Centre Number

Candidate Number

General Certificate of Secondary Education
2023–2024

Single Award Science:
Physics

Unit 3

Higher Tier

[GSA32]   *GSA32*

FRIDAY 7 JUNE 2024, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all nine** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Question **2(c)**.

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1 (a) A student used the following circuit to investigate how the length of a piece of wire affects resistance.
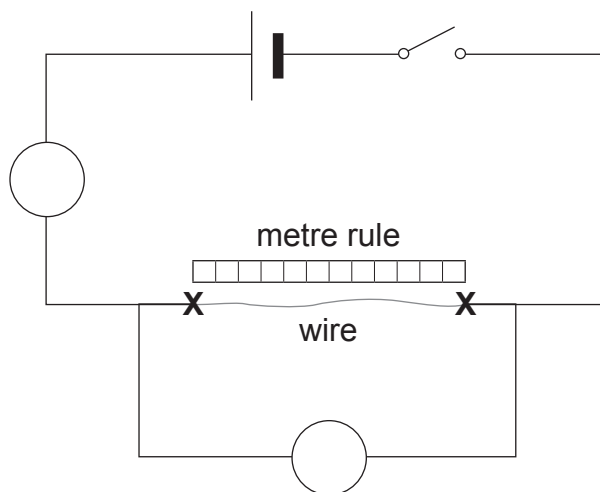
Measurements of current and voltage were recorded for different lengths of wire.

(i) On the diagram above, complete the symbols for the meters used to measure the current and voltage. [2]

When electricity is flowing, the wire will become hot and its resistance will change.

(ii) Name the component in the circuit that controls when the current flows.

_____ [1]

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The graph below shows the results of this investigation.
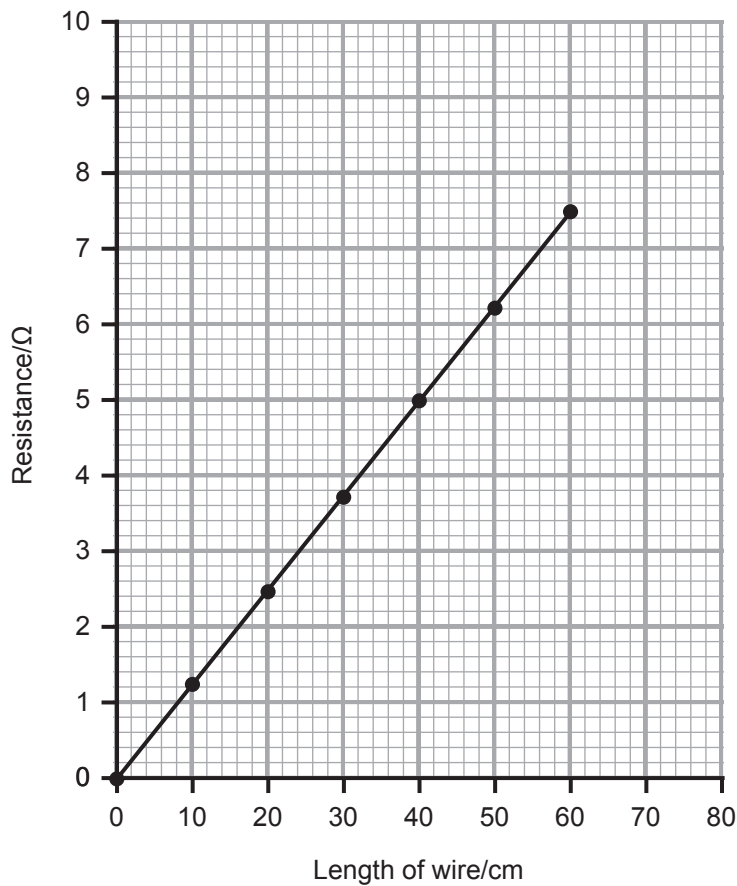
Length of wire/cm

(iii) Use the graph to predict the resistance of an 80 cm length of this wire.

