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

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 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.

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.

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

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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0 1 **Figure 1** shows a mobile phone with its battery removed.

Figure 1

A student measured the potential difference across the battery and then put the battery into the phone.

0 1 . 1 What is the equation linking current (I), potential difference (V) and resistance (R)?

[1 mark]

Tick (✓) **one** box.

$I = V R$ ☐

$R = I V$ ☐

$V = I R$ ☐

$V = I^2 R$ ☐

Question 1 continues on the next page

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0 1 . 2 The current in the electronic circuit in the mobile phone was 0.12 A.

The potential difference across the battery was 3.9 V.

Calculate the resistance of the electronic circuit in the mobile phone.

[3 marks]

Resistance = ______________________ Ω

Do not write outside the box

0 1 . 3 Write down the equation which links energy (E), power (P) and time (t).

[1 mark]

0 1 . 4 The battery was fully charged when it was put into the mobile phone.

The battery discharged when the mobile phone was switched on.

The average power output of the battery as it discharged was 0.46 watts.

The time taken to fully discharge the battery was 2500 minutes.

Calculate the energy transferred by the battery.

[3 marks]

Energy transferred = ____________________ J

Question 1 continues on the next page

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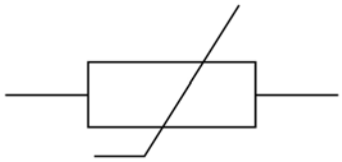
The mobile phone includes a sensor to monitor the temperature of the battery.

Figure 2 shows the circuit symbol for a component used in the sensor.

Figure 2



0 1 . 5 What component does the circuit symbol shown in **Figure 2** represent?

[1 mark]

____

0 1 . 6 The temperature of the component in **Figure 2** increases.

The potential difference across the component remains constant.

Explain what happens to the current in the component.

[2 marks]

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11

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0 2 A radioactive source emits alpha, beta and gamma radiation.

0 2 . 1 An alpha particle is the same as a helium nucleus.

How many times bigger is the radius of a helium atom than the radius of an alpha particle?

[1 mark]

Tick (✓) **one** box.

Less than 100 times bigger ☐

Exactly 5000 times bigger ☐

More than 10 000 times bigger ☐

0 2 . 2 Alpha particles can ionise atoms in the air.

What happens to an atom when it is ionised by an alpha particle?

[2 marks]

Tick (✓) **two** boxes.

A neutron in the atom becomes a proton. ☐

The atom becomes a positive ion. ☐

The atom gains a neutron. ☐

The atom gains a proton. ☐

The atom loses an electron. ☐

Question 2 continues on the next page

0 2 . 3 A spark detector is a device that can be used to detect alpha radiation.

A spark detector works by alpha particles ionising atoms in the air near a wire mesh.

A large potential difference creates a spark when the air near the wire mesh is ionised.

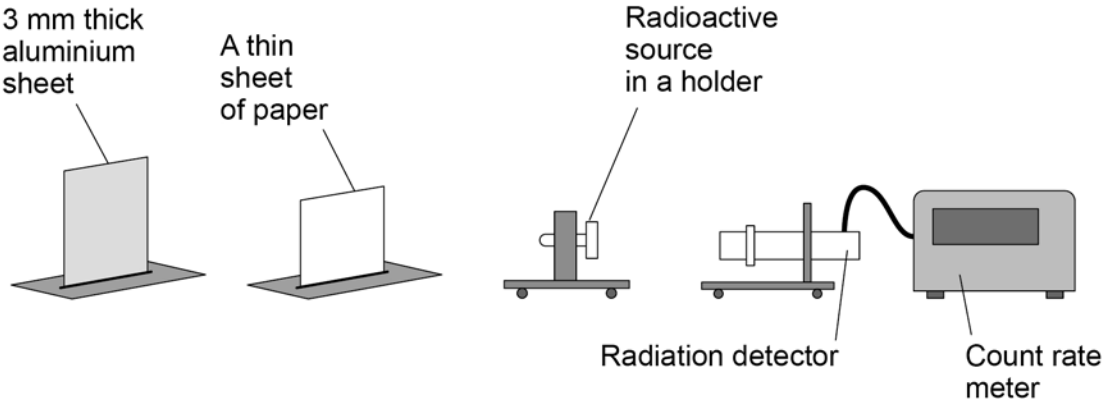
Suggest why a spark detector **cannot** detect beta radiation.

