AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

# GCSE
# PHYSICS

**H**

Higher Tier Paper 1

Wednesday 23 May 2018 Afternoon Time allowed: 1 hour 45 minutes

**Materials**

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

**Instructions**
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the space provided.
- 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 | |
| **TOTAL** | |

**0 1** **Figure 1** shows a student walking on a carpet.

**Figure 1**


↗ transfer of e⁻s

**0 1 . 1** The student becomes negatively charged because of the friction between his socks and the carpet.

Explain why the friction causes the student to become charged.

**[2 marks]**

There is a transfer of electrons ✓ from the carpet to the boy ✓

*Do not write outside the box*

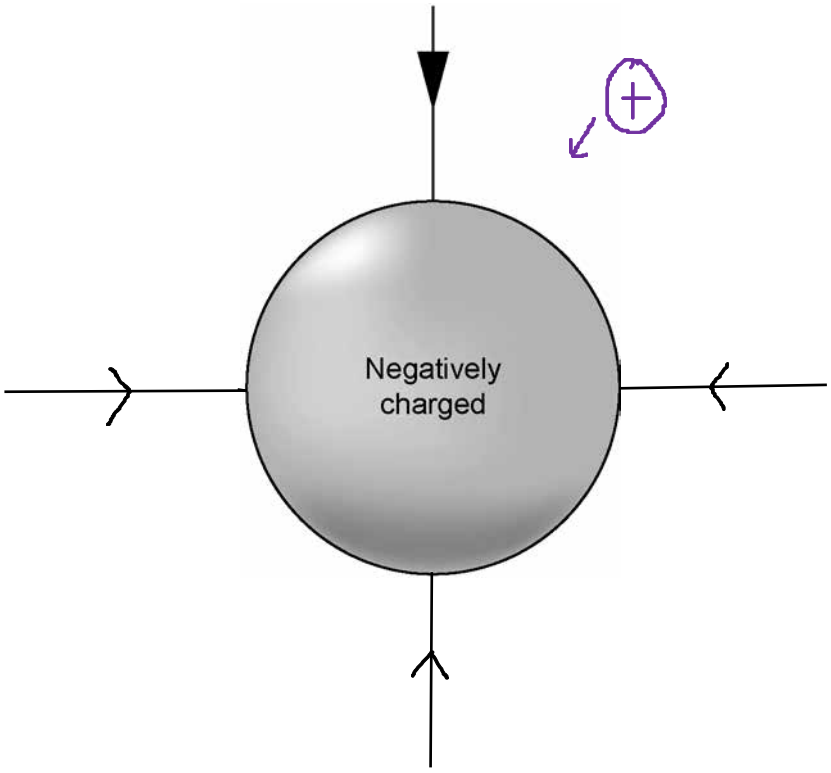
**0 1 . 2** The student's head is represented by the sphere in **Figure 2.**

The student is negatively charged. The arrow shows part of the electric field around the student's head.

Draw **three** more arrows on **Figure 2** to complete the electric field pattern.

**[1 mark]**

**Figure 2**




OV, conductor

**0 1 . 3** The negatively charged student touches a metal tap and receives an electric shock.

Explain why.

**[3 marks]**

There is a potential difference between the student and the tap ✓
This causes a flow of electrons from the student to the tap ✓
This means that the charge has been earthed ✓

**Turn over ►**

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**0 1 . 4** Some carpets have thin copper wires running through them. The student is less likely to receive an electric shock after walking on this type of carpet.

Suggest why.

**[2 marks]**

Copper is a good conductor ✓ so electrons flow through the wire instead of the student. Smaller pd between student and carpet ✓, so the student is less likely to recieve an electric shock.

8

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**0 2** A teacher used a Geiger-Muller tube and counter to measure the number of counts in 60 seconds for a radioactive rock.

**0 2 . 1** The counter recorded 819 counts in 60 seconds. The background radiation count rate was 0.30 counts per second.

→ counts per second

Calculate the count rate for the rock.

**[3 marks]**

$\frac{819}{60}$ ✓ = 13.65 ✓ counts/second

13.65 − 0.3 = 13.35

Count rate = 13.35 ✓ per second

**0 2 . 2** A householder is worried about the radiation emitted by the granite worktop in his kitchen.

1 kg of granite has an activity of 1250 Bq. The kitchen worktop has a mass of 180 kg.

Calculate the activity of the kitchen worktop in Bq.

**[2 marks]**

×180 ( 1 kg → 1250 Bq

↘ 180 kg ↳ 1250 × 180 ✓ = 225,000

Activity = 225,000 ✓ Bq

**Question 2 continues on the next page**

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**0 2 . 3** The average total radiation dose per year in the UK is 2.0 millisieverts.