_____ Ω   [1]

When there is a voltage of 5 V across a wire, a current of 0.5 A flows.

(b) Use the equation:

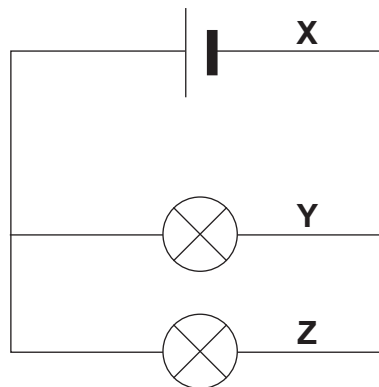$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

to calculate the resistance of this piece of wire.

Show your working out.

_____ Ω   [2]

[Turn over

(c) A student set up the circuit below using two identical bulbs.

(i) Complete the following sentence.

The bulbs in this circuit are connected in _____ . [1]

The current was measured at points **X**, **Y** and **Z** in the circuit.

(ii) Complete the table below to give the current measured at positions **X** and **Y**.

Circuit position	Current/A
X	
Y	
Z	0.5

[2]

(d) Which diagram below shows the correct polarity for a cell?

Circle your answer.

[1]

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(Questions continue overleaf)

2 The table below shows information about four of the planets in the Solar System.

	Distance from Sun/ million km	Orbital time/ years	Average Temperature/°C
Jupiter	778	12	−110
Saturn	1434	29	−140
Uranus	2873	84	−195
Neptune	4495	164	−200

(a) State **two** trends shown by this data.

1. _____

_____

2. _____

_____ [2]

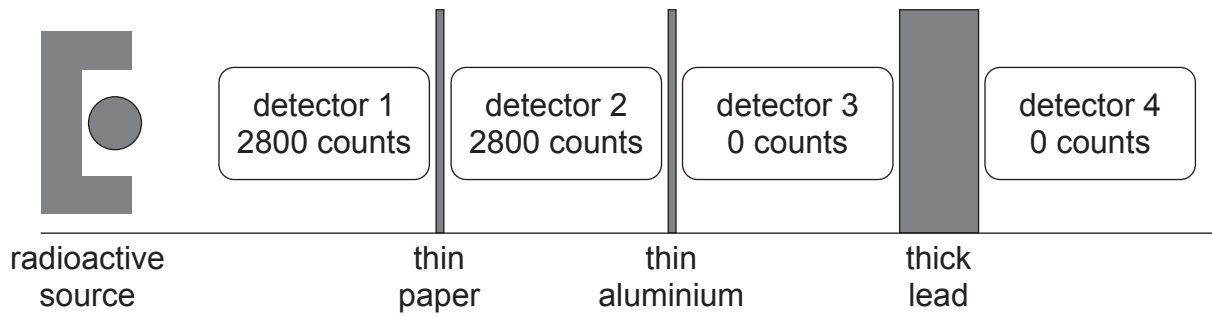The table below gives information about an astronaut travelling from the Earth to the Moon.

	Mass/ kg	Gravity/ N/kg	Weight/ N
Earth	70	10	700
Space		0	0
Moon	70	1.7	119

(b) Complete the table to give the mass of this astronaut in Space. [1]

(c) Describe fully the structure of the inner Solar System.

Your answer should include:

- the names and order of the four inner planets;
- the surface material of the inner planets;
- a description of how planets move and the name of the force involved; and
- examples of natural and artificial objects moving around planets.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

_____

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_____

_____ [6]

[Turn over

3 **(a)** The diagram below shows four detectors used to measure radiation as it passes through different materials.

| | detector 1 2800 counts | detector 2 2800 counts | detector 3 0 counts | detector 4 0 counts |

radioactive source   thin paper   thin aluminium   thick lead

(i) Name the type of radiation emitted by this source.

_____ [1]

(ii) Complete the following sentence.

A nucleus is radioactive because the combination of protons

and _____ is unstable and causes

it to disintegrate. [1]

(b) Give **one** use of radioactivity in medicine.

