AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE

COMBINED SCIENCE: TRILOGY

H

Higher Tier
Physics Paper 1H

Wednesday 20 May 2020 Afternoon Time allowed: 1 hour 15 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.
- 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.

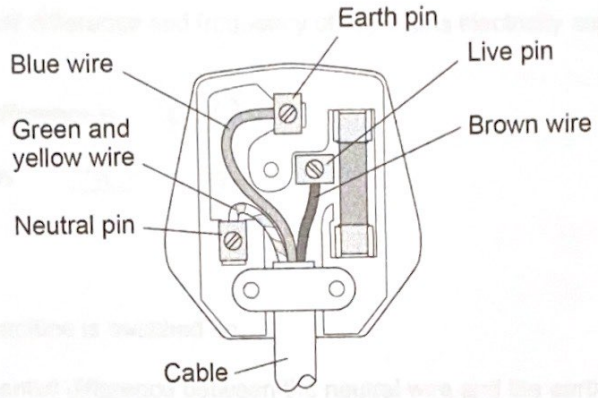
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Information
- The maximum mark for this paper is 70.
- 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.

Do not write outside the box

0 1 **Figure 1** shows the inside of a plug.

Figure 1



0 1 . 1 The plug is **not** wired correctly.

What should be done to connect the wires in the plug correctly?

[1 mark]

Swap the blue wire with the green and yellow wire

Do not write outside the box

The correctly wired plug and cable connects a washing machine to the mains electricity supply.

0 1 . 2 Give the potential difference and frequency of the mains electricity supply in the UK.

[2 marks]

The potential difference is 230 V

The frequency is 50 Hz

0 1 . 3 The washing machine is switched on.

What is the potential difference between the neutral wire and the earth wire?

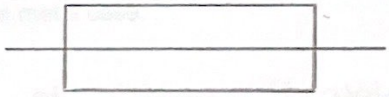
[1 mark]

Potential difference = 0 V

0 1 . 4 The plug has a fuse.

Draw the circuit symbol for a fuse in the space below.

[1 mark]



Question 1 continues on the next page

Do not write outside the box

The washing machine has a metal case.

A fault causes the live wire to make an electrical connection with the metal case of the washing machine.

0 1 . 5 The earth wire is **not** connected to the metal case of the washing machine.

Explain why it would not be safe for a person to touch the metal case.

[2 marks]

The person could get an electric shock because there is a current in the person

0 1 . 6 The earth wire is now connected to the metal case of the washing machine.

Explain why it would now be safe for a person to touch the metal case, even if the live wire touches the metal case.

[2 marks]

Instead of flowing thrugh the person, the charge flows thrugh the earth wire because the resistance of the earth wire is much less than that of a person.

9

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0 2 Different radioactive isotopes emit different types of nuclear radiation.

A polonium-210 (Po) nucleus emits an alpha particle (α) and turns into a lead (Pb) nucleus.

This can be represented by the equation:

$$^{210}_{84}\text{Po} \longrightarrow {}^{A}_{Z}\text{Pb} + \alpha$$

0 2 . 1 What is the value of A in the equation? **[1 mark]**

Tick (✓) **one** box.

A = 206 ☑ A = 208 ☐ A = 210 ☐ A = 211 ☐

0 2 . 2 What is the value of Z in the equation? **[1 mark]**

Tick (✓) **one** box.

Z = 80 ☐ Z = 82 ☑ Z = 85 ☐ Z = 86 ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 A strontium-89 nucleus (Sr) emits a beta particle (β) and turns into an yttrium nucleus (Y).

This can be represented by the equation:

$$^{89}_{38}\text{Sr} \longrightarrow {}^{A}_{Z}\text{Y} + \beta$$

What are the values of A and Z in the equation?

[2 marks]

A = 89

Z = 39

0 2 . 4 Gamma radiation is another type of nuclear radiation.

What does gamma radiation consist of?

[1 mark]

Tick (✓) **one** box.

