

Sparx Science

A Level Transition Booklet



Physics

This booklet contains questions from key topics that you will have seen in GCSE and that contain the key knowledge and skills for you to be successful in your AS Level and A-Levels.

If you have access to Sparx Science, you can also use the topic codes (the codes starting with a Z or and R) to access even more questions which come with targeted support. Simply search the topic codes on your Independent Learning page.

Below is a summary of the topics included in this booklet for you to keep track of your learning.

	Topic	Introduction	Pages	Complete?
1	Handling Data	New discoveries in Physics rely on highly precise experimentation. In this section we reinforce the key ideas you learnt about units, precise measurements, resolution, and experimental validity.	4 - 15	
2	Mechanics and Materials	Physicists seek to explain what happens in the universe both big and small and build models and rules (or laws) that predict what will happen. In this section we recap your knowledge of the principles of forces and motion.	16 - 32	
3	Waves	Waves are used to transmit information and energy in various ways. In this section we reinforce the core properties and types of waves alongside the principles of refraction and reflection.	33 - 40	
4	Electricity	In this section we reinforce your knowledge of circuit symbols, charge, current, potential difference, resistance and series and parallel circuits. This forms the basis for new, more powerful rules you will learn at A Level.	41 - 57	
5	Particle Physics (Edexcel: A Level only)	At A-Level you will look further at the fundamental particles that make up protons and neutrons (quarks), here we reinforce your understanding of Atomic Structure and nuclear decay.	58 - 66	
6	Thermodynamics (A Level Only)	Thermodynamics can be used to explain how engines, refrigerators, and the atmosphere work. Here we reinforce your knowledge of heat capacity, latent heat, and thermal energy transfers.	67 - 78	
7	Fields (A Level Only)	Fields are able to mathematically link our ideas of how planets orbit stars with how electrons move through space. In GCSE, you focused on magnetic fields, and so we will reinforce your knowledge of electromagnets, the motor effect, and Fleming's Left-Hand Rule.	79 - 88	

Mechanics and Materials

distance travelled = speed $\times$ time

acceleration = change in velocity / time taken

$(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times \text{acceleration} \times \text{distance}$

kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

elastic potential energy = $0.5 \times \text{spring constant} \times (\text{extension})^2$

gravitational potential energy = mass $\times$ gravitational field strength $\times$ height

efficiency = useful output energy transfer / total input energy transfer

energy transferred = power $\times$ time

power = energy transferred / time

work done = force $\times$ distance (along the line of action of the force)

weight = mass $\times$ gravitational field strength

resultant force = mass $\times$ acceleration

momentum = mass $\times$ velocity

force = spring constant $\times$ extension

Waves

period = $1 / \text{frequency}$

wave speed = frequency $\times$ wavelength

Electricity

charge flow = current $\times$ time

potential difference = current $\times$ resistance

power = potential difference $\times$ current

power = $(\text{current})^2 \times \text{resistance}$

energy transferred = charge flow $\times$ potential difference

Thermodynamics

change in thermal energy = mass $\times$ specific heat capacity $\times$ temperature change

thermal energy for a change of state = mass $\times$ specific latent heat

density = mass / volume

Fields

force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density $\times$ current $\times$ length

1.1 Write the full name of the unit represented by each of these abbreviations.

a) Hz

.....

b) N

.....

c) J

.....

d) W

.....

e) Pa

.....

f) C

.....

g) V

.....

h) Ω

.....

i) T

.....

1.2 Match each of the unit names to the correct abbreviation.

Unit name	Abbreviation
Nanojoule	μJ
Microjoule	GJ
Millijoule	kJ
Gigajoule	nJ
Kilojoule	mJ
Megajoule	MJ

1.3 Write the following values in order of size:
1 μW , 1 kW, 1 MW, 1 nW, 1 GW, 1 mW

Smallest $\rightarrow$ Largest

.....,,,,,

1.4 a) Convert 0.015 GW into W.

.....W

b) Convert 390 W into mW.

.....mW

1.5

a) Convert 9.8 Pa into nPa.

.....nPa

b) Convert 17.4 Pa into MPa.

.....MPa

1.6

Tick one box in each row of the table to show whether each statement is true or false.

	True	False
1 Pa is larger than 100 nPa		
650 mN is larger than 650 μ N		
3.7 kW is larger than 3.7 GW		

Significant figures

Z740

2.1

Round 791 to 1 significant figure.

.....

2.2

Round 0.61 to 1 significant figure.

.....

2.3 Round 0.18 to 1 significant figure.

.....

2.4 Round 0.041 to 1 significant figure.

.....

2.5 The output of a solar farm each day for one week is shown in the table.

Day	Output (kWh)
Monday	2546
Tuesday	2340
Wednesday	2582
Thursday	2447
Friday	2452
Saturday	2650
Sunday	2553

On which **two** days was the output 2500 kWh when given to 2 significant figures?

..... and

2.6 A student measures the time taken for an object to fall a fixed distance.
They repeat the measurement four times and calculate a mean.

a) How many significant figures should the student report the mean to?

.....

b) Give a reason for your answer.

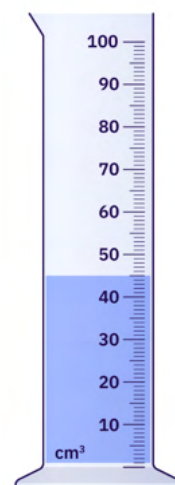
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Test number	Time (s)
1	1.42
2	1.40
3	1.41
4	1.43
Mean	1.415

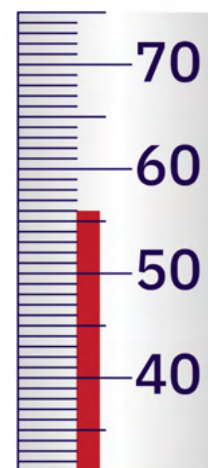
3.1 What volume of liquid is in this measuring cylinder?

.....cm³



3.2 What is the reading on the thermometer?

.....°C



3.3 What is the reading on the voltmeter?

.....V



3.4 What is the reading on the ammeter?

.....mA



3.5

Some liquid in a burette is shown.

- a) Two students incorrectly read the volume of liquid in the burette.
Match each reading to the most likely mistake the student has made.

Reading

Mistake

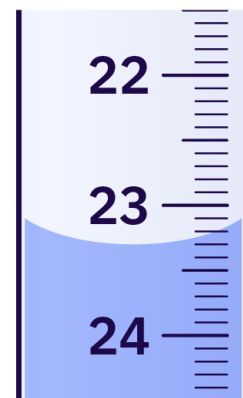
24.7 cm³

They have read from the bottom of the burette, rather than the top

23.1 cm³

They have read from the top of the meniscus

They have taken the reading looking down the burette



- b) What is the correct reading for the volume of liquid in the burette?

.....cm³

Resolution

Z337

4.1

Different measuring devices will have different resolutions.
What is meant by the resolution of a device?

The minimum value it can measure

☐

The smallest change it can detect

☐

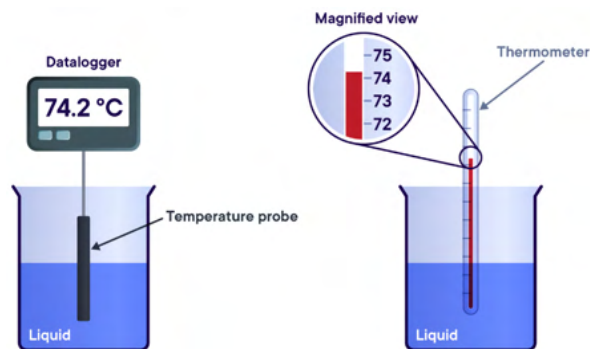
How close the reading it gives is to the true value

☐

The maximum value it can measure

☐

4.2 Two students investigate how the temperature of a liquid changes as it is heated. One student uses a data logger attached to a temperature probe. The other uses a thermometer. Which **two** options describe advantages of the temperature probe compared to the thermometer? Tick **all** that apply.



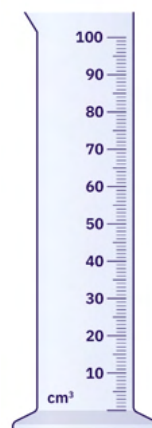
It has a higher resolution ☐

It makes sure the test is valid ☐

It gives quantitative rather than qualitative data ☐

It is harder to misread the temperature ☐

4.3 What is the resolution of this measuring cylinder?



.....cm³

4.4 What is the resolution of this balance?



.....g

4.5 What is the resolution of this voltmeter?



.....V

5.1 Describe what is meant by a **systematic** error in a science experiment.

.....

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5.2 Describe what is meant by a **random** error in a science experiment.

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5.3 Tick one box in each row of the table to show whether each statement describes systematic errors or random errors.

	Systematic error	Random error
Cannot be predicted		
Can be reduced by averaging results		
Includes 'zero' errors		

5.4 Each example describes a possible source of error.
Tick one box in each row of the table to show whether each example involves a systematic or random error.

Example	Systematic	Random
A thermometer reads 95°C when placed in boiling water		
A student estimates the value between two marks on a thermometer scale		
A newton meter reads above zero before any weight is added		
A student decides when a piece of metal has completely reacted with some acid		

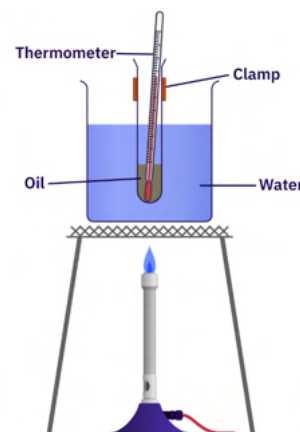
5.5

A student was measuring how long it took to raise the temperature of different oils by 1°C .

They used the apparatus shown in the diagram.

There are some sources of error in their experiment.

- a) Tick one box in each row of the table to show the random and systematic errors in the experiment.



Source of error	Random	Systematic
There is heat lost to the surroundings which affects the temperature change		
The measuring cylinder used to measure the oil is incorrectly calibrated		
The student has to estimate the temperature between marks on the thermometer scale		

- b) The student repeats the experiment multiple times. They calculate a mean time taken. Which type of error will this help to reduce?

.....

Accuracy and precision

Z381, Z231

6.1

Tick one box in each row of the table to show which of these statements are true and which are false.

	True	False
Accurate results are close to the true value		
Precise results are always accurate		
Digital equipment always provides accurate results		

6.2

A teacher measured the volume of acid needed to completely neutralise a volume of alkali. Their results are shown in this table.

Test	Volume of acid (cm ³)
1	22.1
2	22.3
3	22.3
4	22.2

The teacher's results are very precise. How can you tell the results are precise?

The results are close to the true value ☐

The results are all given to 1 decimal place ☐

The range of values is very small ☐

The results have been repeated ☐

6.3

What type of error impacts the precision of results?

Random error ☐

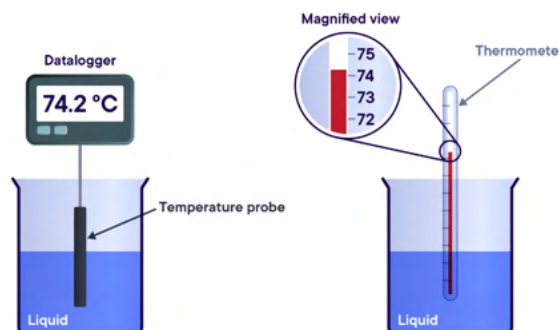
Zero error ☐

Systematic error ☐

6.4

Two students investigate how the temperature of a liquid changes as it is heated.

One student uses a data logger attached to a temperature probe. The other uses a thermometer. Give **two** reasons why the temperature probe and data logger is more likely to give accurate results than the thermometer.



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6.5

A student measures the wavelength of a wave.
 They calculate the mean length to be 70 cm.
 The uncertainty around the mean value is ± 3 cm.
 What does this mean?

The device used to measure the wavelength
 read 3 cm when it should read 0 cm

☐

The true wavelength could be 3 cm
 above or below the mean

☐

The student has excluded three anomalous results when
 calculating the mean

☐

The true wavelength is three times larger than
 the mean wavelength

☐

6.6

Below are two students' results from the same experiment.

Student A	Repeat 1	Repeat 2	Repeat 3	Mean
Temperature ($^{\circ}\text{C}$)	101	85	102	96

Student B	Repeat 1	Repeat 2	Repeat 3	Mean
Temperature ($^{\circ}\text{C}$)	100	100	99	100

a) Without making any calculations, which student's results have a bigger uncertainty?

Student A

☐

Student B

☐

b) Give a reason for your answer.

.....

.....

6.7

A student records the wavelength of the waves on a standing string.
 They calculate the mean wavelength to be 74 ± 5 cm.
 Give the range in which the true wavelength is likely to lie.

.....

6.8

A student measures how the height from which they drop a ball affects the height it bounces. One student drops the ball and the other reads the bounce height from a ruler. They find the uncertainty in their results is ± 3 cm. To reduce the uncertainty, they repeat the experiment but use a camera to record the motion of the ball. Explain why using a camera could reduce the uncertainty in the results for the bounce height.



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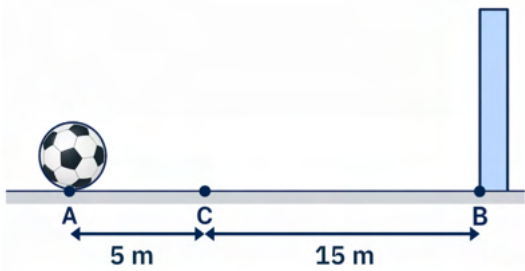
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1.1 Tick one box in each row of the table to show whether each of these quantities is vector or scalar.

	Vector quantity	Scalar quantity
Displacement		
Distance		
Mass		
Speed		
Velocity		
Weight		

1.2 A student kicks a football.
The ball is kicked along the ground from A.
It hits the wall at B.
It then bounces back to come to a rest at C,
as shown in the diagram.
a) What distance has the ball travelled from A to B?



-m
- b) What distance has the ball travelled from A to C?
-m
- c) What is the displacement of the ball between A and C?
-m

1.3 A helicopter flies 40 km due north, then 30 km due east, then 40 km due south.
What is the magnitude of its final displacement from the starting point?

.....km

- 1.4** A car travels in a straight line for 2 km.
It then turns right and travels a further 0.5 km.
Explain why the distance it has travelled is different from its displacement.

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Speed and velocity

R374, R639, R908

- 2.1** A train travels for 150 s at an average speed of 32 m/s.
Calculate the distance travelled by the train in this time.

.....m

- 2.2** A car travels a distance of 340 m in 20 s.
Calculate the average speed of the car.

.....m/s

2.3

Betelgeuse is a distant star that can be seen from Earth.
 The distance between Betelgeuse and the Earth is 6.0×10^{15} km.
 The speed of light is 3.0×10^8 m/s.
 Calculate the time taken for light from Betelgeuse to reach the Earth.

