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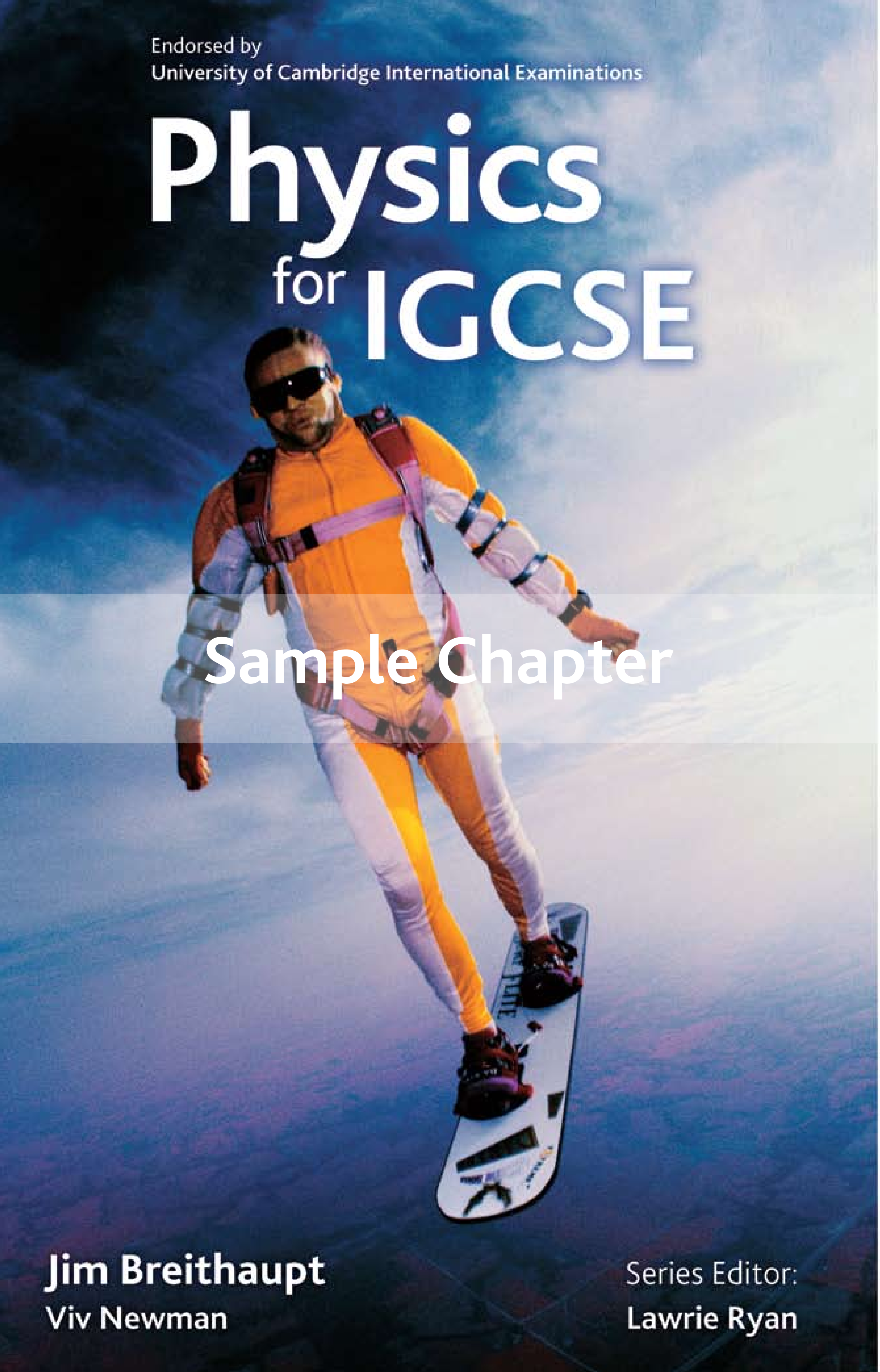
Physics for IGCSE



Sample Chapter

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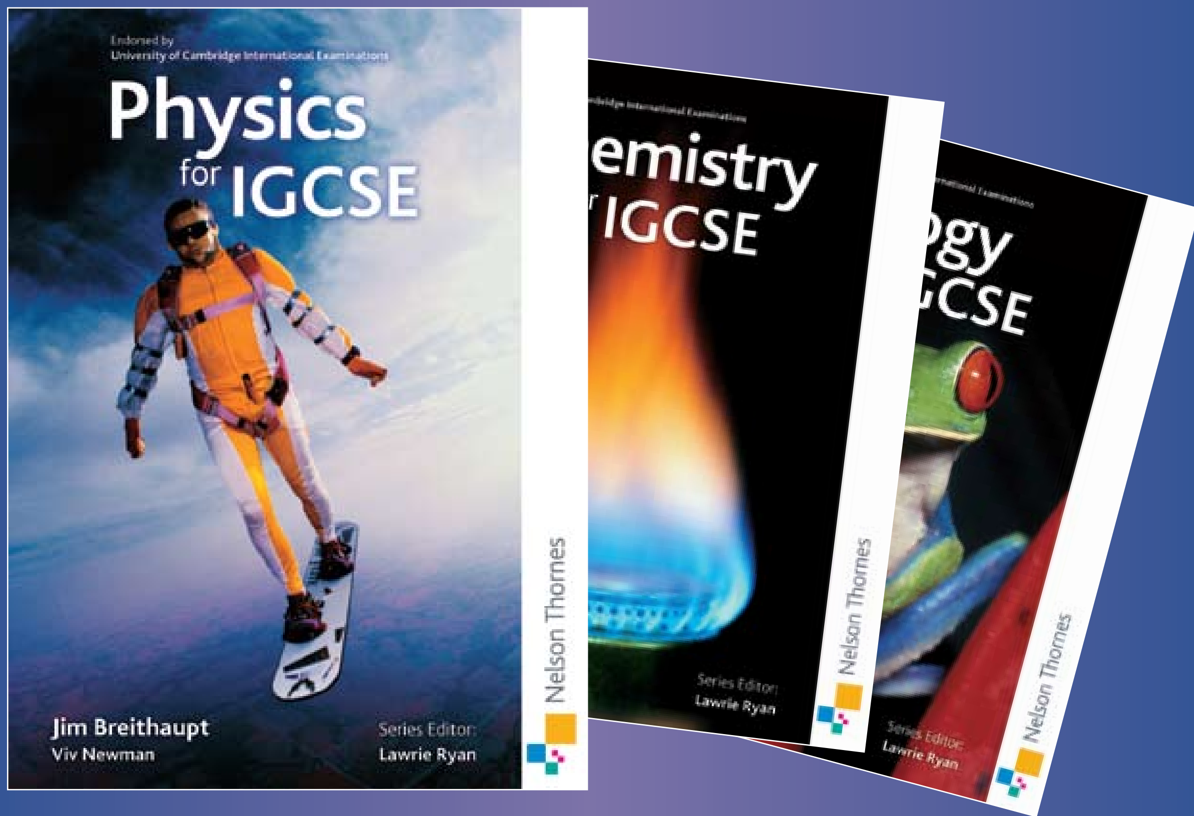

Author credentials

Authors

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Introduction

Nelson Thornes

Nelson Thornes are proud to present you with a sample chapter to our new title, Physics for IGCSE. Physics for IGCSE is the third title in a unique new series from Nelson Thornes that matches Cambridge specifications and the needs of students and teachers of the Cambridge syllabuses.

