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Centre number

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INTERNATIONAL GCSE COMBINED SCIENCE

Paper 3 Physics Extension

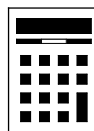


Thursday 6 June 2019 07:00 GMT Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- the Physics Equations Sheet (enclosed).



Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- 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.

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

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a scientific calculator where appropriate.
- The Physics Equations Sheet is provided as a loose insert.



Answer **all** questions in the spaces provided.

0 1

A student investigated the effect of the starting temperature of hot water on the rate at which it cooled.

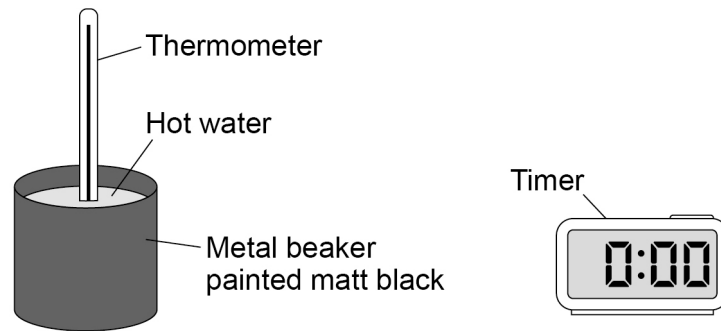
Table 1 shows the student's results.

Table 1

Starting temperature in °C	Temperature after 5 minutes in °C
80	66
70	59
60	52
50	45
40	37

Figure 1 shows the equipment used.

Figure 1



0 1 . 1

Describe a method the student could use to carry out the investigation safely and obtain the results in **Table 1**.

[6 marks]



0 1 . 2

What was the resolution of the thermometer used in the investigation?

[1 mark]

Resolution = _____ °C

0 1 . 3

Explain **one** conclusion the student should make from the results in **Table 1**.

[2 marks]

0 1 . 4

The student repeated the investigation using a metal beaker of the same shape and size but painted shiny silver.

Explain why the temperature after 5 minutes was higher than with the matt black beaker for each starting temperature.

[2 marks]

11



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ANSWER IN THE SPACES PROVIDED**

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0 2

Light and sound are examples of waves.

0 2 . 1

Give **two** differences and **two** similarities between light waves and sound waves.**[4 marks]**

Difference 1 _____

Difference 2 _____

Similarity 1 _____

Similarity 2 _____

0 2 . 2

Figure 2 shows a loudspeaker connected to a signal generator.

The loudspeaker emits sound waves that are detected by the microphone.
The oscilloscope produces a trace that represents the sound waves.

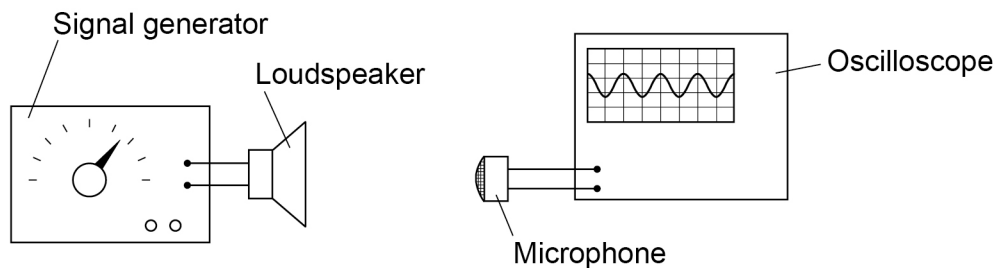
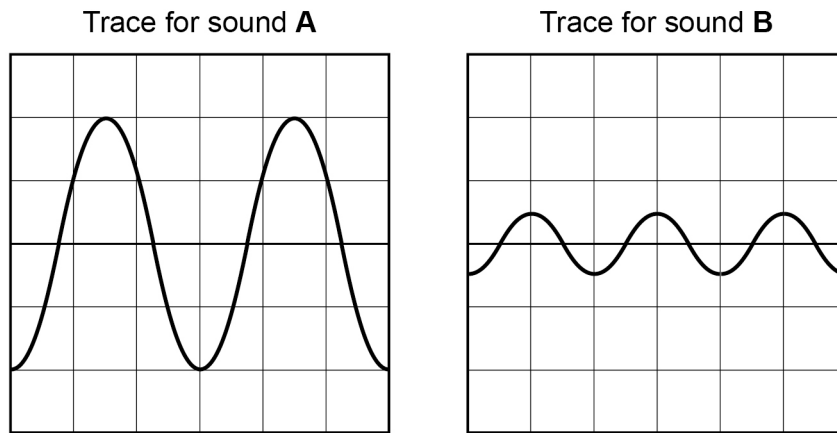
Figure 2

Figure 3 shows oscilloscope traces for two different sound waves, **A** and **B**.
The oscilloscope settings remain constant.