**Table 1** shows the effects of radiation dose on the human body.

**Table 1**

| Radiation dose in millisieverts | Effects |
|---|---|
| 10 000 | Immediate illness; death within a few weeks |
| 1000 | Radiation sickness; unlikely to cause death |
| 100 | Lowest dose with evidence of causing cancer |

The average radiation dose from the granite worktop is 0.003 millisieverts per day.

Explain why the householder should **not** be concerned about his yearly radiation dose from the granite worktop.

One year is 365 days.

**[2 marks]**

0.003 × 365 = 1.095 mSv ✓

This value calculated is significantly less than 100 mSv ✓ which is the lowest dose required to cause harm, so the householder does not need to be concerned.

**0 2 . 4** Bananas are a source of background radiation. Some people think that the unit of radiation dose should be changed from sieverts to Banana Equivalent Dose.

Suggest **one** reason why the Banana Equivalent Dose may help the public be more aware of radiation risks.

**[1 mark]**

The banana equivalent dose makes it easier for people to understand radiation risks as the dose can be compared ✓ to an everyday object.

8

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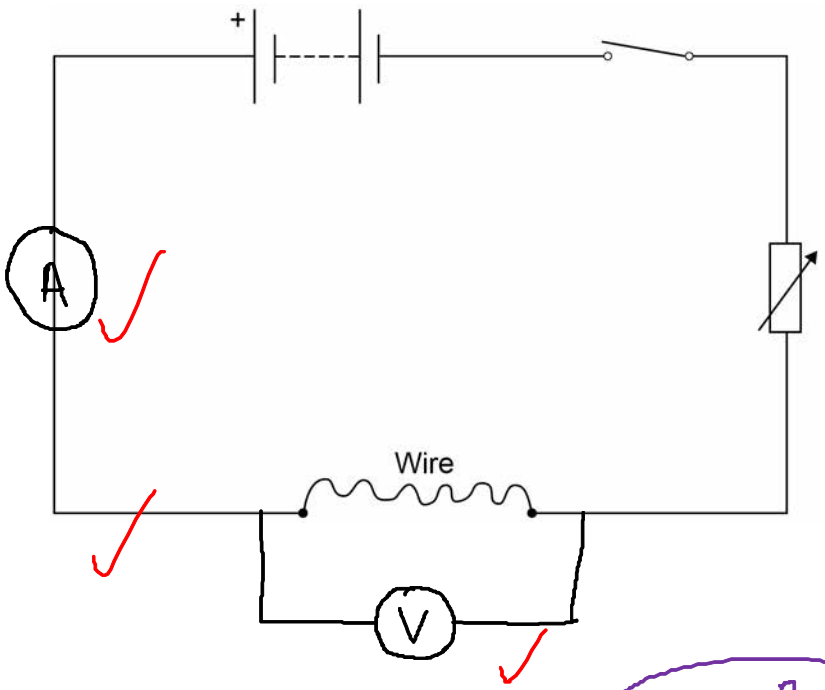
**0 3** A student investigated how the resistance of a piece of nichrome wire varies with length.

**Figure 3** shows part of the circuit that the student used.

**Figure 3**




**0 3 . 1** Complete **Figure 3** by adding an ammeter and a voltmeter.

Use the correct circuit symbols.

**[3 marks]**

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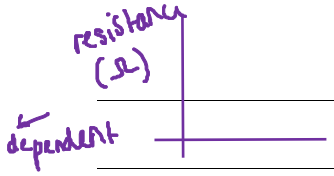
**0 3 . 2** Describe how the student would obtain the data needed for the investigation.

Your answer should include a risk assessment for **one** hazard in the investigation.

**[6 marks]**




Use a ruler to measure the length of the wire, then use an ammeter to measure the current through the wire and a voltmeter to measure the potential difference across the wire. ✓ Use $R = \frac{V}{I}$ to calculate the resistance for this length. ✓

Vary the length of the wire and repeat. Take multiple voltage and current readings for the length of wire, ✓ plot resistance against length. ✓ The wire could heat up if high currents are used, this could lead to burns, ✓ to avoid this we should use low currents. ✓

for 6/6
- all key pts identified
- written logically

**0 3 . 3** Why would switching off the circuit between readings have improved the accuracy of the student's investigation?

Tick **one** box.

control variable - temp of wire

**[1 mark]**

The charge flow through the wire would not change. ☐

The potential difference of the battery would not increase. ☐

The power output of the battery would not increase. ☐

The temperature of the wire would not change. ☑ ✓

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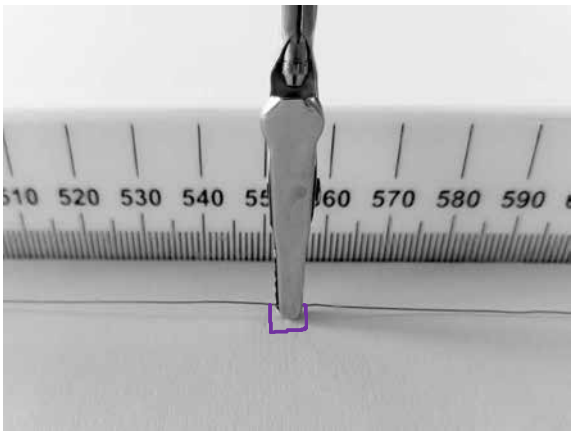
**0 3 . 4** The student used crocodile clips to make connections to the wire.