The IGCSE Science series has been written afresh and specifically for international schools. Chemistry, Biology and now completing the series, Physics, have been endorsed by University of Cambridge International Examinations.

Key features include:

- Content is presented clearly and concisely to make it accessible for international school students with wide ranging backgrounds
- The examiners give tips and hints throughout that address common misconceptions and errors
- Each chapter has a section of exam-style questions, written by Cambridge IGCSE Principal Examiners, that closely match papers 1, 2 and 3
- Each title has a section dedicated to the Assessing Practical Physics paper prepared by the examiner for Paper 5 and 6
- All titles have a revision checklist that covers the whole Cambridge IGCSE syllabus to make sure students know what they have covered

Topics are presented in an innovative 'lesson on a page' double page spread format, providing all pertinent material and emphasizing the key learning points.

Spread features:

- Learning outcomes – these are clearly stated at the start of each spread. Extension outcomes are also stated where applicable
- As well as being presented in a direct and accessible manner, content is supplemented by flow diagrams, tables and bulleted text
- Practical activities – these allow students to take an active approach to science
- Extension material – this is clearly distinguished where it occurs
- Examiner says – notes written by Cambridge IGCSE Principal Examiners to help students overcome common errors and misconceptions
- Did you know – interesting information that uses contexts relevant to international school students
- Summary questions – test and consolidate students' learning
- Key points – at the end of the spread, these relate directly to the learning objectives and provide the key information that students need to learn

We hope you will be as pleased and excited by the results as we are, for further information please contact us using the details on the back of this booklet.

Yours faithfully,

Oliver Thornton
International Publishing Manager
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2 Forces and their effects

2.1 Mass and weight

LEARNING OUTCOMES

- Recognise that the mass of a body is a measure of how much matter is in it.
- Compare different masses using a balance.
- Recognise that the weight of an object depends on its mass.

Extension

- Recognise that the weight of an object depends on the gravitational field it is in.
- Know that the greater the mass of an object is, the greater the resistance to change of its motion.

Figure 2.1.1 Using kilograms

Mass and matter

The mass of an object depends on how much matter there is in the object. The amount of matter in an object determines its **mass,** regardless of whether the object is a solid or a liquid or a gas. Two objects of the same mass contain the same amount of matter. Two objects of different mass contain different amounts of mass.

The SI unit of mass is the **kilogram** (kg). We usually use this unit of mass in everyday life although we sometimes find it is more convenient to use the gram which is 0.001 kg.

The mass of a body is a measure of the amount of matter it contains

Weight

The weight of an object depends on its mass. This is because weight is due to the downward pull of the Earth's gravity on the object and the force of gravity on an object depends on its mass.

The greater the mass of an object is, the greater its weight is

We measure weight in newtons because the SI unit of force is the **newton** (abbreviated N) and weight is a force. Figure 2.1.2 shows an object being weighed using a **newtonmeter** marked in newtons. Measurements using a newtonmeter should show that weight of an object of mass 1 kg near the Earth's surface is 10 N. Therefore the force of gravity on a 1 kg object near the surface of the Earth is 10 N.

For any object near the Earth's surface, the force of gravity on it is 10 N for every kilogram of its mass. So the weight of an object near the Earth's surface is 10 N for every kilogram of its mass. For example, near the surface of the Earth, the weight of an object:

- of mass 1 kg is 10 N
- of mass 5 kg is 50 N
- of mass 20 kg is 200 N.

PRACTICAL

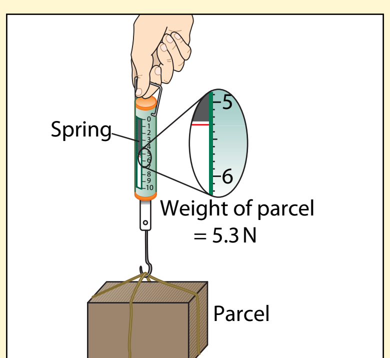


Figure 2.1.2 Using a newtonmeter to weigh an object

Using a newtonmeter

1. Check the pointer of the newtonmeter reads zero on the scale without any object suspended from the newtonmeter.
2. Suspend the object to be weighed from the newtonmeter hook. This causes the spring in the newtonmeter to stretch which makes the pointer move down the scale.
3. Read the position of the pointer on the scale to give the weight of the object in newtons.

Extension

The force of gravity on any object near the Earth's surface is 10 N for every kilogram of its mass. We say that the **gravitational field strength** of the Earth near its surface is 10 N/kg.

If we know the mass of an object, we can calculate its weight using the equation **weight (in newtons) = mass (in kilograms) × gravitational field strength (in N/kg).**

The weight of an object depends on its location. For example, the weight of a 50 kg person near the Earth's surface is 500 N (= 50 kg × 10 N/kg). However, the same person on the surface of the Moon where the gravitational field strength is 1.6 N/kg would weigh only 80 N (= 50 kg × 1.6 N/kg).

Comparing masses

We can compare the weights of two different objects using a balance as shown in Figure 2.1.3.

We can find the mass of an object by placing it on one of the balance pans and placing 'standards' of known mass on the other pan until the arm is level.

Extension

The **inertia** of an object is its resistance to a change of its motion. The greater the mass of an object, the more inertia it has. A fully-loaded lorry takes longer to reach a certain speed from a standstill than if it was carrying no load. Its mass when fully-loaded is much greater than when it is unloaded so it has more inertia and takes longer to accelerate from rest to a certain speed.

WORKED EXAMPLE

Calculate the weight in newtons of a person of mass 60 kg:

a near the Earth's surface

b on the surface of the Moon.

The gravitational field strength near the Earth's surface = 10 N/kg.

The gravitational field strength near the Moon's surface = 1.6 N/kg.

Solution

a Near the Earth's surface, the weight of the person = mass × gravitational field strength = 60 kg × 10 N/kg = 600 N.

b On the Moon's surface, the weight of the person = mass × gravitational field strength = 60 kg × 1.6 N/kg = 96 N.

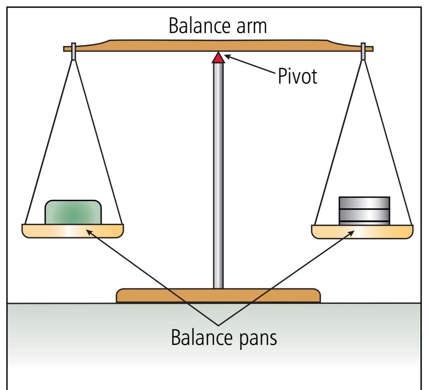


Figure 2.1.3 A balance

SUMMARY QUESTIONS

1 Complete the following sentences below using words from the list.

force matter mass weight

a The ______ of an object is a measure of how much ______ it has.

b The ______ of an object is the ______ on it due to gravity.

c ______ is measured in newtons; ______ is measured in kilograms.

d A newtonmeter may be used to measure the ______ of an object.

