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Candidate Number

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# Physics

**Unit: 4PH0**

**Science (Double Award) 4SC0**

**Paper: 1PR**

Wednesday 23 May 2018 – Afternoon

**Time: 2 hours**

Paper Reference

**4PH0/1PR  
4SC0/1PR**

**You must have:**

Ruler, protractor, calculator

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

## Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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## EQUATIONS

You may find the following equations useful.

$$\text{energy transferred} = \text{current} \times \text{voltage} \times \text{time}$$

$$E = I \times V \times t$$

$$\text{pressure} \times \text{volume} = \text{constant}$$

$$p_1 \times V_1 = p_2 \times V_2$$

$$\text{frequency} = \frac{1}{\text{time period}}$$

$$f = \frac{1}{T}$$

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

$$P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}}$$

$$P = \frac{W}{t}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}}$$

$$v = \frac{2 \times \pi \times r}{T}$$

Where necessary, assume the acceleration of free fall,  $g = 10 \text{ m/s}^2$ .

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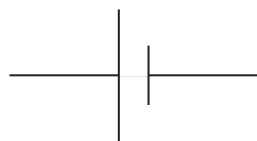
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**Answer ALL questions.**

**1** Identify the circuit diagram symbols.

(a)



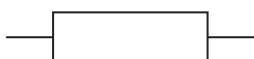
(1)

(b)



(1)

(c)



(1)

(d)



(1)

**(Total for Question 1 = 4 marks)**



2 (a) Diagram 1 shows the orbit of Mercury and the orbit of the Earth.

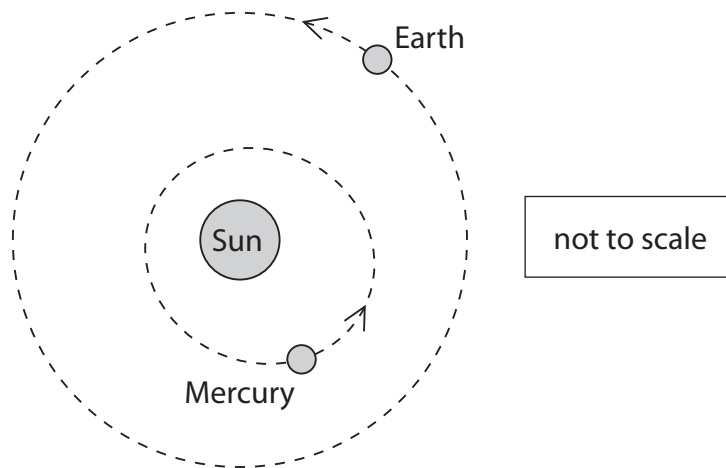


Diagram 1

Describe two differences between the orbit of Mercury and the orbit of the Earth.  
Use diagram 1 to help you with your answer.

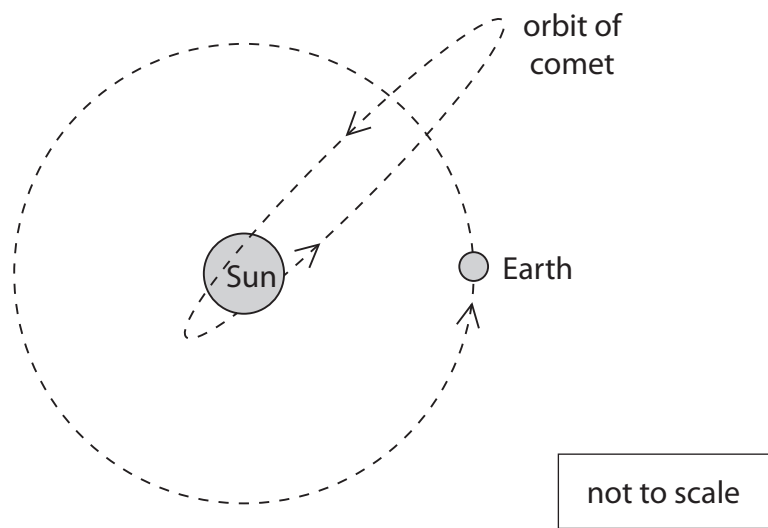
(2)

1 .....

2 .....



(b) Diagram 2 shows the orbit of a comet and the orbit of the Earth.



**Diagram 2**

Describe two differences between the orbit of the comet and the orbit of the Earth.

Use diagram 2 to help you with your answer.

(2)

