AQA

# GCSE
# COMBINED SCIENCE: TRILOGY

**H**

Higher Tier Paper 5: Physics 1H

Specimen 2018 Time allowed: 1 hour 15 minutes

**Materials**

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

**Instructions**
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**
- There are 70 marks available on this paper.
- 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.
- When answering questions 02.5, 04.4 and 06.4 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

**Advice**
- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.

Centre number [ ][ ][ ][ ][ ] Candidate number [8][0][5][5]

Surname [G][O][O][D][O][N][E][-][L][O][O][K][S][L][I][K][E]

Forename(s) [W][H][A][T][T][A]

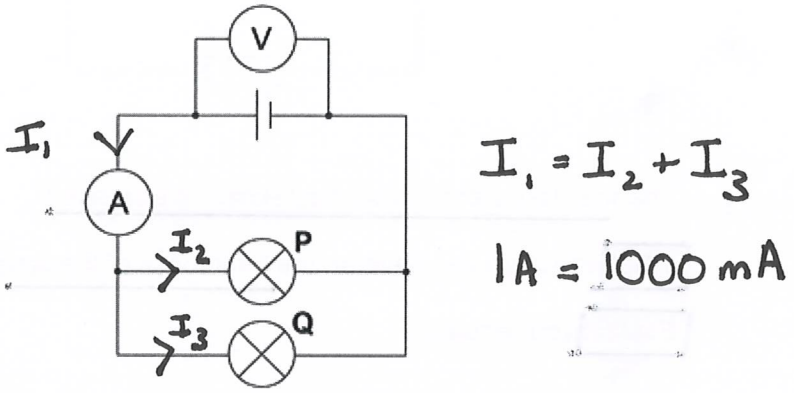
Candidate signature _____

**There are no questions printed on this page**

**0 1** **Figure 1** shows a circuit diagram containing two identical lamps arranged in parallel.

The reading on the ammeter is 186 mA.

**Figure 1**




**0 1 . 1** Which statement about the current through the lamps is true?

**[1 mark]**

Tick **one** box.

- The current through both lamp **P** and lamp **Q** is **0.093 A** ☑
- The current through both lamp **P** and lamp **Q** is **0.186 A** ☐
- The current through both lamp **P** and lamp **Q** is **0.93 A** ☐
- The current through both lamp **P** and lamp **Q** is **1.86 A** ☐

**0 1 . 2** One of the lamps breaks and is not replaced.

Which statement about the current in the other lamp is true?

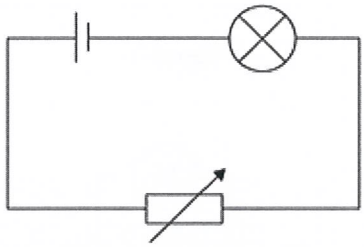
Tick **one** box.

**[1 mark]**

- The current through the lamp is **0.093 A** ☑
- The current through the lamp is **0.186 A** ☐
- The current through the lamp is **0.93 A** ☐
- The current through the lamp is **1.86 A** ☐

**Figure 2** shows a circuit that can be used to alter the brightness of a lamp.

**Figure 2**



**0 1 . 3** The resistance of the variable resistor is increased.

What effect will this have on the brightness of the lamp?

Explain your answer.

**[2 marks]**

THE LAMP WILL GET DIMMER BECAUSE INCREASING THE RESISTANCE IN THE CIRCUIT WILL CAUSE THE CURRENT TO DECREASE.

When the potential difference (V) across the lamp is 3.3 V, the current (I) is 0.15 A.

**0 1 . 4** Write down the equation that links current (I), potential difference (V) and resistance (R).

**[1 mark]**

Equation POTENTIAL DIFFERENCE = CURRENT x RESISTANCE

**0 1 . 5** Calculate the resistance of the lamp.

**[3 marks]**

$V = IR$ REARRANGING $R = \frac{V}{I} = \frac{3.3}{1.5} = 22$

Resistance = 22 Ω

**0 2** **Figure 3** shows a battery operated remote control car.

**Figure 3**

**0 2 . 1** The car's battery contains a store of energy.

As the car moves, energy from one store is transferred to another store.

Describe how different stores of energy change as the car moves.