- High energy neutrons ☐
- Electromagnetic waves ☑
- Particles with no charge ☐
- Positively charged ions ☐

Do not write outside the box

0 2 . 5 Explain the differences between the properties of alpha, beta and gamma radiations.
[6 marks]

An alpha particle is the same as a helium nucleus. It is the least penetrating so can be stopped by paper or skin and can only travel a few cm in air (much less than beta and gamma). This is because alpha is the most ionising with a charge of +2. Beta particles are electrons emitted from the nucleus. It penetrates more than alpha and less than gamma, stopped by a thin sheet of aluminium. Beta can travel up to 1m in air which is more than alpha but much less than gamma. These properties are because it is more ionising than ~~alpha~~ gamma but less than alpha with a charge of -1. Gamma radiation is an electromagnetic wave, is the least ionising and has no charge. This means it is the most penetrating (compared to alpha + beta) only stopped by lead or thick concrete. It also can travel very large distances in air.

11

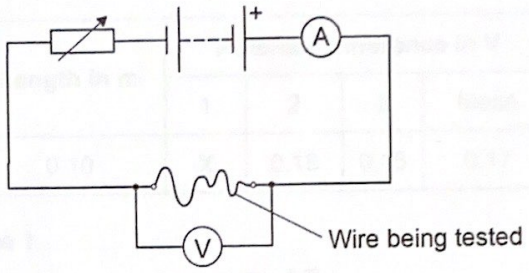
Turn over for the next question

Do not write outside the box

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

0 3 . 1 **Figure 2** shows the circuit used.

Figure 2



Explain why the student needed to adjust the variable resistor each time she changed the length of the wire.

[3 marks]

The variable resistor changes the resistance of the circuit to keep the current the same. This keeps the temperature of the wire constant.

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 The student recorded three measurements of the potential difference across a 0.10 m length of wire.

Table 1 shows the results.

Table 1

Length in m	Potential difference in V			
	1	2	3	Mean
0.10	**X**	0.18	0.15	0.17

Calculate **X** in **Table 1**.

[2 marks]

$0.17 = \frac{X + 0.18 + 0.15}{3}$

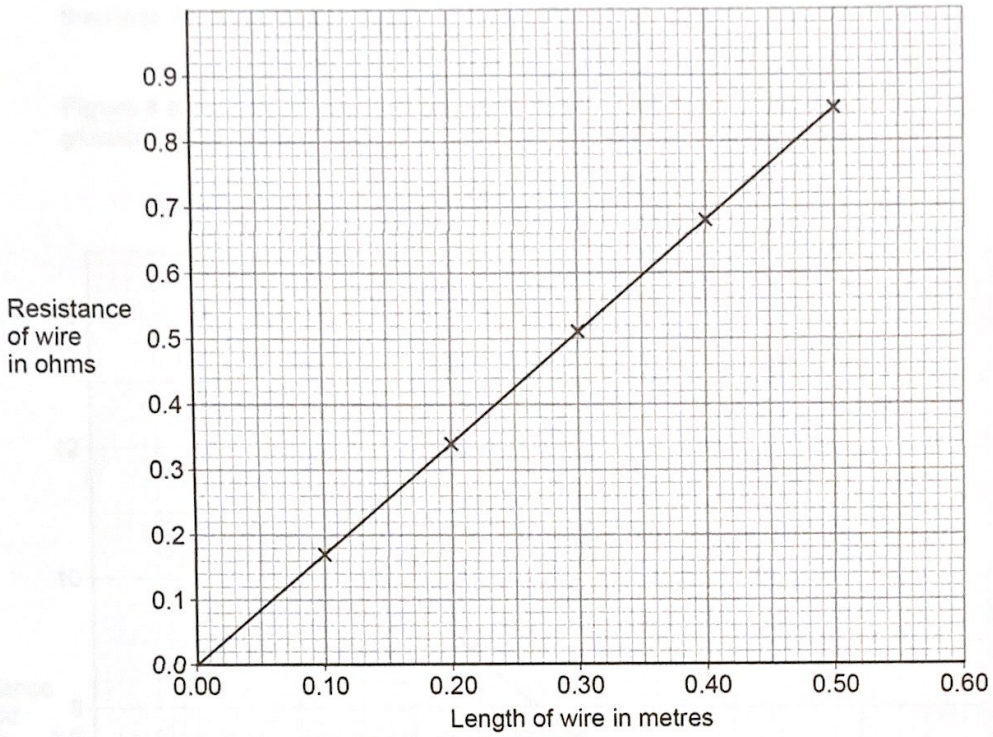
$X = (3 \times 0.17) - 0.18 - 0.15 = 0.18$

