Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________
I declare this is my own work.

GCSE
PHYSICS
Higher Tier   Paper 1

H

Time allowed: 1 hour 45 minutes

Materials
For this paper you must have:
- a ruler
- a scientific calculator
- the Physics Equations Sheet (enclosed).

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer all questions in the spaces provided.
- Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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Answer all questions in the spaces provided.

0 1 Figure 1 shows an electric car being recharged.

Figure 1

0 1 . 1 The charging station applies a direct potential difference across the battery of the car.

What does 'direct potential difference' mean?

[1 mark]

The polarity of the supply does not change

Question 1 continues on the next page

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0 1 . 2 Which equation links energy transferred (*E*), power (*P*) and time (*t*)?

[1 mark]

Tick (✓) one box.

energy transferred = $\frac{\text{power}}{\text{time}}$ ☐

energy transferred = $\frac{\text{time}}{\text{power}}$ ☐

energy transferred = power × time ☑

energy transferred = power2 × time ☐

0 1 . 3 The battery in the electric car can store 162 000 000 J of energy.

The charging station has a power output of 7200 W.

Calculate the time taken to fully recharge the battery from zero.

[3 marks]

162 000 000 = 7200 × t

t = $\frac{162000000}{7200}$

Time taken = 22 500 s

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0 1 . 4 Which equation links current (I), potential difference (V) and resistance (R)?

[1 mark]

Tick (✓) one box.

$I = V \times R$	☐
$I = V2 \times R$	☐
$R = I \times V$	☐
$V = I \times R$	✓

0 1 . 5 The potential difference across the battery is 480 V.

There is a current of 15 A in the circuit connecting the battery to the motor of the electric car.

Calculate the resistance of the motor.

[3 marks]

$480 = 15 \times R$

$R = \frac{480}{15}$

Resistance = 32 Ω

Question 1 continues on the next page

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0 1 . 6 Different charging systems use different electrical currents. •

Charging system A has a current of 13 A.

• Charging system B has a current of 26 A.

• The potential difference of both charging systems is 230 V.

How does the time taken to recharge a battery using charging system A compare with the time taken using charging system B?

[1 mark]

Tick (✓) one box.

Time taken using system A is half the time of system B	☐
Time taken using system A is the same as system B	☐
Time taken using system A is double the time of system B	☑

10

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0 2 Energy from the Sun is released by nuclear fusion.

0 2 . 1 Complete the sentences.

[2 marks]

Nuclear fusion is the joining together of nuclei .

During nuclear fusion the total mass of the particles decreases .

0 2 . 2 Nuclear fusion of deuterium is difficult to achieve on Earth because of the high temperature needed.

Electricity is used to increase the temperature of 4.0 g of deuterium by 50 000 000 °C.

specific heat capacity of deuterium = 5200 J/kg °C

Calculate the energy needed to increase the temperature of the deuterium by 50 000 000 °C.

Use the Physics Equation Sheet.

[3 marks]

m = 0.004 kg

E = 0.004 × 5200 × 50,000000

Energy = 1040000000 J

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0 2 . 3 The idea of obtaining power from nuclear fusion was investigated using models.

The models were tested before starting to build the first commercial nuclear fusion power station.
Suggest two reasons why models were tested.

[2 marks]

1 To make sure the fusion process is possible

2 To develop an understanding of the process

0 2 . 4 Generating electricity using nuclear fusion will have fewer environmental effects than generating electricity using fossil fuels.

Explain one environmental effect of generating electricity using fossil fuels.

[2 marks]

Releases carbon dioxide which causes global warming.

9

Turn over for the next question

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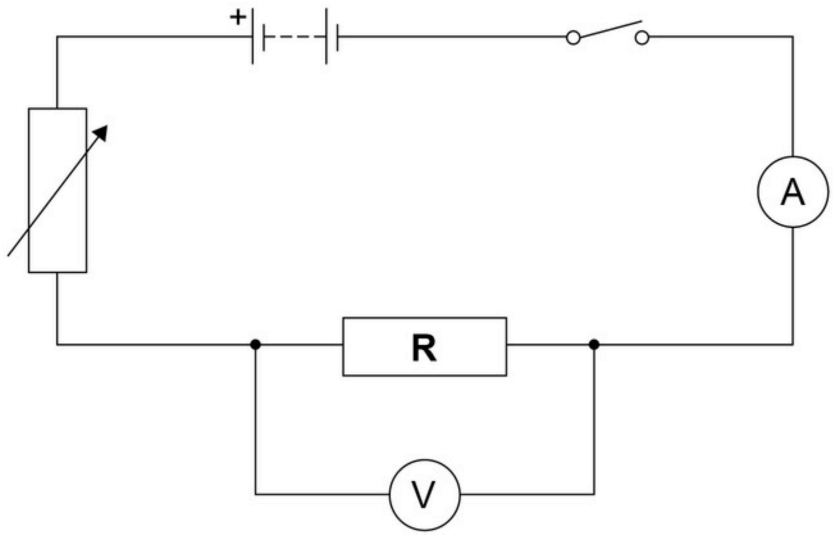
0 3 Student A investigated how the current in resistor R at constant temperature varied with the potential difference across the resistor.