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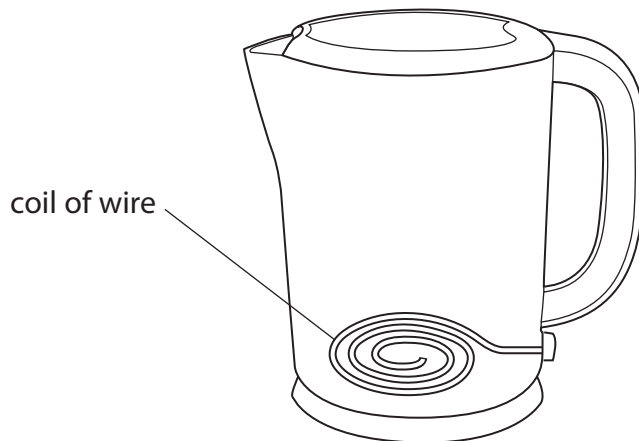
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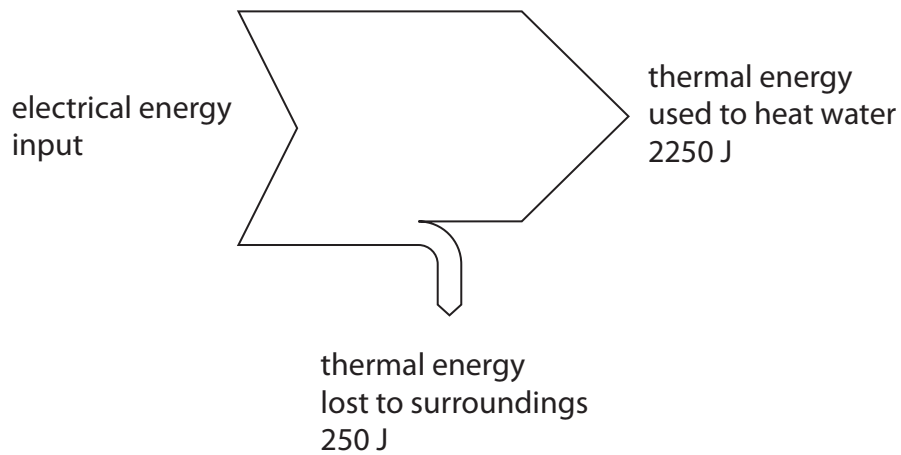
**(Total for Question 2 = 4 marks)**



3 The diagram shows an electric kettle.



(a) The Sankey diagram shows the energy transfers that take place in one second when the kettle heats some water.



What is the energy input in one second?

(1)

- A 250 J
- B 2000 J
- C 2250 J
- D 2500 J



(b) There is a large insulated coil of wire inside the kettle.

Explain why this coil of wire gets hot when the kettle is switched on.

(2)

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(c) The power of the kettle is 2.5 kW when operating at a voltage of 230 V.

(i) State the equation linking power, current and voltage.

(1)

(ii) Show that the current in the kettle is about 11 A.

(2)

(iii) The plug of the kettle is fitted with a 13A fuse.

Describe how the fuse prevents the coil of wire from overheating.

(3)

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**(Total for Question 3 = 9 marks)**



- 4 (a) A student makes some statements about how light from an object forms an image in a plane mirror.

Only two of these statements are correct.

Tick two boxes in the table to show the correct statements.

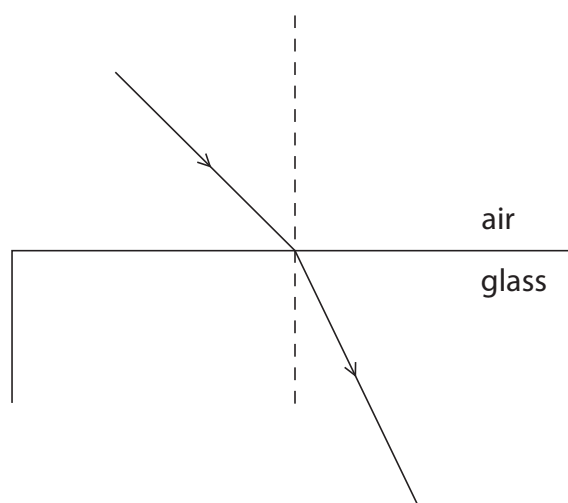
(2)

Statements	Tick
the light from the object passes through the image in a plane mirror	
the light waves are longitudinal	
the angle of incidence equals the angle of reflection	
the image in a plane mirror is virtual	
the incident ray is always at right angles to the reflected ray	

- (b) The diagram shows a ray of light travelling from air to glass.

Measure the angle of incidence ( $i$ ) and the angle of refraction ( $r$ ) for this ray.

(2)



angle of incidence ( $i$ ) = .....

angle of refraction ( $r$ ) = .....

- (c) (i) State the equation linking refractive index, angle of incidence and angle of refraction.

(1)





(ii) Describe an experiment to determine the refractive index of a glass block.

In your answer, you should refer to

- the apparatus that should be used
- the measurements that should be taken
- the method of analysing the data

You may add a diagram to help your answer.

(6)

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**(Total for Question 4 = 11 marks)**



5 An adaptor plugged into the mains supply is used to charge a mobile phone.

The photograph shows the adaptor that displays the voltage and current readings as the battery charges.



(a) (i) State the equation linking voltage, current and resistance.

(1)

(ii) Use the readings on the adaptor to calculate the resistance of the circuit used to charge the battery.

Give the unit.

(4)

resistance = ..... unit .....



(b) The battery of the mobile phone takes 45 minutes to charge.

The charging current is 0.42 A.