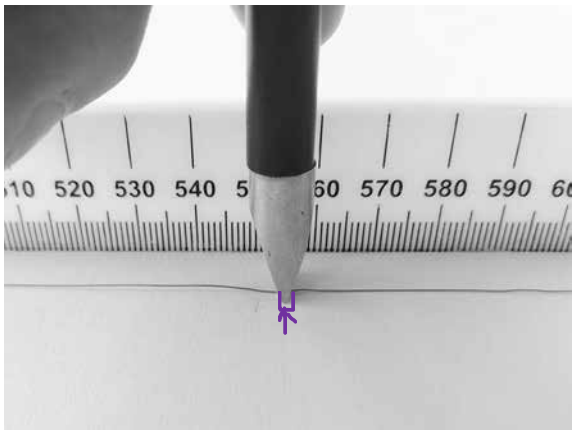
They could have used a piece of equipment called a 'jockey'.

**Figure 4** shows a crocodile clip and a jockey in contact with a wire.

**Figure 4**




**Crocodile clip**




**Jockey**

How would using the jockey have affected the accuracy and resolution of the student's results compared to using the crocodile clip?

accuracy → how close to the true value

resolution → smallest change in length that could be measured

Tick **two** boxes.

**[2 marks]**

- [x] The accuracy of the student's results would be higher. ✓
- [ ] The accuracy of the student's results would be lower.
- [ ] The accuracy of the student's results would be the same.
- [x] The resolution of the length measurement would be higher. ✓
- [ ] The resolution of the length measurement would be lower.
- [ ] The resolution of the length measurement would be the same.

**12**

**Turn over ►**

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**ANSWER IN THE SPACES PROVIDED**

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**0 4** **Figure 5** shows a cyclist riding along a straight, level road at a constant speed.

**Figure 5**

**0 4 . 1** Complete the sentences.

**[2 marks]**

As the cyclist rides along the road, the chemical energy store in the cyclist's body decreases.

velocity is constant → acceleration = 0 → resultant = 0 force

The speed of the cyclist is constant when the work done by the cyclist is equal to the work done against air resistance.

↳ W = F x d

↳ W = F x d

**Question 4 continues on the next page**

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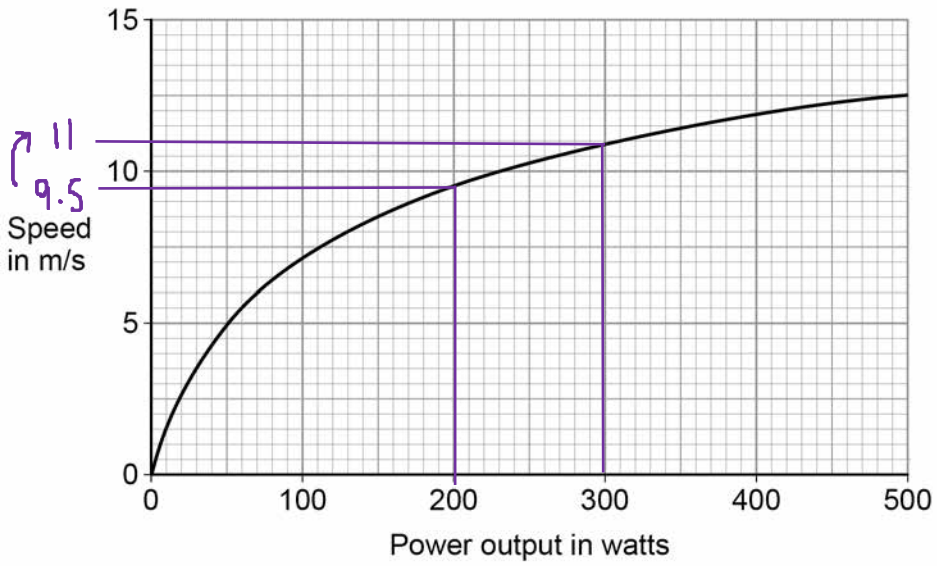
**Figure 6** shows how the speed changes as the power output of the cyclist changes.

**Figure 6**




**0 4 . 2** Write down the equation that links power, time and work done.

**[1 mark]**

Power = work done / time ✓

**0 4 . 3** Calculate the work done by the cyclist when his power output is 200 W for 1800 seconds.

**[3 marks]**

$P = \frac{W}{t} \rightarrow W = Pt$ ✓

$W = 200 \times 1800$ ✓

$W = 360{,}000$ J

Work done = 360,000 ✓ J

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**0 4 . 4** Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 300 W.