[1 mark]

0 2 . 4 A teacher wants to demonstrate that the radioactive source emits alpha, beta and gamma radiation.

Figure 3 shows the equipment the teacher has.

Figure 3



Describe a method the teacher could use.

[6 marks]

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10

Turn over ►

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0 3 **Figure 4** shows a sailing boat crossing an ocean.

Figure 4

There is a wind turbine on the boat.

0 3 . 1 The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

[1 mark]

____

0 3 . 2 The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

[2 marks]

1 ____

____

2 ____

____

Do not write outside the box

0 3 . 3 Explain **one** environmental impact of using fossil fuels to generate electricity.

[2 marks]

0 3 . 4 The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

[4 marks]

Speed = ________________ m/s

Question 3 continues on the next page

0 3 . 5 As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

[3 marks]

Change in height = ______________________ m

12

Do not write outside the box

Turn over for the next question

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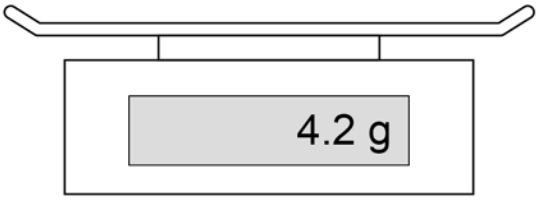
ANSWER IN THE SPACES PROVIDED**

0 4 A student determined the density of a cube made of bronze.

The student used a balance to measure the mass of the bronze cube.

Figure 5 shows the balance before the cube was added.

Figure 5



0 4 . 1 What type of error is shown on the balance?

[1 mark]

____

0 4 . 2 How could the student get a correct value for the mass of the cube from the balance?

[1 mark]

____

____

Do not write outside the box

0 4 . 3 The student measured the length of the bronze cube using Vernier callipers and then using a micrometer.

Table 1 shows the results.

Table 1

Equipment	**Length in mm**
Vernier callipers	20.1
Micrometer	20.14

Complete the sentence.

[1 mark]

The results in **Table 1** show that the Vernier callipers and the micrometer have

a different ________________________________ .

Question 4 continues on the next page

The student wanted to determine the density of a bronze coin.

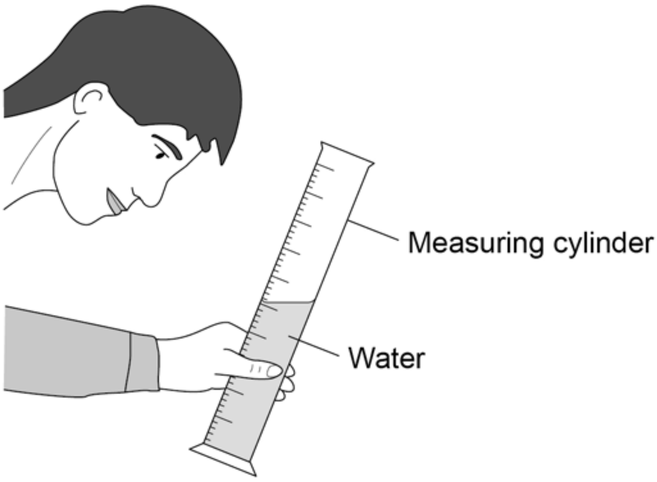
The student had several identical coins.

The volume of each coin was very small.

0 4 . 4 The student added water to a measuring cylinder.

Figure 6 shows the student reading the volume of water in the measuring cylinder.

Figure 6



Give **two** changes the student should make to increase the accuracy of the volume measurement.

[2 marks]

1 ____

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2 ____

____

Do not write outside the box

0 4 . 5 Describe how the student could use a displacement method to determine an accurate value for the volume of a single coin.

[3 marks]

Question 4 continues on the next page

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0 4 . 6 Old penny coins were made from a disc of bronze.

New penny coins are made from a disc of a different metal.

Figure 7 shows a disc of metal.

