Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6356223449

PHYSICS **5054/22**

Paper 2 Theory **May/June 2022**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **two** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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Section A

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

1 Fig. 1.1 shows a waterskier pulled horizontally across the water surface.



Fig. 1.1

The mass of the waterskier is 60 kg. The gravitational field strength g is 10 N / kg.

(a) Calculate the weight of the waterskier.

weight = ... [1]

(b) Mass and weight have different units.

State **two** other differences between mass and weight.

.....

.....

.....

..... [2]

(c) A boat pulls the waterskier to the right with a horizontal force of 50 N. The waterskier travels at a constant speed.

(i) Explain, in terms of the horizontal forces acting, why the speed is constant.

.....

..... [2]

(ii) The horizontal force acting to the right increases from 50 N to 70 N. The sizes of any other forces are unchanged.

Calculate the acceleration of the waterskier.

acceleration = ... [3]

[Total: 8]

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2 Fig. 2.1 shows a long cardboard tube, sealed at both ends, which contains many small pieces of metal.

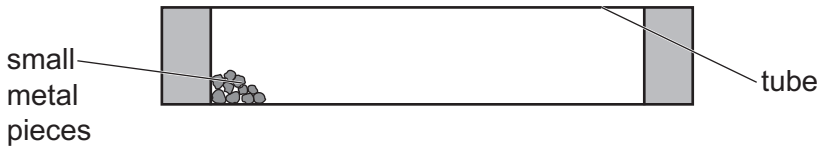


Fig. 2.1

The tube is turned vertically so that the pieces of metal fall from one end to the other.
The temperature of the pieces increases as a result of the fall.

During the fall, the gravitational potential energy of the metal pieces is transferred to other forms of energy.

(a) State **two** forms of energy to which the gravitational potential energy is transferred.

.....

..... [2]

(b) The pieces fall an average distance of 1.2 m during one turn. The total mass of the metal pieces is 150 g.

(i) Calculate the loss in the gravitational potential energy of the pieces as they fall once.

The gravitational field strength g is 10 N / kg.

loss in gravitational potential energy = ... [2]

(ii) A student turns the tube quickly. After the small metal pieces have fallen from one end to the other 80 times, their temperature has increased by 7.0 °C.

Determine the specific heat capacity of the metal.

specific heat capacity = ... [3]

(iii) The student repeats the experiment, turning the tube more slowly.

Suggest why a different temperature increase is obtained.

.....

..... [1]

[Total: 8]

3 Fig. 3.1 shows a syringe mounted vertically in a block of wood and sealed at one end. A plunger is free to move inside the syringe.

There is trapped air in the syringe.

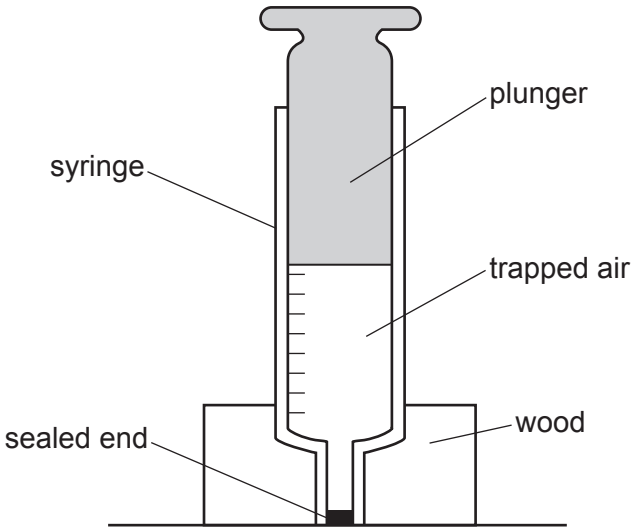


Fig. 3.1

The air inside the syringe exerts a pressure on the walls of the syringe.

(a) Define the term pressure.

.....

.....

..... [1]

(b) Explain how the air molecules in the cylinder of the syringe create a pressure.

.....

.....

.....

.....

..... [3]

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(c) A 10 N weight is placed on top of the plunger. The plunger moves down slowly so that the temperature of the air inside the syringe does not change.

Before the weight is placed on top of the plunger:

- the pressure of the air inside the syringe is 1.0×10^5 Pa
- the volume of the air is 50 cm^3.

The cross-sectional area of the plunger is 1.2×10^{-4} m^2.

(i) Calculate the pressure of the air in the syringe after the plunger stops moving.

pressure = ... [2]

(ii) Calculate the volume of air inside the syringe after the plunger stops moving.

volume = ... [2]

[Total: 8]

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[Turn over

4 Fig. 4.1 shows a ray of white light incident on a glass prism.

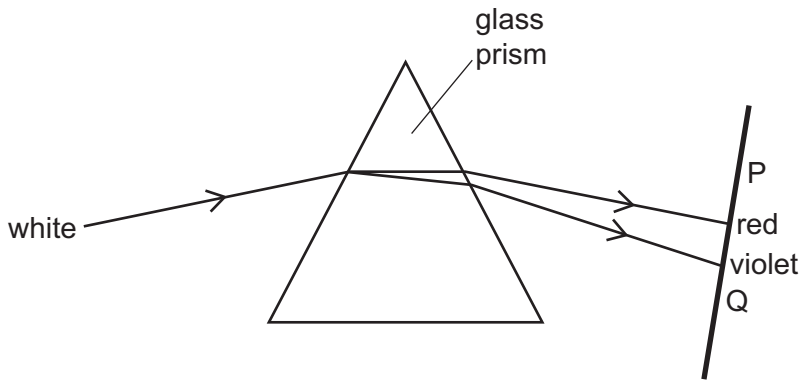


Fig. 4.1 (not to scale)

Refraction causes the white light to separate into different colours.