X = 0.18 V

Do not write outside the box

0 3 . 3 **Figure 3** shows the results for five different lengths of the wire.

Figure 3



Describe the relationship between the length of the wire and the resistance of the wire.

[2 marks]

The resistance of the wire is directly proportional to the length of the wire.

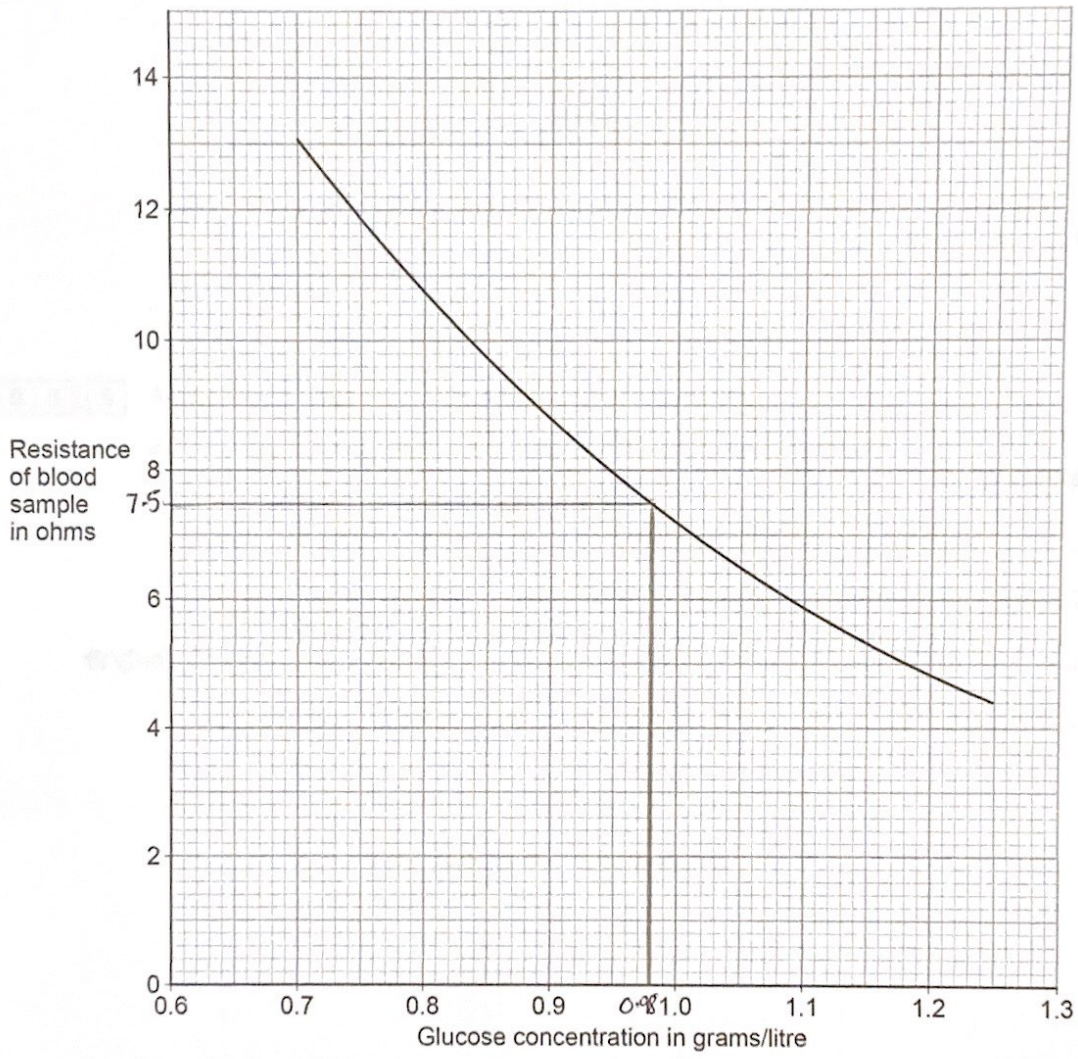
Question 3 continues on the next page

A glucometer uses the resistance of a blood sample to calculate the glucose concentration in a person's blood.

A blood sample is put into a small tube, which is put inside the glucometer. The blood then acts like a resistance wire.

Figure 4 shows the relationship between the resistance of a blood sample and the glucose concentration.

Figure 4



Do not write outside the box

0 3 . 4 The glucometer applies a potential difference of 0.90 volts across a blood sample.

The glucose concentration of the blood sample is 0.98 grams/litre.

Determine the current in the blood sample.

[4 marks]

when concentration of blood = 0·98, resistance = 7·5 ohms

potential difference = current × resistance

$$\text{current} = \frac{\text{potential difference}}{\text{resistance}}$$

$$\text{current} = \frac{0.9}{7.5} = 0.12$$

Current = 0·12 A

0 3 . 5 A new tube is used each time a blood sample is tested.

Explain why valid results are only obtained if each tube is identical.

[2 marks]

The shape and size of the tube affects the resistance of the blood sample so to ensure only glucose concentration affects resistance, a new identical tube must be used each time.