(i) State the equation linking charge, current and time. (1)

(ii) Calculate the charge transferred to the battery. (2)

charge = ..... C

(iii) The cable connecting the mobile phone to the adaptor is changed for a much longer cable of the same type.  
Explain how this would affect the time taken for the battery to charge.  
[assume same charge transferred to battery] (3)

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**(Total for Question 5 = 11 marks)**



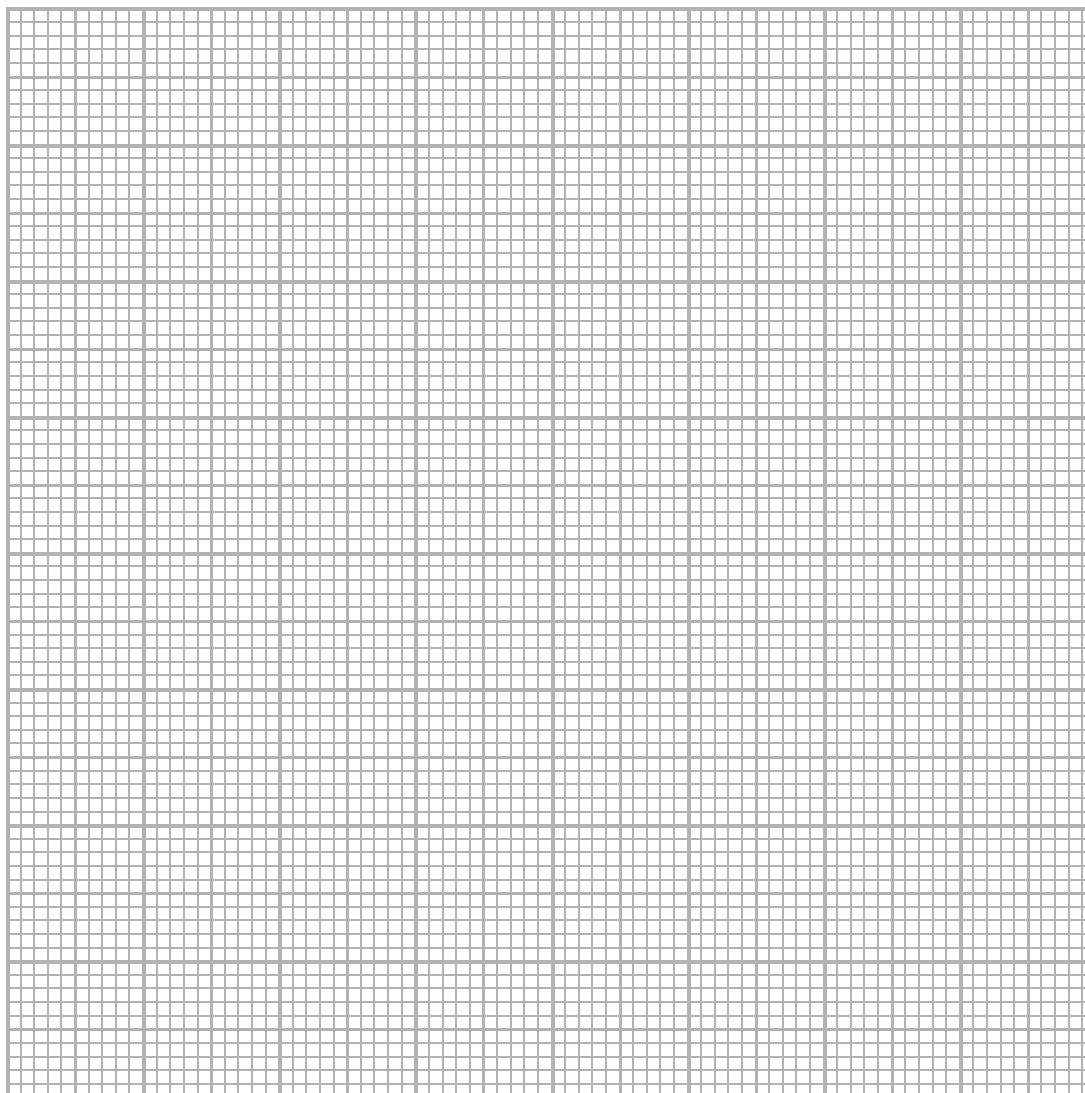
6 A scientist investigates how the wavelength of sound waves in water varies with frequency.

The table shows her data.

<b>Frequency in Hz</b>	6.0	4.2	3.7	1.5	1.1
<b>Wavelength in m</b>	250	360	405	1000	1420

(a) (i) Plot a graph of the results on the grid.

(4)



(ii) Draw the curve of best fit.

(1)

(iii) Use your graph to find the frequency of sound waves that have a wavelength of 600 m in water.

(1)

frequency = ..... Hz



(iv) Describe the relationship between frequency of sound and wavelength.

(2)

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(b) Suggest how the scientist could improve her results.

(1)

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(c) (i) State the equation linking speed, frequency and wavelength of a wave.

(1)

(ii) Calculate the speed of sound in water for a wavelength of 510 m and a frequency of 3.0 Hz.

(2)

speed of sound in water = ..... m/s

**(Total for Question 6 = 12 marks)**

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7 This question is about pressure.

(a) Explain why it is easier to cut vegetables with a sharp knife than with one that is not sharp.

(3)

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(b) Balloons are often filled with helium so that they float in air.

A small canister of pressurised helium is used to fill some balloons.

(i) Using ideas about particles, explain why the pressure in the canister decreases as the helium is used to fill the balloons.

(3)

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(ii) The canister supplies  $18\,000\text{ cm}^3$  of helium at a pressure of  $2300\text{ kPa}$ .

The volume of each balloon is  $8200\text{ cm}^3$ .

The pressure exerted by the helium in each balloon is  $100\text{ kPa}$ .

Calculate how many balloons can be filled using the helium from the canister.

[assume temperature of the helium remains constant]

(3)

number of balloons = .....