2 An object has a mass of 40 kg on the surface of the Earth.

a State whether i its mass, ii weight would be smaller or the same or greater on the Moon.

b Calculate i the weight of the object on the Earth, ii its weight on the Moon.

The gravitational field strength near the Earth's surface = 10 N/kg.

The gravitational field strength near the Moon's surface = 1.6 N/kg.

KEY POINTS

1. The greater the mass of an object, the greater is its inertia.
2. The greater the mass of an object the greater is its weight.

2.2 Density

LEARNING OUTCOMES

- Recognise that density = mass / volume
- Calculate the density of an object from its mass and its volume
- Carry out and describe experiments to measure the density of a regular solid, of a liquid and of an irregularly shaped solid (Extension)
- Carry out calculations using the equation: 'density = mass/volume'

WORKED EXAMPLE

A wooden post has a volume of 0.025 m³ and a mass of 20 kg. Calculate its density in kg/m³.

Solution

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{20\,\text{kg}}{0.025\,\text{m}^3} = 800\,\text{kg/m}^3$$

Figure 2.2.1 Materials of different densities

Density comparisons

Any builder knows that a concrete post is much heavier than a wooden post of the same size. This is because the density of concrete is much greater than the density of wood. A volume of one cubic metre of wood has a mass of about 800 kg whereas a cubic metre of concrete has a volume of about 2400 kg. So the density of concrete is about three times the density of wood.

The density of two different materials can be compared by comparing the masses of same-size blocks of each material. We can do this using a balance as shown in Figure 2.1.3 on page 21 or use an electronic balance to measure the mass of each block. Each block has the same volume so the block with the greater mass has the greater density.

The density of a substance is defined as its mass per unit volume. We can use the equation below to calculate the density of a substance if we know the mass and the volume of a sample of it.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

The SI unit of density is the kilogram per cubic metre (kg/m³) although the gram per cubic centimetre (g/cm³) is often used.

Density tests

For each of the tests below, measure the mass and the volume of the object as explained then use the formula density $= \frac{\text{mass}}{\text{volume}}$ to calculate the density of the object.

1 Measuring the density of a regular solid object

- To measure the mass of the object, use a balance as shown in Figure 2.1.3 on page 21 or an electronic balance. Make sure the balance reads zero before placing the object on it.
- To find the volume of a regular solid such as a cube, a cuboid or a cylinder, measure its dimensions, using a millimetre ruler or a micrometer. Use the measurements and the correct formula shown in Figure 2.2.2 to calculate its volume.

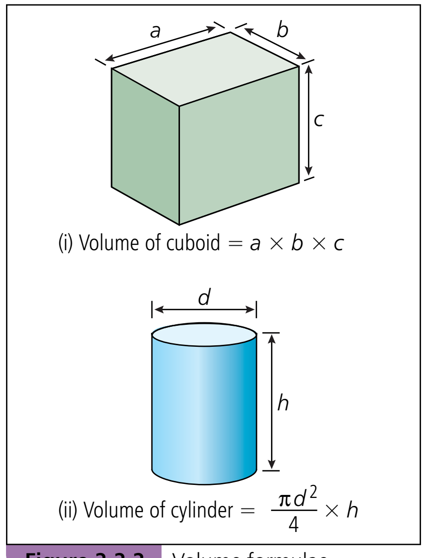


Figure 2.2.2 Volume formulae

2 Measuring the density of a liquid

- Use a measuring cylinder to measure the volume of a certain amount of the liquid.
- Measure the mass of the empty beaker using a balance. Remove the beaker from the balance and pour the liquid from the measuring cylinder into the beaker. Use the balance again to measure the total mass of the beaker and the liquid. The mass of the liquid is worked out by subtracting the mass of the empty beaker from the total mass of the beaker and the liquid.

WORKED EXAMPLE

A measuring cylinder contained a volume of 120 cm³ of a certain liquid. The liquid was then poured into an empty beaker of mass 51 g. The total mass of the beaker and the liquid was then found to be 145 g.

a Calculate the mass of the liquid in grams.

b Calculate the density of the liquid in g/cm³.

Solution

mass of liquid = 145 − 51 = 94 g

volume = 120 cm³

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{94\,\text{kg}}{120\,\text{cm}^3} = 0.78\,\text{g/cm}^3$$

Measuring the density of an irregular solid (Extension)

- Use a balance to measure the mass of the object.
- Determine the volume of the object using a measuring cylinder and a displacement can as shown in Figure 2.2.3. Water is the most suitable liquid to use provided the solid does not dissolve in it Work out the density from the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

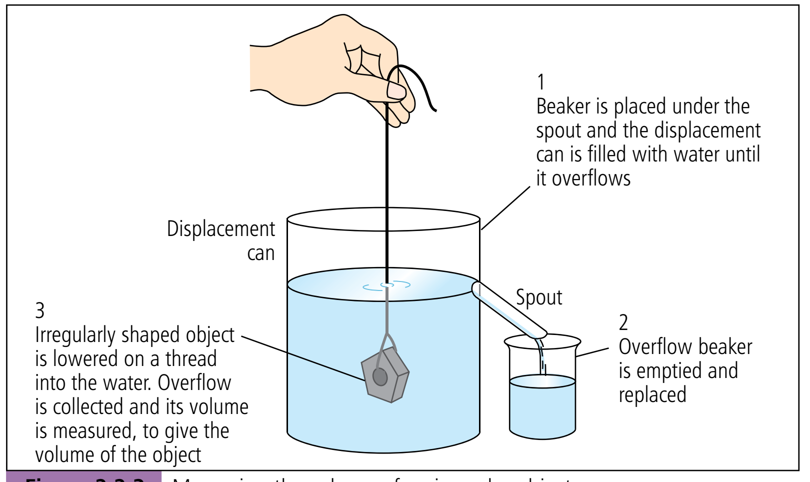


Figure 2.2.3 Measuring the volume of an irregular object

SUMMARY QUESTIONS

1 A rectangular concrete slab is 0.80 m long, 0.60 m wide and 0.05 m thick.
   a Calculate its volume in m³.
   b The mass of the concrete slab is 60 kg. Calculate its density in kg/m³.

2 A measuring cylinder contains 80 cm³ of a certain liquid. The liquid is poured into an empty beaker of mass 48 g. The total mass of the beaker and the liquid was found to be 136 g.
   a Calculate the mass of the liquid in grams.
   b Calculate the density of the liquid in g/cm³.

3 A rectangular block of gold is 0.10 m in length, 0.08 m in width and 0.05 m in thickness.
   a i Calculate the volume of the block.
   ii If the mass of the block is 0.76 kg. Calculate the density of gold.
   b (Extension) A thin gold sheet has a length of 0.15 m and a width of 0.12 m. The mass of the sheet is 0.0015 kg. Use these measurements and the result of your density calculation in a ii to calculate the thickness of the sheet.

4 Describe how you would measure the density of a metal bolt. You may assume the bolt will fit into a measuring cylinder of capacity 100 cm³.