Figure 7

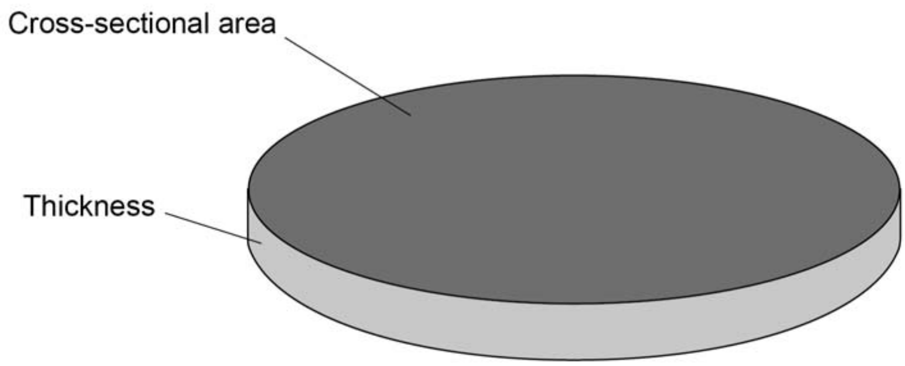


Table 2 shows information about the discs used to make each coin.

Table 2

Disc	Mass in g	Density in g/cm^3	Thickness in cm
Old penny	3.6	8.9	0.16
New penny	3.6	**X**	0.17

Do not write outside the box

The discs used to make the old and the new coins have the **same** cross-sectional area.

Calculate value **X** in **Table 2**.

Give your answer to 2 significant figures.

The volume of a disc can be calculated using the equation:

volume of a disc = cross-sectional area × thickness

[5 marks]

Density (2 significant figures) = ____________________ g/cm^3

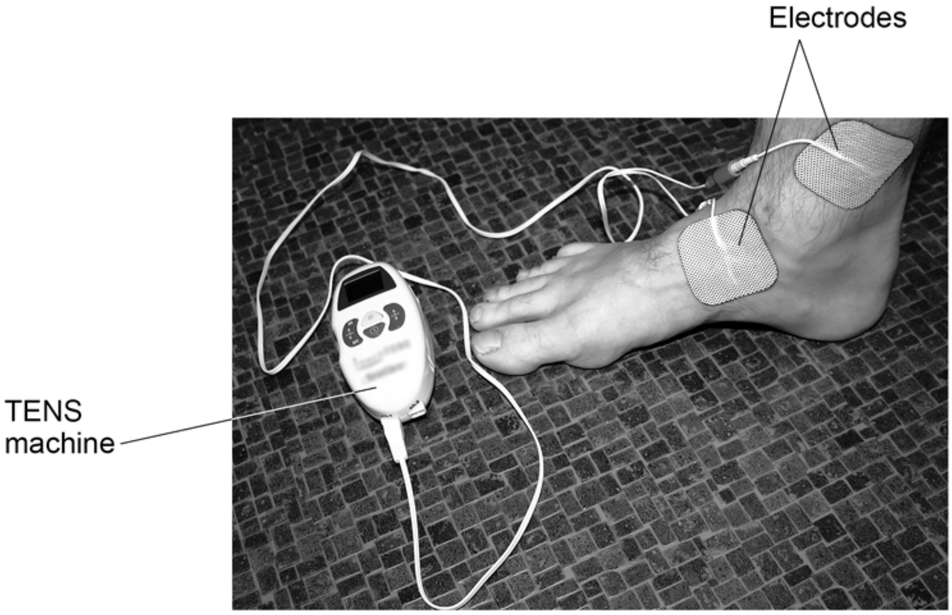
13

Turn over for the next question

0 5 A TENS machine uses an electrical current to relieve pain.

Figure 8 shows the electrodes of a TENS machine connected across an ankle.

Figure 8



0 5 . 1 The maximum power of the TENS machine is 240 mW.

The potential difference across the battery in the TENS machine is 2.5 V.

Calculate the maximum current from the battery.