Student A recorded both positive and negative values of current.

Figure 2 shows the circuit Student A used.

Figure 2



0 3 . 1 Describe a method that Student A could use for this investigation.

[6 marks]

- Measure the current in R using the ammeter
- Measure the p.d. across R using the voltmeter
- Vary the resistance of the variable resistor
- Record a range of values of current and p.d.
- Ensure current is low to avoid temperature increase
- Switch circuit off between readings
- Reverse connection of R to power supply
- Repeat measurements of I and V in negative direction
- Plot a graph of current against p.d.

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0 3 . 2 Student B repeated the investigation.

During Student B's investigation the temperature of resistor R increased.

Explain how the increased temperature of resistor R would have affected Student B's results.

[2 marks]

Current and p.d. would not be directly proportional

Question 3 continues on the next page

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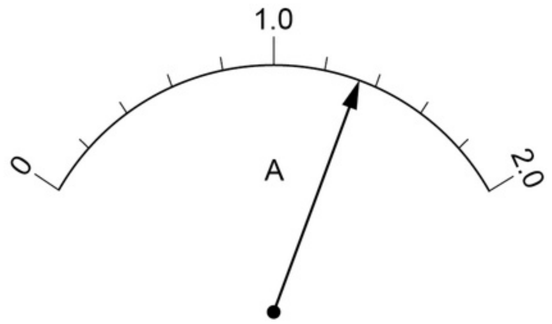
Figure 3 shows the scale on a moving coil ammeter at one time in the investigation.

Figure 3



0 3 . 3 What is the resolution of the moving coil ammeter?

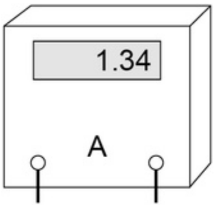
[1 mark]

Resolution = 0.2 A

0 3 . 4 Student B replaced the moving coil ammeter with a digital ammeter.

Figure 4 shows the reading on the digital ammeter.

Figure 4



The digital ammeter has a higher resolution than the moving coil ammeter.

Give one other reason why it would have been better to use the digital ammeter throughout this investigation.

[1 mark]

It can give a reading closer to the true value

10

Turn over for the next question

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0 4 A student investigated the density of different fruits.

Table 1 shows the results.

Table 1

Fruit	Density in g/cm3
Apple	0.68
Kiwi	1.03
Lemon	0.95
Lime	1.05

0 4 . 1 The student determined the volume of each fruit using a displacement can and a measuring cylinder.
What other piece of equipment would the student need to determine the density of each fruit?

[1 mark]

Balance

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0 4 . 2 Write down the equation which links density (ρ), mass (m) and volume (V).

[1 mark]

density = mass / volume

0 4 . 3 The mass of the apple was 85 g.

The density of the apple was 0.68 g/cm3.

Calculate the volume of the apple.

Give your answer in cm3.

[3 marks]

$0.68 = \frac{80}{V}$

$V = \frac{80}{0.68}$

Volume = 125 cm3

0 4 . 4 The student only measured the volume of each fruit once.
The volume measurements cannot be used to show that the method to measure volume gives precise readings.
Give the reason why.

[1 mark]

Repeat readings of volume need taking of each fruit to show that the readings are close together

6

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0 5 . 1 During one year, 1.25 × 1018 J of energy was transferred from the National Grid.

number of seconds in 1 year = 3.16 × 107

Calculate the mean energy transferred from the National Grid each second.

Give your answer to 3 significant figures.

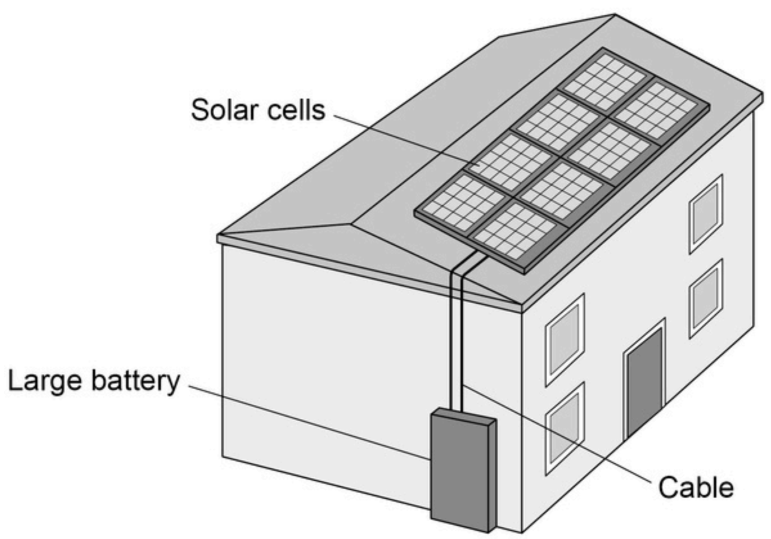
[2 marks]

$$E = \frac{1.25 \times 10^{18}}{3.16 \times 10^{7}}$$

Energy each second (3 significant figures) = 3.69×10^{10} J

Figure 5 shows a house with a solar power system.
The solar cells generate electricity.
When the electricity generated by the solar cells is not needed, the energy is stored in a large battery.