_____ [1]

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4 The table below shows information about the amount of biofuels used for road transport in the UK.

Year	Percentage of road transport using biofuel/%	
	Bioethanol	Biodiesel
2016	4.8	2.4
2018	5.0	3.9
2020	5.6	3.8

In 2018, the UK Government set a target to reach 10% of road transport fuel to be biofuel by 2020.

(a) This target was not met. Calculate by how much it was below the target.

_____ % [1]

(b) Car manufacturers have been trying to minimise reliance on fossil fuels using extenders and substitutes.

  (i) Explain the difference between an extender and a substitute.

  _____

  _____

  _____ [2]

  (ii) Name **one** extender.

  _____ [1]

[Turn over

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5 **(a)** The diagram below shows the forces acting on a **moving** car of mass 1200 kg.

(i) Explain, in terms of forces, the movement of this car.

_____

_____ [2]

The driver then increases the forward force as shown in the diagram below.

(ii) What is the resultant force on this car?

_____ N   [1]

(iii) Use the equation:

resultant force = mass × acceleration

to calculate the acceleration of this car.

Show your working out.

_____ m/s^2 [2]

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(b) In a collision the less force exerted on the driver, the less injury will occur.

The force exerted on the driver depends on how long it takes the driver to come to a complete stop inside the car.

Wearing a seat belt increases the amount of time it takes a driver to stop.

The table below shows the times from a car hitting an object to the driver coming to a complete stop and the forces that are exerted on the driver.

Time for driver to come to a complete stop/s	Force exerted on the driver/N
0.2	12 000
0.4	6000
0.6	4000
0.8	3000
1.0	1000

(i) Use the information in the table to explain why it is safer to wear a seat belt.

_____

_____

_____ [2]

(ii) How does a crumple zone act as a safety feature in a car collision?

_____

_____ [1]

[Turn over

6 Sound is an example of a longitudinal wave.

(a) Describe the movement of particles in a longitudinal wave.

_____

_____ [2]

The table below shows how the maximum frequency of sound heard by a human changes with age.

Age/years	Maximum frequency/Hz
15	20 000
20	19 000
25	17 000
30	16 000
40	15 000
50	12 000
60	10 000

(b) Give the trend shown by this information.

_____

_____ [1]

(c) (i) What is the **lowest** frequency humans can hear?

_____ Hz [1]

(ii) What name is given to sound with frequencies above 20 000 Hz?

_____ [1]

(d) The diagram below shows how the speed of sound can be measured using the flash-bang method.
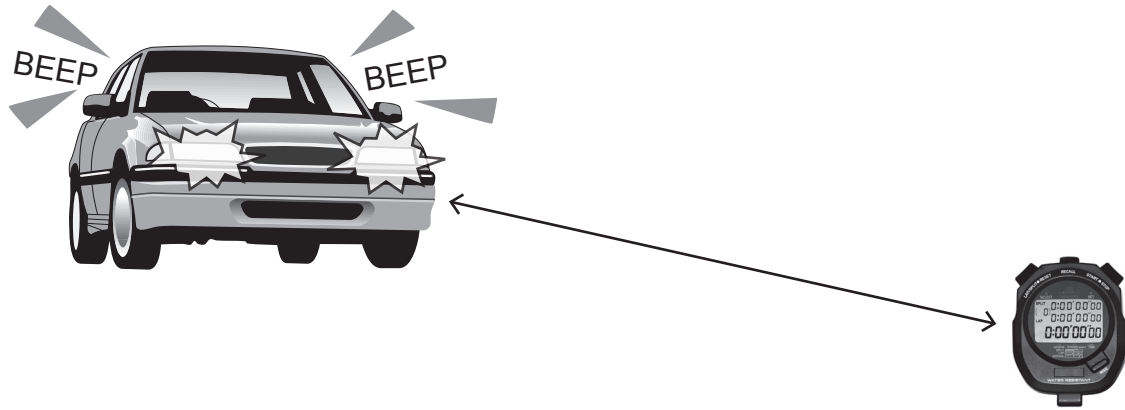
(i) Describe how the speed of sound can be measured using the flash-bang method.