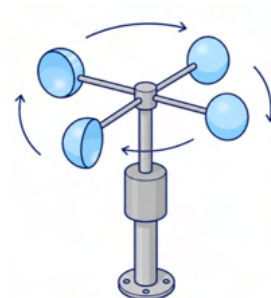
.....S

2.4

The image shows an anemometer. An anemometer is used to measure wind speed. The wind pushes the cups around, causing the anemometer to spin. Describe how you could determine the average wind speed using an anemometer.

You should include:

- the measurements you would need to take
- how you would calculate speed.



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.....

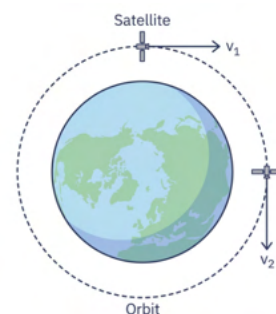
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2.5

A satellite is in orbit around the Earth.
 The image shows the position of the satellite at two points in the orbit.
 Explain why the velocity of the satellite is different at points v_1 and v_2 .



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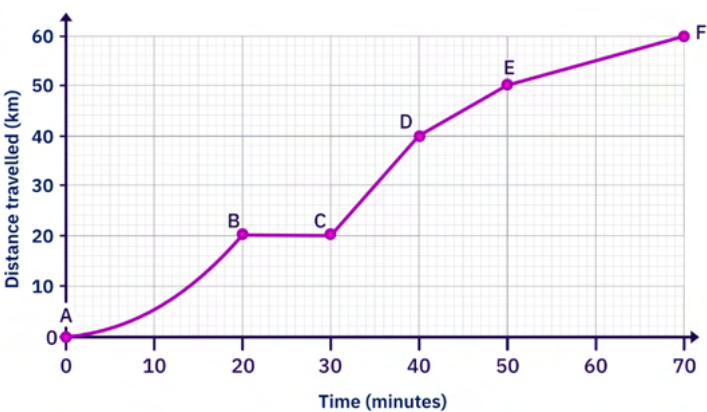
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2.6

The distance-time graph shows a car journey.
Match each section of the graph to the correct description of the motion during the section.



Section	Description
A to B	The car is stationary
B to C	The car is travelling at a constant speed, less than 40 km/h
C to D	The car is accelerating
D to E	The car is moving at 60 km/h
E to F	The car is travelling at the fastest speed

Acceleration

R760, R799

3.1

A car is moving with a velocity of 5.0 m/s.
It takes 4.0 seconds to accelerate to a velocity of 12 m/s.
Calculate the acceleration of the car.

.....m/s²

3.2

A horse, running at a velocity of 18 m/s, takes 5 seconds to slow down to a velocity of 4 m/s.
Calculate the acceleration of the horse.

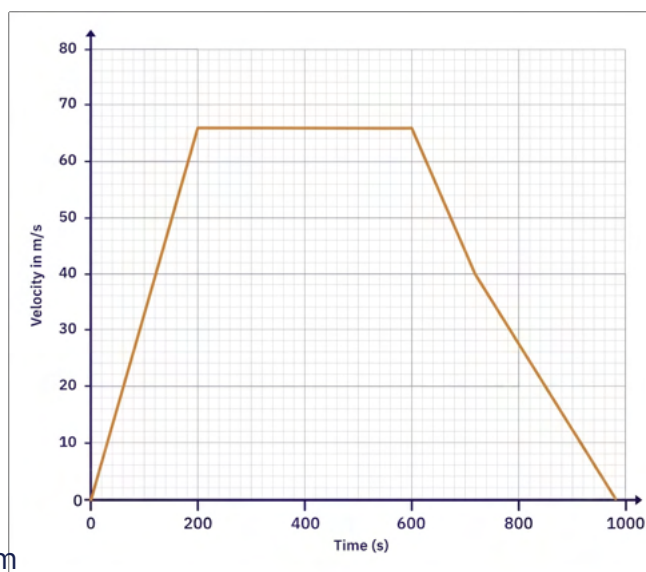
.....m/s²

- 3.3** A cyclist accelerates from rest with a constant acceleration of 1.5 m/s^2 until they reach a velocity of 9 m/s .
Calculate the time taken for the cyclist to reach this velocity.
-s
-
- 3.4** A moving object decelerates at a rate of 8.2 m/s^2 over the course of 15 seconds.
After the deceleration, the velocity of the object is a quarter what it was at the start.
Calculate the initial velocity of the object.
-m/s
-
- 3.5** A lorry travelling at 16 m/s accelerates at a rate of 4 m/s^2 .
In this time, the lorry travels 40 m.
Calculate the final velocity of the lorry.
-m/s

Velocity-time graphs

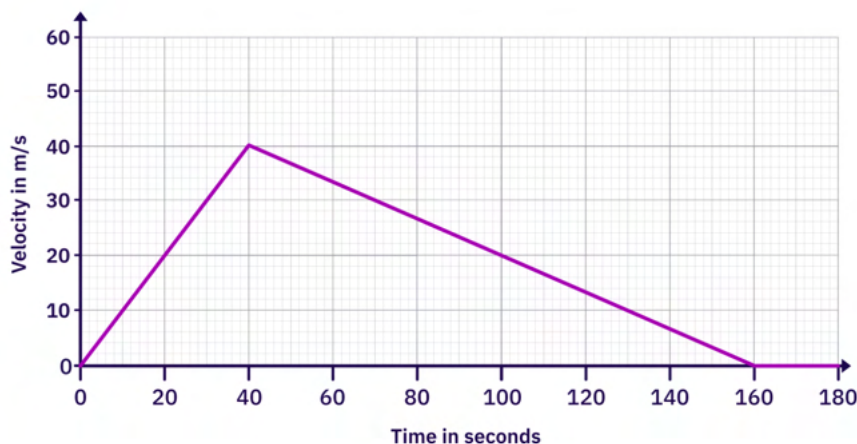
R176, R663

- 4.1** The graph shows a velocity-time graph for a train travelling between two stations. Calculate the distance travelled by the train in the first 600 s.



.....m

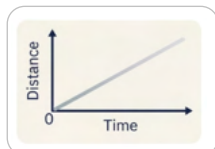
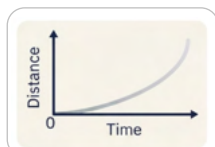
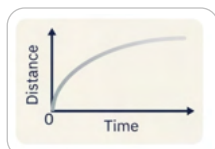
- 4.2** The velocity-time graph shows the journey of a train. How far did the train travel at a velocity greater than 20 m/s?



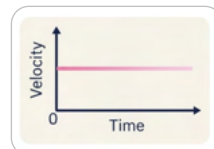
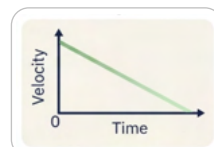
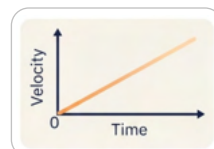
.....m

- 4.3** Match each distance-time graph to the velocity-time graph with the same motion.

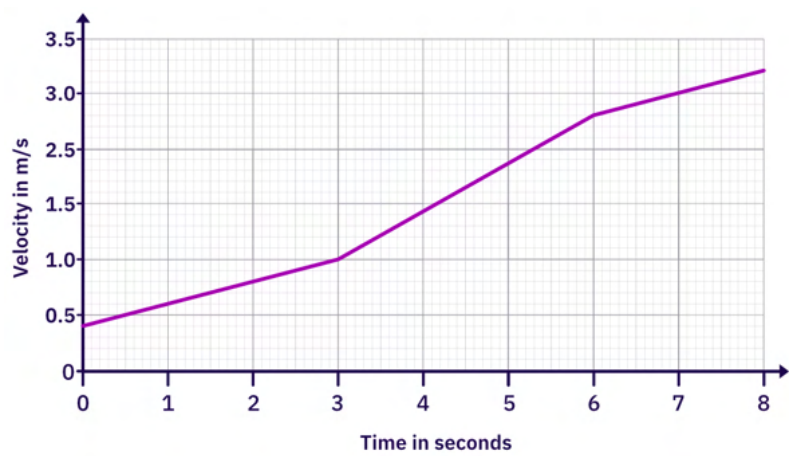
Distance-time graph



Velocity-time graph

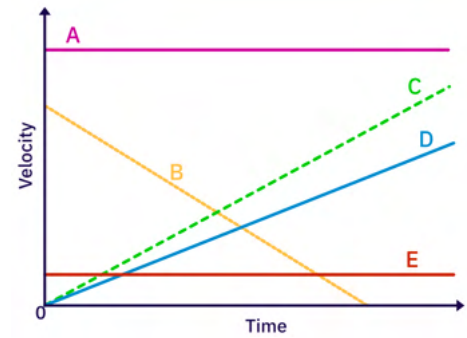


4.4 The graph shows the velocity of a drone over time.
What was the acceleration of the drone between 3 and 6 seconds?



.....m/s²

4.5 The velocity-time graph shows the movement of five objects, A to E.
Tick one box in each row of the table to describe the motion of each object.



Motion	Accelerating	Decelerating	Constant velocity
A			
B			
C			
D			
E			

Kinetic and gravitational potential energy

R704, R751

5.1 A model train has a mass of 8.1 kg. It moves at a speed of 1.4 m/s.
Calculate the kinetic energy of the train.
Give your answer to 2 significant figures.

.....J

- 5.2** A car with a mass of 900 kg is travelling at a constant speed.
The kinetic energy store of the car is 180 kJ.
Calculate the speed of the car.

.....m/s

- 5.3** A tennis ball with a mass of 0.058 kg is launched vertically upwards into the air at a speed of 8.0 m/s.
a) Calculate the kinetic energy of the tennis ball just after it is launched to 2 significant figures.

.....J

- b) Give the maximum gravitational potential energy that could be gained by the tennis ball as it moves upwards to 2 significant figures.
Assume air resistance is negligible.

.....J

- 5.4** A 0.5 kg ball was thrown 1.2 m vertically upwards.
Calculate the gain in gravitational potential energy of the ball.
The gravitational field strength on Earth is 9.8 N/kg.

.....J

- 5.5** A spacecraft is approaching the surface of Mars from a height of 1500 m.
The mass of the spacecraft is 1200 kg.
Calculate the gravitational field strength of Mars if the spacecraft lost
6 660 000 J of energy on its descent to the surface.

.....N/kg

- 5.6** A person with a mass of 60 kg jumps vertically in the air.
They leave the ground with a speed of 3 m/s.
Ignoring the effect of air resistance, calculate the maximum possible height that the
person could reach.
Give your answer to 2 significant figures.
The gravitational field strength on Earth is 9.8 N/kg.

.....m

Energy and work**R307**

- 6.1** Complete this sentence.
Work done is equal to the...

distance an object moves.

useful energy transfers.

energy transferred.

power.

6.2

A cyclist used the brakes to slow down and stop a bicycle.
A constant braking force of 140 N stopped the bicycle in a distance of 24 m.
Calculate the work done by the braking force to stop the bicycle.
Give the unit.

.....

6.3

Applying the brakes of the car causes the temperature of the brakes to increase.
Explain why.

.....

.....

.....

.....

Force diagrams

R744

7.1

If there are multiple forces acting on an object, what do we call the force that has the same effect as all individual forces combined?

.....

7.2

A free body diagram of a falling pen is shown.
What does the length of the arrows represent?

The type of force

☐

The direction of
the force

☐

How long the force
acts for

☐

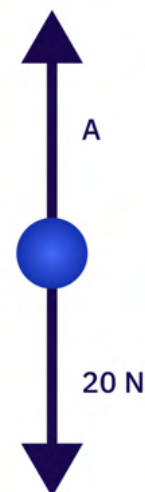
The magnitude of
the force

☐


7.3

A falling object has two forces acting on it, as shown in the diagram. Tick one box in each row of the table to show the possible values of force A for each situation.

	Possible value for A		
	10 N	20 N	40 N
The object accelerates downwards			
The object decelerates downwards			
The object falls at a constant velocity			



7.4

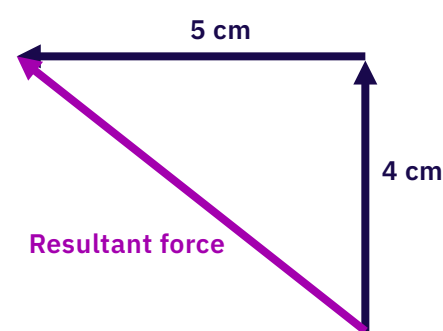
The diagram shows a vector drawing of two forces at right angles to each other.

The scale is 1 cm = 25 N.

a) Determine the magnitudes of the two component forces.

horizontal component: N

vertical component: N



b) The resultant force was calculated to be 160 N.

What was the length of the resultant force arrow on the diagram?

.....cm

Newton's laws of motion

R893, R138, R519

8.1

Describe what Newton's first law of motion tells us about moving objects.

.....

.....

.....

.....

8.2 Which law states that acceleration is proportional to the resultant force and inversely proportional to mass?

.....

8.3 The same resultant force acts on objects A and B.

- Object A accelerates at 3 m/s^2 .
- Object B accelerates at 6 m/s^2 .

a) Which object has the greater mass?

Object A ☐

Object B ☐

b) State the type of relationship that exists between mass and acceleration.

.....

.....

8.4 A car with a mass of 1600 kg accelerates at a rate of 3.5 m/s^2 .
Calculate the resultant force on the car.

.....N

8.5 Describe what Newton's third law of motion states.

.....

.....

.....

.....

8.6

A dog sits on a set of scales.

The scales read 50 kg.

a) Calculate the weight of the dog.

The gravitational field strength on Earth is 9.8 N/kg.

.....N

b) The dog exerts a downward force on the scales.

According to Newton's third law, the scales exert a force on the dog.

Give the size and direction of this force.

Size:N

Direction:

Momentum

R980, R695

9.1

A person with a mass of 65 kg is running with a velocity of 4 m/s.

What is the person's momentum?

.....kg m/s

- 9.2** An object has a momentum of 8.2 kg m/s and is travelling at 2.5 m/s .
Calculate the mass of the object.

.....kg

- 9.3** A 24 g arrow is shot from a bow.
Its initial momentum is 6.21 kg m/s .
Calculate the initial velocity of the arrow.

.....m/s

- 9.4** A moving car collides with a parked car.
a) What was the momentum of the parked car before the collision?

.....kg m/s

- b) What happens to the momentum of the parked car after the collision?

It increases

☐

It decreases

☐

It stays the same

☐

9.5 Someone throws a bowling ball towards a pin.
When the ball collides with the pin, it slows down.
Explain why this happens, using ideas about momentum in your answer.

.....

.....

.....

.....

.....

9.6 A bullet with a mass of 0.030 kg is travelling at 180 m/s.
It collides with a wooden block with a mass of 0.55 kg.
The bullet becomes stuck in the block, and they move together after the collision.
Calculate the velocity of the block and bullet after the collision.
Give your answer to 2 significant figures.

