3 Forces and energy

3.1 Forces and motion

Exercise 3.1A Balanced forces

Focus

In this exercise, you will describe balanced forces.

1 What is needed for two forces to be balanced?

Tick (✓) **two** statements in the table.

Statement	Needed for forces to be balanced?
Two forces must be the same size.	
Two forces must be different sizes.	
Two forces must be in the same direction.	
Two forces must be in opposite directions.	

2 A box sits on the ground. The box is **not** moving.

Write 'true' or 'false' after each statement.

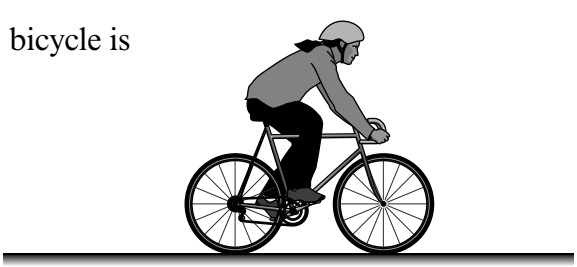
a There are no forces acting on the box. .....

b There are balanced forces acting on the box. .....

c There is an unbalanced force acting on the box. .....

3 Sofia is riding her bicycle. The driving force on the bicycle is balanced with the force of friction on the bicycle.

Draw arrows on the diagram to show these forces.
Write the names of the forces on the arrows.



Exercise 3.1B Unbalanced forces

Practice skills

In this exercise, you will be thinking about the effects of unbalanced forces.

1 Which of these can happen because of unbalanced forces?

Tick (✓) **all** correct statements.

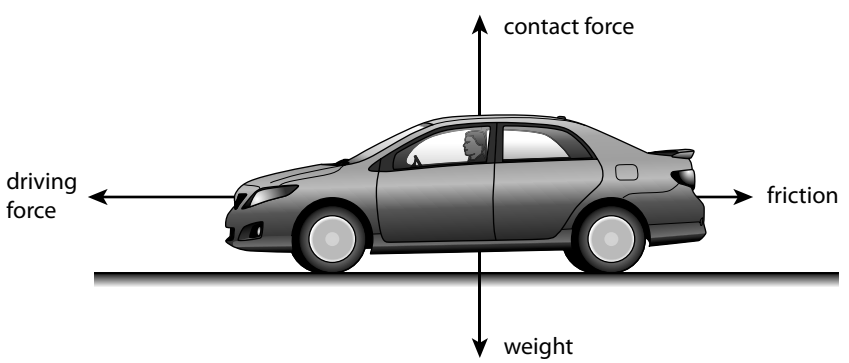
A car will move at a constant speed. ☐

A boat will slow down. ☐

A football will change direction. ☐

A book will not move on a desk. ☐

2 The diagram shows the forces on a car.



State:

a which forces are balanced

..... and .....

b which forces are unbalanced

..... and .....

c what will happen to the car.

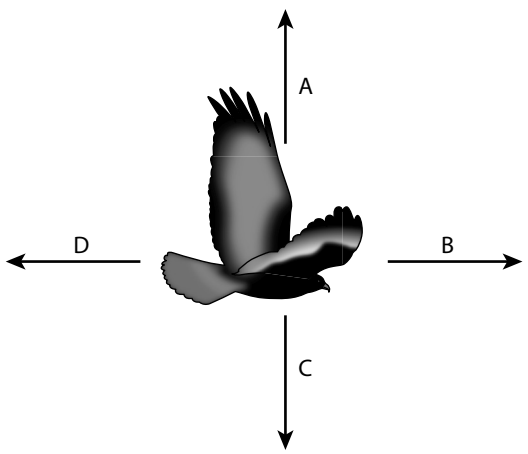
.....

Exercise 3.1C Changing direction

Challenge

In this exercise, you will describe how unbalanced forces can cause a change in direction of movement.

1 The diagram shows the forces, A–D, acting on a bird when it is flying.



a Describe the effect of these forces on the movement of the bird.

.....

.....

.....

b Describe **one** change needed to the forces for the bird to go higher.