**[2 marks]**

THE CHEMICAL ENERGY STORED IN THE BATTERY DECREASES AS IT IS TURNED INTO KINETIC ENERGY OF THE CAR. THE INTERNAL ENERGY OF THE SURROUNDINGS ALSO INCREASES

The car has a top speed of 12 m/s (v) and a mass of 800 g (m). ← CONVERT TO kg

**0 2 . 2** Write down the equation that links kinetic energy, mass and speed.

**[1 mark]**

Equation $E_K = \frac{1}{2}mv^2$

**0 2 . 3** Calculate the maximum kinetic energy of the car.

**[2 marks]**

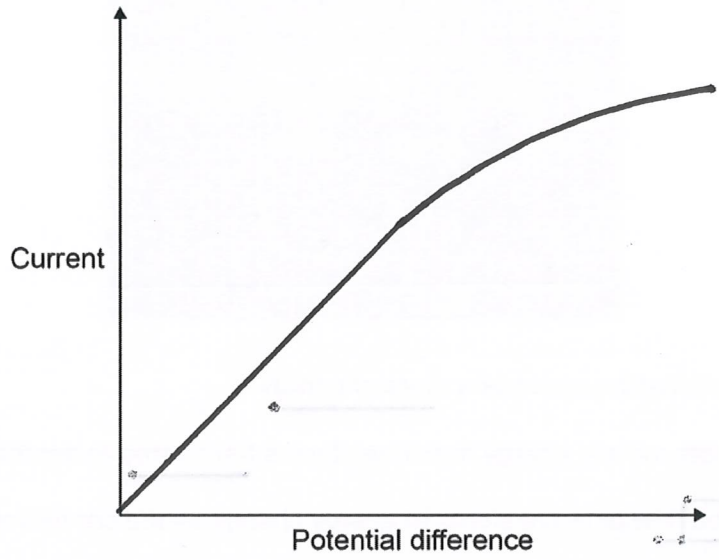
$E_K = \frac{1}{2}mv^2 = \frac{1}{2} \times \left(\frac{800}{1000}\right) \times 12^2$

$= 0.5 \times 0.8 \times 144$

Maximum kinetic energy = 57.6 J

**0 1 . 6** Sketch a current–potential difference graph for a filament lamp.

**[1 mark]**




**Turn over for the next question**

EXAM TIP

MAKE SURE YOU CAN SKETCH AN I-V GRAPH FOR A FILAMENT LAMP, RESISTOR AND DIODE. YOU NEED TO BE ABLE TO DESCRIBE RESISTANCE IN TERMS OF THE GRADIENT OF THE GRAPH.

**0 2 . 4** Explain why having a more efficient motor increases the top speed of the car.

**[2 marks]**

A MORE EFFICIENT MOTOR WASTES LESS ENERGY AS HEAT OR SOUND SO MORE CHEMICAL ENERGY IS TRANSFERRED USEFULLY INTO KINETIC ENERGY ∴ SPEED.

**Question 2 continues on the next page**

**Figure 4** shows an electric car being charged.

**Figure 4**

**0 2 . 5** A driver wishes to buy a new car.

**Table 1** gives some data about an electric car and one with a petrol engine.

**Table 1**

| | Electric car | Petrol engine car |
|---|---|---|
| **Cost (£)** | 27 000 | 15 000 |
| **Running cost per year (£)** | 250 | 2 000 |
| **Average lifetime (years)** | 12 | 12 |

Which car would be the most economic over its 12 year lifetime?

Use data from **Table 1** to support your answer.

You should include the difference in cost in your answer.

**[4 marks]**

TOTAL COST FOR 12 YRS

ELECTRIC = 27000 + (250 x 12) = 30,000

PETROL = 15000 + (2000 x 12) = 39,000

∴ MEAN COST PER YEAR; ELECTRIC = 2500

PETROL = 3250

THE ELECTRIC CAR IS MORE ECONOMICAL EVEN THOUGH IT COSTS MORE TO BUY

**Turn over for the next question**

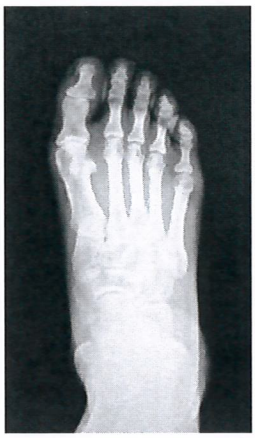
**0 3** Some small fractures do not show up on an X-ray image.

To see the fracture doctors inject the patient with a radioactive isotope.

The image is formed by detecting radiation as it leaves the body.