**(Total for Question 7 = 9 marks)**

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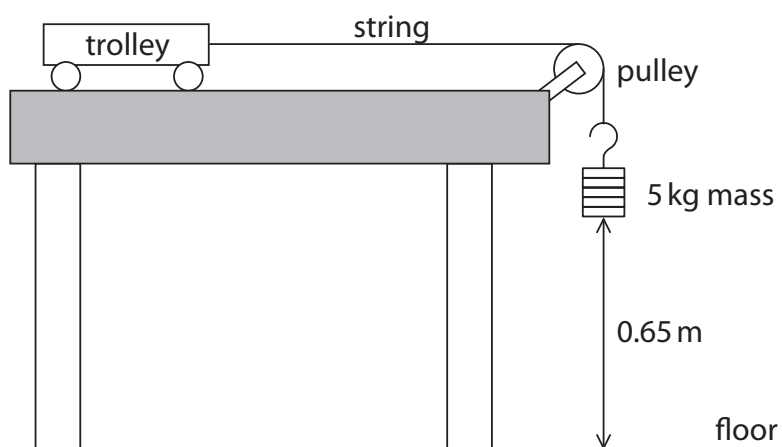
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P 5 3 3 1 4 A 0 1 5 3 6

- 8 (a) This apparatus is used to investigate acceleration.



The trolley starts from rest and accelerates.

$$\text{mass of trolley} = 0.87 \text{ kg}$$

$$\text{acceleration} = 7.9 \text{ m/s}^2$$

- (i) State the equation linking unbalanced force, mass and acceleration.

(1)

- (ii) Calculate the unbalanced force on the trolley.

(2)

$$\text{unbalanced force} = \dots\dots\dots \text{ N}$$

- (iii) What is the direction of the frictional forces acting on the trolley?

(1)

- (iv) State two places where friction occurs as the trolley moves.

(2)

- 1 .....
- 2 .....





(b) (i) State the equation linking gravitational potential energy (GPE), mass,  $g$  and height. (1)

(ii) Calculate the change in GPE of the 5 kg mass as it falls to the floor.  
[gravitational field strength = 10 N/kg] (2)

change in GPE = ..... J

(iii) State the kinetic energy gained by the trolley and mass if there were no frictional forces. (1)

kinetic energy gained = ..... J

**(Total for Question 8 = 10 marks)**



- 9 There are many artificial satellites orbiting the Earth.

Table 1 lists some data for three different satellites.

	International Space Station	Hubble	Iridium
Use	scientific research	stellar observation	satellite phones
Height above Earth's surface in km	405	540	780
Speed in km/s	7.67	7.59	7.50
Period in minutes	92.65	95.47	
Revolutions per day	15.54	15.08	

**Table 1**

- (a) Calculate the period of the Iridium satellite in minutes.

[radius of the Earth = 6371 km]

(4)

period = ..... mins

- (b) Calculate the number of revolutions per day for the Iridium satellite.

(1)

number of revolutions per day = .....



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(c) Table 2 gives some statements about satellite orbits.

Tick three boxes to show which three statements are correct.

Use data from table 1 to help you answer.

(3)

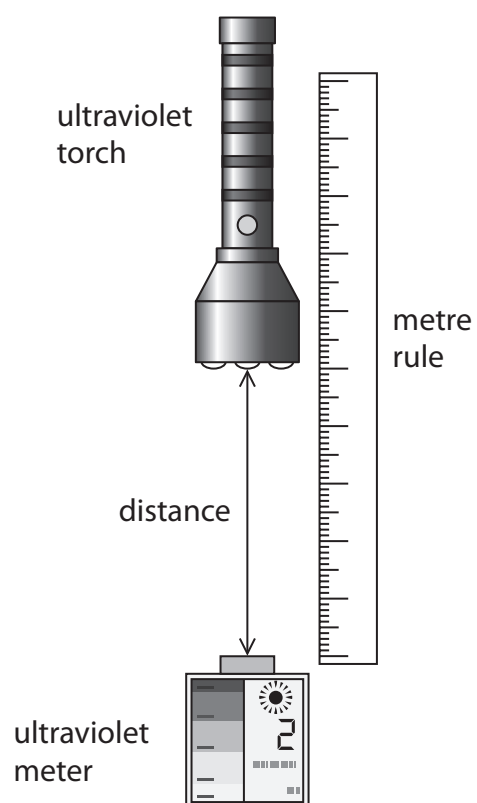
Statements	Tick
the higher the speed, the lower the height of the satellite	
a greater period means that the satellite has a greater speed	
satellites that orbit higher make more revolutions per day	
lower height satellites have shorter periods	
satellites with a higher speed make fewer revolutions per day	
the higher the number of revolutions per day, the shorter the period	

**Table 2**

**(Total for Question 9 = 8 marks)**



- 10 (a) Two students use this apparatus to investigate how the intensity of ultraviolet light varies with distance.



The students take readings for various distances.