.....m/s

Deformation R337

10.1 Tick one box in each row of the table to show whether each example given describes elastic or inelastic deformation.

	Type of deformation	
	Elastic	Inelastic
A plastic ruler is bent and snaps		
A stretched spring returns to its original shape		
A tin can is permanently crushed		

10.2

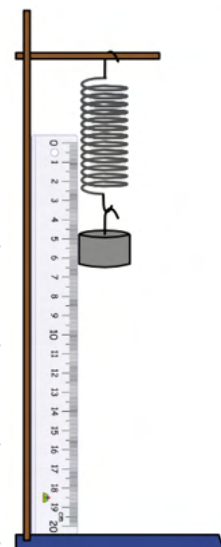
A student has a single weight.
They attach it to a spring and measure the extension.
Given they have no other weights, describe how they could work out if the spring behaves elastically.

.....

.....

.....

.....



10.3

This graph shows how the extension of a spring varies when different forces are applied.
What features of the graph show that extension is directly proportional to force?
Tick **all** that apply.

The values on the x -axis are integers

☐

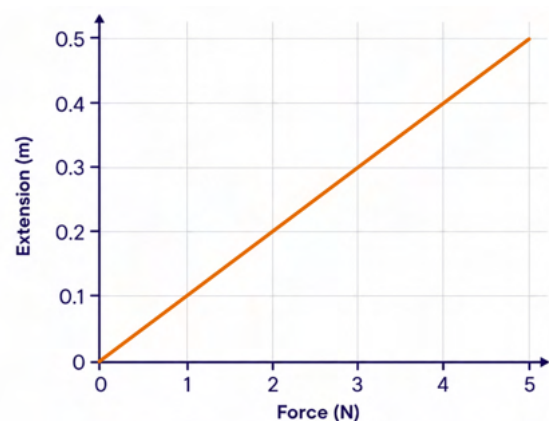
The line goes through the origin

☐

The line is straight

☐

The line goes through major gridlines

☐


10.4

A spring has a spring constant of 80 N/m .
When a force is added, it stretches from 0.15 m to 0.40 m .
a) What is the extension?

.....m

b) Therefore, calculate the force used to stretch the spring.

.....N

10.5 The table shows the spring constants of four springs.

a) Which spring requires the most force to extend it by 1 cm?

Spring A ☐ Spring B ☐

Spring C ☐ Spring D ☐

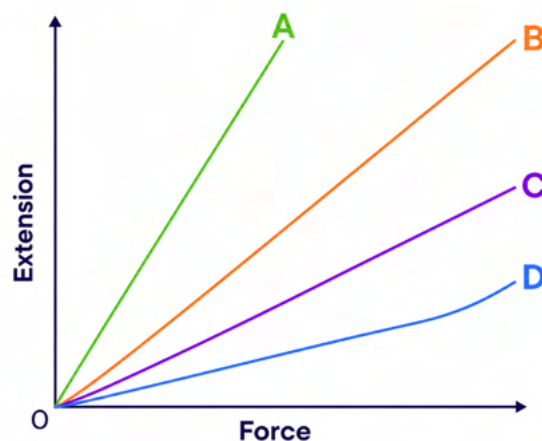
Spring	Spring constant (N/cm)
A	45
B	5
C	0.1
D	100

b) Which spring requires the most force to compress it by 1 cm?

Spring A ☐ Spring B ☐

Spring C ☐ Spring D ☐

10.6 Here is the graph showing the relationship between force and extension for four different springs.



Tick boxes in each row of the table to compare the springs.

	Spring			
	A	B	C	D
Two springs that reach the same final extension	☐	☐	☐	☐
The spring with the smallest spring constant	☐	☐	☐	☐
The spring that shows inelastic deformation	☐	☐	☐	☐

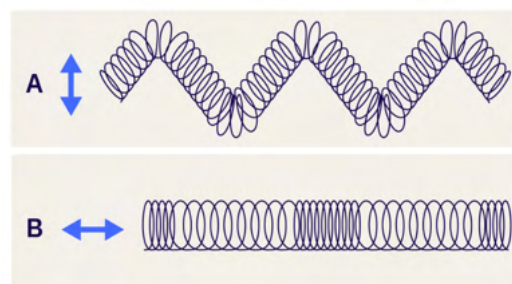
1.1 A student is using a slinky spring to model waves.

- a) They move their hand up and down to form wave A.
What type of wave is this?

.....

- b) They move their hand forwards and backwards to create wave B.
What type of wave is this?

.....

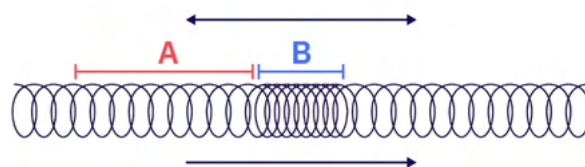


1.2 The diagram shows a wave, modelled using a slinky.

Give the name of the regions labelled A and B.

A:

B:



1.3 A sailing boat is moving vertically on a sea wave as shown.

- a) What type of wave is a sea wave?

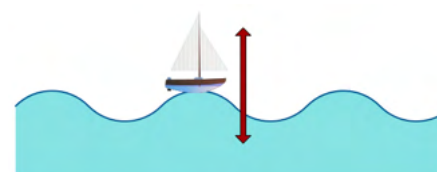
.....

- b) Compared to the direction of the wave, how does the boat move?

.....

- c) Compared to the direction of the wave, in which direction does the wave energy move?

.....



- 1.4** Describe the difference between the particle vibrations in transverse and longitudinal waves.

.....

.....

.....

.....

Waves properties

R103

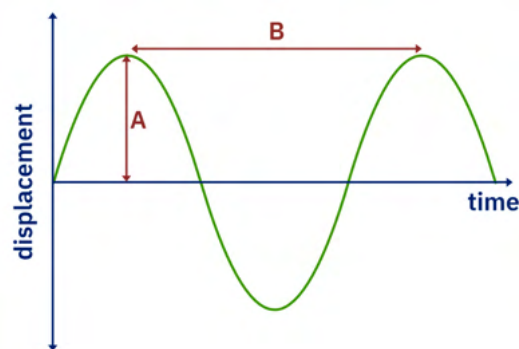
- 2.1** The diagram shows a wave.

a) What is the name of the distance shown by label A?

.....

b) What is the name of the distance shown by label B?

.....



- 2.2** The diagrams show the displacement-time graphs for four different water waves.

a) Which wave has the smallest period?

A ☐

B ☐

C ☐

D ☐

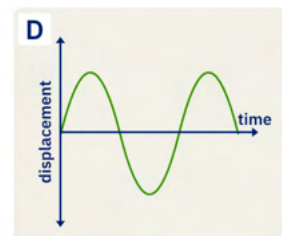
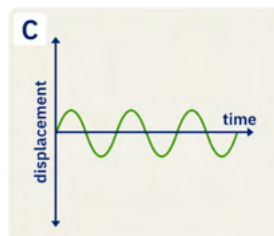
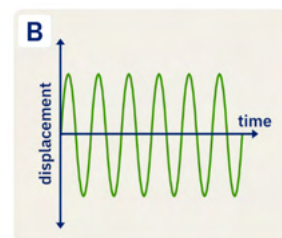
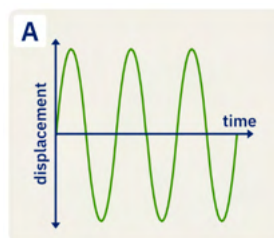
b) Which wave has the highest frequency?

A ☐

B ☐

C ☐

D ☐

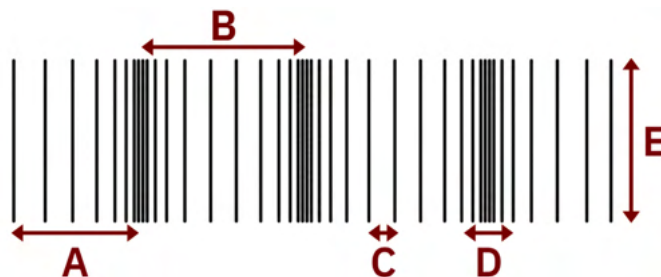


2.3

This diagram represents a wave.

a) What type of wave is shown in the wave diagram?

.....



b) Which label shows a wavelength?

A ☐ B ☐ C ☐ D ☐ E ☐

2.4

The diagram shows four different waves over 1 second.

a) Which **two** waves have the same frequency?

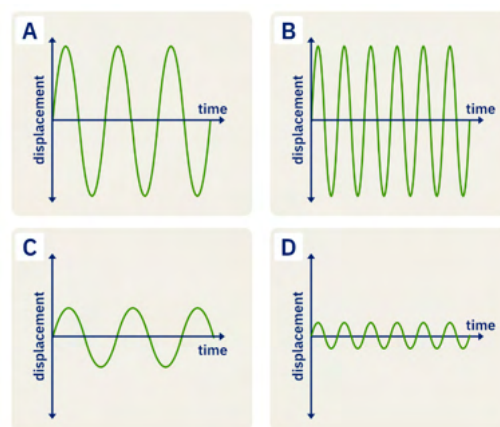
A ☐ B ☐

C ☐ D ☐

b) Which **two** waves have the same amplitude?

A ☐ B ☐

C ☐ D ☐



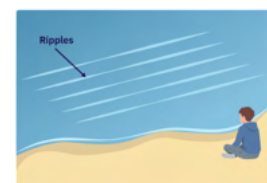
2.5

The image shows a student sitting beside a lake.

The student is watching ripples on the surface of the water.

Describe how the student could determine the

frequency of the ripples on the lake using a stopwatch.



.....

.....

.....

.....

.....

2.6

The image shows the effect of a sound wave on air particles at one moment in time.

a) Which label on the image shows one wavelength?

A	☐	B	☐
C	☐	D	☐

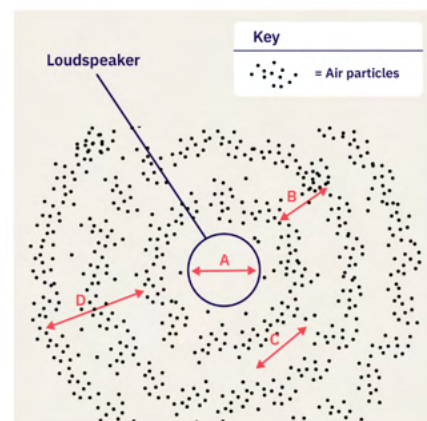
b) Describe the motion of particles as the wave travels through the air.

.....

.....

.....

.....



Wave calculations

R569, R452

3.1

A sound wave in water has a frequency of 20 kHz.
The wavelength of the sound is 0.07 m.
Calculate the speed of the sound wave in water.

.....m/s

3.2

The diagram represents a sea wave which:

- is travelling at 2.8 m/s
- has a frequency of 0.35 Hz.

Calculate the distance marked A on the diagram.



.....m

3.3

The diagram represents a water wave.

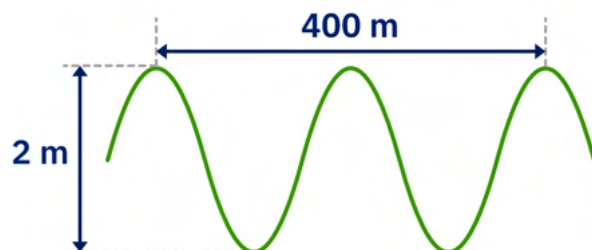
a) What is the amplitude of the water wave?

.....m

b) The water wave is travelling at 12 m/s.

Calculate the frequency of the wave and give the correct unit.

.....



3.4

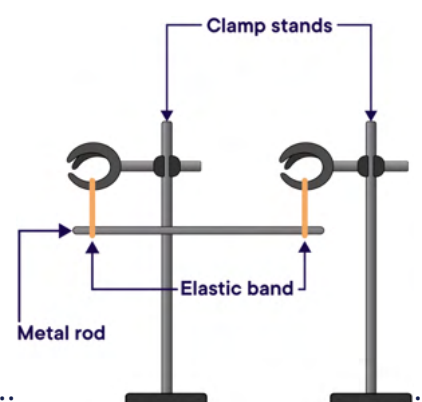
A student plans to use this equipment to measure the speed of a wave through the rod. They strike the rod at one end and use a frequency recorder to measure the peak frequency. They also need to measure the wavelength. Describe how the student should calculate the wavelength of the wave through the metal rod.

.....

.....

.....

.....



Behaviour of waves

R241, R992

4.1

Match each description below to the name of the process it describes.

Description

Waves bounce off the surface of a material.

Waves pass through a material.

Wave energy is transferred to a material

Name

Absorption

Reflection

Transmission

Emission

4.2 This diagram shows a light ray being reflected from a plane mirror.

a) What are the names of the rays labelled A and B?

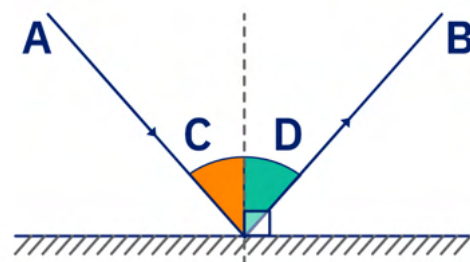
A:

B:

b) What are the names of the angle labelled C and D?

C:

D:



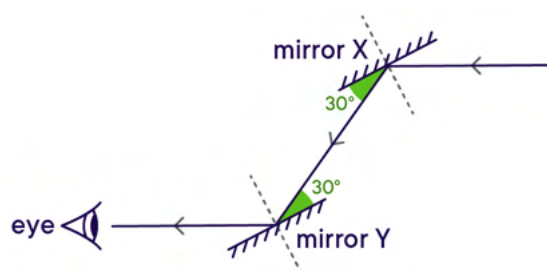
4.3 A light ray reflects off two mirrors, X and Y.

a) What is the angle of incidence at mirror X?

.....°

b) What is the angle of reflection at mirror Y?

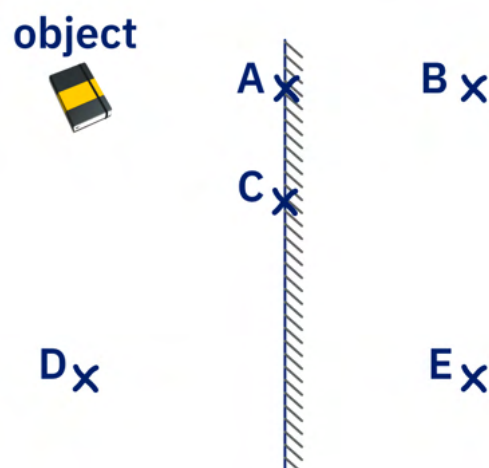
.....°



4.4 An object is being reflected in a plane mirror.

At which position is the image of the object formed?