_____

_____

_____

_____

_____ [3]

[Turn over

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The experiment was repeated on different days and the results are shown in the table below.

Day of week	Speed of sound/ m/s
Monday	327.1
Tuesday	333.4
Wednesday	334.2

(ii) Use the information in the table to calculate the average speed of sound. Give your answer to one decimal place.

_____ m/s   [2]

(iii) Apart from human error, suggest what could cause the different values for the speed of sound.

_____

_____   [1]

7 The cross-sectional area of a wire affects its resistance.

The table below shows how the resistance of 100 m of wire changes with cross-sectional area.

Cross-sectional area/mm²	Resistance/Ω
0.5	3.4
1.0	1.7
1.5	1.1
2.0	0.9
2.5	0.7

(a) On the grid below plot and draw a line graph for this information.
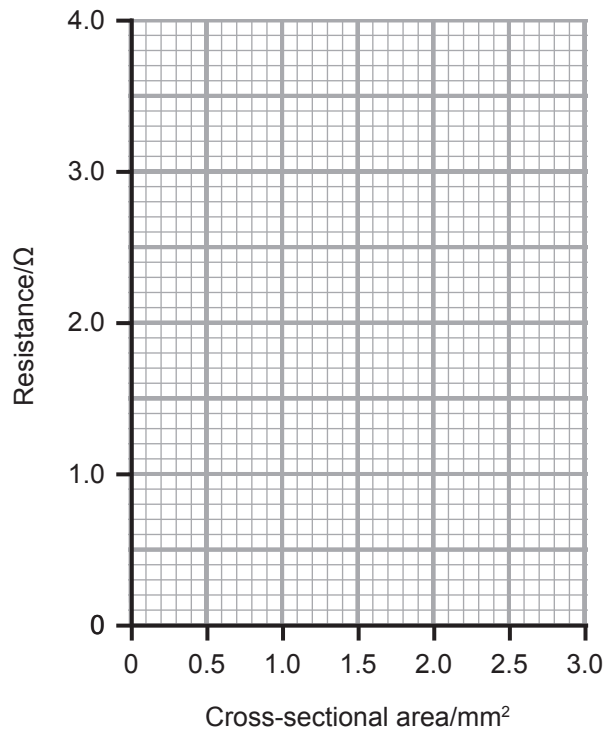
[3]

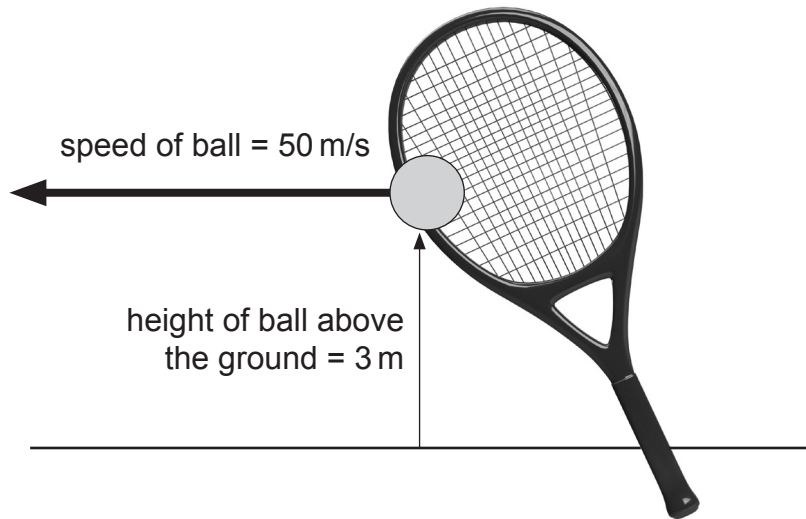**(b)** Predict the resistance when the cross-sectional area of this wire is 3 mm².