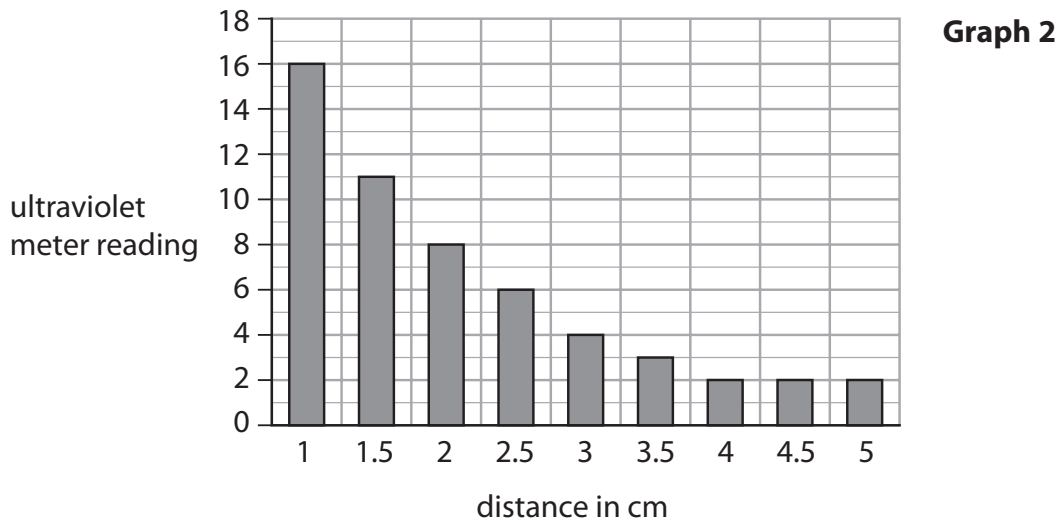
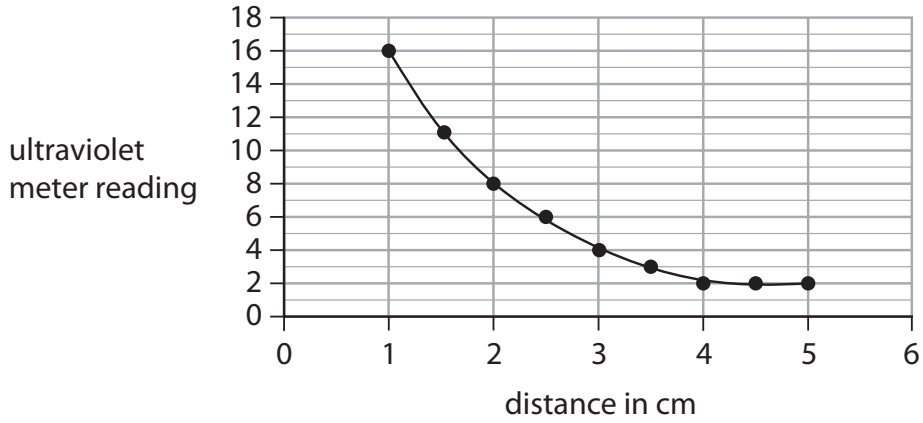
The ultraviolet meter only gives readings in whole numbers.

The table shows their results.

Distance in cm	Ultraviolet meter reading
1.0	16
1.5	11
2.0	8
2.5	6
3.0	4
3.5	3
4.0	2
4.5	2
5.0	2



Each student displays the results as a different graph.



(i) Discuss which graph is best for displaying this type of data.

(3)

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(ii) Suggest how the students could improve the accuracy of their distance measurement. (1)

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(iii) Suggest why the reading on the ultraviolet meter remains the same for the last three readings. (1)

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(b) Sunscreen cream can be used to protect skin from ultraviolet light.

The students change their investigation to measure how effective the different sunscreen creams are at absorbing ultraviolet light.

They place a thin sheet of plastic between the ultraviolet torch and the meter.

They coat this plastic sheet with the different sunscreen creams.

Describe how the students should control the variables in this investigation. (4)

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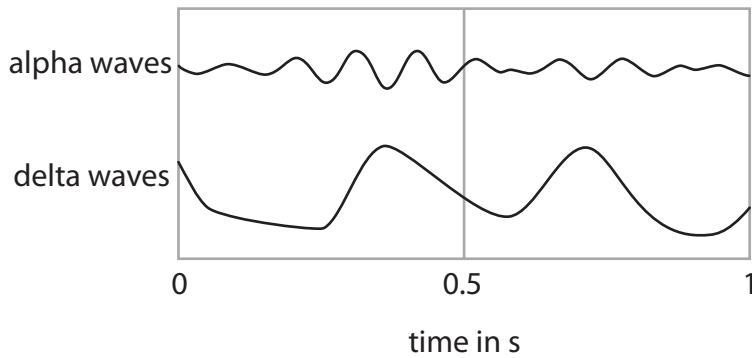
**(Total for Question 10 = 9 marks)**



11 This question is about different waves.

(a) The diagram shows two types of brain wave, alpha and delta.

Brain waves are caused by electrical signals in the brain.



Which row of the table correctly compares alpha and delta waves?

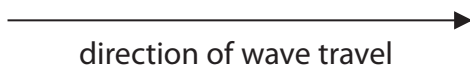
(1)

- A
- B
- C
- D

	Amplitude of alpha wave is	Frequency of alpha wave is
A	smaller	higher
B	larger	higher
C	smaller	lower
D	larger	lower

(b) Waves produced in earthquakes can be classified as transverse or longitudinal.

An earthquake wave is travelling in the direction shown by the arrow.