2.3 Force and shape

LEARNING OUTCOMES

- Describe how to measure the extension of an object when it is stretched.
- Recognise that an elastic body regains its shape after being deformed.
- Describe extension–load graphs for a spring, for rubber and for polythene.

Extension

- Interpret extension–load graphs including the limit of proportionality.
- State and use Hooke's law.

DID YOU KNOW?

Rubber and other soft materials dipped in liquid nitrogen become as brittle as glass. Such frozen materials shatter when struck with a hammer.

Figure 2.3.1 A shattered flower

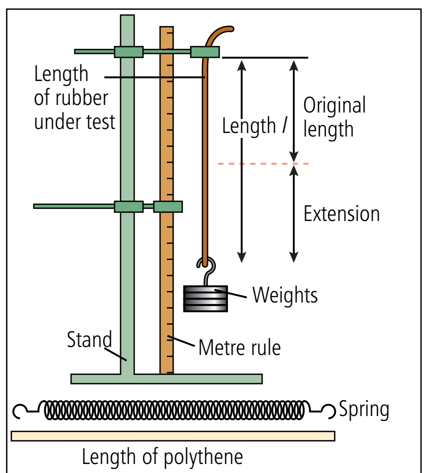


Figure 2.3.2 Investigating stretching

Stretching and squeezing

Squash players know that hitting a squash ball changes its shape briefly. An object is said to be **elastic** if it regains its original shape when the forces that deform it are removed. A squash ball is elastic because it regains its shape. So too is a rubber band as it regains its original length after it is stretched and then released. Rubber is an example of an elastic material.

Stretch tests

We can investigate how easily a material stretches by hanging weights from it, as shown in Figure 2.3.2.

- The strip of material under test is clamped at its upper end and its initial length is measured using the metre ruler. A small weight or a weight hanger attached to the material is used to keep it straight.
- The amount of weight hung from the material is then increased in stages. The strip stretches each time more weight is hung from it.
- At each stage, the total weight added is recorded in a Table and the length of the strip is measured and also recorded in the Table. The position of the upper end should stay the same throughout.

The change of length from the initial length is called the **extension**. This is calculated for each stage and recorded in the Table, as shown below.

The extension of the strip of material at any stage = its length at the stage – its initial length

weight / N	length / mm	extension / mm
0	120	0
1.0	152	32
2.0	190	70
3.0	250	

The measurements may be plotted on a graph of extension on the vertical axis against length on the horizontal axis. Figure 2.3.3 shows the results for strips of different materials and a steel spring plotted on the same axes.

- The steel spring gives a straight line through the origin. This shows that the extension of the steel spring is directly proportional to the weight suspended on it. For example, doubling the weight from 2.0 to 4.0 N doubles the extension of the spring.
- The rubber band does not give a straight line. When the weight on the rubber band is doubled from 2.0 to 4.0 N, the extension more than doubles.
- The polythene strip does not give a straight line either. As the weight is increased from zero, the polythene strip stretches very little at first then it 'gives' and stretches easily.

Testing for elasticity

An elastic material regains its initial length when the force used to stretch it is removed. We can easily investigate the elasticity of a strip of material by measuring its length as it loaded then unloaded.

1. A steel spring and a rubber band both return to their initial lengths after being loaded then unloaded.
2. A polythene strip does not return to its initial length if it is loaded beyond a certain limit. This limit is known as the **elastic limit**. Beyond the elastic limit, the polythene is permanently extended.

The elastic limit of a spring or a strip of material is the limit to which it can be stretched without being permanently extended

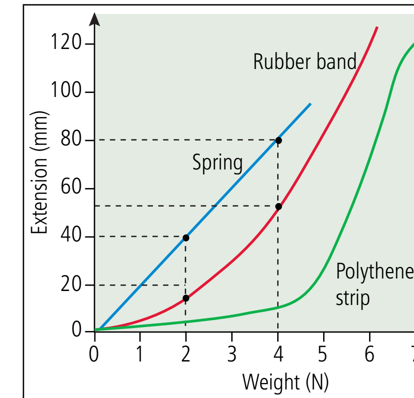


Figure 2.3.3 Extension versus weight for different materials

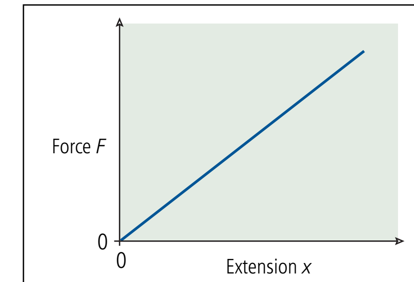


Figure 2.3.4 Graph to show Hooke's law

SUMMARY QUESTIONS

1 Complete the following sentences below using words from the list.

elastic limit extension length

a When a steel spring is stretched, its ______ is increased.

b When a strip of polythene is stretched beyond its ______, its length is permanently increased.

c When rubber is stretched and unstretched, its ______ afterwards is zero.

2 Describe how you would use the arrangement in Figure 2.3.2 to find out if a strip of material is an elastic material.

Extension

3 In a Hooke's Law test on a spring, the following results were obtained.

weight/N	0	1.0	2.0	3.0	4.0	5.0	6.0
length/mm	245	285	324	366	405	446	484
extension/mm	0	40					

a Complete the third column of the Table.

b Plot a graph of the extension on the vertical axis against the length on the horizontal axis.

c If a weight of 7.0 N is suspended on the spring, what would be the extension of the spring?

d i Calculate the spring constant of the spring.

ii An object suspended on the spring gives an extension of 140 mm. Calculate the weight of the object.

Extension

Hooke's law for springs states that the extension of a spring is directly proportional to the weight it supports

Notes

1. Hooke's law applies up to a limit known as **the limit of proportionality**. The graphs in Figure 2.3.3 show that rubber and polythene have a low limit of proportionality. A steel spring has a much higher limit of proportionality
2. Hooke's law may be written as an equation

$$F = kx$$

where F is the stretching force or tension, x is the extension and k is the **spring constant**. A graph of F against x gives a straight line through the origin (Figure 2.3.4)

2.4 Force and motion 1

LEARNING OUTCOMES

- Describe how a force may change the motion of an object.
- Recognise that a resultant force acts on an object when the object accelerates or decelerates.
- Extension: Recall and use the equation 'force = mass × acceleration'.