Figure 3



Explain why the two different sound waves, **A** and **B**, sound different.

[4 marks]

0 2 . 3

Sound wave **A** has a frequency of 12 kHz and a wavelength of 2.8 cm.

Calculate the speed of sound wave **A**.
Use the Physics Equations Sheet.

[4 marks]

Speed = _____ m/s

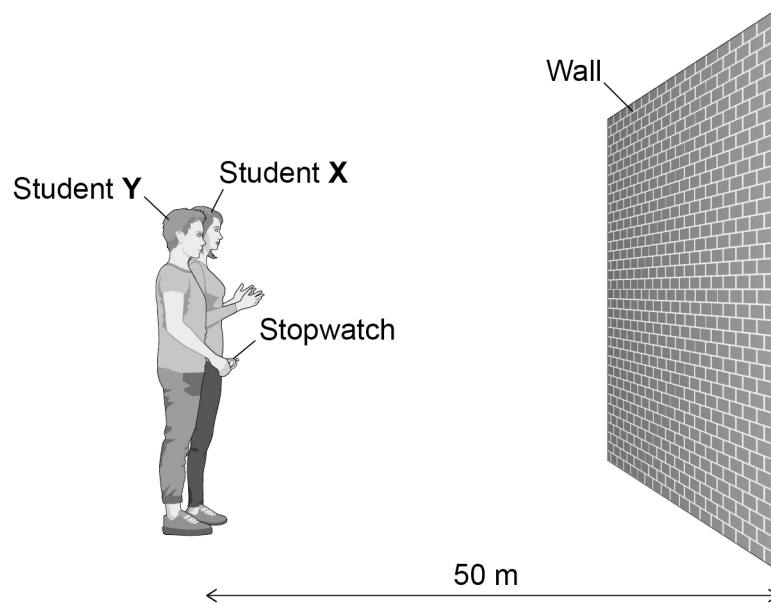
Question 2 continues on the next page

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Figure 4 shows two students measuring the speed of sound in air.

Figure 4



This is the method used.

- The students stood 50 m away from a wall.
- Student **X** produced a sound and at the same time student **Y** started a stopwatch.
- Student **Y** stopped the stopwatch when they heard the echo from the wall.

Measurements were taken three times. **Table 2** shows the results.

Table 2

Measurement number	1	2	3
Time for echo to be heard in seconds	0.45	0.35	0.40



0 2 . 4

Explain why it was a good idea to take the measurements three times.

[2 marks]

0 2 . 5

The results in **Table 2** do **not** give an accurate value for the speed of sound in air.

Suggest **one** improvement to the method that would increase the accuracy of the results.

Give a reason for your answer.

[2 marks]

16

Turn over for the next question

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0 3

A driver wants to buy a new car.

Table 3 shows some information about petrol cars, diesel cars and electric cars.**Table 3**

Feature	Petrol car	Diesel car	Electric car
Cost of the car	\$13 500	\$16 000	\$21 500
Cost of driving	\$1.17 per litre of petrol	\$1.06 per litre of diesel	\$0.20 per kW h of energy
Maximum storage capacity	50 litres	50 litres	40 kW h
Maximum range in kilometres	720	960	240
Carbon dioxide emission while being driven in grams per kilometre	99	94	0

Maximum range is the distance the car can travel before needing to be refuelled or recharged.

0 3 . 1

Electric cars have a battery that needs to be charged using mains electricity.

Explain why the total carbon dioxide emission is **not** zero for an electric car.**[2 marks]**

0 3 . 2

Determine the difference between the cost of driving a petrol car and the cost of driving an electric car for 240 kilometres.