_____ Ω [1]

[Turn over

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8 **(a)** State the Principle of Conservation of Energy.

_____

_____ [1]

The diagram below shows a tennis racket hitting a ball of mass 0.06 kg.

speed of ball = 50 m/s

height of ball above
the ground = 3 m

(b) **(i)** Use the equation:

$$E_p = mgh$$

to calculate the gravitational potential energy of this ball when it is hit by the racket.

Use g = 10 N/kg.

Show your working out.

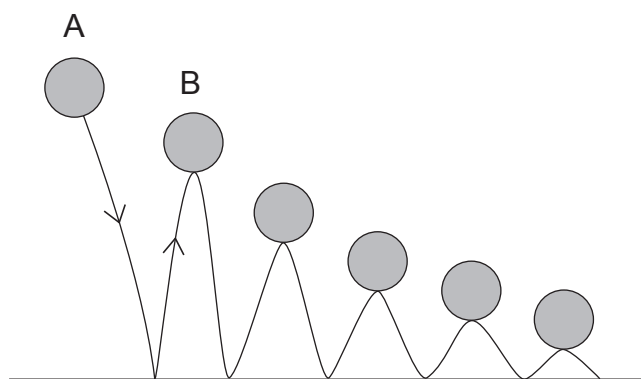_____ J   [2]

When the ball is hit, it gains kinetic energy.

(ii) Choose the equation which is used to calculate kinetic energy.

Circle your answer.

$$E_K = mv^2 \qquad : \qquad E_K = \frac{1}{2}\,mv \qquad : \qquad E_K = \frac{1}{2}\,mv^2$$

[1]

When a falling ball bounces on the ground, it rebounds to a lower height.

(c) Describe the energy changes of the ball as it rebounds from A to B.

_____

_____

_____ [2]

[Turn over

9 **(a)** The diagram below shows two identical metal cans containing boiling water. One can has a dark, matt surface and the other has a light, shiny surface.
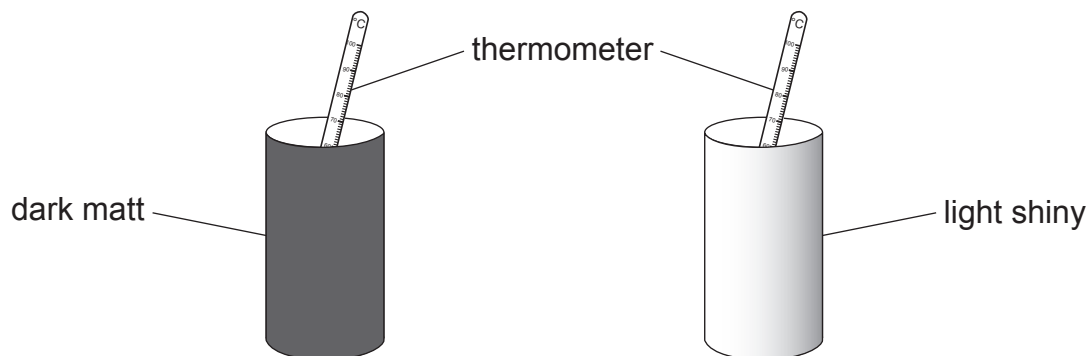
The temperature of the water in each can was recorded as it cooled.

The results are given in the table below.

Time/minutes	Temperature/°C	
	Dark matt surface	Light shiny surface
0	98	98
5	39	52
10	26	39
15	20	32
20	20	30
25	20	29

(i) Give the trend for the dark, matt surface.

_____

_____ [1]

(ii) Why does the dark, matt can cool faster than the light shiny can?

_____

_____

_____ [1]

(iii) Describe how the heat travels from the inner surface of the metal cans to the outer surface.

_____

_____ [2]

(b) Why would putting a lid on the metal cans keep the water warmer for longer?

_____

_____ [1]

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