.....

c Describe **two** changes to the forces that would make the bird go slower.

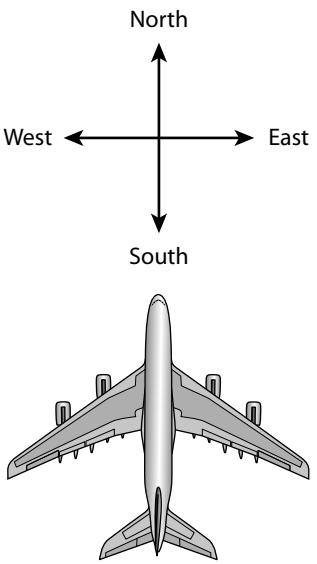
1 .....

2 .....

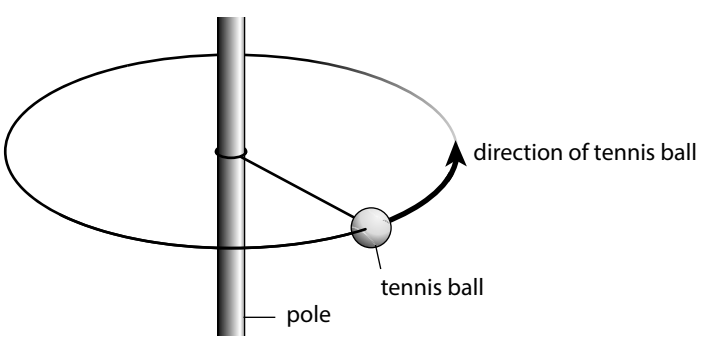
2 An aeroplane is flying north, in a straight line, at a constant speed.

The aeroplane needs to turn towards east.

Draw an arrow on the diagram to show the direction of the unbalanced force needed to make the aeroplane turn east.



3 Tetherball is a game. A tennis ball is attached to a string. The string can rotate around a vertical pole. The tennis ball moves in a circle around the pole.



The tennis ball in the diagram has been hit by a player and is moving in the direction shown.

a Draw an arrow on the diagram to show the direction of the force on the tennis ball. Label this arrow F.

The string breaks when the tennis ball is at the position shown in the diagram.

b Draw another arrow on the diagram to show the direction that the tennis ball will move when the string breaks. Label this arrow D.

› 3.4 Turning forces

Exercise 3.4A Identifying turning forces

Focus

In this exercise, you will decide where turning forces are used.

1 Which of these actions needs a turning force to happen?

Tick (✓) **all** that apply.

pushing a door open ☐

pulling a chair across the floor ☐

twisting the top off a bottle ☐

pushing the hands of a clock around ☐

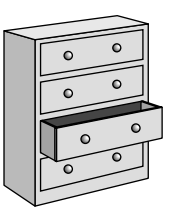
pushing a trolley up a ramp ☐

stretching an elastic band ☐

2 Which of these objects needs a turning force to work?

Tick (✓) **all** that apply.

☐



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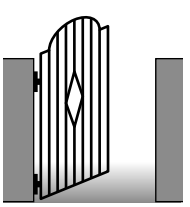

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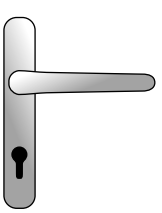


☐

☐

3 What name is given to the turning effect of a force?

Circle **one** word.