**[2 marks]**

200 W → 9.5 m/s

300 W → 11 m/s

% change = change / original value × 100

$\frac{11 - 9.5}{9.5} \times 100 = 15.8\%$

Percentage increase in speed = 15.8 %

**0 4 . 5** The maximum speed this cyclist can travel on a level road is 14 m/s.

How does cycling uphill affect the maximum speed of this cyclist?

Explain your answer.

**[3 marks]**

The maximum speed of the cyclist will decrease. The total power input stays the same however work is done against gravity so the max speed must decrease.

energy in → Ek + GPE

↳ no change in GPE

↑ change in height

change in GPE = mgh

↳ work is done against gravity

11

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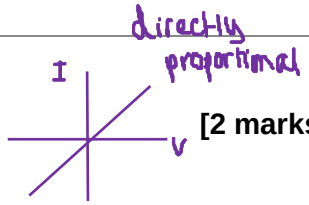
**0 5 . 1** Complete the sentence. Choose answers from the box.

Ohm's Law → resistance is constant provided temp is constant




**[2 marks]**

| charge | potential difference | power | temperature | time |
|---|---|---|---|---|

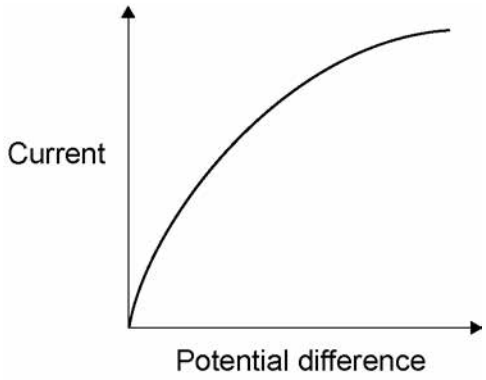
The current through an ohmic conductor is directly proportional to the

potential difference ✓ across the component, provided

that the temperature ✓ remains constant.

**0 5 . 2** **Figure 7** shows a current – potential difference graph for a filament lamp.

**Figure 7**




Explain how the resistance of a filament lamp changes as the potential difference across it increases.

**[3 marks]**

As potential difference increases the current through the lamp increases, this causes the temp of the lamp to increase ✓ Therefore the resistance of the filament lamp increases as the potential difference increases ✓

Do not write outside the box

**0 5 . 3** Many householders are replacing their filament lamps with LED lamps which are more energy efficient.

What does more energy efficient mean?

efficiency = useful output energy / total input energy

**[1 mark]**

A higher proportion of the energy inputted is outputted as useful energy ✓

**Question 5 continues on the next page**

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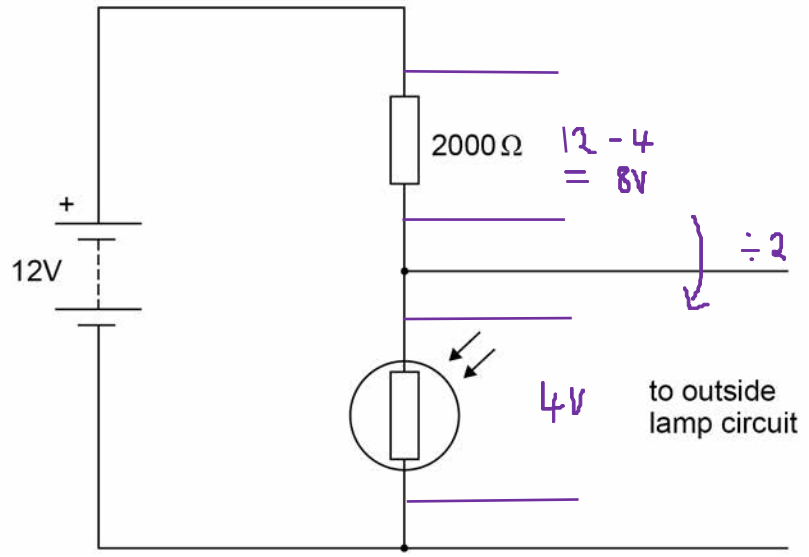
A Light Dependent Resistor (LDR) is used to turn on an outside lamp when it gets dark.

Part of the circuit is shown in **Figure 8**.

**Figure 8**




$R = \frac{V}{I}$

$R \propto V$ $R \propto \frac{1}{I}$

for an LDR → light intensity ↓ = R ↑

**0 5 . 4** The light intensity decreases.

What happens to the potential difference across the LDR and the current in the LDR?
**[2 marks]**

Potential difference increases ✓

Current decreases ✓

**0 5 . 5** What is the resistance of the LDR when the potential difference across it is 4 V?

Give a reason for your answer. **[2 marks]**

$\frac{2000}{2} = 1000$

÷2 (8V → 2000 Ω, 4V → ?)