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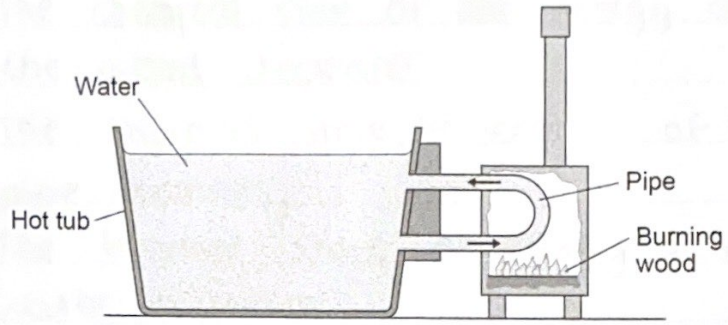
Turn over for the next question

Do not write outside the box

0 4 **Figure 5** shows a wood-fired hot tub.

Figure 5



0 4 . 1 What type of fuel is wood?

[1 mark]

Tick (✓) **one** box.

- A non-renewable biofuel ☐
- A non-renewable fossil fuel ☐
- A renewable biofuel ☑
- A renewable fossil fuel ☐

0 4 . 2 Give **two** environmental effects of using wood as an energy resource.

[2 marks]

1 Burning wood causes air pollution

2 Burning ~~wood~~ wood may lead to deforestation and therefore loss of habitats.

Do not write outside the box

0 4 . 3 Describe the change to the stores of energy of the wood, pipe and water as the water is heated.

[3 marks]

Wood The chemical store of energy of the wood decreases

Pipe The thermal store of energy of the pipe increases

Water The thermal store of energy of the water increases.

0 4 . 4 The temperature of the water reaches 42 °C

The temperature then stays constant even though the fire continues to burn.

Explain why the temperature of the water stays constant.

[2 marks]

The energy is dissipated from the water into the surroundings at the same rate that energy is transferred to the water.

8

Turn over for the next question

Do not write outside the box

0 5 Ice cream is made by cooling a mixture of liquid ingredients until they freeze.