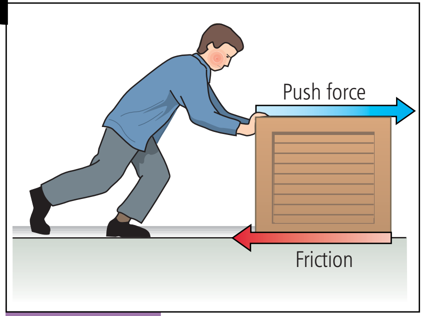


Figure 2.4.1 Overcoming friction

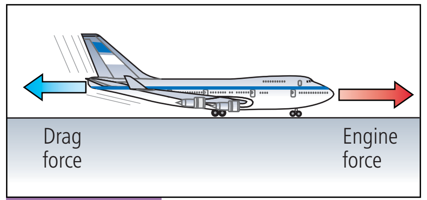


Figure 2.4.2 A passenger jet on take-off

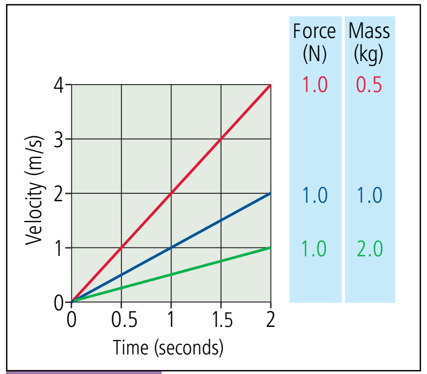


Figure 2.4.4 Speed–time graphs for different forces and masses

Most objects around us are acted on by more than one force. We can work out the effect of the forces on the motion of an object by replacing them with a single force, the **resultant force**. This is a single force that has the same effect as all the forces acting on the object.

When the resultant force on an object is zero, the object:

- remains at rest if it was already at rest
- continues to move at the same speed and in the same direction if it was already moving.

For example, when a heavy crate is pushed across a rough floor, the crate moves at constant velocity across the floor. The push force on the crate is equal and opposite to the force of friction of the floor on the crate. The resultant force on the crate is therefore zero.

When the resultant force on an object is not zero, the movement of the object depends on the size and direction of the resultant force.

For example, when a jet plane is taking off, the force of its engines is greater than the force of air resistance on it. The resultant force on it is the difference between the thrust force and the force of air resistance on it. The resultant force is therefore not zero. The greater the resultant force, the sooner the plane reaches its take-off speed.

PRACTICAL

Investigating force and acceleration

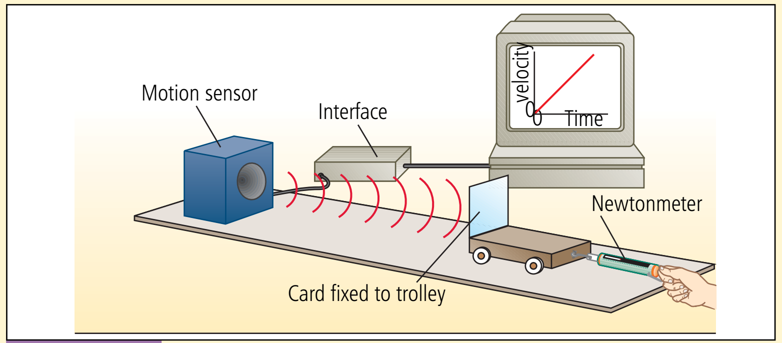


Figure 2.4.3 Investigating the link between force and motion

We can use the apparatus in Figure 2.4.3 to investigate how the acceleration of a trolley depends on the resultant force acting on it.

- A newtonmeter is used to pull the trolley along with a constant force.
- The total moving mass can be doubled or trebled by using by using double-deck and triple-deck trolleys.
- A motion sensor and a computer is used to record the speed of the trolley as it accelerates. The results are displayed as a speed–time graph on the computer screen

Figure 2.4.4 shows speed–time graphs for different amounts of force. The slope of each line gives the acceleration. These and similar graphs show that

- **for a given mass, the greater the force, the greater the acceleration**
- **for a given force, the greater the mass, the smaller the acceleration**.

Extension: An equation for force and acceleration

We can work out the acceleration from the gradient of the graph, as explained in Topic **1.X.**

Some typical results are given in Table 2.4.1

resultant force (in newtons)	0.5	1.0	1.5	2.0	4.0	6.0
mass (in kilograms)	1.0	1.0	1.0	2.0	2.0	2.0
acceleration (in m/s²)	0.5	1.0	1.5	1.0	2.0	3.0
mass × acceleration (in kg m/s²)	0.5	1.0	1.5	2.0	4.0	6.0

The results show that the resultant force, the mass and the acceleration are linked by the equation

resultant force (N) = mass (kg) × acceleration (m/s²)

Maths notes

1 The word equation above may be written in the form

Resultant force $F = ma$, where m = mass and a = acceleration

2 Rearranging this equation gives $a = \frac{F}{m}$ or $m = \frac{F}{a}$

WORKED EXAMPLE

Calculate the resultant force on an object of mass 6.0 kg when it has an acceleration of 3.0 m/s².

Solution

Resultant force $F = ma = 6.0\,\text{kg} \times 3.0\,\text{m/s}^2 = 18.0\,\text{N}$.

KEY POINTS

	object at the start	resultant force	effect on the object
1	at rest	zero	stays at rest
2	moving	zero	speed and direction of motion stay the same
3	moving	non-zero in the same direction as the direction of motion of the object	accelerates
4	moving	non-zero in the opposite direction to the direction of motion of the object.	decelerates
5	**Resultant force (N) = mass (kg) × acceleration (m/s²)**		

EXAMINER SAYS...

If an object is accelerating there must be a resultant force acting on it.

SUMMARY QUESTIONS

1 Complete the sentences below using words from the list.

acceleration force mass resultant motion speed

a A moving object decelerates when a ______ acts on it in the opposite direction to its ______.

b The greater the ______ of an object, the less its acceleration when a ______ acts on it.

c The ______ of a moving object increases when a ______ acts on it in the same direction as it is already moving.

2 A jet plane lands on a runway and stops.

a What can you say about the direction of the resultant force on the plane as it lands?

b What can you say about the resultant force on the plane when it has stopped?

3 (Extension) Copy and complete the following table.

	force / N	mass / kg	acceleration / m/s²
a	?	20	0.80
b	200	?	5.0
c	840	70	?
d	?	0.40	6.0
e	5000	?	0.20

2.5 Force and motion 2

LEARNING OUTCOMES

- Recognise how to find the resultant of two forces that act along the same straight line
- Describe how to represent a force as a vector

Extension

- Recognise that an object in circular motion is acted on by a centripetal force that acts towards the centre of the circle

Figure 2.5.1 On an incline

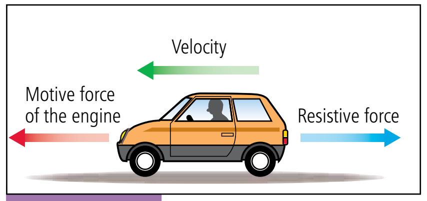


Figure 2.5.3 Terminal speed

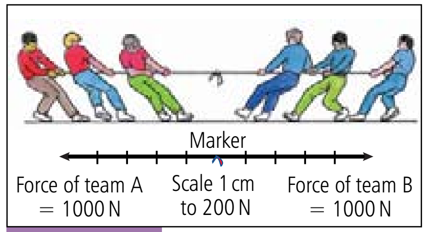


Figure 2.5.4 A tug-of-war

On the move

A railway engine pulling a train of carriages and wagons along a track needs to have enough power to pull the train up the steepest incline on the track. If the engine power is not enough, a second engine could be used to help (Figure 2.5.1). The force of the two engines on the train is equal to the sum of the force of each engine on the train. For example, if one engine pulls with a force of 10 000 N on the train and the other pushes with a force of 8000 N, the total force on the train is 18 000 N (= 10 000 N + 8000 N).