A	☐	B	☐	C	☐
D	☐	E	☐		



4.5

A student is investigating what happens when a ray of light passes from air into a block of glass.

a) What are the names of angles A and B?

A:

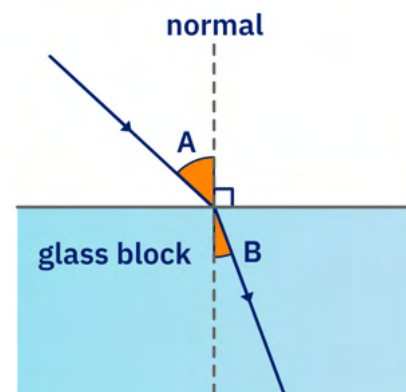
B:

b) What is the dotted line at right angles to the surface called?

.....

c) Which piece of equipment is used to measure the angles?

.....



4.6

The diagrams show light rays moving between different mediums.

Tick one box in each row of the table to show whether the ray in each diagram is moving into a more dense medium or a less dense medium.

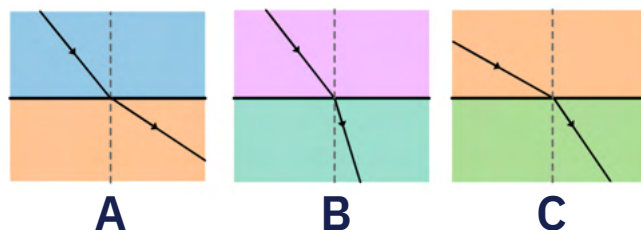


Diagram	Moving to a less dense medium	Moving to a denser medium
A		
B		
C		

4.7

State **three** ways in which a light wave will change when it travels from air into water.

.....

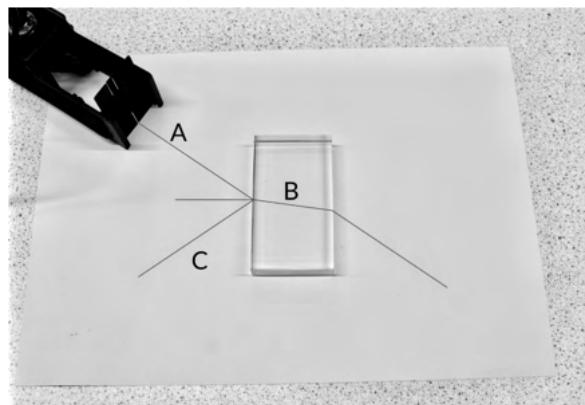
.....

.....

.....

4.8

A student is investigating the behaviour of light through a perspex block. They shine a ray of light at the block and trace the pattern formed, as shown. Name the rays A, B and C.



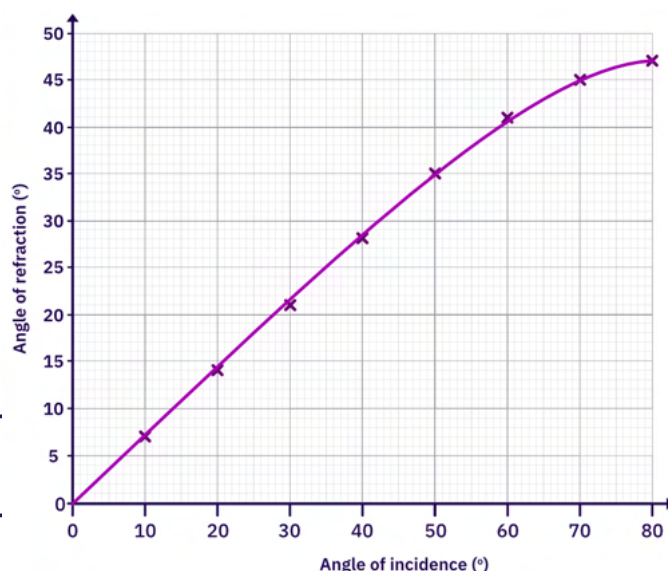
A:

B:

C:

4.9

A student varies the angle of incidence of a ray of light to a perspex block. They measure the corresponding angle of refraction. The graph shows their results. Write a conclusion to describe the student's results.



.....

.....

.....

.....

.....

.....

4. Electricity and circuits

Charge and current

R274

1.1 What is required for a current to flow in a circuit?

Tick **all** that apply.

A potential difference

☐

A closed circuit

☐

Protons

☐

A switch

☐

A resistance

☐

1.2 In the context of electricity, what is current?

.....

.....

1.3 A power supply gives a current of 0.06 A to charge a phone's battery.

It takes 6 hours for the battery to be full.

Calculate how much charge flows during this time.

.....C

1.4 When a kettle boils, 2160 C of charge flows through the heating element in 3 minutes.
Calculate the size of the current that is flowing.

.....A

4. Electricity and circuits

1.5

The current in a lamp is 0.5 A.

Calculate how long it will take for 150 C of charge to flow through the lamp.

.....S

1.6

A bulb is connected to a cell.

a) In which direction does the current flow around the circuit?

From positive
to negative ☐

From negative
to positive ☐

From negative
to negative ☐

From positive
to positive ☐

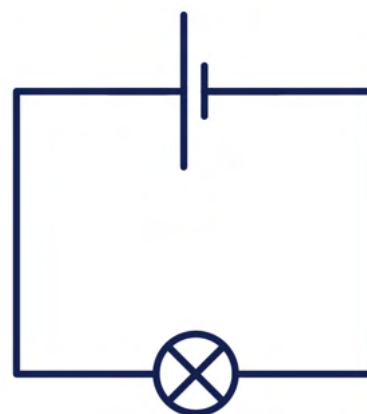
b) In which direction do the electrons flow around the circuit?

From positive
to negative ☐

From negative
to positive ☐

From negative
to negative ☐

From positive
to positive ☐



Potential difference

Z828

2.1

Complete the sentence.

Potential difference (or voltage) is the

energy
power
current
force

transferred per unit charge.

4. Electricity and circuits

- 2.2** A power station generates electricity at a potential difference of 25 000 V.
The charge flow from the power station in one second is 900 000 C.
Calculate the energy transferred by the power station in one second.

.....J

- 2.3** 15 C of charge passes through a bulb and transfers 75 J of energy.
Calculate the potential difference across the bulb.

.....V

Resistance in devices

R302

- 3.1** What word describes the opposition to the flow of charge?

.....

- 3.2** At 3.2 V, the current through a fixed resistor is 2.1 A.
The potential difference is increased to 6.4 V.
What is the current through the fixed resistor when the potential difference is 6.4 V?

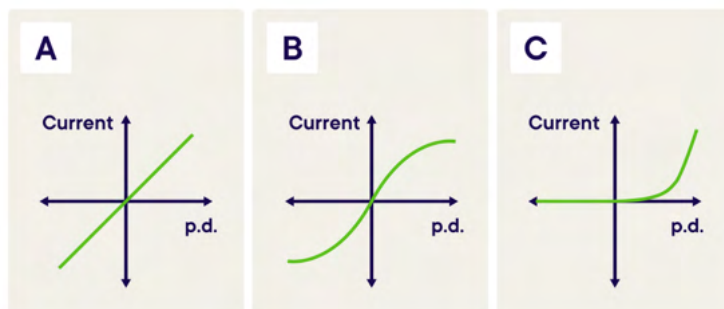
.....A

4. Electricity and circuits

3.3

Three current potential graphs are shown.

Name the component that would produce each graph.



A:

B:

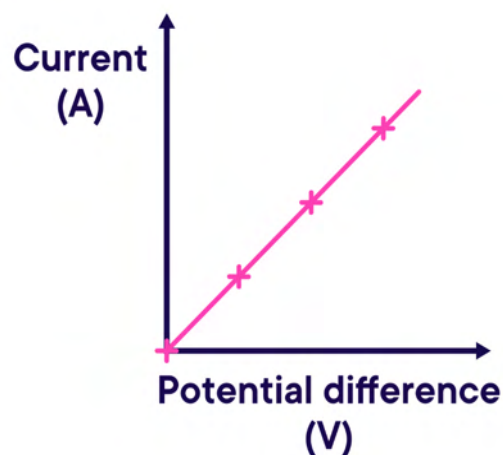
C:

3.4

A student investigates the current and potential difference through a component. They let the component cool down between readings. The graph shows their results.

a) Which of the following components could the student have been testing?

- | | |
|----------------|--------------------------|
| Fixed resistor | ☐ |
| Filament lamp | ☐ |
| Diode | ☐ |

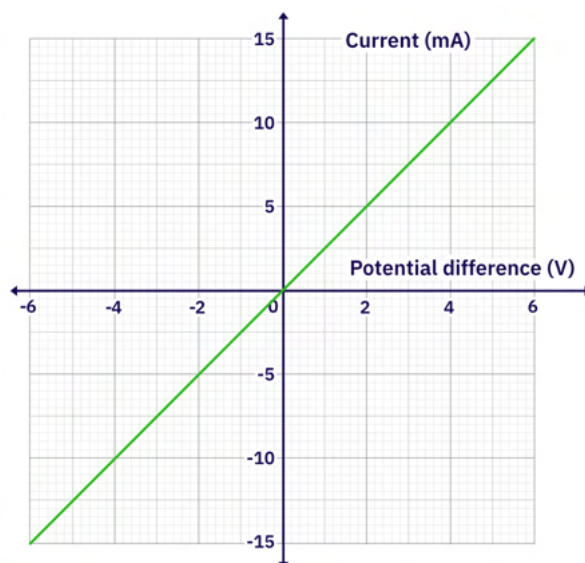


b) The student repeated the experiment.

This time, they did not let the component cool between readings and so it heated up. How might the graph for this experiment look different to the graph for experiment 1? Tick **all** that apply.

- | | | | |
|----------------------------------|--------------------------|--|--------------------------|
| The line would not be straight | ☐ | The line would not go through the origin | ☐ |
| The gradient would be less steep | ☐ | The gradient would be steeper | ☐ |

- 3.5** The graph shows how the current varies with potential difference for a component. What is the resistance of the component?



..... Ω

- 3.6** A current of 35 mA flows through a resistor with a resistance 120 Ω . Calculate the potential difference across the resistor.

.....V

- 3.7** A 1.5 V cell is used to provide energy in a circuit. It can transfer 43.2 C of charge in 3 hours before it runs out of energy.
a) Calculate the current in the circuit in milliamps.

.....mA

- b) Calculate the initial energy stored in the battery.
Give your answer in joules to 2 significant figures.

.....J

3.8

A filament lamp is most likely to melt and break in the first few seconds after it is switched on.

Using what you know about the resistance of a filament lamp, explain why this is the case.

.....

.....

.....

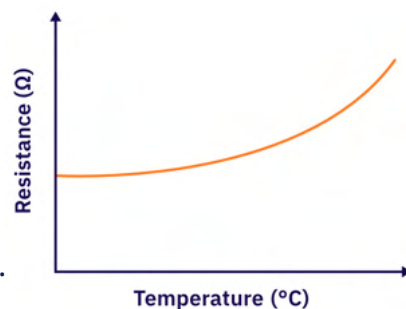
.....

.....

3.9

This graph shows how the resistance of a filament lamp varies with temperature.

Explain, in terms of the electrons and ions inside the filament, why the resistance increases with temperature.



.....

.....

.....

.....

.....

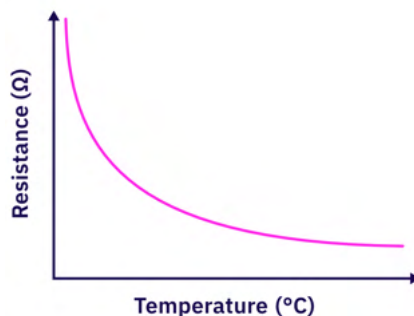
3.10

The graph shows how the resistance of the component changes with temperature.

a) What is the name of the component?

.....

b) What happens to the resistance of this component as the temperature increases?



It increases

☐

It decreases

☐

It stays constant

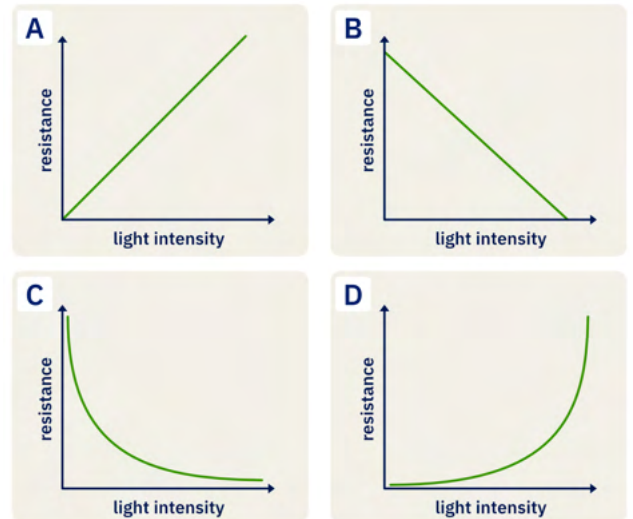
☐

4. Electricity and circuits

3.11 Which graph shows how resistance changes with light intensity for a light dependent resistor?

A ☐ B ☐

C ☐ D ☐

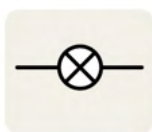
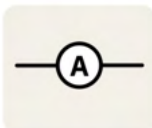
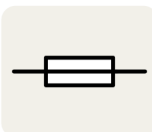
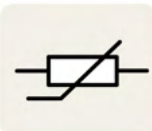
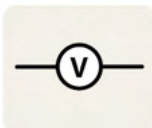
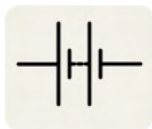


Circuits

R780, R955

4.1 Match each circuit symbol to its correct name.

Circuit symbol



Name

Voltmeter

Lamp

Battery

Thermistor

Ammeter

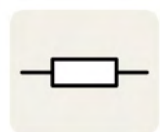
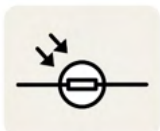
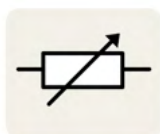
Fuse

4. Electricity and circuits

4.2

Match each circuit symbol to its correct name.

Circuit symbol



Name

Resistor

Diode

LED

LDR

Variable resistor

Thermistor

4.3

a) What type of circuit is shown in A?

.....

b) Which description describes the path of the current in circuit A?

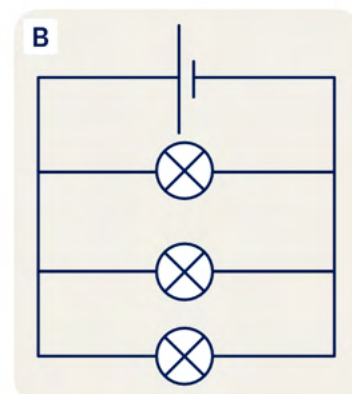
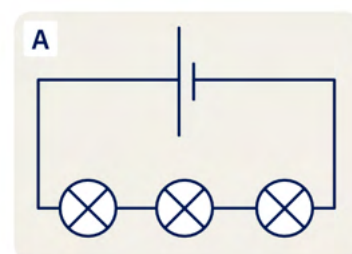
- | | | | |
|--|--------------------------|--------------------------------------|--------------------------|
| It takes one route through all 3 bulbs | ☐ | It flows through the first bulb only | ☐ |
| It can take a different route to each bulb | ☐ | It does not flow through any bulb | ☐ |

c) What type of circuit is shown in B?