Use information from **Table 3**.**[4 marks]**

Difference = \$ _____



0 4

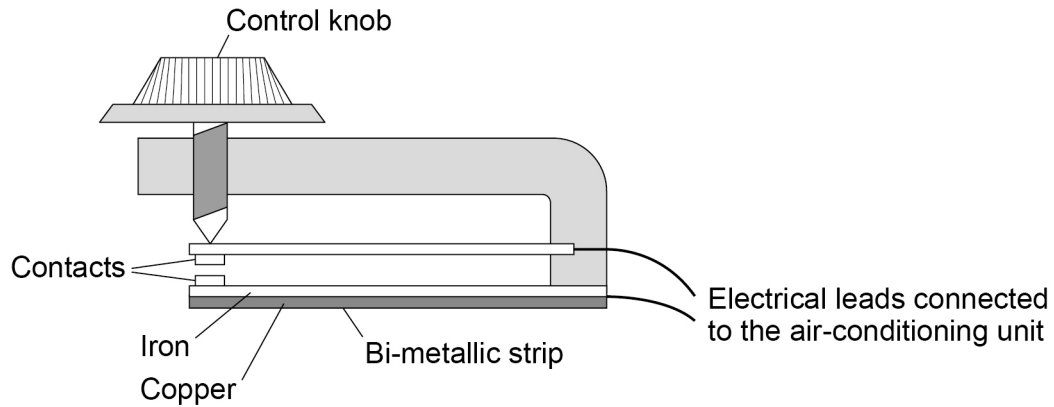
Thermostats are used to control temperature.

0 4 . 1

Figure 5 shows part of a simple thermostat circuit.

The circuit uses a bi-metallic strip to switch an air-conditioning unit on and off. The bi-metallic strip is made from copper and iron. Copper expands more than iron when heated.

Figure 5



Explain how the air-conditioning unit switches on when the temperature of the room increases.

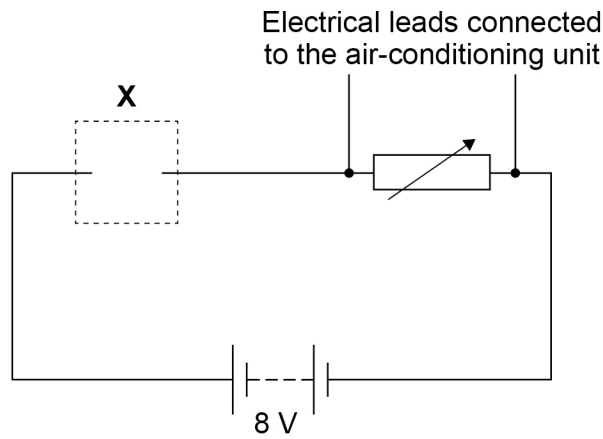
[4 marks]



0 4 . 2 Another type of thermostat uses a thermistor.

Figure 6 shows a simple sensor circuit for a thermostat connected to an air-conditioning unit.

Figure 6



The component labelled **X** is a thermistor.

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

[1 mark]

0 4 . 3 The temperature in the room increases.

Describe how the thermistor controls the air-conditioning unit.

[4 marks]

Question 4 continues on the next page

Turn over ►



0	4	.	4
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The resistance of the variable resistor is set to $2000\ \Omega$.
The potential difference across the variable resistor is $3.2\ \text{V}$.

Calculate the resistance of the thermistor.
Use the Physics Equations Sheet.