- **A car stuck in mud can be difficult to shift.** A tractor can be very useful here. Figure 2.5.2 shows the idea. One end of the rope is tied to the back of the tractor and the other end to the front of the car. To pull the car out of the mud, the force of the tractor on the car needs to be greater than the force of the mud on the car. If the force of the mud on the car is equal to the force of the tractor on the car, the car stays stuck in the mud.

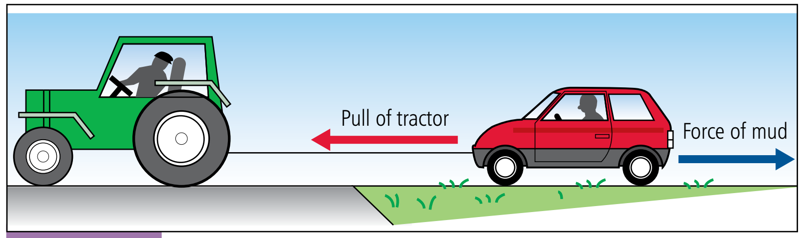


Figure 2.5.2 In the mud

- **A vehicle on a flat road moving at its terminal speed** is pushed forward by the 'motive' force of its engine and opposed by a resistive force due to drag and friction. At terminal speed, the resistive force is equal and opposite to the engine force (Figure 2.5.3). Therefore, the resultant force is zero and so the acceleration is zero.

Vectors

- The size and direction of a force can be represented by a **vector**. A vector is an arrow of length that represents the magnitude (size) of the force in the direction of the force. Any force has magnitude and direction and so can be drawn as a vector.
- Figure 2.5.4 shows the pull of two tug-of-war teams as vectors. A scale of 1 cm to 200 N is used here so the force of 1000 N is represented by a vector 5 cm long. In this example, the magnitudes of the two forces are the same so the two vectors are the same length. Because the forces are in opposite directions, the two vectors point in opposite directions.

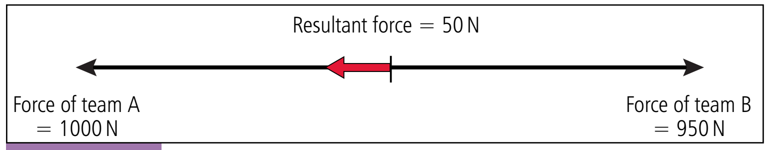


Figure 2.5.5 Unequal forces in opposite directions

- Suppose one team pulls with a force of 1000 N and the other team with a force of 950 N. The vector diagram for this situation is shown in Figure 2.5.5. The smaller force nearly cancels out the other force, but not quite. The stronger team exerts a force which is 50 N greater than the other team. So the resultant force (i.e. their combined effect) is 50 N.

In general, if an object is acted on by two forces

- in the same direction, the resultant force is the sum of the two forces
- in opposite directions, the resultant force is the difference between the two forces.

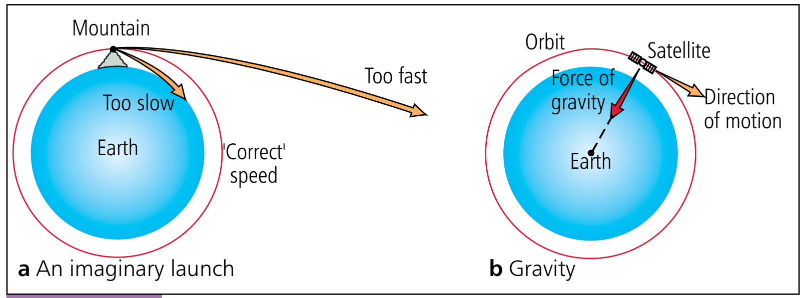


Figure 2.5.6 A satellite in orbit

SUMMARY QUESTIONS

1 Complete the following sentences using words from the list.

equal to greater than less than not zero zero

A car starts from rest and accelerates along a straight flat road until it reaches a certain speed which it then travels at.

a When it is accelerating, the force of its engine is ______ the resistive forces acting on it. The resultant force is ______ .

b When it is travelling at constant speed, the force of air resistance on it is ______ the force of its engine. The resultant force on the vehicle is ______ .

2 A stone of weight 1.5 N released at the surface of a swimming pool drops to the bottom of the pool at constant speed.

a What can you say about the resultant force on the stone as it descends?

b State the magnitude and direction of the resistive force on the stone as it descends.

3 a A lorry tows a car by means of a tow bar along a straight road at constant speed.

i When at can you say about the acceleration of the lorry?

ii The force of the lorry on the car was 200 N. State the magnitude of resistive force on the car.

b The lorry driver applies the brakes to the lorry, causing the lorry and the car to slow down and stop. In terms of the forces on the car, explain why the car comes to a stop.

Extension

When the resultant force is non-zero, the object experiences an acceleration given by

'acceleration = resultant force/mass

Extension

Going round in circles

A satellite in a circular orbit above the Earth moves along its orbit at constant speed. The only force acting on the satellite is the force of gravity on it due to the Earth. This force acts towards the centre of the Earth, pulling on the satellite to prevent it from flying off 'at a tangent' into space. So it changes the direction of motion of the satellite without changing its speed. The same effect happens when an object is whirled round on the end of a string. The pull of the string on the object prevents the object from flying off 'at a tangent' and make it go round in a circle.

Any object moving round a circular path is acted by a resultant force which is directed towards the centre of the circle. The resultant force is called the **centripetal force** because it acts towards the centre of the circle.

KEY POINTS

1 The resultant force due to two forces acting long the same line is given by

- the sum of the two forces if the forces act in the same direction
- the difference between the two forces if they act in opposite directions.

Extension

2 When the resultant force is non-zero, the object experiences an acceleration given by

'acceleration = $\frac{\text{resultant force}}{\text{mass}}$'

SUMMARY QUESTIONS

1 The gravitational field strength at the Earth's surface is 10 N/kg. Calculate the weight of the following:

(i) a person of mass 80 kg

(ii) a 2 kg bag of sugar

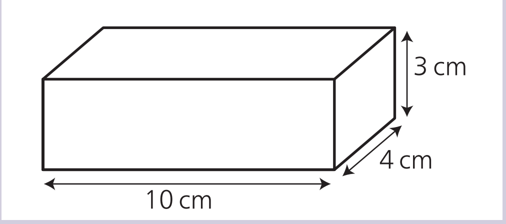
(iii) a 125 g pack of tea

(iv) a 70 g chocolate bar

2 (a) Write down the equation used for calculating density.

(b) Describe, with the aid of diagrams, the displacement method for finding the density of a small, irregularly shaped object.

3 A rectangular block has the dimensions shown in the diagram.



(i) Calculate the volume of the block.

(ii) The block has a mass of 150 g. Calculate the density of the material of the block.

(iii) Will this block float on water?

(iv) Suggest a material from which the block might have been made.

4 (a) State the resultant force acting on a vehicle travelling at a constant speed of 120 km/h on a straight section of road.