.....

d) Which description describes the path of the current in circuit B?

- | | | | |
|--|--------------------------|--------------------------------------|--------------------------|
| It takes one route through all 3 bulbs | ☐ | It flows through the first bulb only | ☐ |
| It can take a different route to each bulb | ☐ | It does not flow through any bulb | ☐ |



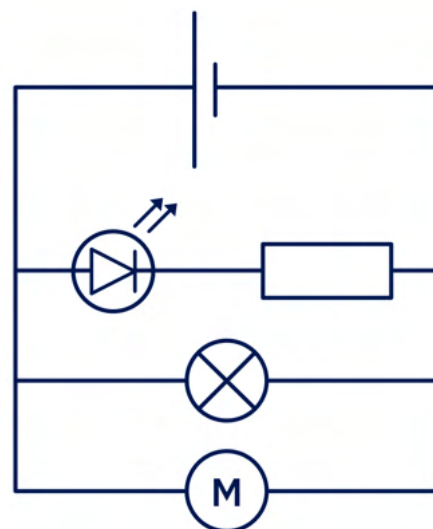
4. Electricity and circuits

4.4

The diagram shows a circuit.

Tick one box in each row of the table to show whether each of these pairs of devices are connected in series or parallel.

	How are the devices connected?	
	In series	In parallel
LED and resistor	☐	☐
Lamp and motor	☐	☐
Resistor and lamp	☐	☐



4.5

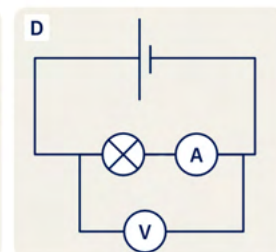
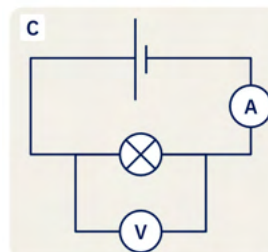
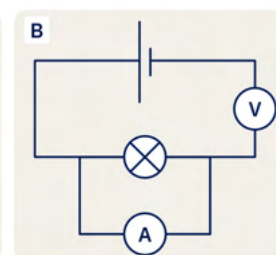
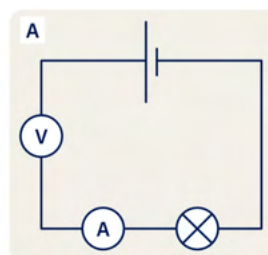
Which circuit shows an ammeter and voltmeter correctly connected?

A ☐

B ☐

C ☐

D ☐



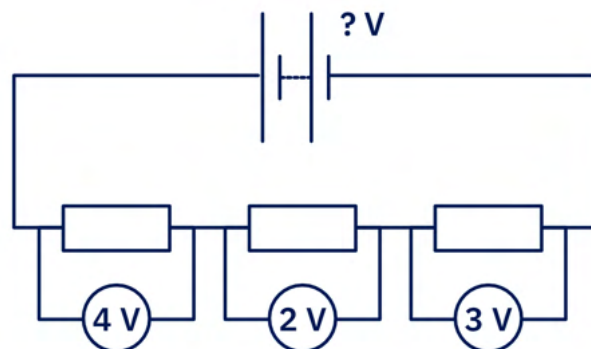
Properties of series and parallel circuits

R302, R409

5.1

Look at the circuit.

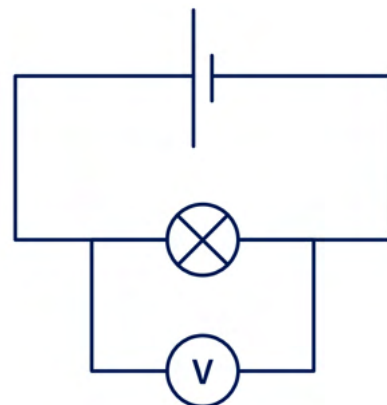
What is the potential difference of the battery?



.....V

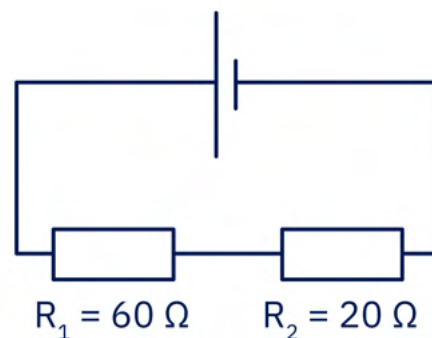
4. Electricity and circuits

- 5.2** The potential difference across the lamp is 3 V.
Predict the potential difference across the lamp if another two identical lamps were added to the circuit in series.



.....V

- 5.3** Calculate the total resistance of this circuit.



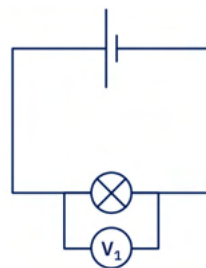
.....Ω

- 5.4** These circuits are all built using different numbers of cells which each provide 2 V of potential difference.

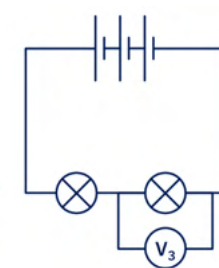
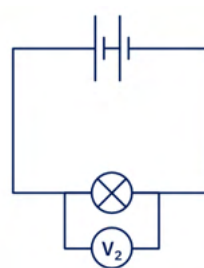
The bulbs are identical.

- a) Which voltmeter will give the highest reading?

V_1



V_2



V_3

- b) Calculate the reading on this voltmeter.

.....V

4. Electricity and circuits

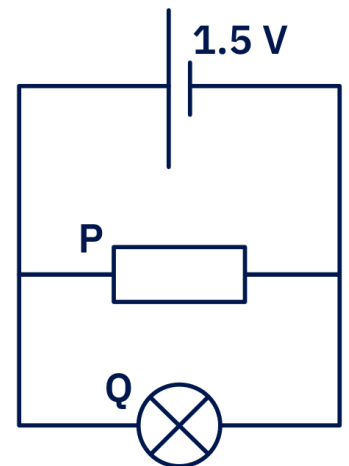
5.5

a) What is the potential difference across resistor P?

.....V

b) What is the potential difference across lamp Q?

.....V



5.6

Which of these value could be the total resistance in this circuit?

7 Ω

☐

10 Ω

☐

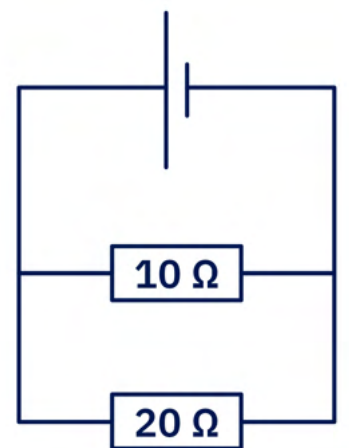
15 Ω

☐

20 Ω

☐

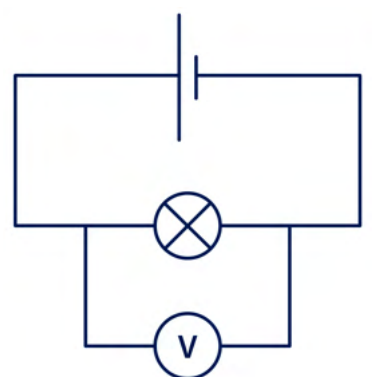
30 Ω

☐


5.7

The potential difference across the lamp is 9 V.
Predict the potential difference across the lamp if another two identical lamps are added to the circuit in parallel.

.....V

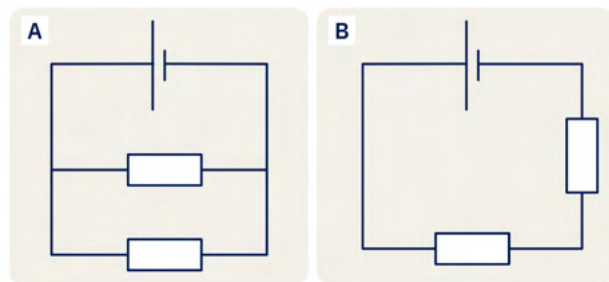


5.8

A student sets up these two circuits.
The resistance in a circuit changes depending on how the resistors are arranged.
a) In which circuit is the total resistance lower?

Circuit A ☐

Circuit B ☐



b) Explain your answer.

.....

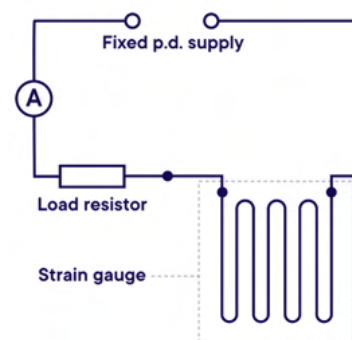
.....

.....

.....

5.9

A strain gauge is an electrical component.
Its resistance increases when it is stretched.
Strain gauges are often used on bridges with weight limits.
As a vehicle passes over the bridge, the bridge flexes which stretches the strain gauge.
A simplified circuit that could be used on a bridge is shown.
A heavy lorry passes over the bridge.
Explain how the reading on the ammeter will change as the lorry passes over the bridge.



.....

.....

.....

.....

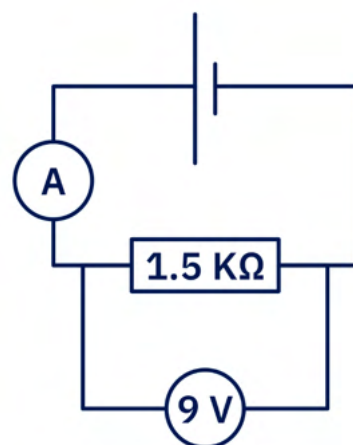
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.....

- 6.1** A resistor with a resistance of $3000\ \Omega$ and a resistor with a resistance of $2000\ \Omega$ are connected in series.
Given the supply voltage is 16 V , what is the current through the resistors?

.....A

- 6.2** Calculate the current flowing through the $1.5\text{ k}\Omega$ resistor.



.....A

- 6.3** In this circuit, the current flowing through each of the lamps is 1.5 A .
In 20 s how much charge flows
a) through one of the lamps?

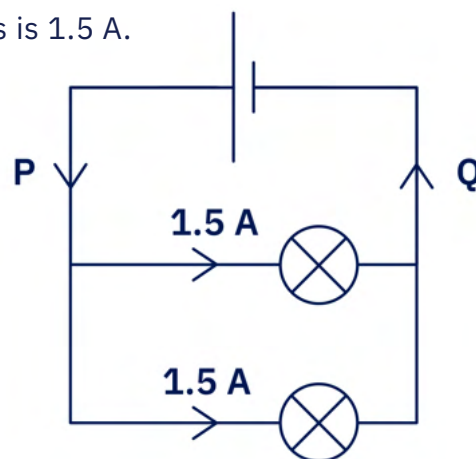
.....C

- b) past point P?

.....C

- c) past point Q?

.....C

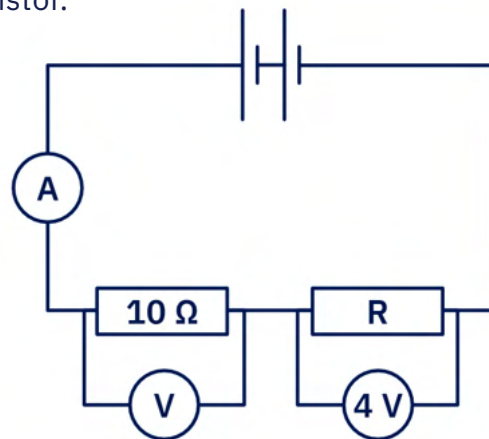


- 6.4** a) Calculate the potential difference across the $10\ \Omega$ resistor.

.....V

- b) Calculate the resistance of resistor R.

..... Ω



- 6.5** Look at the diagram of a circuit.
If the resistance of the variable resistor is increased, what will happen to the reading on

- a) the voltmeter?

It will increase ☐

It will decrease ☐

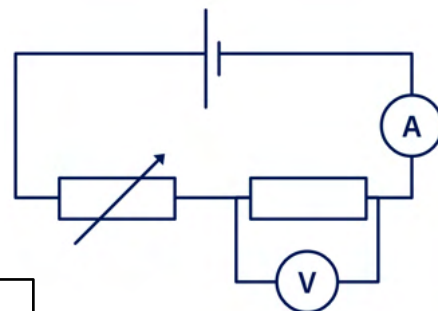
It will stay the same ☐

- b) the ammeter?

It will increase ☐

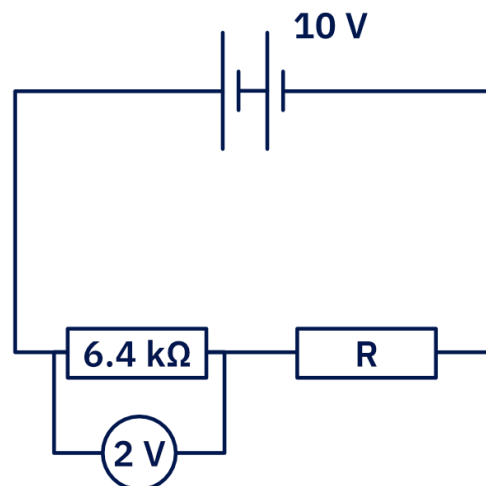
It will decrease ☐

It will stay the same ☐



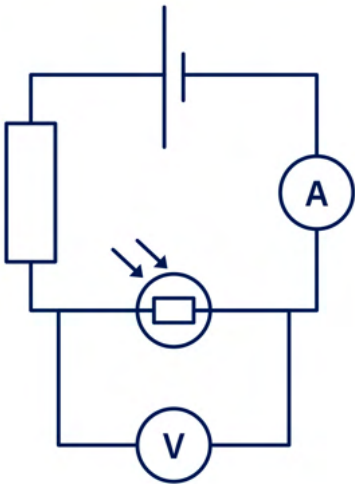
- 6.6** Calculate the value of resistor R.
Give your answer in $k\Omega$.

..... $k\Omega$



6.7 An LDR is connected in the circuit shown.
 The light intensity increases.
 Tick one box in each row of the table to show what happens to the reading on each device.

	Reading		
	Increases	Decreases	No change
Ammeter			
Voltmeter			



Power in circuits

R773, R490

7.1 The current in an interior light is 600 mA when connected to a 12 V battery.
 Calculate the energy transferred to the interior light in 7 minutes.