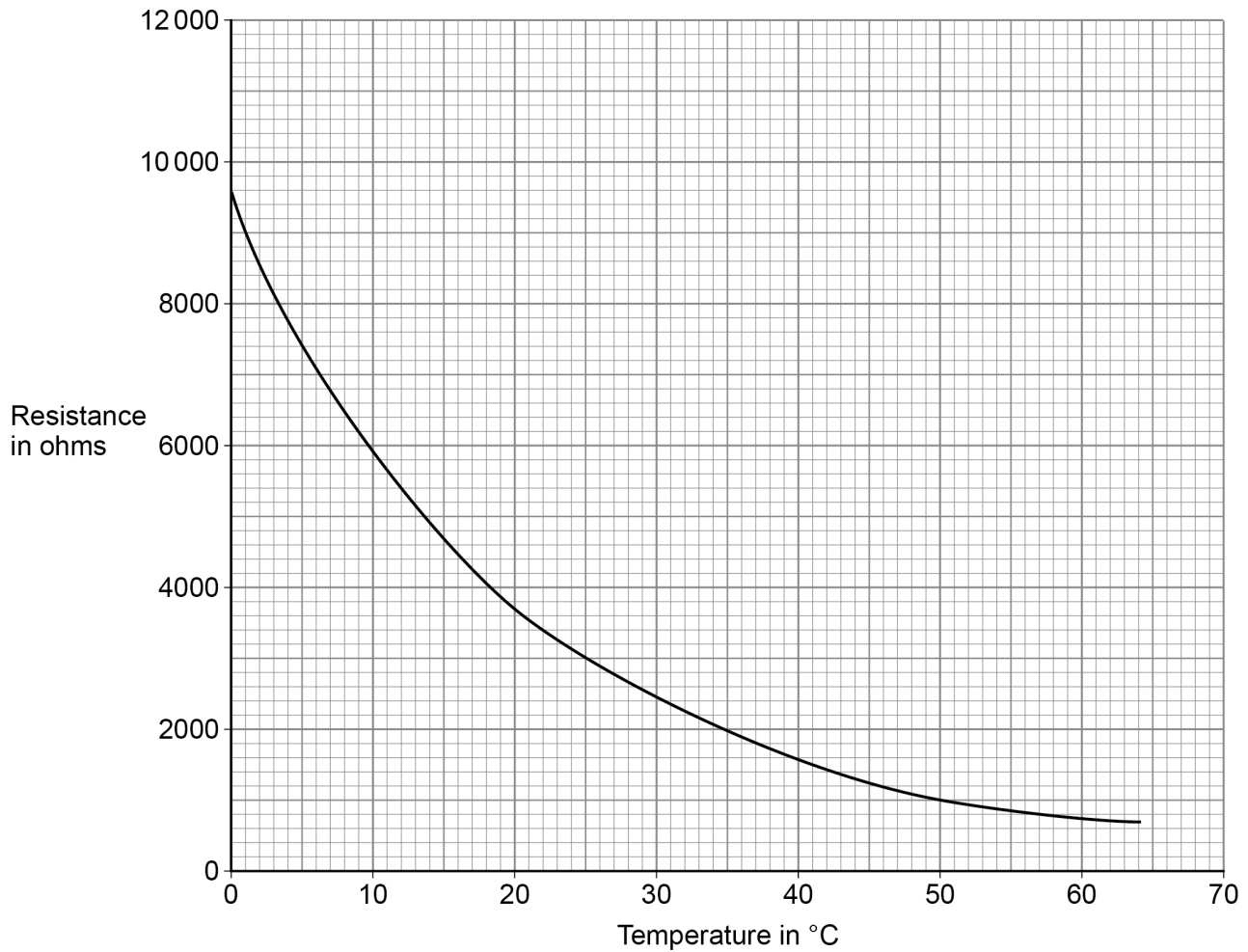
[4 marks]

Resistance = _____ Ω



0 4 . 5 Figure 7 shows how the resistance of the thermistor varies with temperature.

Figure 7



The temperature changes from 20 °C to 40 °C.

Determine the change in resistance of the thermistor.

[1 mark]

Change in resistance = _____ Ω

0 4 . 6 The thermistor in **Figure 6** is replaced with a second thermistor that has a greater change in resistance between 20 °C and 40 °C. This makes the thermostat more sensitive at room temperature.

Sketch a curve for the second thermistor on **Figure 7**.

[1 mark]

15

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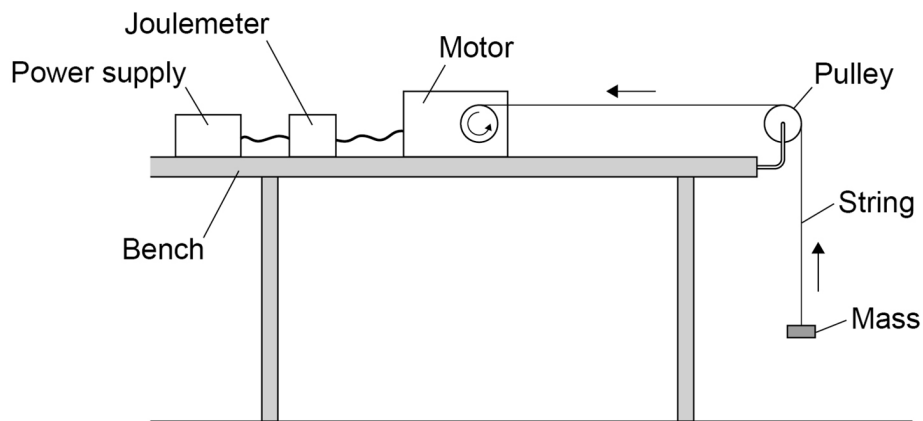


0 5

A student investigated how the mass lifted by a motor affected the efficiency of the motor.