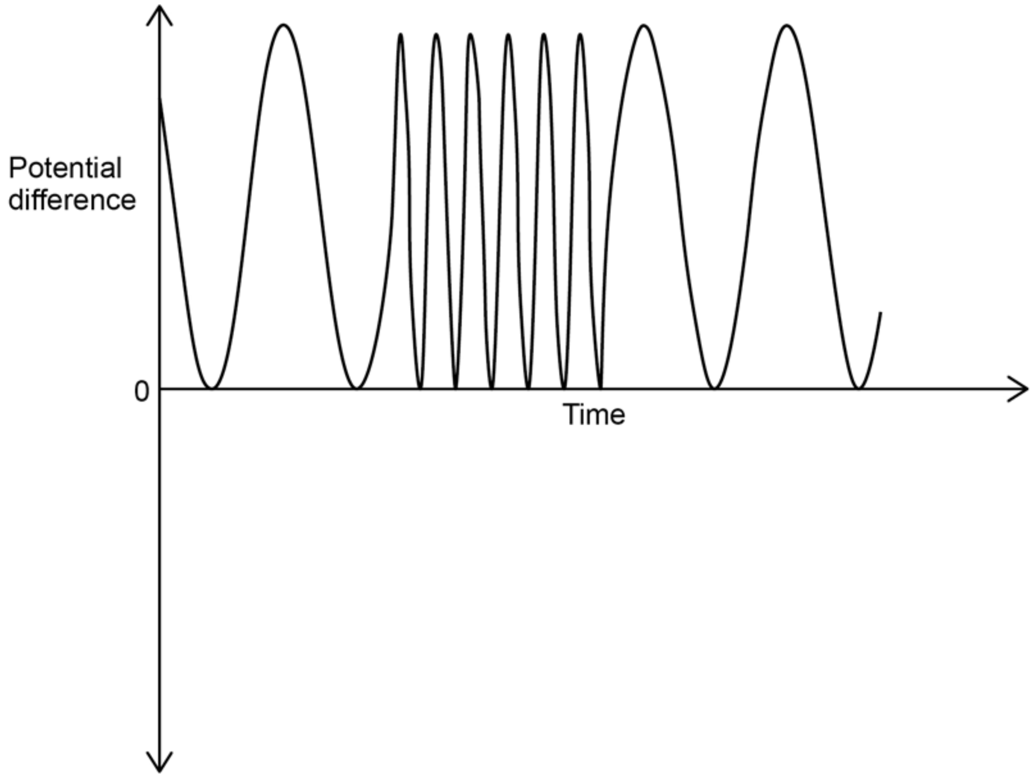
[4 marks]

Maximum current = ________________________ A

Do not write outside the box

0 5 . 2 **Figure 9** is a sketch graph showing how the potential difference across the electrodes varies with time.

Figure 9



A student concluded that there was an alternating potential difference across the electrodes.

How does **Figure 9** show that the student was **not** correct?

[1 mark]

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Question 5 continues on the next page

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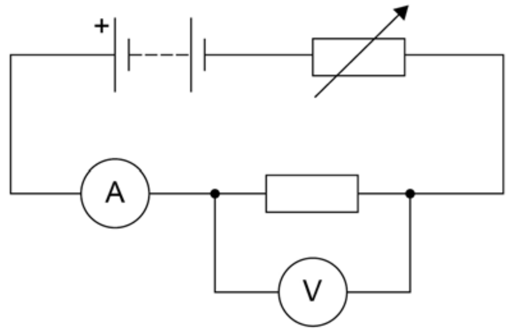
Figure 10 shows a circuit the student built using the battery from the TENS machine.

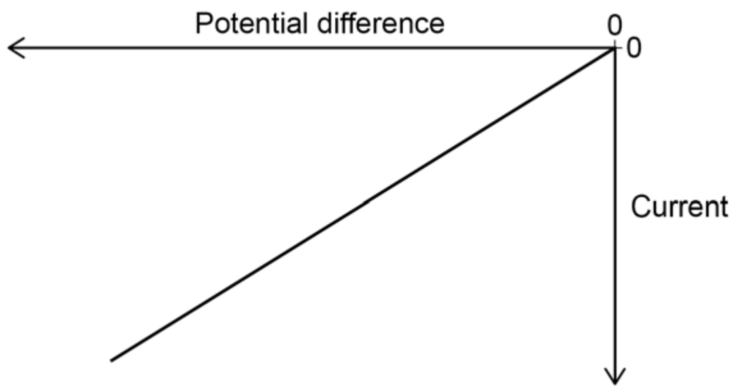
Figure 10



The student recorded how the current in the resistor varied with the potential difference across the resistor.

Figure 11 shows a sketch graph of the results.

Figure 11



0 5 . 3 What relationship does **Figure 11** show?