Which row of the table correctly shows the motion of the particles in each type of wave?  
(1)

	Motion of particles in a transverse wave	Motion of particles in a longitudinal wave
<input type="checkbox"/> A	↑	→
<input type="checkbox"/> B	↕	↔
<input type="checkbox"/> C	→	→
<input type="checkbox"/> D	↔	↕



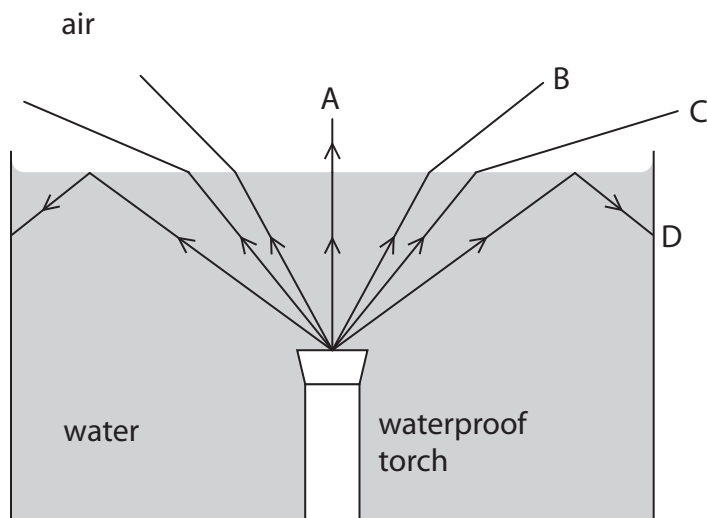


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(c) The diagram shows a waterproof torch submerged in a tank of water. Some rays of light, A, B, C and D, are shown.



Describe what is happening to rays A, B, C and D.

(4)

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(Total for Question 11 = 6 marks)



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12 Most carbon exists in the form of carbon-12, which is a stable isotope of carbon.

Carbon-14 is another isotope of carbon.

Carbon-14 forms in the upper atmosphere when a nitrogen nucleus absorbs a neutron.

(a) (i) Complete the nuclear equation for the formation of carbon-14.

(2)



(ii) Identify particle X.

(1)

(iii) Compare an atom of carbon-14 to an atom of carbon-12.

(2)

(iv) Carbon-14 is radioactive and decays by emitting  $\beta^-$  particles.

Describe what happens to the atomic number and mass number of carbon-14 when it decays.

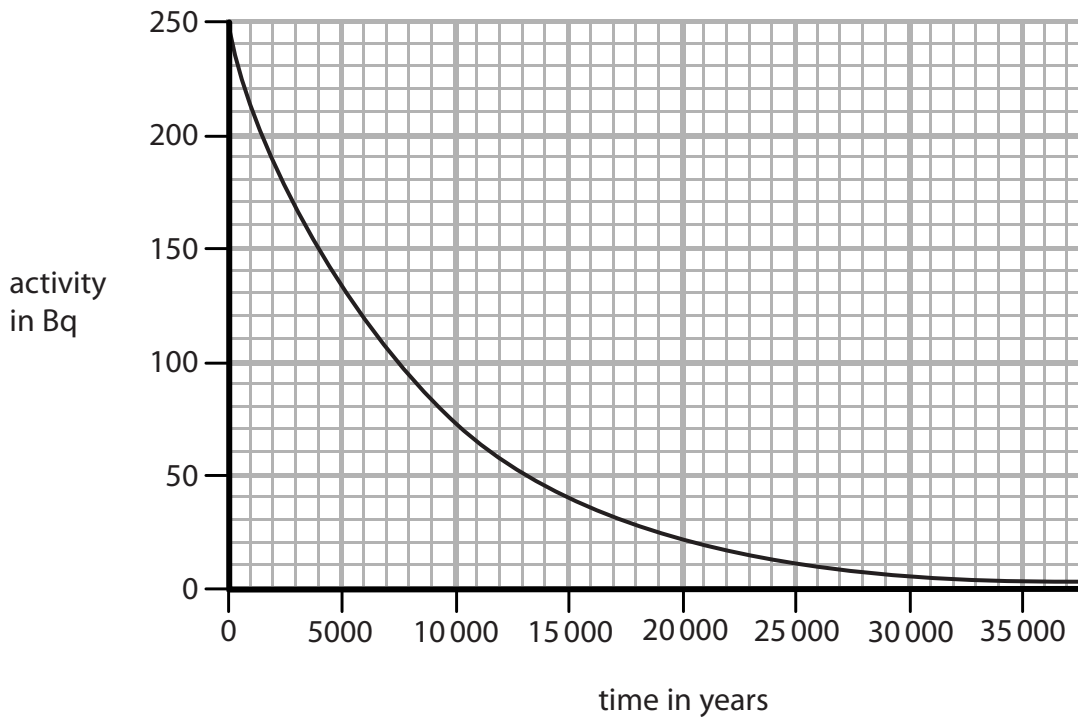
(2)



(b) The graph shows how the activity of a sample of carbon-14 changes with time.

Use the graph to determine the half-life of carbon-14.

(2)



half-life = ..... years

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(c) A scientist uses carbon-14 dating to find the age of a very old wooden bowl.

He uses this method.

- take samples of wood of the same mass from the bowl and from a tree
- determine the corrected activity for each sample of wood
- find the age of the bowl by determining the ratio of carbon-14 in the bowl to carbon-14 in the tree.

(i) State why the scientist has to correct the activities.

(1)

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(ii) State why the scientist takes samples of the same mass.