.....J

7.2 A car battery supplies a current of 110 A to a motor to start a car.
 The motor turns for 3 seconds and transfers 4.62 kJ of energy.
 Calculate the potential difference across the motor.

.....V

- 7.3** A solar panel supplies 5.8 A of current at a potential difference of 230 V.
Calculate the electrical power output of the solar panel.
Give your answer to 2 significant figures.

.....W

- 7.4** A toaster is connected to a 230 V supply.
Calculate the current in the toaster when its power is 1900 W.
Give your answer to 2 significant figures.

.....A

- 7.5** An electrical heater has a power rating of 2800 W.
Calculate the total resistance of the wire in the heater when a current of 5 A is
flowing through it.

..... Ω

7.6

An electric blanket uses the resistance of a wire to cause a heating effect when a current flows through the wire.
The resistance of the wire is $1200\ \Omega$ and the current flowing through the wire is $250\ \text{mA}$.
Calculate the electrical power of the electric blanket.

.....W

7.7

An extension cable has a resistance of $750\ \text{m}\ \Omega$.
The rate of energy transfer is $56\ \text{J/s}$.
Calculate the current in the cable to 3 significant figures.

.....A

7.8

A heater in a shower has $18\ 000\ \text{C}$ of charge flowing through it in 300 seconds.
It has a power of $13.8\ \text{kW}$.
Calculate the resistance of the heater in the shower.
Give your answer to 3 significant figures.

..... Ω

1.1 Substances can be represented using the particle model.

a) What does the potential energy of the particles in a substance depend on?

The separation of
the particles ☐

The speed of
the particles ☐

The mass of
the particles ☐

b) In which state the particles have the least potential energy?

.....

1.2 Which of the following correspond to an increase in the kinetic energy of the particles in a substance?

The particles moving
further apart ☐

The particles moving
closer together ☐

The particles
moving slower ☐

The particles
moving faster ☐

1.3 Describe what is meant by the internal energy of the particles in a substance.

.....
.....
.....
.....

1.4 A glass of water has a temperature of 60°C .
A block of aluminium has a temperature of 60°C .
Which quantity is the same for both the water and the aluminium?

The kinetic energy of
the particles ☐

The potential energy
of the particles ☐

The internal energy of
the substance ☐

The separation
of the particles ☐

1.5

Two gases A and B are at the same temperature.
Gas A is formed of molecules with a higher mass than the molecules in gas B.
Which statements correctly compare the molecules in gases A and B?
Tick **all** that apply.

- | | | | |
|--|--------------------------|---|--------------------------|
| Gas A molecules move faster than gas B | ☐ | Gas A molecules move more slowly than gas B | ☐ |
| Gas A molecules have a lower kinetic energy than gas B | ☐ | Gas A molecules have a higher kinetic energy than gas B | ☐ |
| Molecules in both gases have the same kinetic energy | ☐ | | |

Specific heat capacity

R527

2.1

The specific heat capacity of aluminium is $910 \text{ J/kg } ^\circ\text{C}$.
This means that a 1 kg block of aluminium needs 910 J of energy to increase its temperature by 1°C .
a) How much energy does it take to increase the temperature of a 1 kg block of aluminium by 2°C ?

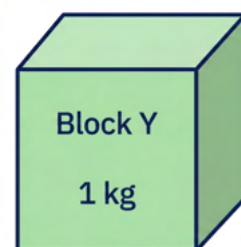
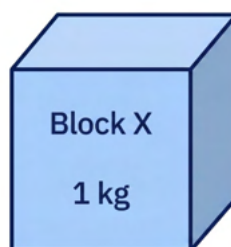
.....J

b) How much energy does it take to increase the temperature of a 1 kg block of aluminium by 6°C ?

.....J

2.2

Block X and block Y are made of different metals.
The same amount of energy is supplied to each block to heat the blocks.
The temperature of block X increases more than the temperature of block Y.
What does this tell you?



- | | | | |
|--|--------------------------|---|--------------------------|
| Block X has a lower specific heat capacity than block Y. | ☐ | Block X has a higher mass than block Y. | ☐ |
| Block X is a better thermal conductor than block Y. | ☐ | Block X has a higher specific heat capacity than block Y. | ☐ |

- 2.3** A scientist adds 3000 J of energy to a 0.5 kg block of an unknown metal. The temperature rises by 12°C. Calculate the specific heat capacity of the unknown metal.

.....J/kg °C

- 2.4** 200 g of a copper pipe is heated with a Bunsen burner. The energy supplied by the Bunsen burner is 7410 J. The specific heat capacity of copper is 390 J/kg °C. Assuming all the energy from the Bunsen burner goes into heating the pipe, calculate the change in temperature of the pipe.

.....°C

- 2.5** A student heated 250 g of water in a beaker and measured the amount of energy it took to increase the temperature by 10°C. They calculated the specific heat capacity to be 4400 J/kg °C.
- a) Do you expect the student's calculated value to be an underestimate, overestimate or the same as the actual specific heat capacity of water?

An underestimate

☐

An overestimate

☐

The same

☐

- b) Explain your answer.

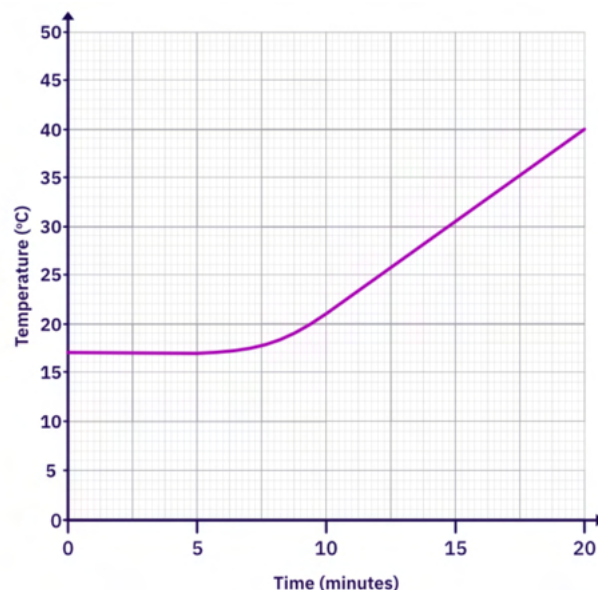
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2.6

A student is investigating the specific heat capacity of a 2.0 kg metal block. The graph shows their results. The energy transferred to the block between 10 and 20 minutes was 16 530 J. Calculate the specific heat capacity of the metal.

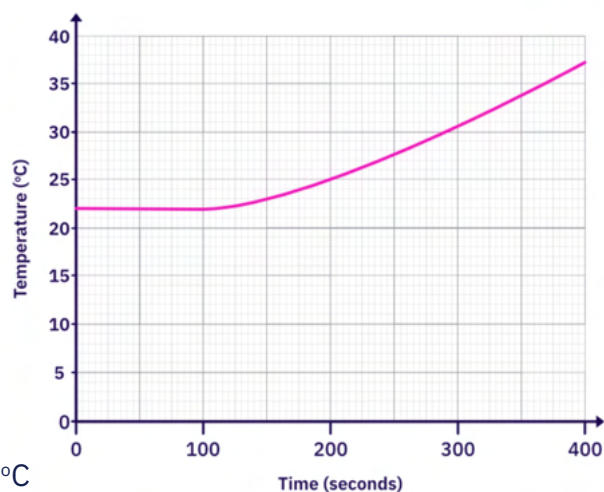


.....J/kg °C

2.7

A student is investigating the specific heat capacity of a metal block. The block has been sitting in the room before the practical. They heat the block using an electric heater, and measure the temperature of the metal block and plot the graph as shown.

a) Estimate the temperature of the room.



.....°C

b) Explain why the temperature of the block did not immediately start to increase.

.....

.....

.....

.....

- 3.1** Describe the difference between the term 'specific heat capacity' and the term 'specific latent heat' when applied to heating substances.

.....

.....

.....

.....

- 3.2** The diagram shows the masses of two blocks, X and Y. They are made from different materials. It takes the same amount of energy to completely melt the blocks. How does the specific latent heat of block X compare with the specific latent heat of block Y?



The specific latent heat of X is equal to that of Y ☐

The specific latent heat of X is twice that of Y ☐

The specific latent heat of X is a quarter that of Y ☐

The specific latent heat of X is four times that of Y ☐

- 3.3** A substance has a specific latent heat of 1.5 MJ/kg. Calculate the energy needed to change the state of 4 kg of this substance. Give your answer in joules.

.....J

- 3.4** It takes 1.13 kJ of energy to melt 50.5 g of lead at 327°C.
Calculate the specific latent heat of fusion of lead.
Give your answer in J/kg to 3 significant figures.

.....J/kg

- 3.5** An aircraft uses a device called a pitot tube to measure speed.
To prevent water from freezing on the tube at high altitudes, it is heated by a 50 W heater.
During part of the flight, the heater is on for 120 seconds.
The specific latent heat of fusion for ice is 334 000 J/kg.
Calculate the maximum mass of ice at 0°C that could be melted while the heater is on.
Give your answer to 2 significant figures.

.....kg

Heating and cooling graphs

R927

- 4.1** This is the heating graph for a substance.
In which section(s) of the graph is the substance

a) a solid?

.....

b) a liquid?

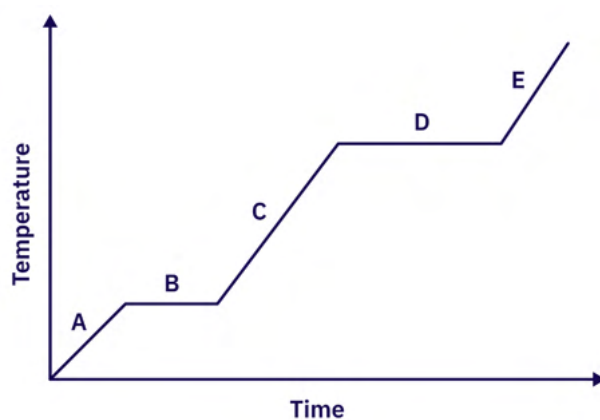
.....

c) a gas?

.....

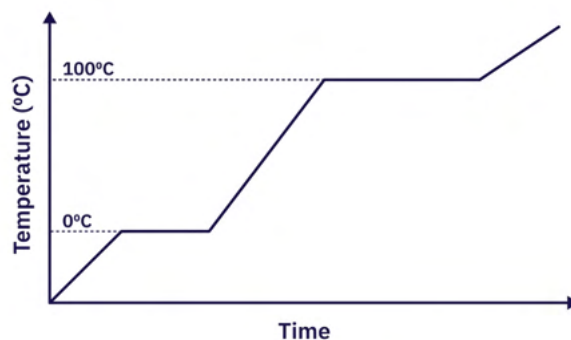
d) changing state?

.....



4.2

The image shows a heating curve for a substance. The curve provides us with the melting and boiling points of the substance.



a) Complete these sentences.

0°C is the point of the substance.

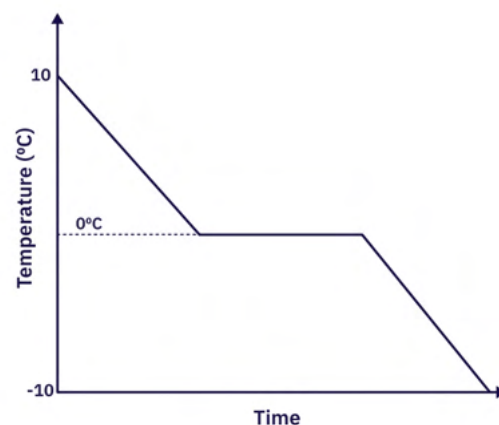
100°C is the point of the substance.

b) Suggest the identity of the substance.

.....

4.3

A student cooled a sample of water from 10°C to -10°C. They recorded the temperature over time. The graph shows their results.



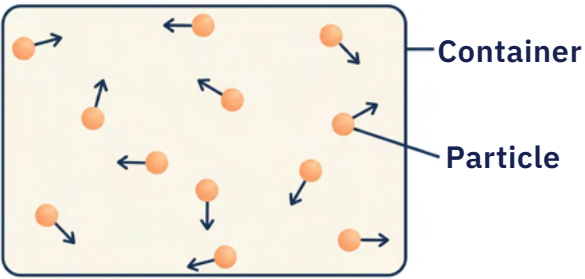
Write statements A-D in order to explain why the graph is flat at 0°C.

- A.** At 0°C, the energy transfer is used to form stronger intermolecular forces between water particles.
- B.** The temperature stays constant until all the water has frozen, then decreases again.
- C.** The stronger intermolecular forces cause the water to change state (freeze).
- D.** As the water cools, energy is transferred to the surroundings.

First step _____ Last step

.....,,,

5.1 The diagram shows the movement of gas particles in a container.
The gas is heated, which causes the particles to move more quickly.



Tick one box in each row of the table to show how this affects the following factors.

	Effect		
	Increases	Decreases	Stays constant
Frequency of collisions between the particles and container walls			
The force with which particles collide with the container walls			
The pressure inside the container			

5.2 The particle model can be used to explain the properties of gases.
Explain why heating a gas increases the average speed of the gas particles.

.....

.....

.....

.....

.....

.....

5.3

A scuba diver's air tank is filled with gas.

The tank is moved from a warm boat deck to the cold water.

Tick one box in each row of the table to show what will happen to the different properties.

	Effect		
	Increases	Decreases	Stays constant
Force exerted on the inside walls of the tank			
The volume of the gas			
The kinetic energy of the gas particles			
The average speed of the gas particles			

5.4

A motorist checks the pressure in their car tyres before and after a long journey.

The temperature of the gas in the tyres heats up on the journey.

Explain how the increase in temperature affects the pressure in the tyres.

.....

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1.1 Name the three subatomic particles found in an atom.

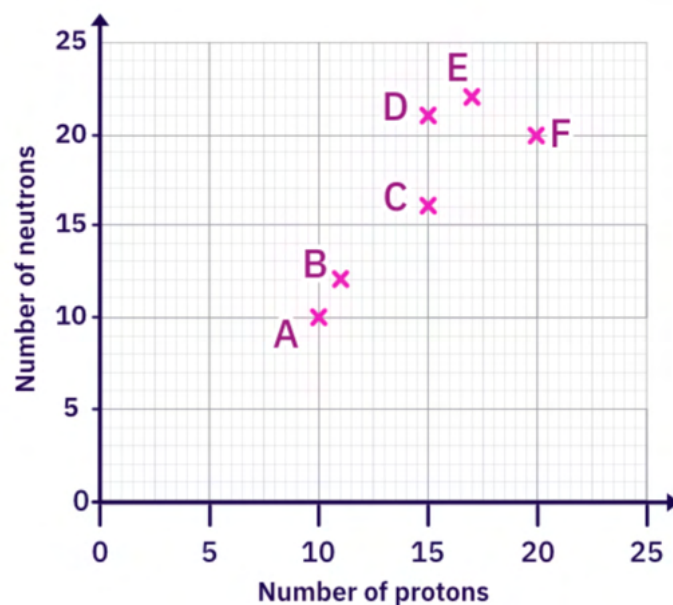
.....,, and

1.2 Tick one box in each row of the table to give the charge of each subatomic particle.

Particle	Charge				
	-2	-1	0	+1	+2
Electron					
Proton					
Neutron					

1.3 Each cross marks an atom.
Which **two** atoms contain the same total number of particles in their nuclei?

A	☐	B	☐
C	☐	D	☐
E	☐	F	☐



1.4

The atomic number and mass number of each element are shown on the Periodic Table. Tick boxes in each row of the table to show which particles contribute to each number. You may tick more than one box per row.