[1 mark]

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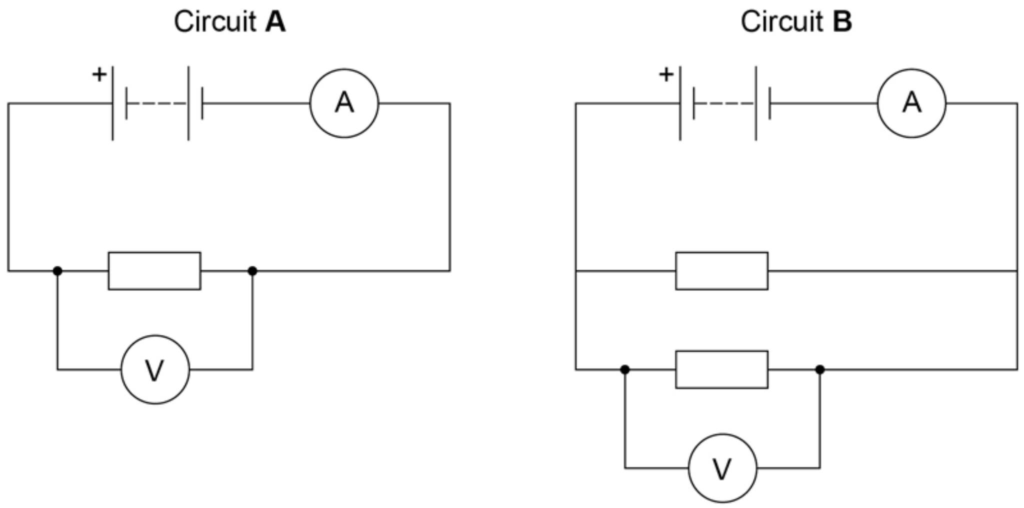
0 5 . 4 **Figure 12** shows two more circuits that the student built using the battery from the TENS machine.

Figure 12



The resistors all have the same resistance.

Compare the readings on the voltmeter and ammeter in circuit **A** and circuit **B**.

[3 marks]

Voltmeter ____

____

____

Ammeter ____

____

____

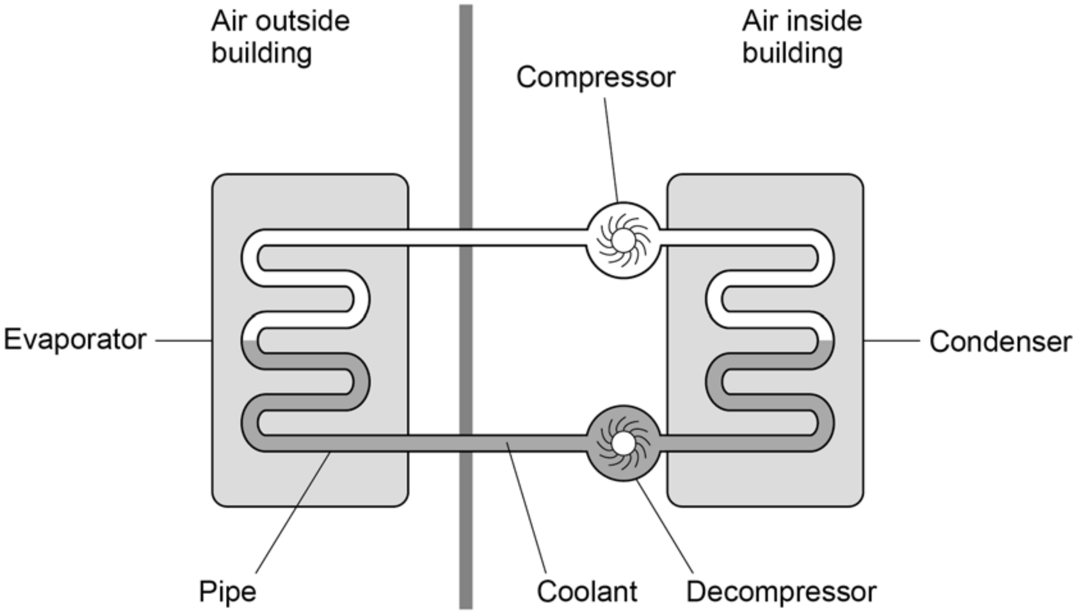
9

Turn over for the next question

0 6 An air source heat pump transfers energy from the air outside a building to increase the temperature of the air inside the building.

Figure 13 shows an air source heat pump.

Figure 13



The compressor is connected to the mains electricity supply.

The pipe in the heat pump contains a substance called coolant.

In the evaporator, energy is transferred from the air outside the building to the liquid coolant.