Figure 5



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0 5 . 2

The charge flow through the cable between the solar cells and the battery in 24 hours was 27 000 coulombs.
Calculate the mean current in the cable.

[4 marks]

t = 86 400

27000 = I x 86 400

I = 27000 / 86400

Mean current = 0.1325 A

0 5 . 3

At one time, the total power input to the solar cells was 7.8 kW.

The efficiency of the solar cells was 0.15

Calculate the useful power output of the solar cells.

[3 marks]

0.15 = useful power output / 7800

= 0.15 x 7800

Useful power output = 1170 W

Question 5 continues on the next page

0 5 . 4 It is unlikely that all of the electricity that the UK needs can be generated by solar power systems.
Explain why.

[2 marks]

A really large area of land would need to be covered with solar cells.
Due to the low useful power output of the solar cells.

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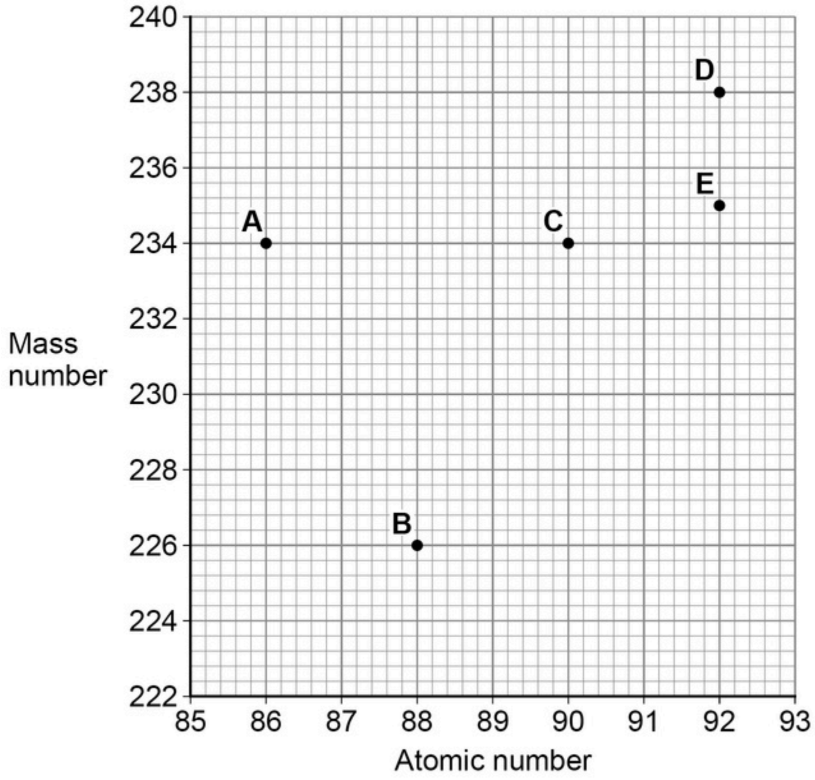
0 6 Figure 6 shows the mass number and the atomic number for the nuclei of five different atoms.

Figure 6



0 6 . 1 How many neutrons are there in a nucleus of atom A?

[1 mark]

148

____

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0 6 . 2 Which two atoms in Figure 6 are the same element?

[1 mark]

Tick (✓) one box.

A and B	☐
A and C	☐
C and D	☐
D and E	☑

Question 6 continues on the next page

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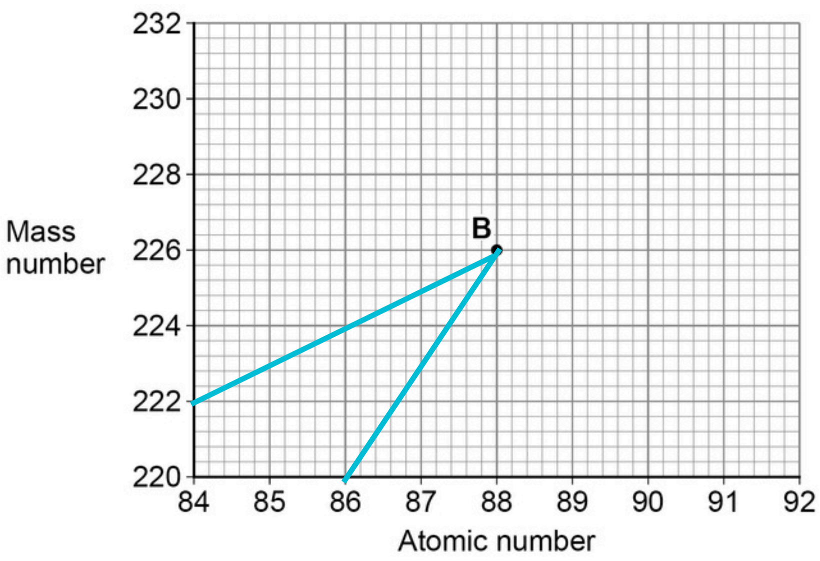
0 6 . 3 Nucleus B decays by emitting an alpha particle.