minute **moment** **rotate** **revolve**

Exercise 3.4B Calculating moments

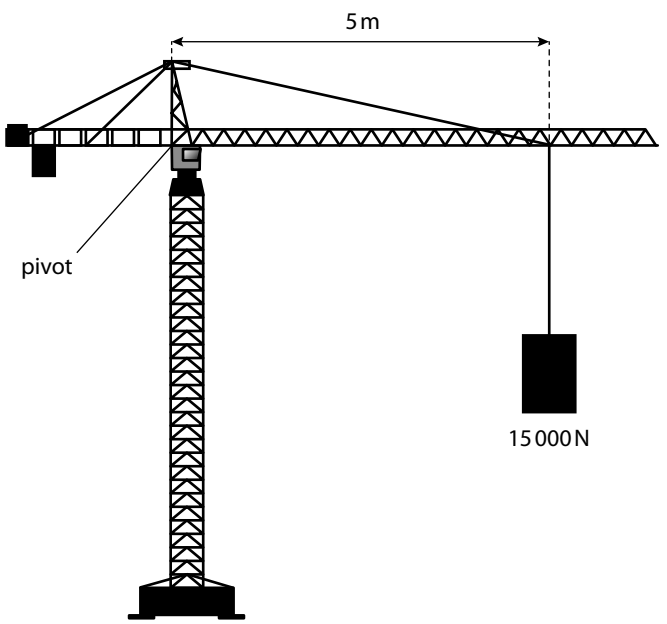
Practice

In this exercise, you will calculate moments and make predictions about moments.

1 Write the equation that links moment, force and distance.

2 The picture shows a crane supporting a 15 000 N weight.

The weight is supported 5 m from the pivot of the crane.



a Calculate the moment caused by the weight on the crane.

Show your working.

.....Nm

b Explain the effect on this moment of:

i moving the weight further from the pivot

.....

.....

ii moving the weight closer to the pivot.

.....

.....

3 Some people use units that are **not** international standard units.

One of these units of distance is the foot.

One of these units of force is pounds.

Write the unit of moment in these units.

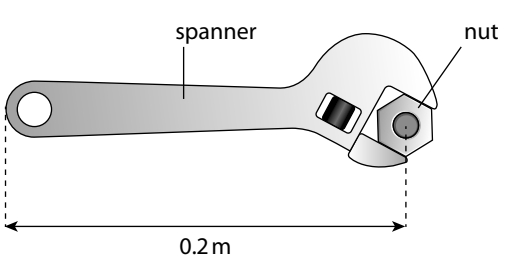
.....

Exercise 3.4C Moments, force and distance

Challenge

In this exercise, you will calculate forces and distances for moments.

1 A spanner will turn a nut. The nut needs a moment of 40 Nm to turn. The spanner is 0.2 m long.



a Calculate the force that must be exerted on the spanner.

Show your working and give the unit.

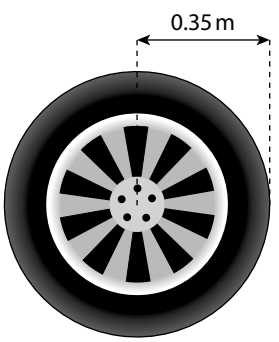
.....

b Explain why using a longer spanner will make the nut easier to turn.

.....

.....

2 An engine exerts a moment of 350 Nm when measured at a wheel.
The engine drives a wheel that has a radius of 0.35 m The pivot of the wheel is at the centre.

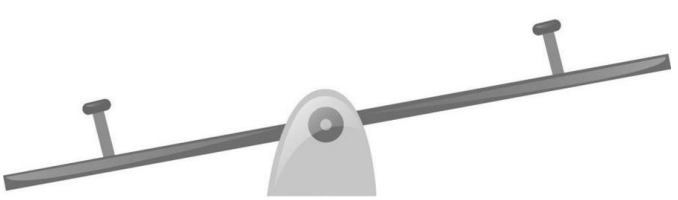


Calculate the force at the outside of the wheel.

Show your working and give the unit.

.....

3 Sofia weighs 500 N. She sits on a seesaw at a distance of 2 m from the pivot.



a Calculate the moment that Sofia exerts on the seesaw.
Show your working and give the unit.

.....

The seesaw will balance when the moments on both sides are equal.
Zara weighs 400 N.

b Calculate the distance from the pivot to where Zara should sit to balance the seesaw.
Show your working and give the unit.

.....

3.5 Pressure between solids

Exercise 3.5A Describing pressure

Focus

In this exercise, you will describe what affects pressure in solids.