	Particles that contribute to this number		
	Electrons	Protons	Neutrons
Atomic number			
Mass number			

1.5

Use the Periodic Table to answer these questions about fluorine.

a) How many protons does an atom of fluorine contain?

.....

b) How many neutrons does an atom of fluorine contain?

.....

1.6

Two isotopes of potassium are:

- potassium-39 (${}_{19}^{39}\text{K}$)
- potassium-40 (${}_{19}^{40}\text{K}$).

Describe what is meant by the term "isotopes".

.....

.....

.....

.....

1.7 The following shows three isotopes of carbon:

- Carbon-12: ${}^{12}_6\text{C}$
- Carbon-13: ${}^{13}_6\text{C}$
- Carbon-14: ${}^{14}_6\text{C}$

a) How many protons does carbon have?

.....

b) How many neutrons are present in carbon-13?

.....

c) How many neutrons are present in carbon-12?

.....

1.8 Even though isotopes have different atomic structures, the charge on atoms of an isotope is the same. Suggest why.

.....

.....

1.9 Ultraviolet(UV) light is emitted when electrons change energy levels. Write steps A-D in the correct order to describe how an atom can emit UV light.

- A.** The electron drops to a lower energy level.
- B.** The atom emits UV light.
- C.** An atom absorbs electromagnetic radiation.
- D.** An electron moves to a higher energy level.

First step _____ → Last step

.....,,,

- 1.10** A calcium atom reacts and loses two electrons.
Explain how this affects the charge on the atom.

.....

.....

.....

.....

Types of radiation and their properties

R937, R694

- 2.1** Alpha, beta and gamma radiation are described as ionising radiation.
What does this mean?

The radiation is emitted
as electrons ☐

The radiation can cause
atoms to lose electrons ☐

The radiation is emitted
as helium ions ☐

The radiation is made up
of ions ☐

- 2.2** Some atoms can release beta particles during radioactive decay.
Where in the atom does a beta particle come from?

The outer electron shell ☐

The inner electron shells ☐

The nucleus ☐

Ionisation of the atom ☐

- 2.3** Match each type of radiation to its correct description.

Type of radiation

Alpha

Beta

Gamma

Description

Electromagnetic wave

Electron

Helium nucleus

2.4

This question is about alpha particles.

a) How many protons, neutrons and electrons does an alpha particle contain?

number of protons:

number of electrons:

number of neutrons:

b) Therefore, what is the charge on an alpha particle?

.....

2.5

An unstable nucleus may emit gamma radiation.

Explain what effect emitting gamma radiation has on the nucleus.

.....
.....
.....
.....

2.6

Three types of radiation are: **alpha radiation**, **beta radiation** and **gamma radiation**.

Write these types of radiation in order of how ionising they are.

Least ionising  Most ionising

.....,,

2.7

Tick boxes in each row of the table to show which materials can block the travel of each type of radiation. You may tick more than one box per row.

Type of radiation	The radiation can be blocked by...		
	Thick paper	Thick aluminium	Thick lead
Alpha radiation			
Beta radiation			
Gamma radiation			

2.8

Smoke detectors contain an alpha radiation source.
It would be more hazardous to use beta radiation in smoke detectors.
Explain why.

.....

.....

.....

.....

2.9

Alpha radiation is more ionising than beta radiation.
Give a reason why alpha radiation is more ionising than beta radiation.

.....

.....

Nuclear equations

R193

3.1

An atom undergoes alpha decay.
Tick one box in each row of the table to show how the mass number and atomic number of the atom change.

	Increases	Decreases	Stays the same
Mass number			
Atomic number			

3.2 The equation below shows how an atom of astatine decays.



a) What type of radiation is astatine emitting?

.....

b) What number replaces the question mark in the equation?

.....

3.3 An isotope of uranium, ${}_{92}^{238}\text{U}$, undergoes one alpha decay followed immediately by one beta decay.

a) What is the atomic (proton) number of the resulting final nucleus?

.....

b) What is the mass number of the resulting final nucleus?

.....

3.4 A student writes down the following equation.



a) Give **one** way that you know this equation is incorrect.

.....

.....

b) Once the student corrects the equation, ${}_{-1}^0\text{e}$ is still emitted.
What type of radiation is Americium emitting?

.....

- 4.1** This question is about the units of radioactivity.
Complete these sentences.

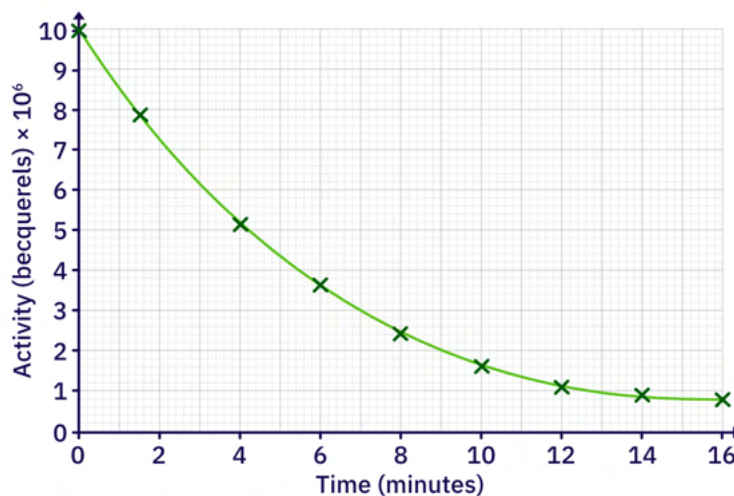
The unit of activity of a radioactive isotope is the

It has the symbol

- 4.2** A radioactive source for an airport security radiation scanner has an activity of 1200 Bq.
How many nuclei in the source will decay in 1 minute?

.....

- 4.3** The graph shows how the activity of a sample changes with time.



- a) What was the activity of the sample after 2 minutes?

.....Bq

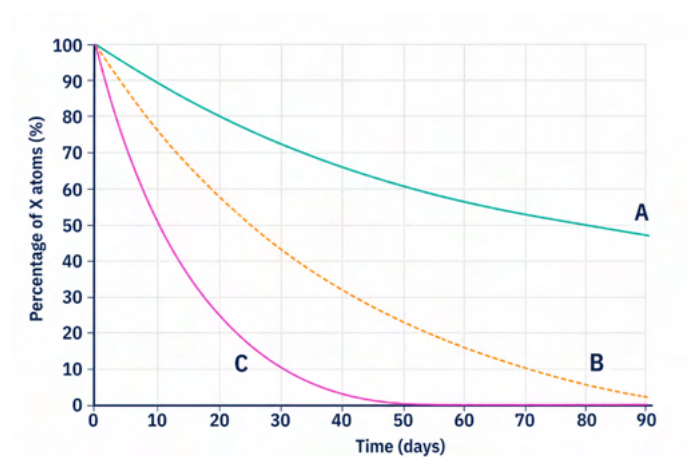
- b) How long did it take for the activity to decrease to 2×10^6 Bq?

.....minutes

4.4

Element X has three radioactive isotopes (A, B and C).

The graph shows how the percentage of X atoms changes over time for each isotope.



a) Which isotope is the most unstable?

A ☐

B ☐

C ☐

b) Give a reason for your answer.

.....

.....

4.5

An isotope of protactinium-234 has a half-life of 1.17 minutes.

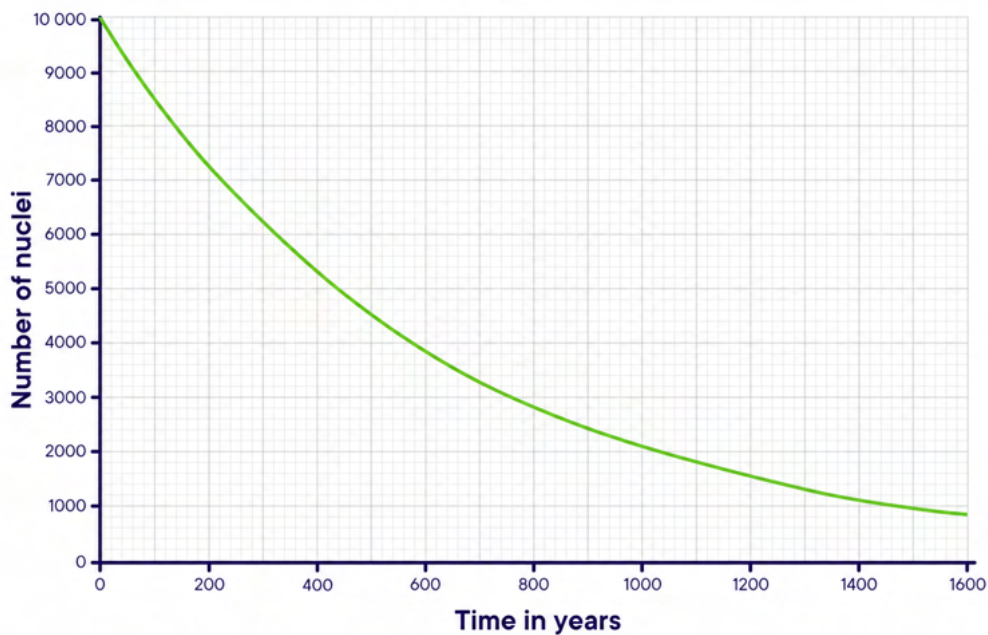
Describe what is meant by the term half-life.

.....

.....

4.6

The graph shows how the number of americium-241 nuclei changes with time.



- a) How many years does it take for the number of americium-241 nuclei to decrease from 10 000 to 5000?

.....years

- b) What is the half-life of americium-241?

.....years

4.7

The half-life of carbon-14 is 5730 years.

A sample contains 100 g of carbon-14.

Calculate the mass of the sample that will be carbon-14 after 17 190 years.

.....g

4.8

A student was using dice to model radioactivity.

- They started with 112 dice.
- They rolled all of the dice and removed any that landed on a one.
- They rolled the remaining dice and again removed those that had landed on a one.

When the student had rolled the dice 20 times, there were 7 dice left.

Calculate the most likely number of times the student had rolled the dice before the number of dice remaining had halved.

.....

4.9

A student uses dice to model radioactive decay.

- Each dice represents one radioactive nucleus.
- He takes 100 dice, rolls them and removes all the dice showing a one.
- He then repeats this another 5 times.

Give **two** reasons why this is a good model for the random nature of radioactive decay.

.....

.....

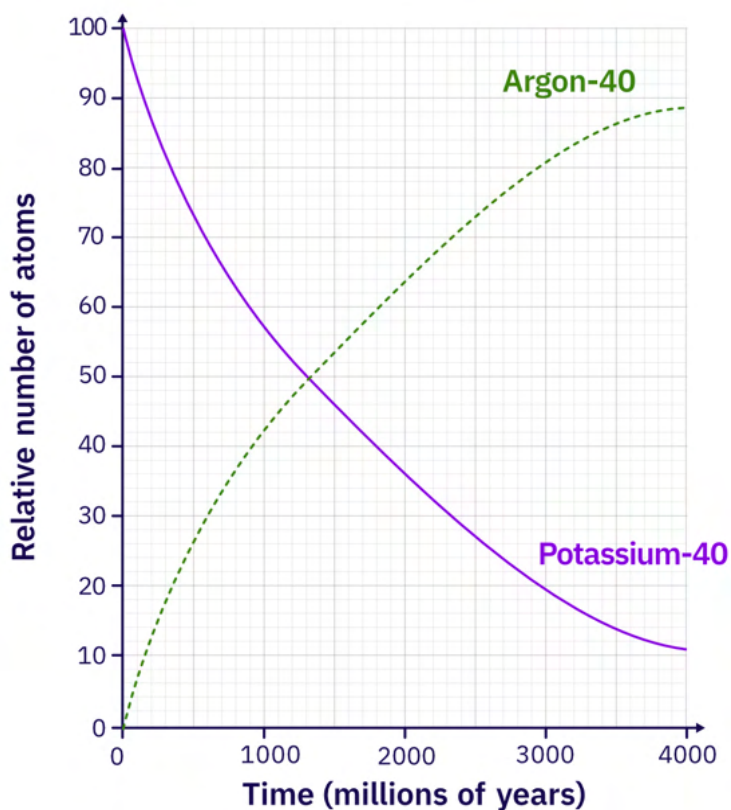
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4.10

An isotope of potassium, potassium-40, decays to form a stable isotope of argon, argon-40.

This graph shows the relative amounts of potassium-40 and argon-40 as a sample of potassium-40 decays.



a) What is the half-life of potassium-40?

.....million years

b) Use the graph to estimate how many millions of years it would take for the sample to contain **three times** as many argon-40 nuclei as potassium-40 nuclei.

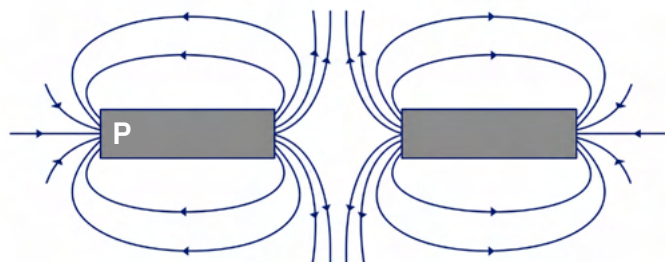
.....million years

1.1

The diagram shows the magnetic field pattern around two bar magnets.

a) What type of pole is labelled P?

.....



b) What interaction is there between these two magnets?

They attract ☐

They repel ☐

There is no
interaction ☐

1.2

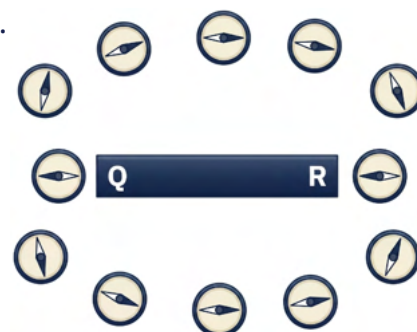
The diagram shows a series of compasses around a bar magnet. The red needle on the compass points north.

a) Which label shows the south pole of the magnet?