Draw an arrow on Figure 7 to represent the alpha decay.

[2 marks]

Figure 7



0 6 . 4 What is meant by the 'random nature of radioactive decay'?

[1 mark]

Can't predict which nucleus will decay next

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0 6 . 5 A polonium (Po) nucleus decays by emitting an alpha particle and forming a lead (Pb) nucleus.

$$Po \rightarrow Pb + \alpha$$

The lead (Pb) nucleus then decays by emitting a beta particle and forms a bismuth (Bi) nucleus.

$$Pb \rightarrow Bi + \beta$$

The bismuth (Bi) nucleus then decays by emitting a beta particle and forms a polonium (Po) nucleus.

$$Bi \rightarrow Po + \beta$$

Explain how these three decays result in a nucleus of the original element, polonium.

[3 marks]

One alpha decay would decrease proton number by 2.
Two beta decays would increase proton number by 2.
So the atomic number of the final nucleus is the same as the atomic number of the original nucleus

8

Turn over for the next question

Do not write outside the box

0 7 A student investigated how the current in a series circuit varied with the resistance of a variable resistor.
Figure 8 shows the circuit used.

Figure 8

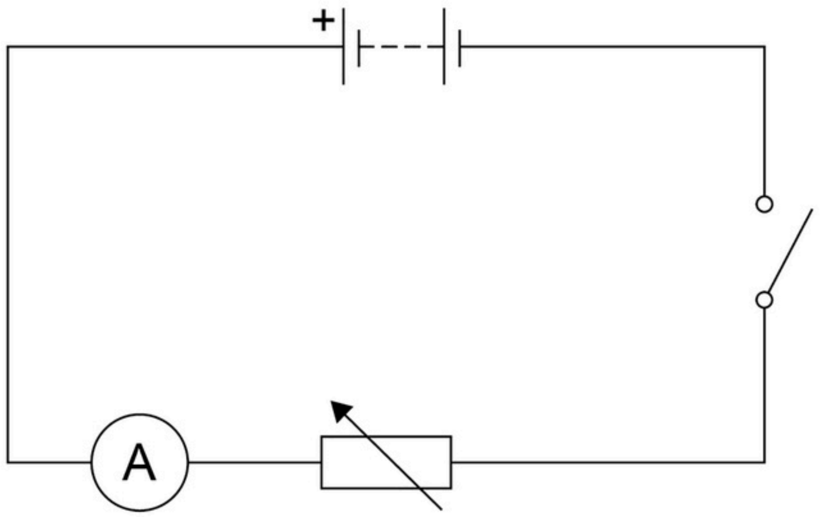
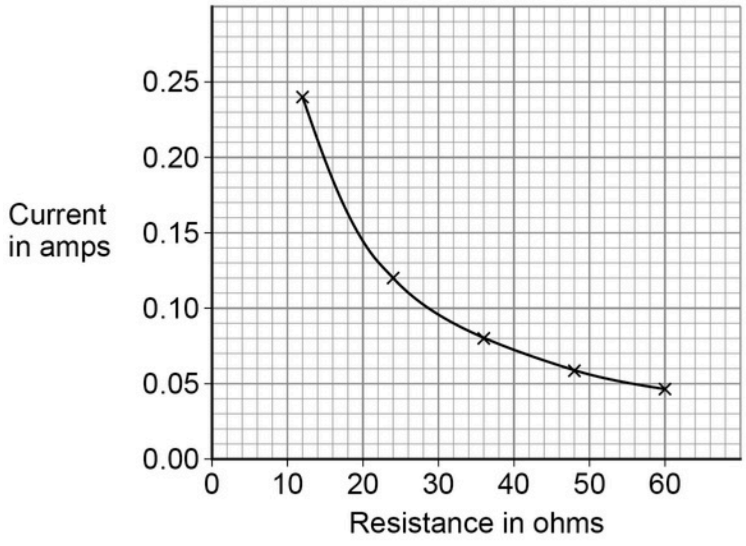


Figure 9 shows the results.

Figure 9



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0 7 . 1 The battery had a power output of 230 mW when the resistance of the variable resistor was 36 Ω.
Determine the potential difference across the battery.

[4 marks]

$I = 0.08A$

$0.230 = 0.08 \times V$

$V = \frac{0.230}{0.08}$

Potential difference = 2.875 V

0 7 . 2 The student concluded:

'the current in the circuit was inversely proportional to the resistance of the variable resistor.'