Figure 8 shows the apparatus used.

Figure 8



This is the method used.

1. Add the mass to the string.
2. Switch on the power supply so that the motor lifts the mass through a height of 1.2 m.
3. Record the electrical energy transferred from the joulemeter.
4. Repeat steps 1 to 3 with different masses.

0 5 . 1

Give the independent variable in the investigation.

[1 mark]

Question 5 continues on the next page

Turn over ►



Table 4 shows the results.

Table 4

Mass in kilograms	Percentage (%) efficiency
0.020	7.8
0.030	10.4
0.040	12.1
0.050	X
0.060	14.4
0.070	15.0

0 5 . 2 When the motor lifted a 0.050 kg mass, the energy transferred to the motor was 4.4 J.

Calculate **X**, the percentage efficiency of the motor when it lifted this mass through 1.2 m.

Use the Physics Equations Sheet.

gravitational field strength = 9.8 N/kg

[4 marks]

Percentage efficiency = _____ %



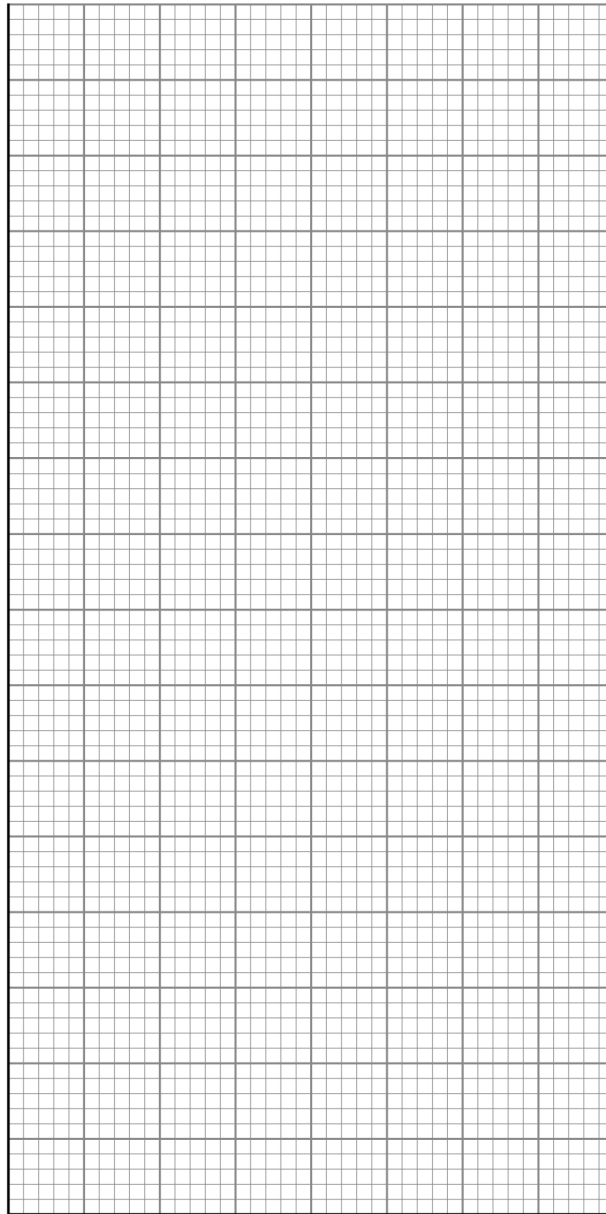
0 5 . 3

Plot a graph on **Figure 9** of mass against percentage efficiency for the results in **Table 4**. Draw a line of best fit.

[4 marks]

Figure 9

Percentage
efficiency



Mass in kilograms

0 5 . 4

Give **two** conclusions from your graph.

[2 marks]

- 1 _____
- 2 _____

Question 5 continues on the next page

Turn over ►



0 5 . 5 The motor wastes energy as it lifts the mass.

What happens to the wasted energy?

[1 mark]

0 5 . 6 The student continued to increase the mass on the string until the motor could not lift the mass.

Explain what happens to the efficiency of the motor when it can no longer lift the mass.