0 5 . 1 Which statement describes the motion of the particles in solid ice cream?

[1 mark]

Tick (✓) **one** box.

They are stationary. ☐

They move freely. ☐

They vibrate about fixed positions. ☑

0 5 . 2 How do the kinetic energy and the potential energy of the particles change as a liquid is cooled and frozen?

[1 mark]

Tick (✓) **one** box.

Kinetic energy	Potential energy	
Decreases	Decreases	☑
Decreases	Does not change	☐
Does not change	Decreases	☐
Does not change	Does not change	☐

Do not write outside the box

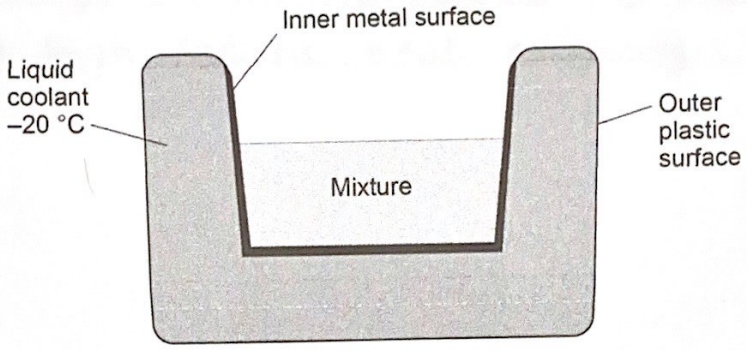
Figure 6 shows a bowl used for making ice cream.

The walls of the bowl contain a liquid coolant.

The bowl is cooled to –20 °C before the mixture is put in the bowl.

The bowl causes the mixture to cool down and freeze.

Figure 6



0 5 . 3 Explain why the different thermal conductivities of metal and plastic are important in the design of the bowl.

[4 marks]

Metal Has a high thermal conductivity which increases the rate of energy transfer from the mixture to cool the mixture and make the icecream.

Plastic Has low thermal conductivity which reduces the rate of energy transfer from the surroundings to the liquid coolant.

Question 5 continues on the next page

Do not write outside the box

0 5 . 4 The liquid coolant has a freezing point below –20 °C

Explain **one** other property that the liquid coolant should have.

[2 marks]

The coolant should be able to absorb a large amount of energy with minimal change to the temperature so should have a high specific heat capacity.

Do not write outside the box

0 5 . 5 The initial temperature of the mixture was +20 °C. The mixture froze at –1.5 °C.

A total of 165 kJ of internal energy was transferred from the mixture to cool and freeze it.

specific heat capacity of the mixture = 3500 J/kg °C

specific latent heat of fusion of the mixture = 255 000 J/kg

Calculate the mass of the mixture.

Give your answer to 2 significant figures.

[6 marks]

Change in thermal energy (ΔE) = mass × specific heat capacity × temperature change.

$\Delta E = m \times 3500 \times 21.5$ $(20 + 1.5 = 21.5)$

$\Delta E = m \times 255000$

165 kJ = 165000 J

$165000 = 75250m + 255000m$

$165000 = 330250m$

$m = \frac{165000}{330250} = 0.499621$

$= 0.50$

Mass (2 significant figures) = 0.5 kg

14

Turn over for the next question

Do not write outside the box

0 6 A student modelled radioactive decay by rolling some dice in a tray.

Dice that landed on the number six were removed from the tray.

The removed dice represent nuclei that have decayed.

0 6 . 1 Why is rolling dice a suitable model for radioactive decay?

[1 mark]

Both rolling a dice and radioactive decay are random processes.

0 6 . 2 The student rolled 144 dice and removed all those that landed on the number six.

The student rolled the remaining dice and again removed all those that landed on the number six.

When the student had rolled the dice 20 times there were 9 dice left.

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

You should show how you work out your answer.