Explain how Figure 9 shows that the student is correct.

[2 marks]

The product of current and resistance = a constant
Calculation of constant (2.88) using three or more pairs of values.

Question 7 continues on the next page

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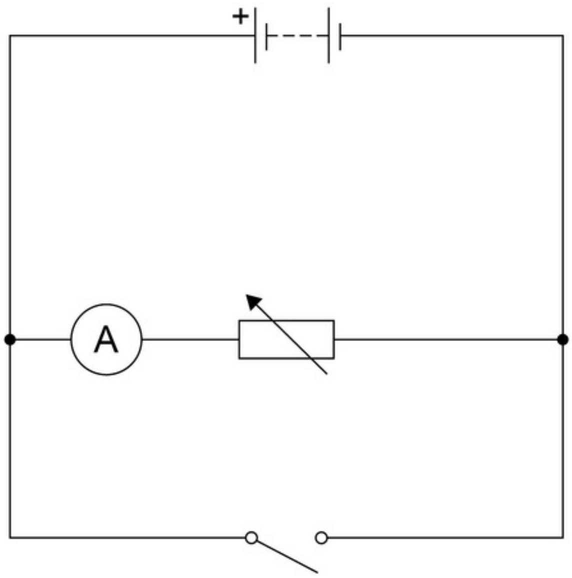
0 7 . 3 Figure 10 shows a circuit with a switch connected incorrectly.

Figure 10



Explain how closing the switch would affect the current in the variable resistor.

[2 marks]

Current would be almost zero in the variable resistor because the switch has effectively zero resistance.

8

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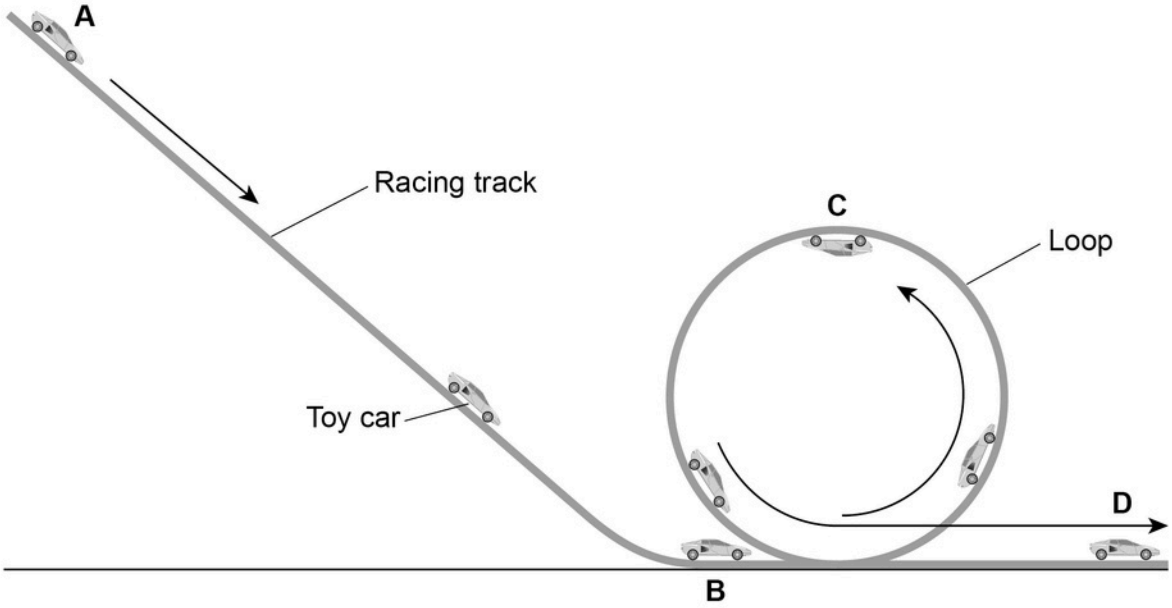
0 8 Figure 11 shows a toy car in different positions on a racing track.

Figure 11



0 8 . 1 The toy car and racing track can be modelled as a closed system.

Why can the toy car and racing track be considered 'a closed system'?

[1 mark]

Tick (✓) one box.