(1)

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(d) The scientist is asked to find the age of a dinosaur bone that is about 68 million years old.

Explain why he would not be able to use carbon-14 dating to find the age of the bone.

(2)

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**(Total for Question 12 = 13 marks)**



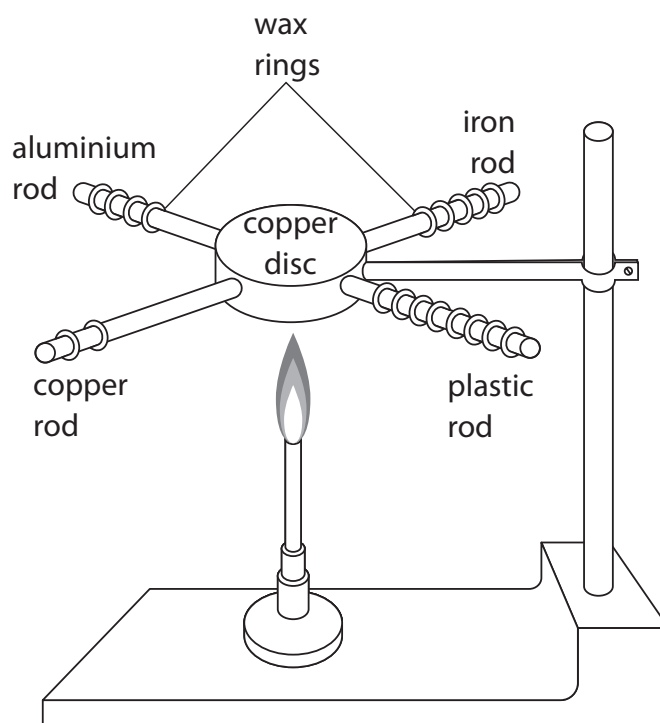
13 A student does three separate experiments to investigate conduction of thermal energy.

(a) In her first experiment, the student inserts four rods made of different materials into a copper disc.

She puts 8 wax rings onto each rod.

She then heats the copper disc with a Bunsen burner.

The diagram shows the experiment after the copper disc has been heated for a few minutes.



Explain what this experiment shows about conduction.

(3)

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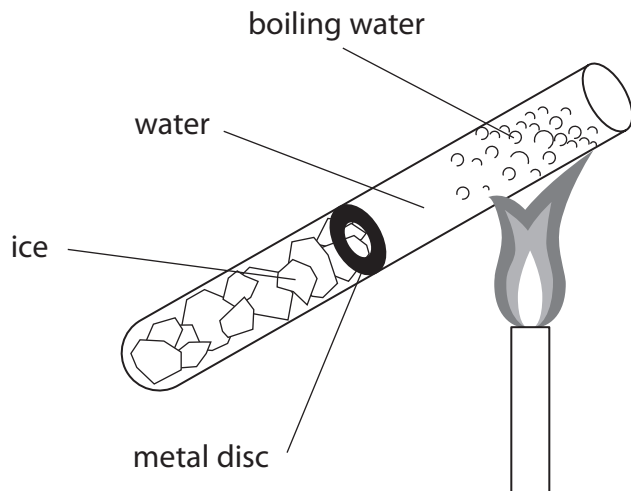
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(b) In her second experiment, the student places some ice in a test tube and then fills the test tube with water.

She puts a metal disc on top of the ice to stop the ice from floating.

She heats the top of the tube until the water boils, as shown in the diagram.



The water boils at the top of the tube, but the ice remains frozen at the bottom of the tube.

Explain why the ice remains frozen when the top of the tube is heated.

(2)

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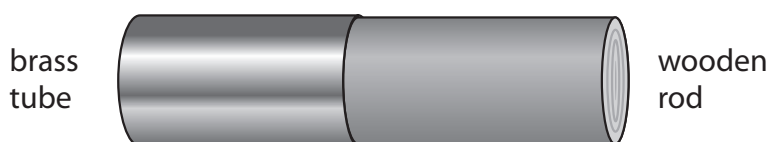
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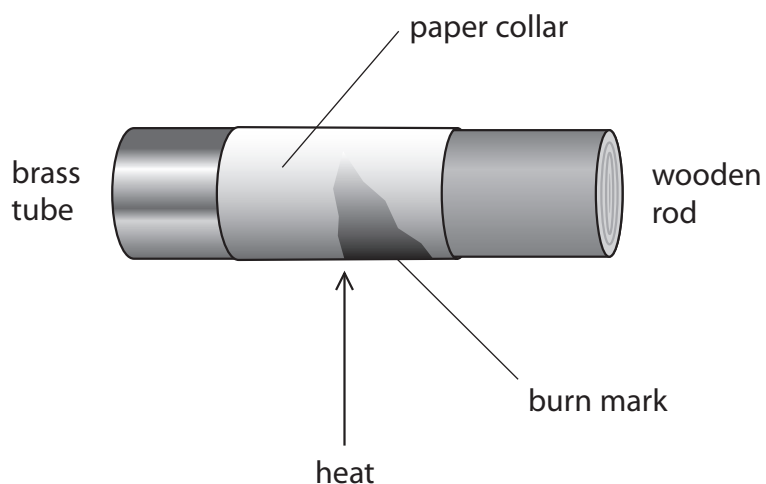
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(c) In her third experiment, the student inserts a wooden rod into the end of a brass tube.