(b) (i) A heavy truck is slowing down because the driver has applied the brakes. What can you conclude about the direction of the resultant force acting on the truck?

(ii) What is the resultant force acting on the truck when it has come to a halt?

Extension

5 (a) An object of mass 2.5 kg is acted on by a force of 5 N. Calculate the acceleration that this force produces.

(b) The same object is acted on by a different force and the acceleration is 3.2 m/s^2. Calculate the value of the force.

EXAM-STYLE QUESTIONS

1 A student has an apple in his pocket. The weight of the apple is approximately

A 0.1 N

B 1 N

C 10 N

D 100 N

(Paper 1) *[1]*

2 The correct formula for density is

A density = mass × volume

B density = $\frac{\text{mass}}{\text{volume}}$

C density = weight × volume

D density = $\frac{\text{weight}}{\text{volume}}$

(Paper 1) *[1]*

3 A car is travelling at a constant speed in a straight line on a motorway. The resultant force acting on the car is

A equal to its weight

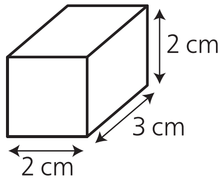
B equal and opposite to the frictional force

C greater than the air resistance

D zero

(Paper 1) *[1]*

4 The diagram shows a metal block.



(a) Calculate the volume of the block in cm^3. *[2]*

6 A stone is tied firmly to a length of string. The stone is then whirled round in a horizontal circle. The speed at which the stone is moving is constant.

(a) State whether or not the velocity of the stone is constant. Briefly explain your answer.

(b) The stone is accelerating. Explain how it can be accelerating whilst moving at constant speed.

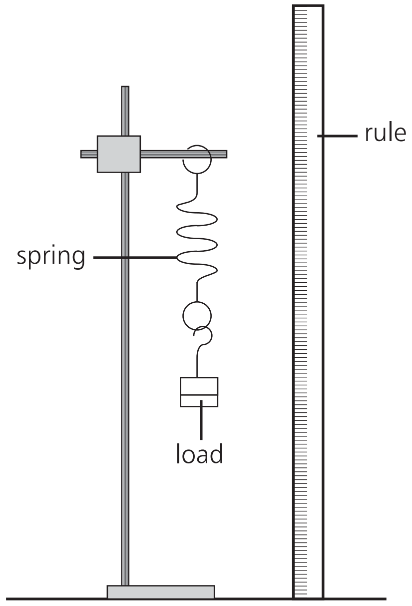
The acceleration is caused by a force. State the direction of the force and what type of force it is.

(b) The mass of the block is 54 g. Calculate the density of the metal in g/cm^3. *[2]*

(c) A block of glass has the same mass as the block of metal but a larger volume. State whether its density compared with that of the metal block is greater, smaller or the same. *[1]*

(Paper 2)

5 The diagram shows the apparatus used for an experiment in which a steel spring is stretched.



(a) The original length of the spring, before a load is hung on it is 17 mm. When a load of 1.0 N is hung on the spring, the length is 20 mm.

(i) Calculate the extension of the spring in mm.

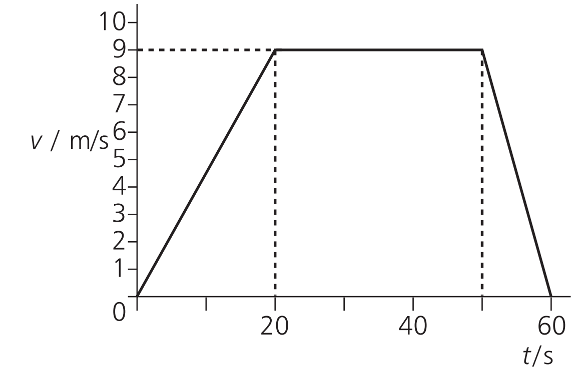
(ii) The load is increased to 2.0 N and the length increases to 23 mm. Calculate the extension of the spring in mm. *[2]*

(b) The load is increased to 4.0 N. The spring does not overstretch. Calculate the extension with the 4.0 N load. *[2]*

(c) Name the instrument that uses a spring to measure weight. *[1]*

(Paper 2)

6 The speed–time graph shows the motion of a car travelling in a straight line.



(a) Describe the motion of the car

(i) during the first 20 s.

(ii) during the next 30 s.

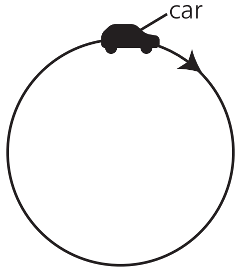
(iii) during the final 10 s. *[4]*

(b) Calculate the acceleration of the car during the first 20 s. *[2]*

(c) The car has a mass of 800 kg. Calculate the resultant force acting on the car during the first 20 s. *[2]*

(d) Calculate the distance travelled by the car in 60 s. *[2]*

(e) The car now moves in a circle at constant speed as shown in the diagram.



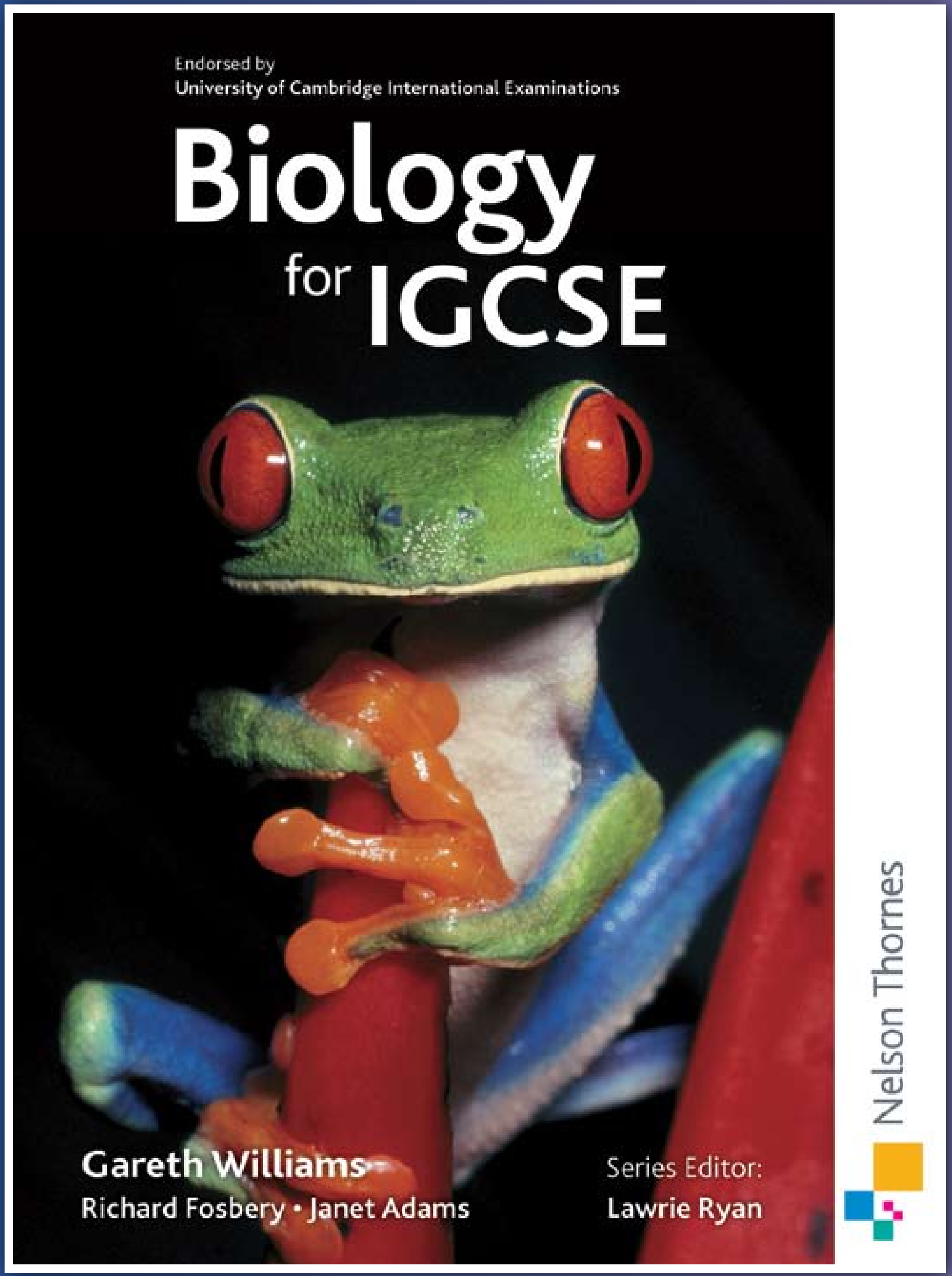
A resultant force is required to make the car move in a circle.