The racing track and the car both have gravitational potential energy.	☐
The racing track and the car are always in contact with each other.	☐
The total energy of the racing track and the car is constant.	✓

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0 8 . 2 The car is released from rest at position A and accelerates due to gravity down the track to position B.

mass of toy car = 0.040 kg

vertical height between position A and position B = 90 cm

gravitational field strength = 9.8 N/kg

Calculate the maximum possible speed of the toy car when it reaches position . B

[5 marks]

$E_p = 0.040 \times 9.8 \times 90$

$E_p = 0.3528$

$0.3528 = 0.5 \times 0.040 \times v^2$

$v^2 = \frac{0.3528}{0.5 \times 0.040}$

Speed = 4.2 m/s

Question 8 continues on the next page

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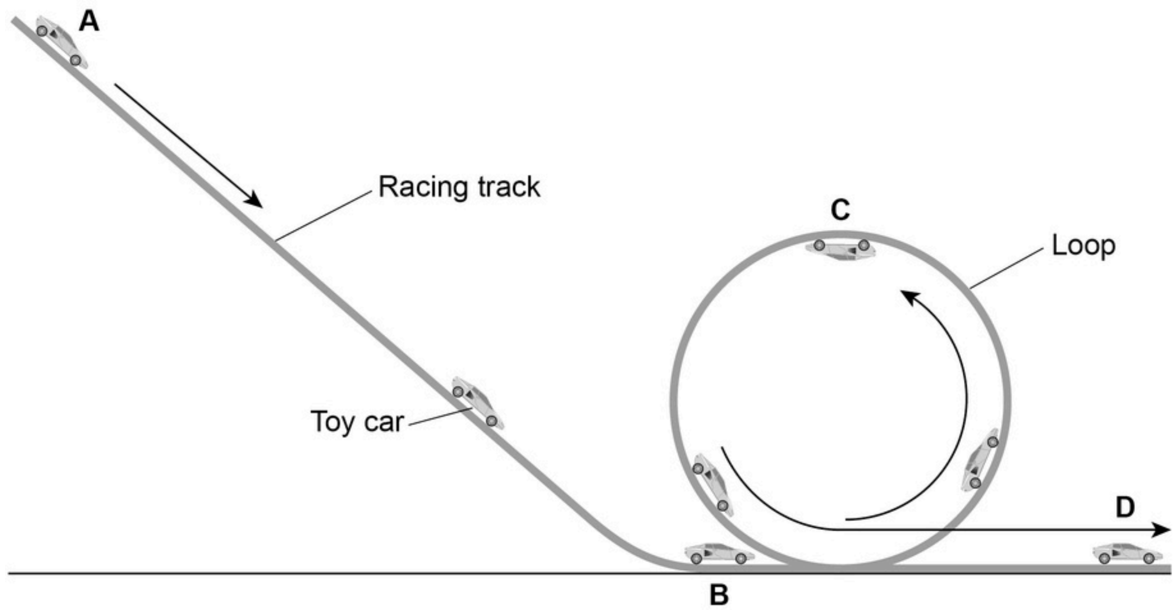
Figure 11 is repeated below.

Figure 11



0 8 . 3 At position C the car's gravitational potential energy is 0.20 J greater than at position B.

How much kinetic energy does the car need at position B to complete the loop of the track?

Give a reason for your answer.

[2 marks]

Tick (✓) one box.

Less than 0.20 J ☐

Exactly 0.20 J ☐

More than 0.20 J ☑

Reason Because the car needs to be moving at the top of the loop.

8

Turn over for the next question

Turn over ►

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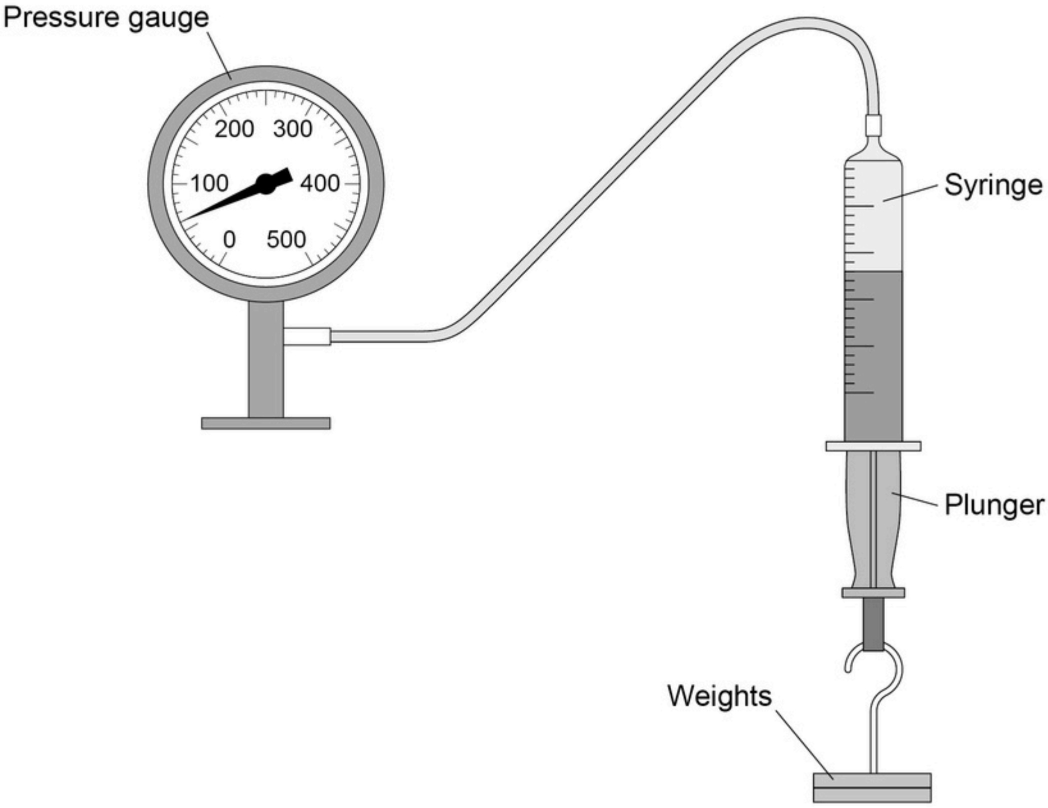
0 9 A teacher demonstrated the relationship between the pressure in a gas and the volume of the gas.
Figure 12 shows the equipment used.