Resistance = 1000 ✓ Ω

Reason The potential difference is shared in proportion with resistance

Do not write outside the box

**0 5 . 6** Calculate the current through the LDR when the resistance of the LDR is 5000 Ω.

Give your answer to 2 significant figures.

total R = 2000 + 5000

V = 12V

**[4 marks]**

V = IR

12 = I × 7000 ✓

I = 12 / 7000 ✓ = 1.71 × 10$^{-3}$ A ✓

Current = 1.7 × 10$^{-3}$ ✓ A

14

**Turn over for the next question**

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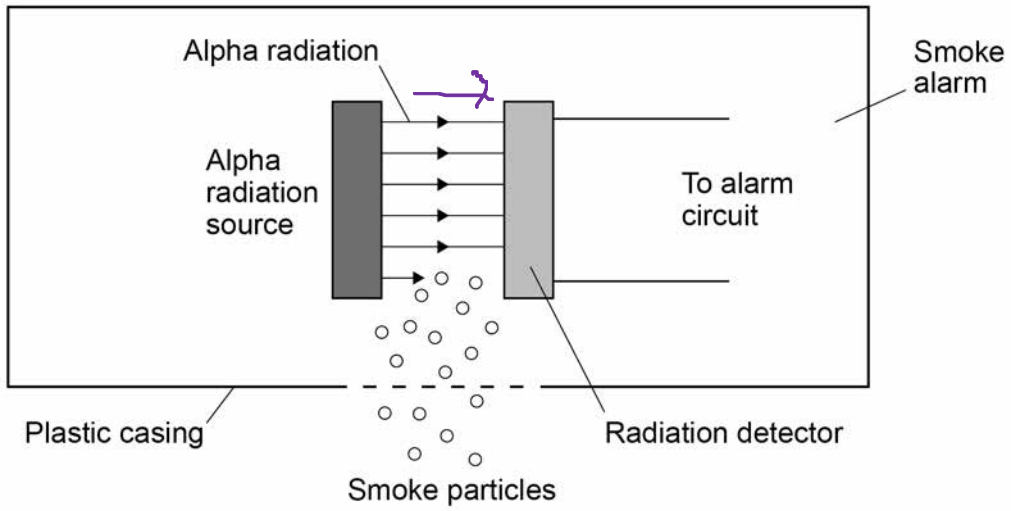
**0 6** Smoke alarms contain an alpha radiation source and a radiation detector.

**Figure 9** shows part of the inside of a smoke alarm.

**Figure 9**




**0 6 . 1** The smoke alarm stays off while alpha radiation reaches the detector.

Why does the alarm switch on when smoke particles enter the plastic casing?

**[1 mark]**

The alpha radiation is absorbed by the smoke particles ✓

**0 6 . 2** Why is it safe to use a source of alpha radiation in a house?

**[1 mark]**

Alpha radiation has only a short range in air so will not travel far away enough from the detector to cause any damage ✓

or alpha is only weakly penetrating

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**0 6 . 3** The smoke alarm would not work with a radiation source that emits beta or gamma radiation.

Explain why.

**[2 marks]**

Both beta and gamma radiation will penetrate smoke, this means that no change in count rate would be detected and so the smoke alarm would not work