**Figure 5** shows an image of a foot after the patient was injected with the radioactive isotope technetium-99.

**Figure 5**



Technetium-99 emits gamma radiation.

**0 3 . 1** What is gamma radiation?

**[1 mark]**

AN ELECTROMAGNETIC WAVE EMITTED FROM THE NUCLEUS OF AN UNSTABLE ATOM

**0 3 . 2** Explain why a gamma emitter is used.

**[2 marks]**

GAMMA IS THE MOST PENETRATING TYPE OF RADIATION SO WILL PASS THROUGH THE BODY ENABLING IT TO BE DETECTED OUTSIDE THE BODY.

Technetium-99 has a **half-life** of 6 hours.

**0 3 . 3** Give the meaning of the term **half-life**.

**[1 mark]**

THE TIME IT TAKES FOR THE ACTIVITY OF A RADIOACTIVE SUBSTANCE TO FALL BY HALF

**0 3 . 4** After treatment, hospital equipment may become contaminated.

Describe the level of the hazard associated with contamination with technetium-99.

You should include in your answer a description of how the level of hazard changes over time.

**[3 marks]**

INITIALLY THE ACTIVITY WILL BE HIGH AND THEREFORE THE HAZARD LEVEL WILL BE HIGH. IT HAS A SHORT HALF LIFE OF 6 HOURS SO THE LEVEL OF HAZARD WILL FALL VERY QUICKLY AS THE RADIOACTIVE PARTICLES DECAY

EXAM TIP - MAKE SURE THAT YOU CAN USE A GRAPH TO DETERMINE HALF-LIFE

**Question 3 continues on the next page**

**0 3 . 5** Some of the hospital equipment may also be irradiated during treatment.

Describe how equipment becomes irradiated.

**[1 mark]**

OBJECTS BECOME IRRADIATED WHEN THEY ARE EXPOSED TO IONISING RADIATION

**0 3 . 6** Why is irradiated equipment not hazardous?

**[1 mark]**

BECAUSE IT DOES NOT BECOME RADIOACTIVE

**Turn over for the next question**

**0 4** Atoms are very small and most of their mass is concentrated in the nucleus.

Electrons orbit at different distances from the nucleus.

**0 4 . 1** A nucleus is much smaller than an atom.

Approximately how many times smaller is a nucleus than an atom?

**[1 mark]**

Tick **one** box.

- 100 ☐
- 1000 ☐
- 10 000 ☑
- 100 000 ☐

EXAM TIP

LEARN THE APPROXIMATE SIZE OF AN ATOM AND A NUCLEUS

**0 4 . 2** The electrons in an atom can only orbit at specific distances from the nucleus.

State what causes an electron's distance from the nucleus to increase or decrease.

**[2 marks]**

Increase THE ELECTRONS GAIN ENERGY BY ABSORBING EM RADIATION

Decrease THE ELECTRONS LOSE ENERGY BY EMITTING EM RADIATION

**0 4 . 3** Atoms have different atomic numbers and mass numbers.

In terms of sub-atomic particles, describe the difference between an atom's atomic number and its mass number.

**[2 marks]**

AN ATOMS ATOMIC NUMBER IS THE NUMBER OF PROTONS IN THE NUCLEUS WHEREAS THE MASS NUMBER IS THE NUMBER OF PROTONS + NEUTRONS IN THE NUCLEUS

**0 4 . 4** Transmutation is the name given to a process where one element changes into another.

Explain and compare how two different types of radioactive decay can cause transmutation.

**[4 marks]**

WHEN A RADIOACTIVE ELEMENT EMITS AN ALPHA PARTICLE ITS MASS NUMBER DECREASES BY 4 AND ATOMIC NUMBER BY 2.
WHEN A BETA PARTICLE IS EMITTED THE MASS STAYS THE SAME AND THE ATOMIC NUMBER INCREASES BY 1.
THE ATOMIC NUMBER DETERMINES WHAT ELEMENT AN ATOM IS, SO DIFFERENT NUMBER = DIFFERENT ELEMENT.

**Turn over for the next question**

0 5 **Figure 6** shows a kettle a student used to determine the specific heat capacity of water.

**Figure 6**

The student placed different masses of water into the kettle and timed how long it took for the water to reach boiling point.

The student carried out the experiment three times.

The student's results are shown in **Table 2**.