1 Which of these is used to work out pressure?
Tick (✓) **one** box.

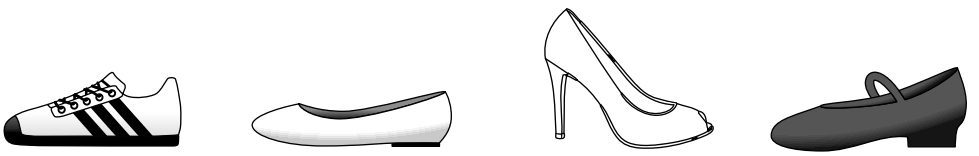
pressure = $\frac{\text{force}}{\text{area}}$ ☐ pressure = mass × area ☐

pressure = $\frac{\text{mass}}{\text{area}}$ ☐ pressure = force × area ☐

2 Zara has four different styles of shoes.

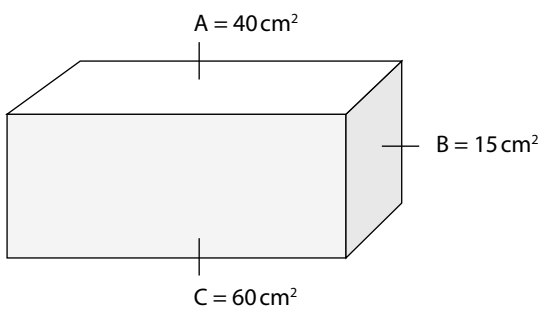
Which shoes will exert the greatest pressure on the floor when Zara wears them?

Tick (✓) **one** box.



☐ ☐ ☐ ☐

3 The picture shows a box. The areas of three faces of the box, A, B and C are shown.



a Which face of the box will exert the **smallest** pressure on the floor?

Write the letter. .....

b Explain your answer to part **a**.

.....

.....

Exercise 3.5B Calculating pressure

Practice

In this exercise, you will calculate pressure in solids and think about the units of pressure.

1 A rock exerts a pressure of 20 N/cm^2 on the ground.

What does 20 N/cm^2 mean?

Complete the sentence.

A force of ..... acts on each ..... of area.

2 A large book has a weight of 15 N. The area of one end of the book is 60 cm^2.

Calculate the pressure the book exerts when standing on this end.

Show your working.

..... N/cm^2

3 A nail will go into wood if the pressure on the end of the nail is 60 N/mm^2.

The area of the end of the nail in contact with the wood is 0.5 mm^2.

Calculate the force needed on the nail to make it go into the wood.

Show your working and give the unit with your answer.

.....

4 Not all of the units used by people are standard scientific units. Some people use other units.

One of these other units of force is pounds.

One of these other units of area is square inch.

State the unit of pressure in these other units.

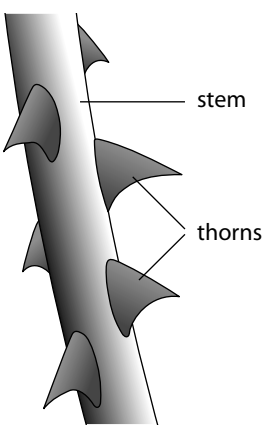
.....

Exercise 3.5C
Variables affecting pressure

Challenge

In this exercise, you will consider the variables that affect pressure in solids.

1 The picture shows part of the stem of a plant called a rose. The stem has parts called thorns.



Explain why touching the thorns is more dangerous than touching other parts of the stem.

.....

.....

.....

2 Cars can get stuck in sand when a wheel sinks down into the sand.

Explain why putting a large piece of wood under the wheel can stop the wheel from sinking.

.....

.....

.....

3 Arun is cutting bread.

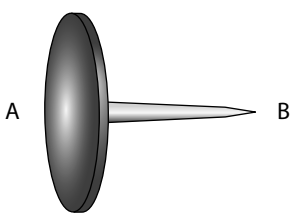
Explain why a sharp knife is better for cutting bread than a knife that is **not** sharp.

.....

.....

.....

4 The picture shows a drawing pin. The two ends of the drawing pin are labelled A and B.



Part A is pushed by your thumb.

Part B goes into a wall or drawing board.

Explain the shape of each end of the drawing pin.

.....

.....

.....

.....