(i) On the diagram show the direction of the resultant force. *[1]*

(ii) Since there is a resultant force acting on the car it must be accelerating. Explain how the car can be accelerating whilst travelling at a constant speed. *[2]*

(Paper 3)

Also available



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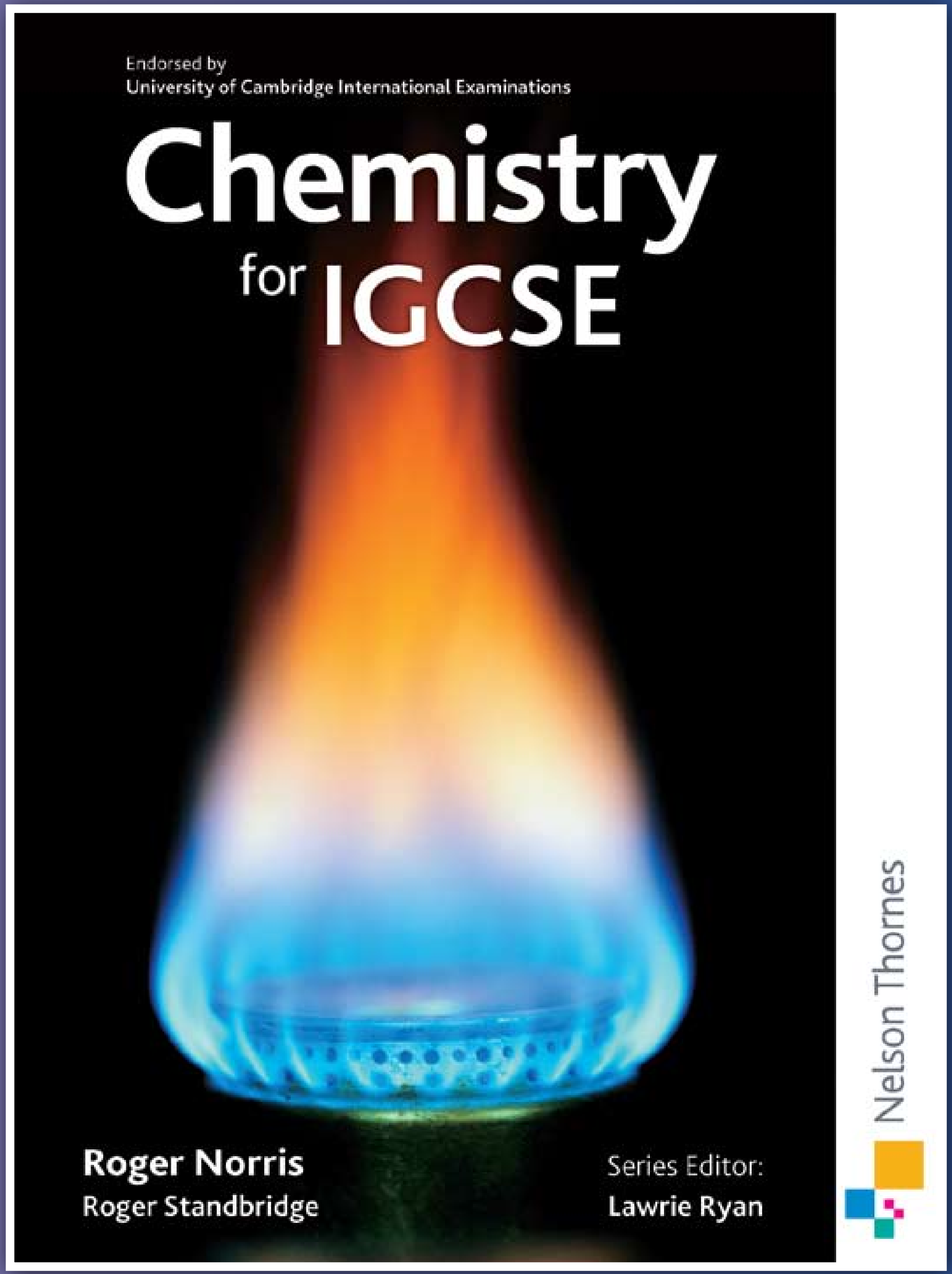

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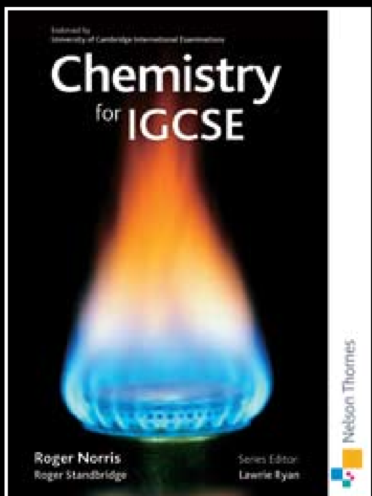

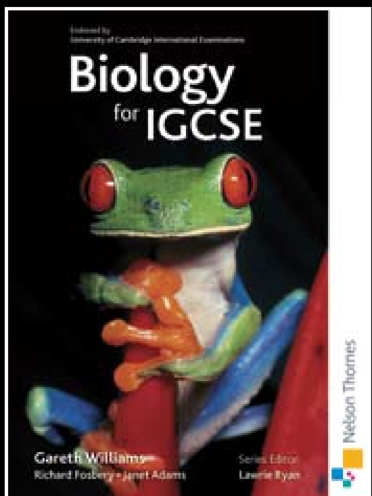

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