**Table 2**

| Mass of water in kg | Time for water to boil in seconds | | | | Mass × change in temperature in kg°C | Energy supplied in kJ |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | Mean | | |
| 0.25 | 55 | 60 | 63 | 59 | 20 | 131 |
| 0.50 | 105 | 110 | 116 | 110 | 40 | 243 |
| 0.75 | 140 | 148 | 141 | 143 | 60 | 314 |
| 1.00 | 184 | 190 | 183 | 182 | 80 | 401 |
| 1.25 | 216 | 215 | 211 | 214 | 100 | 471 |
| 1.50 | 272 | 263 | 266 | 267 | 120 | 587 |
| 1.75 | 298 | 300 | 302 | | 140 | |

0 5 . 1 Suggest how the student was able to ensure that the change in temperature was the same for each mass of water.

**[2 marks]**

- WATER BOILS AT THE SAME TEMPERATURE EACH TIME
- CONTROLLED THE STARTING TEMPERATURE BY ALLOWING THE KETTLE TO COOL BETWEEN EACH ATTEMPT

**0 5 . 2** Calculate the uncertainty in the student's measurements of time to boil when the mass of water was 1.75 kg.

**[2 marks]**

UNCERTAINTY = RANGE ÷ 2 = (302 − 298) ÷ 2

Uncertainty = ± 2 s

**0 5 . 3** The power rating of the kettle is 2.20 kW.

Calculate the average electrical energy used by the kettle, in kJ, for 1.75 kg of water to reach boiling point.

**[2 marks]**

ENERGY TRANSFERRED = POWER × TIME

= 2.20 × 300

Average energy = 660 kJ

**0 5 . 4** * Use information from **Table 2** to calculate the change in temperature of the water during the investigation.

**[2 marks]**

$\Delta\theta = \frac{\text{mass} \times \text{change in temp}}{\text{mass}} = \frac{20}{0.25}$

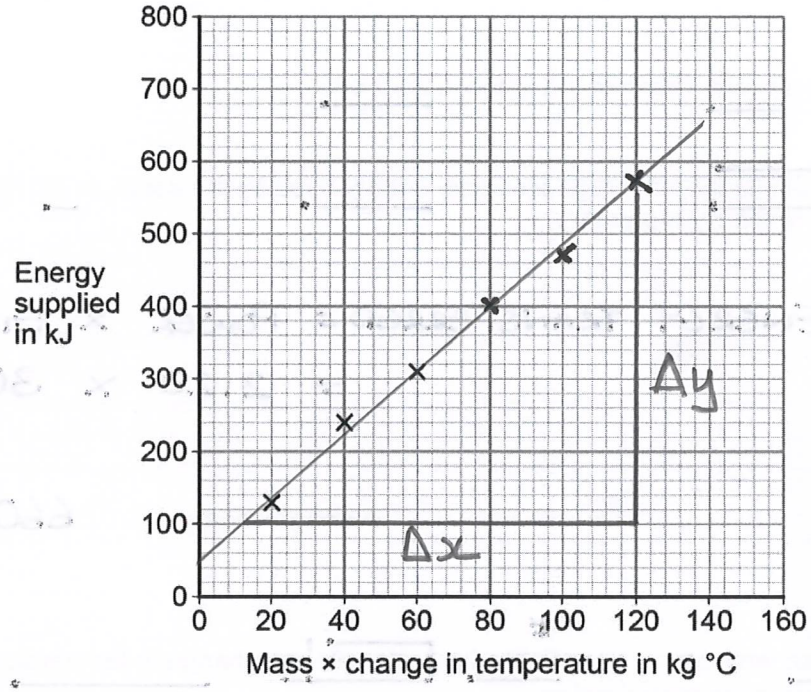
Change in temperature = 80 °C

**Question 5 continues on the next page**

The student plotted a graph of energy supplied in kJ against mass × change in temperature in kg °C.

**Figure 7** shows the graph the student plotted.

**Figure 7**




**0 5 . 5** Use data from **Table 2** to plot the four missing points.

Draw a line of best fit on the graph.

**[3 marks]**

EXAM HINT

- POINTS MUST BE PLOTTED TO WITHIN ±1 SQUARE
- DON'T FORCE LINES OF BEST FIT THROUGH THE ORIGIN AND USE A RULER IF IT IS A STRAIGHT LINE.

**0 5 . 6** Use the graph to determine the mean value of the specific heat capacity of water, for the student's investigation.