The temperature of the coolant increases and it evaporates.

0 6 . 1 Explain what happens to the internal energy of the coolant as its temperature increases.

[2 marks]

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0 6 . 2 What name is given to the energy needed to change the state of the liquid coolant?

[1 mark]

____

0 6 . 3 What happens to the mass of the coolant as it evaporates and becomes a vapour?

[1 mark]

Tick (✓) **one** box.

Decreases ☐

Stays the same ☐

Increases ☐

0 6 . 4 The compressor increases the density and temperature of the coolant vapour inside the pipe.

Explain why the pressure in the pipe increases.

[2 marks]

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Question 6 continues on the next page

0 6 . 5 The condenser transfers energy from the coolant to the air in the building.

When the total energy input to the heat pump system is 1560 kJ the temperature of the air in the building increases from 11.6 °C to 22.1 °C.

The efficiency of the heat pump system is 87.5%.

The mass of the air inside the building is 125 kg.

Calculate the specific heat capacity of the air in the building.

Give your answer in standard form.

[6 marks]

Specific heat capacity (standard form) = ____________________ J/kg °C

0 6 . 6 The air in the building gains 400 J for every 100 J of energy transferred from the mains electricity supply to the compressor.

An advertisement claims that the heat pump system has an efficiency of 400%.

Explain why the advertisement is **not** correct.

[3 marks]

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15

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

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AQA

GCSE
COMBINED SCIENCE: TRILOGY
8464/P/1H

Physics Paper 1H

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

216G8464P1H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	**Response**	**Marks awarded**
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	**Response**	**Marks awarded**
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	$V = I R$		1	AO1 6.2.1.3
01.2	3.9 = 0.12 × R $R = \frac{3.9}{0.12}$ R = 32.5 (Ω)	 allow R = 33 (Ω)	1 1 1	AO2 6.2.1.3
01.3	energy = power × time **or** E = P t		1	AO1 6.2.4.2
01.4	time = 150 000s energy = 0.46 × 150 000 energy = 69 000 (J)	 allow a substitution using an incorrectly/not converted value of time allow a correct calculation using an incorrectly/not converted value of time	1 1 1	AO2 6.2.4.2
01.5	thermistor		1	AO1 6.2.1.1
01.6	the current will increase (because) the resistance decreases		1 1	AO1 6.2.1.4
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	more than 10 000 times bigger		1	AO1 6.4.1.1
02.2	the atom becomes a positive ion the atom loses an electron		1 1	AO1 6.4.1.2
02.3	beta radiation is only weakly ionising		1	AO3 6.4.2.1

Question	Answers	Mark	AO / Spec. Ref.
02.4	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3 6.4.2.1
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • move the detector very close to the source • record the count rate • position the paper between the source and the detector • record the new count rate • alpha radiation will not penetrate through paper • if the count rate with the paper is (significantly) less than without then the source emits alpha radiation • remove the paper and position the aluminium between the source and the detector • record the new count rate • (alpha and) beta radiation will not penetrate through the aluminium • if the count rate has (significantly) reduced compared with using paper then beta radiation is present • if radiation penetrates through the aluminium then gamma radiation is present • the experiment should be repeated and mean results calculated because radioactivity is a random process To access level 3, the candidate must use the paper sheet, the aluminium sheet and no sheet, and describe how the results would indicate the presence of alpha, beta or gamma radiation.		
Total		**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	solar	allow biofuel / biodiesel allow wave power	1	AO1 6.1.3
03.2	sometimes there is no wind (but the battery can still be charged using the generator)	allow if the generator breaks then the turbine can still generate electricity	1	AO1 6.1.3
	when there is wind less fuel is burned	allow a disadvantage of burning fossil fuel	1	
03.3	carbon dioxide		1	AO1 6.1.3
	increases global warming	allow increases the greenhouse effect	1	
	OR			
	sulfur dioxide or NOx emissions (1)			
	increases acid rain (1)			
	OR			
	particulates or NOx emissions (1)			
	can harm living organisms (1)			

03.4	81 kJ = 81 000 J		1	AO2 6.1.1.2
	$81000 = 0.5 \times 8000 \times v^2$	allow a correct substitution using an incorrectly/not converted value of energy	1	
	$v = \sqrt{\frac{81\,000}{0.5 \times 8000}}$	allow a correct re-arrangement using an incorrectly/not converted value of energy	1	
	v = 4.5 (m/s)	allow a correct calculation using an incorrectly/not converted value of energy	1	