She then wraps a paper collar around the join and heats the apparatus, as shown in the diagram.



Explain why the paper burns on the wooden rod, but not on the brass tube.

(2)

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**(Total for Question 13 = 7 marks)**





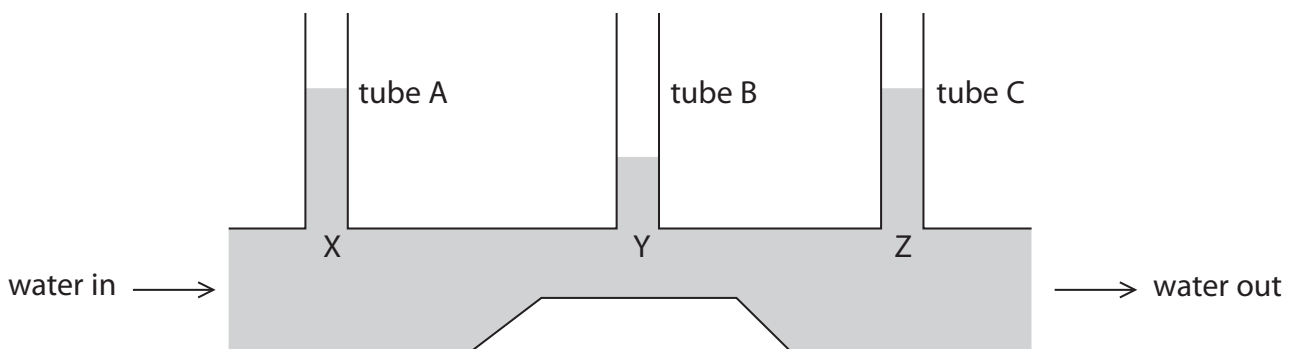
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14 (a) A student uses this apparatus to investigate the relationship between the speed of a fluid and its pressure.

The apparatus consists of a pipe of variable diameter with three tubes attached.



The student passes a constant flow of water through the pipe.

(i) State the equation linking pressure difference, height, density and  $g$ . (1)

(ii) The pressure at point Y is lower than the pressure at points X and Z. Explain how the diagram shows that the pressure is lower at Y. (2)

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(iii) A constant volume of water flows through the pipe each second. Explain how the speed of water at Y differs from the speed of water at X and Z. (2)

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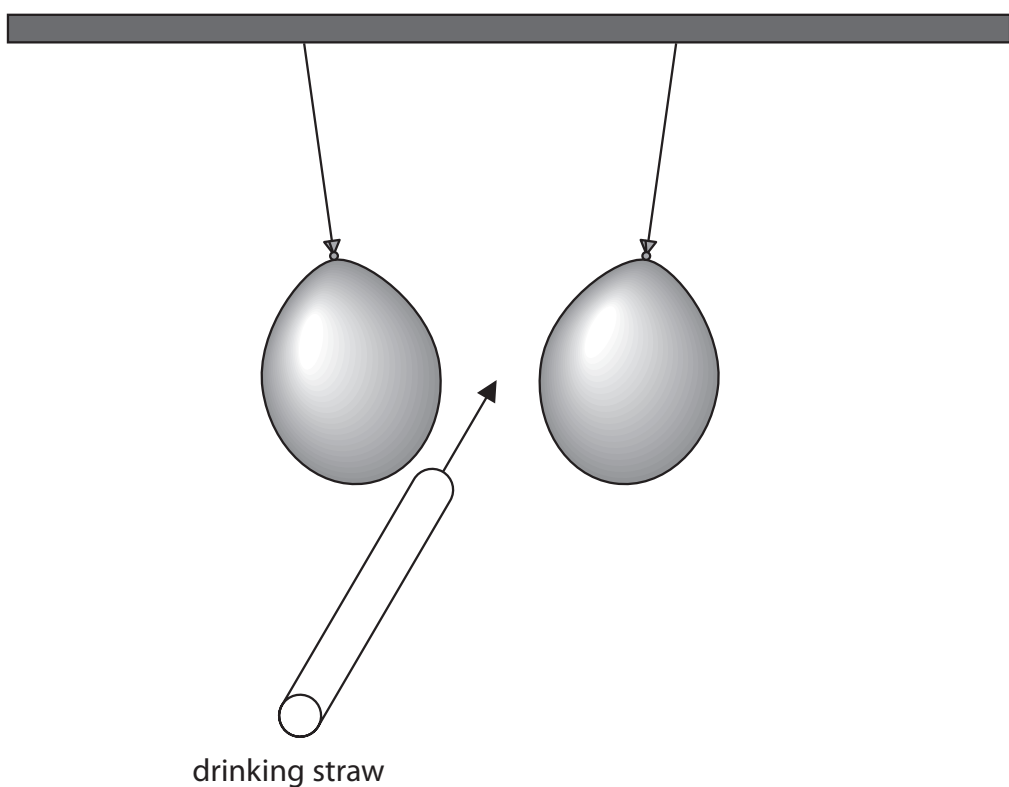
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(b) The student hangs two balloons from the ceiling.

He then uses a drinking straw to blow air between the balloons.



Explain why the balloons move towards each other when the student blows air between them.

Refer to air speed and pressure in your answer.

(2)

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**(Total for Question 14 = 7 marks)**

**TOTAL FOR PAPER = 120 MARKS**



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