Figure 12



This is the method used.

1. Record the initial volume of gas in the syringe and the pressure reading before any weights are attached.
2. Attach a 2.0 N weight to the syringe.
3. Record the volume of the gas and the reading on the pressure gauge.
4. Repeat steps 2 and 3 until a weight of 12.0 N is attached to the syringe.

0 9 . 1 What was the range of force used?

[1 mark]

From N to 0.0 12.0 N

0 9 . 2 Give one control variable in the investigation.

[1 mark]

Mass of gas in the syringe

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0 9 . 3 When the volume of gas in the syringe was 45 cm3, the pressure gauge showed a value of 60 kPa.

Calculate the pressure in the gas when the volume of gas in the syringe was 40 cm3.

[4 marks]

Constant = 60 × 45
= 2700

2700 = p × 40

p = $\frac{2700}{40}$

Pressure = 67.5 kPa

0 9 . 4 When the volume of gas in the syringe increased, the pressure on the inside walls of the syringe decreased.
Explain why.

[3 marks]

There is more time between collisions of particles and the walls of the syringe.

Causing a lower average force on the walls of the syringe and pressure is the total force per unit area.

9

Turn over for the next question

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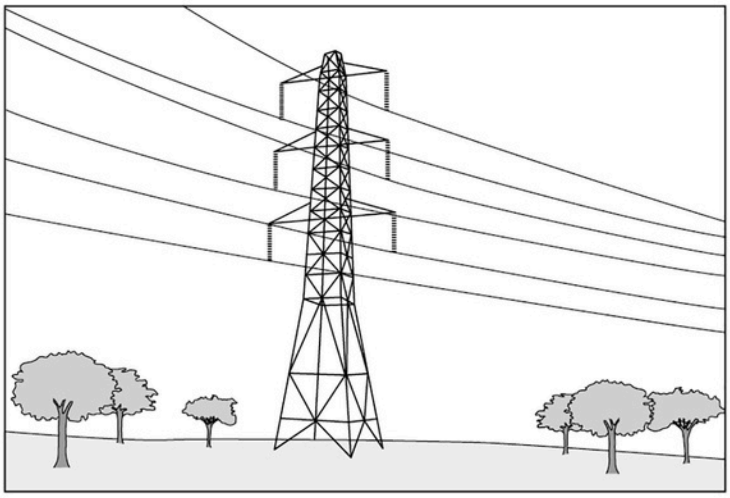
1 0 Figure 13 shows some overhead power cables in the National Grid.

Figure 13



1 0 . 1 Explain the advantage of transmitting electricity at a very high potential difference.

[3 marks]

Very high p.d. means very low currents which means less thermal energy is transferred to surroundings which increases the efficiency of power transmission.

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1 0 . 2 It is dangerous for a person to fly a kite near an overhead power cable.

Figure 14 shows a person flying a kite.

Figure 14

The person could receive a fatal electric shock if the kite was very close to, but not touching the power cable.

Explain why.

[3 marks]

Electric field strength is very high causing the air to become ionised . The kite string conducts charge to the person.

Question 10 continues on the next page

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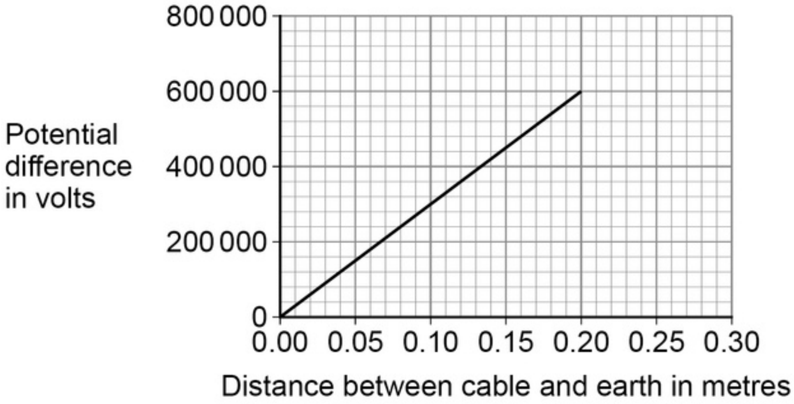
A scientist investigated how the potential difference needed for air to conduct charge varies with the distance between a cable and earth.
Figure 15 shows the results.