03.5	$19600 = 8000 \times 9.8 \times \Delta h$		1	AO2 6.1.1.2
	$\Delta h = \frac{19\,600}{8000 \times 9.8}$		1	
	Δh = 0.25 m		1	

Total			**12**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	zero error	allow systematic error	1	AO1 6.3.1.1 RPA17
04.2	reset the balance to zero g	allow subtract the reading shown on the balance from the reading taken	1	AO1 6.3.1.1 RPA17
04.3	resolution	this answer only	1	AO1 6.3.1.1 RPA17
04.4	place the measuring cylinder on a horizontal surface		1	AO1 6.3.1.1 RPA17
	view with eye in line with the level of the water	allow read from the bottom of the meniscus	1	
04.5	add several coins to the measuring cylinder	allow a minimum of 5 coins if a number of coins is given	1	AO3
	measure the change in the water level in the measuring cylinder		1	AO1
	divide by the number of coins added		1	AO3 6.3.1.1 RPA17

04.6	$8.9 = \frac{3.6}{\text{area} \times 0.16}$	allow $8.9 = \frac{3.6}{\text{volume}}$	1	AO3
	$\text{area} = \frac{3.6}{8.9 \times 0.16}$	allow area = 2.5(28…) (cm^2)	1	AO3
	$\text{density} = \frac{3.6}{2.528 \times 0.17}$	allow $\frac{3.6}{\text{their calculated area} \times 0.17}$	1	AO3
	density = 8.37… (g/cm^3)	allow a correct calculation using their calculated area	1	AO3
	density = 8.4 g/cm^3	this mark can only be scored for a correct rounding of a value of density calculated using correct equations	1	AO2 6.3.1.1 RPA17
Total			**13**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	240 mW = 0.24 W		1	AO2 6.2.4.1
	0.24 = 2.5 × I	allow a correct substitution using an incorrectly/not converted value of power	1	
	$I = \frac{0.24}{2.5}$	allow a correct re-arrangement using an incorrectly/not converted value of power	1	
	I = 0.096 (A)	allow a correct calculation using an incorrectly/not converted value of power	1	
05.2	because the potential difference is always positive	allow because potential difference does not change direction	1	AO1 6.2.3.1
05.3	potential difference is (directly) proportional to current		1	AO2 6.2.1.4
05.4	voltmeter: the reading is the same in both circuits		1	AO2 6.2.2
	ammeter: the reading in circuit **B** is twice the reading of circuit **A**	allow **1** mark for the reading in circuit **B** is bigger than circuit **A**	2	
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the kinetic energy (and the potential energy) of the particles increases so the internal energy increases because it is the sum of kinetic and potential energy (of the particles)	allow the speed of the particles increases	1 1	AO1 6.3.2.1 6.3.2.3
06.2	latent heat (of vaporisation)	allow specific latent heat (of vaporisation)	1	AO1 6.3.2.3
06.3	stays the same		1	AO1 6.3.1.2
06.4	more collisions per second a greater force per collision		1 1	AO1 6.3.3.1

06.5	$0.875 = \frac{\text{useful output energy transfer}}{1\ 560\ 000}$	allow a correct substitution using incorrectly/not converted values of efficiency and/or energy	1	AO2 6.1.2.2 6.1.1.3 6.3.2.2
	useful output energy transfer = 1 365 000(J)	this answer only	1	
		the equation efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$ must have been used to score subsequent marks		
	1 365 000 = 125 × c × (22.1–11.6)	allow a correct substitution using their calculated value of useful output energy	1	
	$c = \frac{1\ 365\ 000}{125 \times 10.5}$	allow a correct re-arrangement using their value of useful output energy	1	
	c = 1040 (J/kg °C)	allow a correct calculation using with their value of useful output energy	1	
	$c = 1.04 \times 10^3$ (J/kg °C)	this mark can only be awarded for a calculation using the correct equations	1	

06.6	the advertisement has ignored the energy input from the surrounding air so the total energy input is greater than the energy supplied from the electricity the efficiency must be less than 100%	 an answer that the total energy input comes from the electricity supply and the air outside the building gains the first two marking points	1 1 1	AO3 AO2 AO1 6.1.2.2

Total			**15**