[3 marks]

$144 \xrightarrow{\div 2} 72 \xrightarrow{\div 2} 36 \xrightarrow{\div 2} 18 \xrightarrow{\div 2} 9$

4 half lives

$\frac{20}{4} = 5$

Answer = 5 rolls of the dice

Do not write outside the box

0 6 . 3 The number of times the dice have to be rolled to halve the original number of dice in the tray represents the half-life.

Figure 7 shows an eight-sided dice and a six-sided dice.

Figure 7

The student now used eight-sided dice to model radioactive decay. Dice that landed on the number six were again removed from the tray.

The half-life represented by rolling eight-sided dice is likely to be different from the half-life represented by rolling six-sided dice.

Explain how.

[2 marks]

The 8-sided dice will have a smaller chance of decay ($\frac{1}{8}$) than the 6-sided dice ($\frac{1}{6}$) so the dice with 8 sides have a greater half life.

0 6 . 4 A teacher has two radioactive sources, **A** and **B**.

Source **A** has a longer half-life than source **B**.

What can be deduced about the nuclei in source **A** compared with the nuclei in source **B**?

Do **not** refer to isotopes in your answer.

[1 mark]

The nuclei in source A are more stable than the nuclei in source B

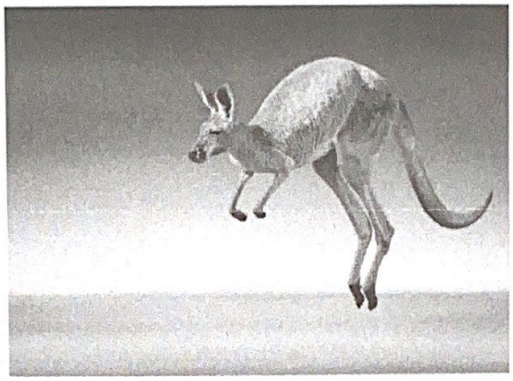
7

Do not write outside the box

0 7 Kangaroos are large animals that travel by jumping.

Figure 8 shows a kangaroo.

Figure 8



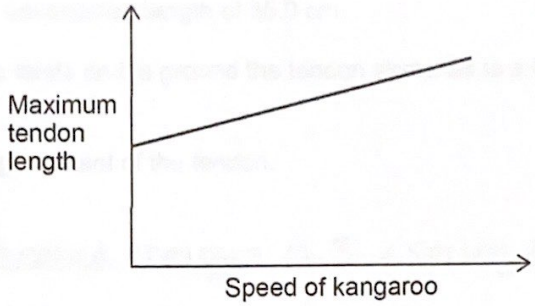
Each leg of a kangaroo has a tendon connected to a muscle. Each tendon can be modelled as a spring.

When a jumping kangaroo lands on the ground, the tendons stretch.

Do not write outside the box

0 7 . 1 **Figure 9** shows a sketch graph of how the maximum tendon length during a jump changes with the speed of the kangaroo.

Figure 9



Explain why a kangaroo can jump higher as its speed increases.

[3 marks]

As the speed increases, the maximum tendon length increases and so does the ~~ele~~ elastic potential energy. When the kangaroo jumps, this energy is transferred into gravitational potential energy and so the higher the ~~speed~~ tendon length, the higher the jump.

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 A kangaroo has a maximum gravitational potential energy during one jump of 770 J

When the kangaroo lands on the ground 14% of the maximum gravitational potential energy is transferred to elastic potential energy in one tendon.

The tendon has an unstretched length of 35.0 cm

When the kangaroo lands on the ground the tendon stretches to a length of 42.0 cm

Calculate the spring constant of the tendon.

[5 marks]

elastic potential energy = 0.5 × Spring Constant × extension^2

elastic potential energy = ~~700~~ 770 × 0.14 = 107.8

extension = ~~[redacted]~~ 42 − 35 = 7 cm or 0.07 m

$107.8 = 0.5 \times K \times 0.07^2$

$K = 2 \times \frac{107.8}{0.07^2}$

$= 44\,000$

Spring constant = 44 000 N/m

8

END OF QUESTIONS