**[4 marks]**

$C = \frac{E}{m\Delta\theta}$ WHICH IS THE GRADIENT OF THE GRAPH

$= \frac{\Delta y}{\Delta x} = \frac{587 - 100}{120 - 12} = \frac{487 \times 1000}{108}$ AS E IS IN KJ

Specific heat capacity of water = 4509 J/kg °C

**0 5 . 7** The student's value for the specific heat capacity of water was greater than the accepted value.

Suggest why

**[1 mark]**

SOME OF THE ENERGY SUPPLIED WILL HAVE BEEN LOST TO THE SURROUNDINGS

**0 5 . 8** The kettle used in the experiment had a label stating that the power rating of the kettle was 2.2 kW.

The student did not measure the power of the kettle.

Suggest why measuring the power of the kettle may improve the student's investigation.

**[1 mark]**

THE ACTUAL POWER MIGHT NOT BE EXACTLY 2.2 KW

**0 6** The particle model can be used to explain the properties of gases.

**0 6 . 1** Describe the direction of motion of the particles in a gas.

**[1 mark]**

PARTICLES IN A GAS MOVE RANDOMLY AND IN ALL DIRECTIONS

**0 6 . 2** Explain why heating a gas increases the average speed of the gas particles.

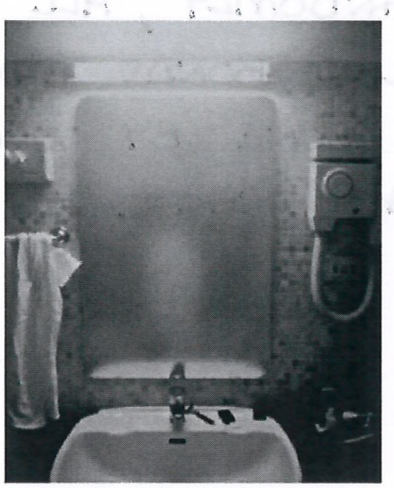
**[3 marks]**

HEATING INCREASES THE TEMPERATURE. TEMPERATURE IS DIRECTLY RELATED TO THE INTERNAL ENERGY / KINETIC ENERGY OF THE PARTICLES. SO IF KINETIC ENERGY INCREASES THEN SPEED INCREASES AS $E_K = \frac{1}{2}mv^2$

Water vapour is a gas. Gases change state when they cool.

**Figure 8** shows condensation on a cold bathroom mirror.

**Figure 8**



**0 6 . 4** A volume of $2.5 \times 10^{-5}$ $m^3$ of condensation forms on the mirror.

Density of water = 1000 $kg/m^3$

Specific latent heat of vaporisation of water = $2.26 \times 10^6$ J/kg.

Calculate the energy released when the condensation forms.

**[5 marks]**

$E = mL$ but $m = \rho \times V$

$\therefore E = \rho V L = 1000 \times (2.5 \times 10^{-5}) \times (2.26 \times 10^6)$

$= 56,500$

Energy released = 56,500 J

**0 6 . 3** Water can exist as either a liquid or a gas at 100 °C.

Explain why a mass of gaseous water at 100 °C contains more energy than an equal mass of liquid water at 100 °C.

**[2 marks]**

THE PARTICLES IN A GAS MOVE FREELY AND RANDOMLY, ALL THE INTERMOLECULAR MOLECULAR BONDS HAVE BEEN BROKEN THIS IS DONE BY INCREASING THEIR INTERNAL ENERGY.

**Question 6 continues on the next page**

**0 6 . 5** Central heating boilers burn gas and use the energy released to heat water.

Modern condensing central heating boilers take advantage of the energy that is released when water condenses.

Waste water vapour produced when the water is heated in the boiler is used to preheat the cold water entering the boiler.

Give some of the arguments in favour of condensing boilers compared to older non-condensing boilers.

**[4 marks]**

MODERN CONDENSING BOILERS USE LESS ENERGY TO HEAT WATER SO ARE MORE EFFICIENT. THEY CAN DO THIS BECAUSE THEY USE THE ENERGY RELEASED WHEN WATER CONDENSES TO PREHEAT THE WATER. BY USING LESS ENERGY TO HEAT THE WATER THEY ARE SAVING GAS (FOSSIL FUEL) WHICH IS BENEFICIAL AS IT IS NON-RENEWABLE. ALSO IT WOULD COST LESS TO RUN & RELEASE LESS $CO_2$ REDUCING GLOBAL WARMING.

**END OF QUESTIONS**