**Question 6 continues on the next page**

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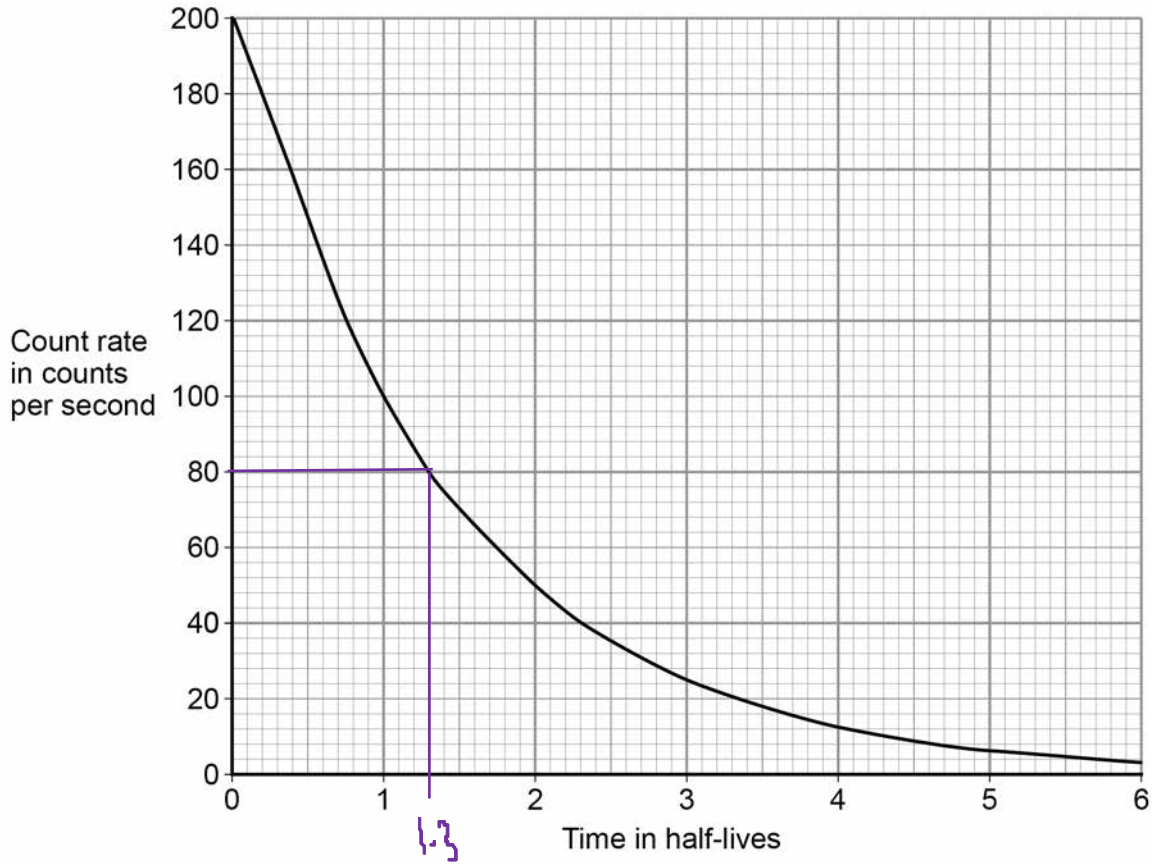
**0 6 . 4** **Figure 10** shows how the count rate detected from the radiation source in the smoke alarm changes with time.

**Figure 10**




The smoke alarm switches on when the count rate falls to 80 counts per second.

Explain why the radiation source inside the smoke alarm should have a long half-life.

**[2 marks]**

For the radiation, the countrate falls to 80 counts per second after 1.3 half lives ✓. If the source had a short halflife, the count rate would decrease very quickly and so the alarm would switch on even with no smoke ✓. Therefore a source with a long half-life should be used

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**0 6 . 5** **Figure 11** shows a patient who has been injected with a radioactive source for medical diagnosis.

**Figure 11**


Explain the ideal properties of a radioactive source for use in medical diagnosis.

**[4 marks]**

Ideally the source would have a short half life to limit the damage done to the patient's cells ✓ The source should also be highly penetrating so it can be detected by the radiation detector after passing out of the patient's skin. ✓ Finally the source should have a low ionising power to reduce damage to the cells. ✓✓

10

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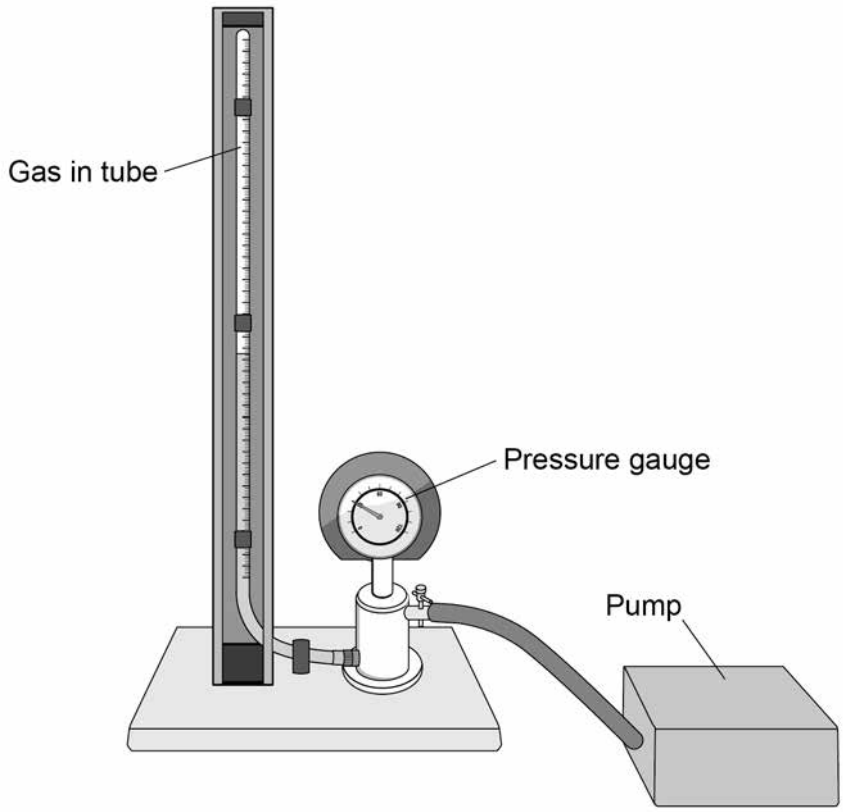
**0 7** A student investigated how the pressure exerted by a gas varied with the volume of the gas.

