 85 N upthrust, 900 N weight and 50 N drag. Calculate the **resultant force** on the diver in the vertical direction and in the horizontal direction.

1 Think about the horizontal forces on the diver.

a What is the resultant *forwards* force?

b What is the overall resultant force in the horizontal direction?

2 What is the resultant force in the vertical direction?

E2 Draw a diagram of the diver and add force arrows to show the two resultant forces.

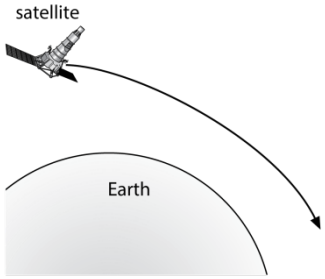
3 Remember that:

- force arrows show the direction and relative sizes of forces, so the two arrows you draw should be of different lengths
- your sketch of the diver can be a stick-figure, it does not have to be a detailed drawing.

4 The diagram shows the path of a satellite around the Earth.

a Explain why we can say that the **velocity** of the satellite is changing even though it is moving at a constant **speed**.

b Make a copy of the diagram and draw arrows on it to show the force(s) acting on the satellite.



5 Three people are pushing a car. Each person pushes with a force of 200 N. Friction forces cause a force of 50 N. What is the resultant force on the car?

6 An Ariane 5 rocket has a main engine and two booster engines. The main engine produces a thrust of 960 kN and each of the boosters produces a thrust of 7080 kN. The weight of the rocket and boosters at take-off is 7700 kN.

a Calculate the resultant force on the rocket as it is taking off.

b Explain why the resultant force on the rocket will be greater 10 seconds after take-off.

These hints may help you with questions 5 and 6.

Question 5: start by working out the force in the forwards direction by adding up the forces from three people pushing the car. Then subtract the friction force.

Question 6a: Remember that the upwards force comes from the main engine and *two* booster engines. Add up the upwards forces first, then subtract the downwards force. As all the forces given are in kilonewtons, you do not need to convert them to newtons before carrying out the calculations.

Question 6b: Part of the weight of the rocket is the fuel for the engines. What happens to the weight of fuel in the rocket as the engines burn?

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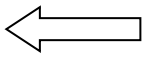
1 A force is a **vector quantity**. Tick the box next to the best description of what this means.

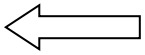
- ☐ A force can be represented using an arrow.
- ☐ A force has both a size and a direction.
- ☐ Forces always act in the same direction.
- ☐ Forces can be pushes or pulls.

2 The arrow on the right represents a force.

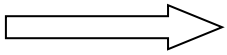


Draw another arrow underneath it that represents a larger force acting in the opposite direction.

3 The arrows represent forces on a car.



friction and drag



forwards force from engine

Draw an arrow underneath that represents the **resultant force** on the car.

4 The drawing shows a sailing boat.

a The weight and upthrust forces are the same size as each other. Draw labelled force arrows on the diagram to show these two forces.

b There is a forwards force from the sails acting on the boat. Draw a labelled force arrow to show this force.

c There is also a drag force on the boat. This force is smaller than the force from the sails. Draw a labelled force arrow to show this force.

5 The upthrust force on the boat in question **4** is 50 000 N and its weight is 50 000 N. Circle the words or phrases that describe the vertical forces on the boat.

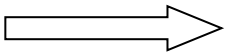
balanced	unbalanced	non-zero resultant	zero resultant
resultant acts upwards		resultant acts downwards	

6 The force from the sails is larger than the drag forces on the boat. Circle the words or phrases that describe the horizontal forces on the boat.

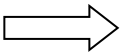
balanced	unbalanced	non-zero resultant	zero resultant
resultant acts forwards		resultant acts backwards	

1 Describe the difference between **speed** and **velocity**.

2 The arrows represent forces on a car but some forces are missing.



forwards force from engine



resultant force

a Describe the size and direction of the missing force(s).

b Explain how you worked out your answer to part **a**.

c Are the forces on the car balanced or unbalanced? Explain your answer.

3 For each of the following situations:

- sketch the situation and draw arrows to represent the forces
- state the size and direction of the resultant force
- say whether the forces on the object are balanced or unbalanced.

a There is an upthrust on a boat of 500 N. The weight of the boat is 550 N.

b A man throws a ball upwards. The weight of the ball is 2 N and the force from his hand is 5 N.

c The ball in part **b** is moving up through the air.

d A girl is standing on a cliff-top on a windy day when the force of the wind on her is 50 N. The forces on her are balanced.

e A boat sailing on a lake has a weight of 50 000 N and the forwards force from its sails is 200 N. The drag is 150 N.

f A cannonball with a weight of 40 N is flying horizontally through the air. The air resistance on it is 200 N.

Extra challenge

4 A spacecraft returning to Earth goes through the following stages. For each stage, sketch a diagram showing the forces on the spacecraft and explain whether or not the forces are balanced:

- orbiting around the Earth at constant speed
- slowing down as it enters the atmosphere
- falling at a constant speed under a parachute
- floating on the sea.

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Progression questions

Answer these questions.

1 What is the difference between the **speed** of an object and its **velocity**?

_____

_____

2 How do we represent all the forces acting on an object?

_____

_____

3 How do we calculate **resultant forces**?

_____

_____

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

_____

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

_____

_____