Q ☐

R ☐

It is impossible
to tell ☐



b) Which label shows the north pole of the magnet?

Q ☐

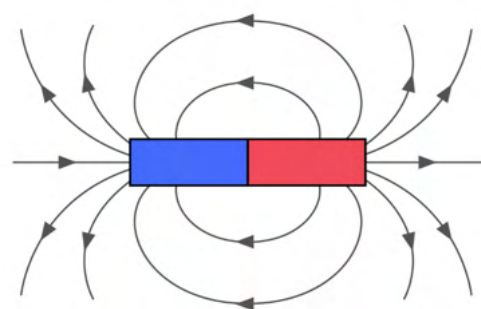
R ☐

It is impossible
to tell ☐

1.3

The diagram below shows the magnetic field around a bar magnet.

What tells you how strong the magnetic field is in a given place?



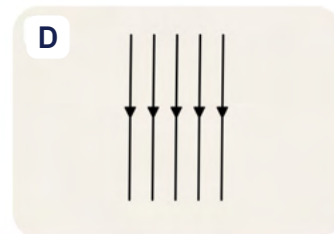
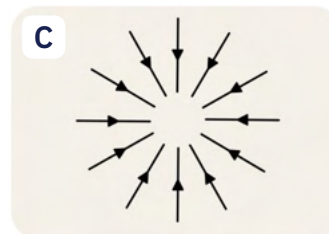
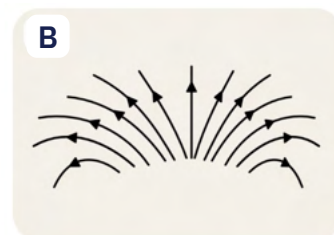
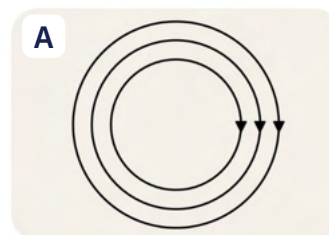
Whether there are
arrows on the field lines ☐

How long the magnetic
field lines are ☐

How close the field
lines are to each other ☐

How curved the field
lines are ☐

- 1.4** Four different magnetic field patterns are shown.
Which pattern shows a uniform magnetic field?

A ☐B ☐C ☐D ☐

Types of magnet

R882

- 2.1** Which of these materials are attracted to a magnet?
Tick **all** that apply.

Aluminium ☐Cobalt ☐Gold ☐Iron ☐Lead ☐Nickel ☐

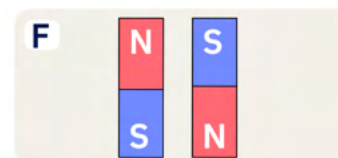
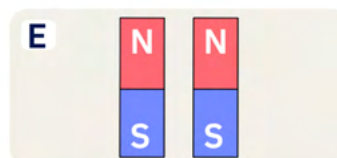
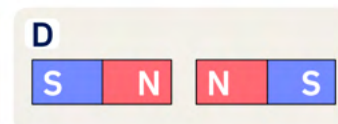
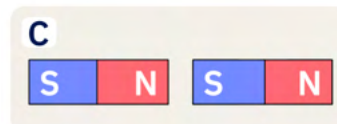
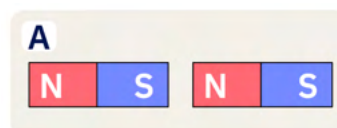
- 2.2** a) What term describes a magnet that is always magnetic?

.....

- b) What term describes a metal that only becomes magnetic when it is placed in a magnetic field?

.....

- 2.3** In which of the diagrams will the magnets attract each other?
Tick **all** that apply.

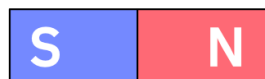
A ☐B ☐C ☐D ☐E ☐F ☐

2.4

An iron bar is placed close to the north pole of a bar magnet.

The iron bar becomes magnetised.

a) What type of pole is induced at Y?



iron bar

b) What interaction will there be between the magnet and the iron bar?

They will
attract

☐

They will
repel

☐

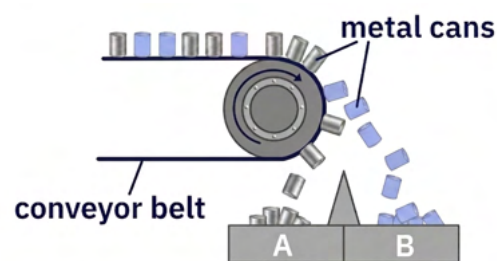
There will be
no interaction

☐

2.5

Magnetic conveyor belts are used to separate metal cans in a recycling centre, as shown in the diagram. Steel cans collect at point A and aluminium cans collect at point B.

Tick one box in each row to show the magnetism of the following objects.



Object	Type of magnet		
	Induced	Permanent	Not magnetised
Conveyor belt			
Steel cans			
Aluminium cans			

3.1

A current carrying wire creates a magnetic field pattern around the wire.
Which of the following would increase the strength of the magnetic field?

Increase the current in
the wire ☐

Decrease the current in
the wire ☐

Increase the thickness
of the wire ☐

Decrease the thickness
of the wire ☐

3.2

A current-carrying wire creates a magnetic field pattern around a wire, as shown in the diagram.

a) The current moves upwards through the wire.

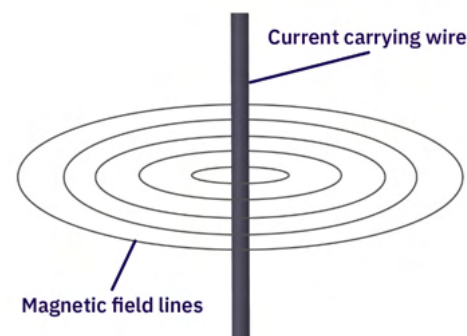
Which direction is the magnetic field around the wire?

Clockwise ☐

Anticlockwise ☐

Upwards ☐

Downwards ☐



b) The distance between the circular field lines increases with distance from the wire.
What does the diagram show about the magnetic field strength as you move away from the wire?

It increases ☐

It decreases ☐

It is consistent in
strength ☐

It fluctuates in
strength ☐

3.3

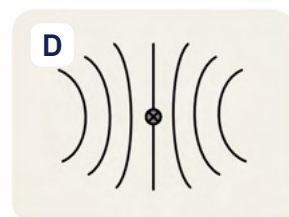
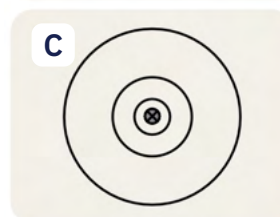
A wire is carrying a current.
The direction of the current flows into the screen.
Which diagram shows the magnetic field pattern around the wire?

A ☐

B ☐

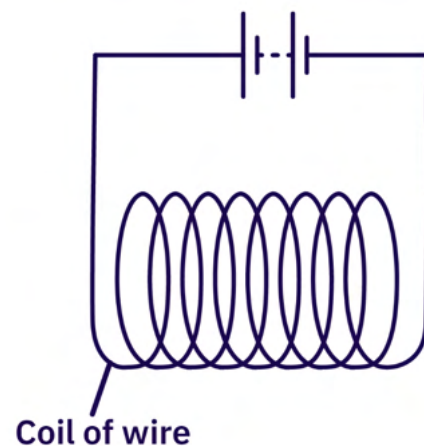
C ☐

D ☐



3.4

The diagram shows a circuit containing a coil of wire called a solenoid. When a current flows through the wires, it produces a magnetic field.



- a) What can be placed inside the solenoid to make the magnetic field stronger?

.....

- b) What kind of magnet is produced when this material is placed in the solenoid?

Permanent

☐

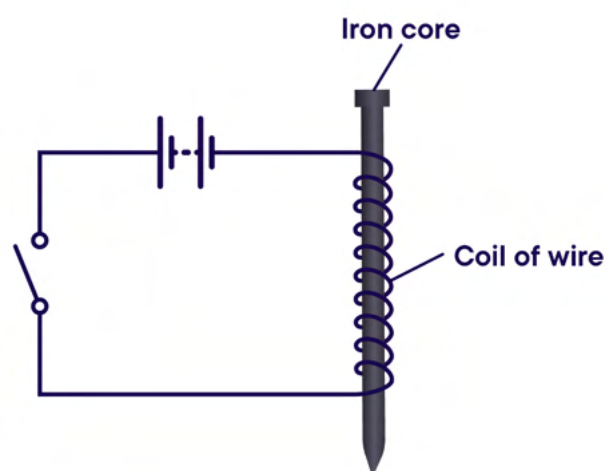
Non-permanent

☐

3.5

The diagram shows a magnet made from a coil of wire and an iron nail.

Tick one box in each row to show how each of the following will affect the strength of the magnet.



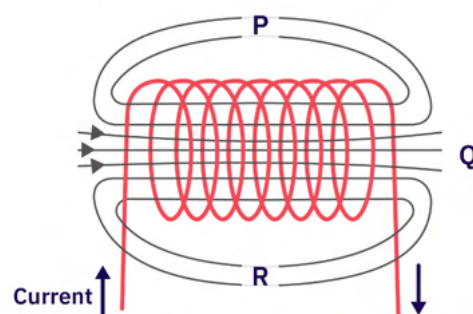
	Effect on strength of magnet		
	Increase	Decrease	No effect
Decreasing the number of turns on the coil of wire			
Increasing the current through the coil			
Removing the iron nail			

- 3.6** In electromagnets, the iron core is often described as **soft**.
What does the word soft mean in this context?

.....

.....

- 3.7** When a coil of wire carries a current there is a magnetic field around the coil, as shown in the diagram.
To show the direction of the magnetic field,



a) P?

Up arrow	☐	Down arrow	☐
Left arrow	☐	Right arrow	☐

b) Q?

Up arrow	☐	Down arrow	☐
Left arrow	☐	Right arrow	☐

c) R?

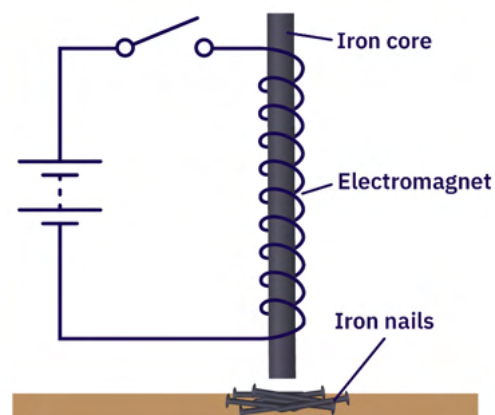
Up arrow	☐	Down arrow	☐
Left arrow	☐	Right arrow	☐

3.8

A student is asked to investigate how the number of nails picked up by an electromagnet changes with the number of turns in the coil of wire.

The student sets up the equipment shown in the diagram above and records the following results.

Measurement	Number of turns	Number of nails
A	10	5
B	15	9
C	20	14
D	25	13
E	30	25
F	35	30



- a) The student notices an anomaly in the results.
Which row contains an anomalous result?

A ☐

B ☐

C ☐

D ☐

E ☐

F ☐

- b) Suggest what the student should do with the anomalous result.

.....

.....

- c) Suggest how the student could improve the experiment to reduce the effect of random errors.

.....

.....

.....

.....

- 4.1 Fleming's left-hand rule is shown in the diagram.
What does each finger represent?

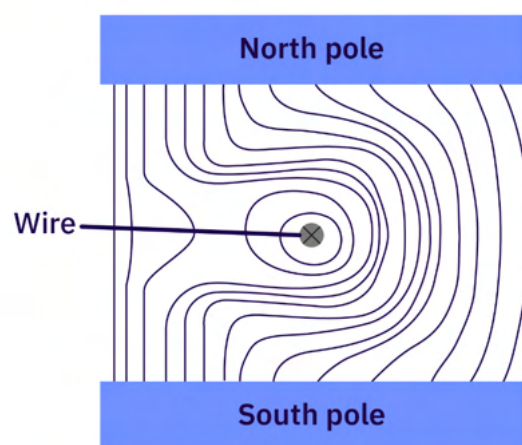
first finger:

second finger:

thumb:



- 4.2 The diagram shows the combined magnetic field when a current carrying wire is placed between two magnets.
There is a force acting on the wire due to the interaction of the fields.
In which direction is the force acting?



- 4.3 A current carrying wire near a magnet is shown in the diagram.
There is a force on the wire in the direction shown.

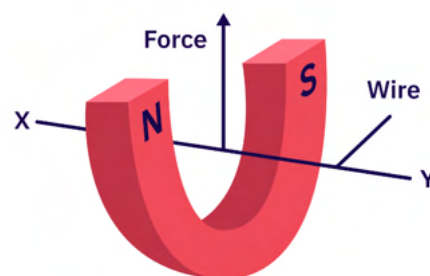
a) Which direction is the current flowing along the wire?

From X to Y ☐

From Y to X ☐

From N to S ☐

From S to N ☐



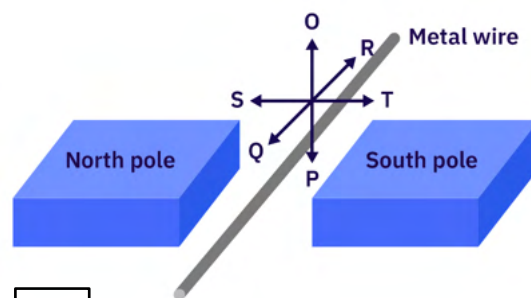
b) Suggest **one** way that the force on the wire could be increased.

.....

.....

4.4

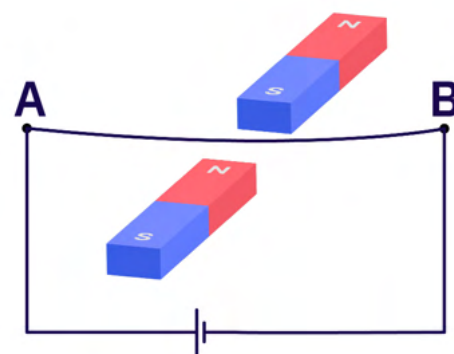
The diagram shows a wire in a magnetic field.
In which directions can the wire be forced to move?
Tick **all** that apply.

O ☐P ☐Q ☐R ☐S ☐T ☐

4.5

A wire is suspended between two points (A and B) and connected to a DC power supply.

- a) Explain how the wire moves when the circuit is completed.



.....

.....

.....

.....

.....

- b) The student replaces the DC power supply with an AC power supply, describe the movement of the wire with the new power supply.

.....

.....

.....

.....

4.6

A wire of length 0.2 m is placed in a magnetic field and experiences a force of 0.06 N.
The current in the wire is 1.2 A.
Calculate the magnetic flux density of the magnetic field.

.....T

4.7

A wire is placed in a magnetic field with a flux density of 0.2 T and
experiences a force of 3.4 N.
The current in the wire is 3.9 A.
Calculate the length of the wire in the magnetic field.
Give your answer to 2 significant figures.

.....m