**Figure 12** shows the equipment the student used.

**Figure 12**




A pump was used to compress the gas in a tube. As the volume of the gas decreases, the pressure of the gas increases.

**0 7 . 1** The student only recorded one set of results.

Give **two** reasons why taking repeat readings could provide more accurate data.

**[2 marks]**

1 Allows us to identify and remove anomalies ✓

2 This allows us to calculate a mean ✓

Or reduces the effect of random errors

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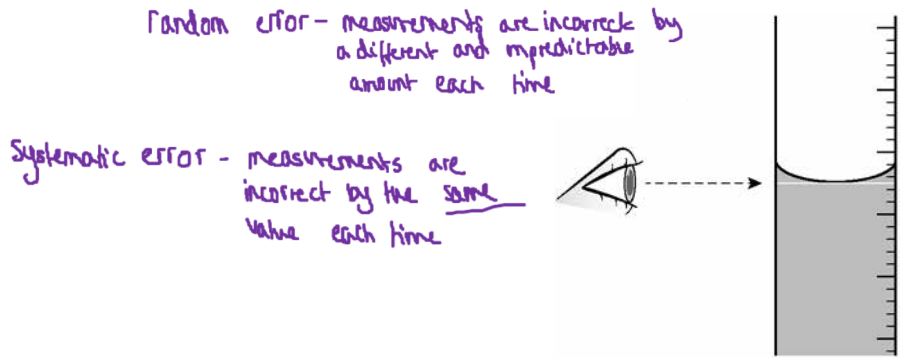
**0 7 . 2** **Figure 13** shows the position of the student's eye when taking volume measurements.

**Figure 13**




Explain what type of error would be caused if the student's eye was **not** in line with the level of the liquid in the tube.

**[2 marks]**

This would cause a random error because for every reading the students eye position will be different relative to the liquid

**0 7 . 3** If the gas is compressed too quickly the temperature of the gas increases.

Explain how the temperature increase would affect the pressure exerted by the gas.

**[2 marks]**

Pressure increases because the particles have more kinetic energy

T ↑ Ek ↑ velocity ↑ force on walls ↑ $p = \frac{F}{A}$ → F ↑ pressure increases

**Question 7 continues on the next page**

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**0 7 . 4** One of the student's results is given below.

pressure = $1.6 \times 10^5$ Pa
volume = 9.0 $cm^3$

$PV$ = constant

Calculate the volume of the gas when the pressure was $1.8 \times 10^5$ Pa.

The temperature of the gas was constant.

**[3 marks]**

$P_1V_1 = k$ $\quad P_2V_2 = k$

$P_1V_1 = P_2V_2$ ✓

$\frac{(1.6 \times 10^5) \times 9}{1.8 \times 10^5}$ ✓ $\quad V_2 = 8.0\ cm^3$

Volume = 8.0 ✓ $cm^3$

*Do not write outside the box*

**0 7 . 5** **Figure 14** shows a person using a bicycle pump to inflate a tyre.

**Figure 14**

sum of the Ek + Ep of all the particles

The internal energy of the air increases as the tyre is inflated.

Explain why.

**[2 marks]**

Work is done on the air in the tyre ✓ so the temperature of the air increases ✓ so the Ek of the particles increases so the internal energy increases.

**11**

**Turn over for the next question**

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**0 8** Nuclear power stations generate electricity through nuclear fission. Electricity can also be generated by burning shale gas.

**0 8 . 1** Shale gas is natural gas trapped in rocks. Shale gas can be extracted by a process called fracking. There is some evidence that fracking causes minor earthquakes. Burning shale gas adds carbon dioxide to the atmosphere.

Describe the advantages of nuclear power compared with the use of shale gas to generate electricity.

↳ no $CO_2$ - global warming
↳ no earthquakes

**[3 marks]**

With nuclear power, no $CO_2$ is emitted in order to produce electricity ✓ This is an advantage because $CO_2$ contributes to global warming. ✓

Nuclear power is also less destructive than using shale gas as it does not cause earthquakes. ✓

Or more energy released per kg of fuel

**0 8 . 2** What is the name of **one** fuel used in nuclear power stations?

**[1 mark]**

Uranium ✓

Or plutonium

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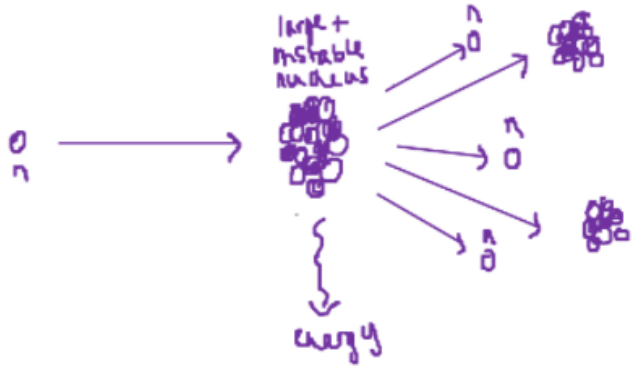
**0 8 . 3** Describe the process of nuclear fission.