[2 marks]

0 5 . 7 Explain how the student could use the motor to lower the mass to the floor before each measurement.

[2 marks]



0 6 . 2 Table 5 shows information about three satellites orbiting the Earth.

Table 5

Satellite	Height above the Earth's surface in kilometres	Orbital speed in kilometres per second
Hubble Space Telescope (HST)	600	7.56
Global Positioning System (GPS)	20 200	3.87
Television satellite	35 800	3.07

A student says that for satellites, the orbital speed is inversely proportional to height above the Earth's surface.

Explain why the student is **not** correct.
Use data from **Table 5**.

[2 marks]

0 6 . 3 Explain why a satellite is accelerating even when its orbital speed is constant.

[3 marks]



0 6 . 4

Explain how the orbital speed of a satellite changes as its height above the Earth's surface changes.

[2 marks]

0 6 . 5

The television satellite takes 86 320 s to orbit the Earth once.

Explain whether the television satellite is in a geostationary orbit.

[2 marks]

0 6 . 6

The HST is used to produce images of objects in space.

Suggest **one** advantage of putting a telescope in orbit above the Earth.

[1 mark]

Question 6 continues on the next page

Turn over ►

- 0 6 . 7** Calculate the time that the HST takes to make one orbit of the Earth.
Use **Table 5**.

radius of Earth = 6.4×10^3 km

[3 marks]

Time for one orbit = _____ s

- 0 6 . 8** The Earth exerts a gravitational force on the HST. The HST exerts an equal and opposite force on the Earth.

Which of Newton's laws is this an example of?
Tick (✓) **one** box.

[1 mark]

First law

Second law

Third law

18



0 7

Electromagnetic waves form a continuous spectrum which includes visible light and X-rays.

0 7 . 1

What is the range of wavelengths of the electromagnetic spectrum?
Tick (✓) **one** box.

[1 mark]

10^4 m to 10^{15} m and beyond

10^{-15} m to 10^4 m and beyond

10^{-4} m to 10^{15} m and beyond

0 7 . 2

How does visible light compare with X-rays?
Tick (✓) **one** box.

[1 mark]

Visible light has a longer wavelength and a higher frequency than X-rays.

Visible light has a longer wavelength and a lower frequency than X-rays.

Visible light has a shorter wavelength and a higher frequency than X-rays.

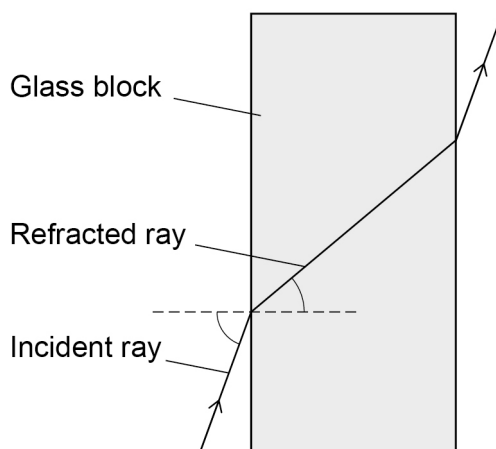
Visible light has a shorter wavelength and a lower frequency than X-rays.

Question 7 continues on the next page

Turn over ►

Figure 10 shows the refraction of visible light as it passes into a glass block and out the other side.

Figure 10



A teacher demonstrated how to determine the relationship between the wavelength of light and angle of refraction. A Vernier protractor was used to measure angles to the nearest 0.01° .

This is the method used.

1. Use a Vernier protractor to measure an angle of 70.00° to the normal on the glass block and draw a line.
2. Shine a very narrow ray of red light along the line.
3. Measure the angle of refraction of the light when it passes from the air into the glass block.
4. Repeat steps 1 to 3 for very narrow rays of different colours of light.

Table 6 shows the results that the teacher recorded.

Table 6

	Mean angle of refraction in degrees
Red	38.17
Yellow	38.08
Green	38.00
Blue	37.92



0 7 . 3

Explain why the teacher used a Vernier protractor to measure angles.

[2 marks]

0 7 . 4

The teacher repeated the measurements several times and calculated a mean.

Explain **one** other way the teacher made sure that the results were as accurate as possible.**[2 marks]**

0 7 . 5

What is the relationship between the wavelength of light and the angle of refraction in **Table 6**?**[1 mark]**

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