Figure 15



1 0 . 3 The data in Figure 15 gives the relationship between potential difference and distance when the air is dry.
When the humidity of air increases the air becomes a better conductor of electricity.

Draw a line on Figure 15 to show how the potential difference changes with distance if the humidity of the air increases.

[2 marks]

Straight line passing through the origin
line drawn below existing line for all values.

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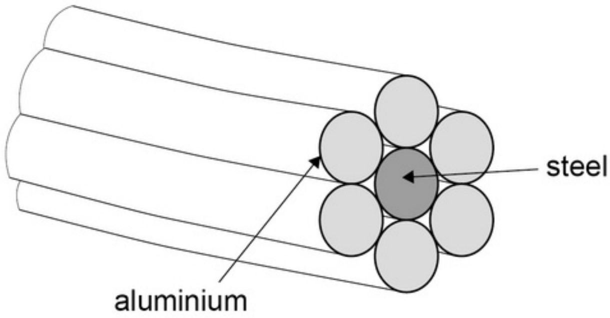
1 0 . 4 Figure 16 shows a cross-section through a power cable.

Figure 16



A 1 metre length of a single aluminium wire is a better conductor than a 1 metre length of the steel wire.

The individual wires behave as if they are resistors connected in parallel.

Explain why the current in the steel wire is different to the current in a single aluminium wire.

[2 marks]

The potential difference across the wires is the same. But the resistance of the steel wire is greater and so less current in the steel.

10

Turn over for the next question

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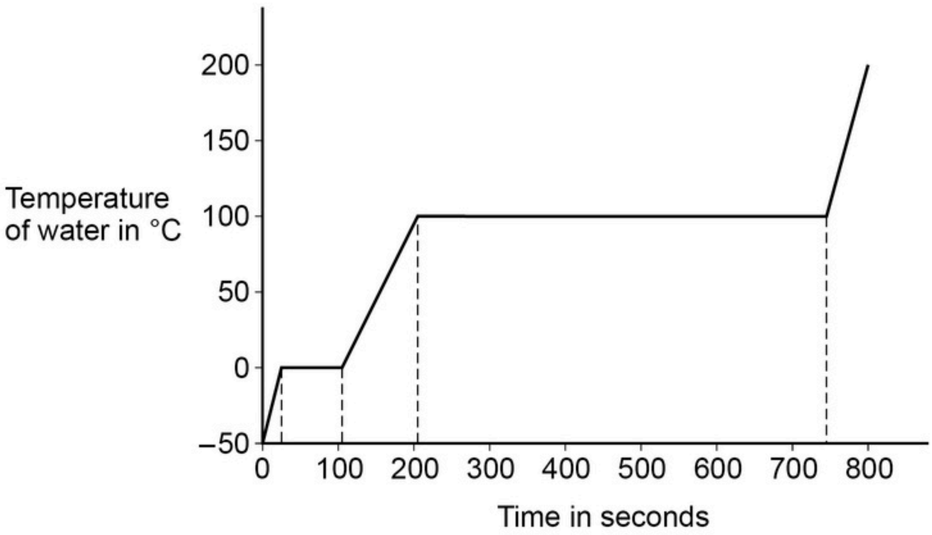
1 1 A student investigated how the temperature of a lump of ice varied as the ice was heated.
The student recorded the temperature until the ice melted and then the water produced boiled.
Figure 17 shows the student's results.
The power output of the heater was constant.

Figure 17



1 1 . 1 The specific heat capacity of ice is less than the specific heat capacity of water.

Explain how Figure 17 shows this.

[2 marks]

The gradient for ice is steeper than the gradient for water liquid. Which means that less energy is needed to increase the temperature by a fixed amount.

Do not write outside the box

1 1 . 2 The specific latent heat of fusion of ice is less than the specific latent heat of vaporisation of water.
Explain how Figure 17 shows this.

[2 marks]

Water took more time to vaporise than the ice took to melt.
Which means that less energy is needed to change the state from solid to liquid than from liquid to vapour.

1 1 . 3 A second student did the same investigation and recorded the temperature until the water produced boiled.

In the second student's investigation more thermal energy was transferred to the surroundings.

Describe two ways the results of the experiment in Figure 17 would have been different.

[2 marks]

1 Ice would take more time to increase in temperature.

2 Ice would take more time to change state

Question 11 continues on the next page

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1 1 . 4 When the water was boiling, 0.030 kg of water turned into steam.

The energy transferred to the water was 69 kJ.

Calculate the specific latent heat of vaporisation of water.

Give the unit.

[5 marks]

E = 69 000

69000 = 0·030 × L

L = 69000 / 0·030

= 2300 000

Specific latent heat of vaporisation = 2.3×10^6

Unit J/kg

11

END OF QUESTIONS

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