**[4 marks]**

Firstly, a neutron is absorbed by a large, unstable nucleus ✓. The larger nucleus then splits into two lighter nuclei ✓ as well as emitting 2 or 3 neutrons ✓ and releasing energy ✓.




8

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**0 9** **Figure 15** shows a coffee machine. The coffee machine uses an electric element to heat water.

**Figure 15**


**0 9 . 1** The coffee machine has a metal case.

Why would it be dangerous for the live wire of the electric cable to touch the metal case?

**[1 mark]**

If someone touched the metal case they would risk getting an electric shock ✓

**0 9 . 2** The power output of the coffee machine is 2.53 kW. → 2530W

The mains potential difference is 230 V.

Calculate the current in the coffee machine.

P = IV → A
W → A

**[3 marks]**

P = IV

2530 = I × 230 ✓

I = 2530 / 230 ✓

I = 11 A

Current = 11 ✓ A

*Do not write outside the box*

**0 9 . 3** The coffee machine heats water from 20 °C to 90 °C.

The power output of the coffee machine is 2.53 kW.

The specific heat capacity of water is 4200 J/kg °C.

$\Delta E = m c \Delta\theta$ (J, kg, J/kg°C, °C)

$P = \frac{E}{t}$ (W, J, s)

Calculate the mass of water that the coffee machine can heat in 14 seconds.

**[5 marks]**

$P = \frac{E}{t}$ $\quad E = Pt$ $\quad E = 2530 \times 14$ ✓

$= 35,420$ J ✓

$35,420 = m \times 4200 \times (90 - 20)$ ✓

$m = \frac{35,420}{4200 \times 70}$ ✓ $\quad m = 0.12047\ldots$

$m = 0.12$ kg

Mass = 0.12 ✓ kg

9

**Turn over for the next question**

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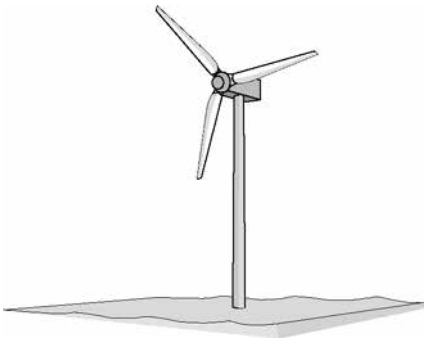
**1 0** **Figure 16** shows a wind turbine.

**Figure 16**



**1 0 . 1** At a particular wind speed, a volume of $2.3 \times 10^4$ $m^3$ of air passes the blades each second.

The density of air is 1.2 $kg/m^3$.

$\rho = \frac{m}{V}$ → kg; kg/m³ → $m^3$

Calculate the mass of air passing the blades per second.

**[3 marks]**

$\rho = \frac{m}{V}$ $\quad 1.2 = \frac{m}{2.3 \times 10^4}$ ✓

$m = 1.2 \times (2.3 \times 10^4)$ ✓

$= 27{,}600$ kg

Mass of air per second = 27,600 ✓ kg

**1 0 . 2** The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

$P \propto E_K$ $\quad E_K = \frac{1}{2}mv^2$

Describe the effect on the power output when the wind speed is halved.

**[3 marks]**

Wind speed / 2 → $v \div 2$ → $m \div 2$ $\quad E_K \propto m$ $\quad E_K \propto v^2$

The mass of air passing the blades each second is halved, so the kinetic energy is halved. ✓

$\left(\frac{v}{2}\right)^2 = \frac{v^2}{4}$

The velocity of the air is halved so the kinetic energy decreases by a factor of 4 ($2^2$). ✓

Therefore the kinetic energy of the air decreases by a factor of 8, and so the power output decreases by a factor of 8. ✓

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**1 0 . 3** At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

**[3 marks]**

$P = 388{,}000$ W  $P = \frac{E}{t}$  $E = Pt = 388{,}000$ J

$t = 1$ s  $E_k = \frac{1}{2}mv^2$

$m = 13{,}800$ kg  $388{,}000 = \frac{1}{2} \times 13{,}800 \times v^2$  $v = \sqrt{\frac{2 \times 388{,}000}{13{,}800}}$

$v = ?$  $v^2 = \frac{2 \times 388000}{13{,}800}$  $= 7.498\ldots$

Speed of air = 7.50 m/s

9

**END OF QUESTIONS**

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