(a) Define the term 'angle of refraction'.

.....

..... [2]

(b) The angle of incidence of the white light as it enters the prism is 40° and the angle of refraction for the red light is 25°.

Calculate the refractive index of the glass for red light. Show your working.

refractive index = ... [2]

(c) Using Fig. 4.1, state and explain how the refractive index for red light differs from the refractive index for violet light.

.....

.....

.....

..... [2]

(d) The source of white light used in Fig. 4.1 produces other types of electromagnetic radiation as well as visible light.

State the name of the invisible radiation found at P and the invisible radiation found at Q.

at P ..... at Q ..... [1]

[Total: 7]

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5 **(a)** A student connects a battery, thermistor X and resistor Y in parallel, as shown in Fig. 5.1.

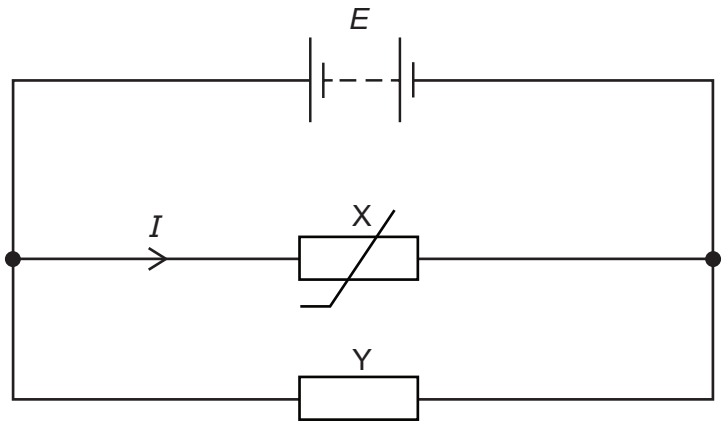


Fig. 5.1

- The electromotive force (e.m.f.) of the battery is E.
- The current in X is I.
- The resistance of Y is greater than the resistance of X.

Tick **two** boxes, one to show the correct statement about the potential difference across Y and the other to show the correct statement about the current in Y.

The potential difference across Y:

is less than E ☐

is equal to E ☐

is greater than E. ☐

The current in Y:

is less than I ☐

is equal to I ☐

is greater than I. ☐

[1]

(b) The student connects thermistor X in series with the resistor Y and a battery of e.m.f. 6.0 V, as shown in Fig. 5.2.

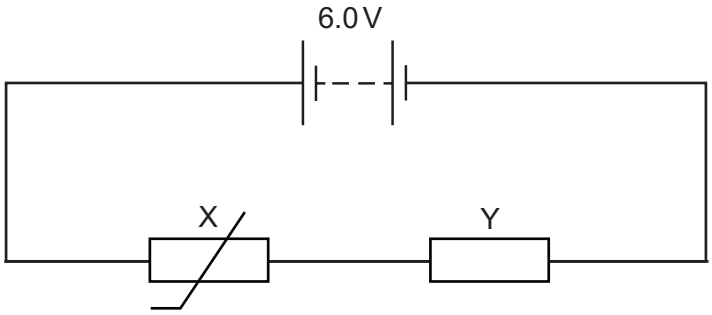


Fig. 5.2

In this circuit, at room temperature, the resistance of thermistor X is 600 Ω and the current in thermistor X is 0.0020 A.

(i) Calculate the power produced in the thermistor.

power = ... [2]

(ii) Calculate the resistance of Y.

resistance = ... [3]

(iii) The thermistor is cooled.

Explain why this causes the potential difference across Y to decrease.

.....

.....

..... [2]

[Total: 8]

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6 **(a)** Fig. 6.1 shows part of a toy which contains two ring-shaped, permanent magnets. A plastic rod passes through the centre of both magnets.

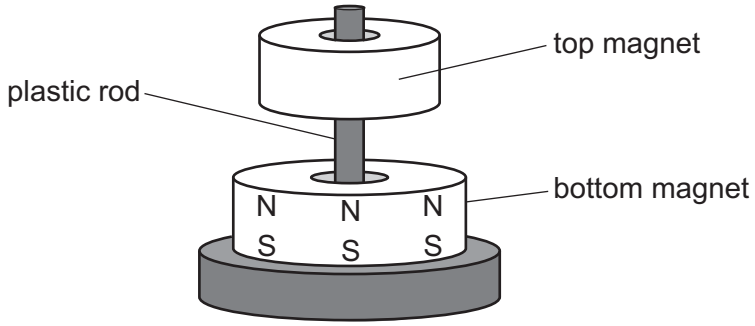


Fig. 6.1

The top magnet can move up and down freely around the plastic rod.

The magnetic poles on the bottom magnet are shown in Fig. 6.1.

(i) The top magnet floats in the air above the bottom magnet.

On Fig. 6.1, mark the poles on the top magnet and explain why it floats in the air above the bottom magnet.

.....

.....

.....

..... [2]

(ii) The top magnet is replaced with a ring made of iron.

Explain why the iron ring sticks to the bottom magnet.

.....

.....

.....

..... [2]

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[Turn over

(b) A wire carrying a current passes at right angles through a piece of paper.

Fig. 6.2 shows a cross and circle where the current in the wire passes into the plane of the paper.

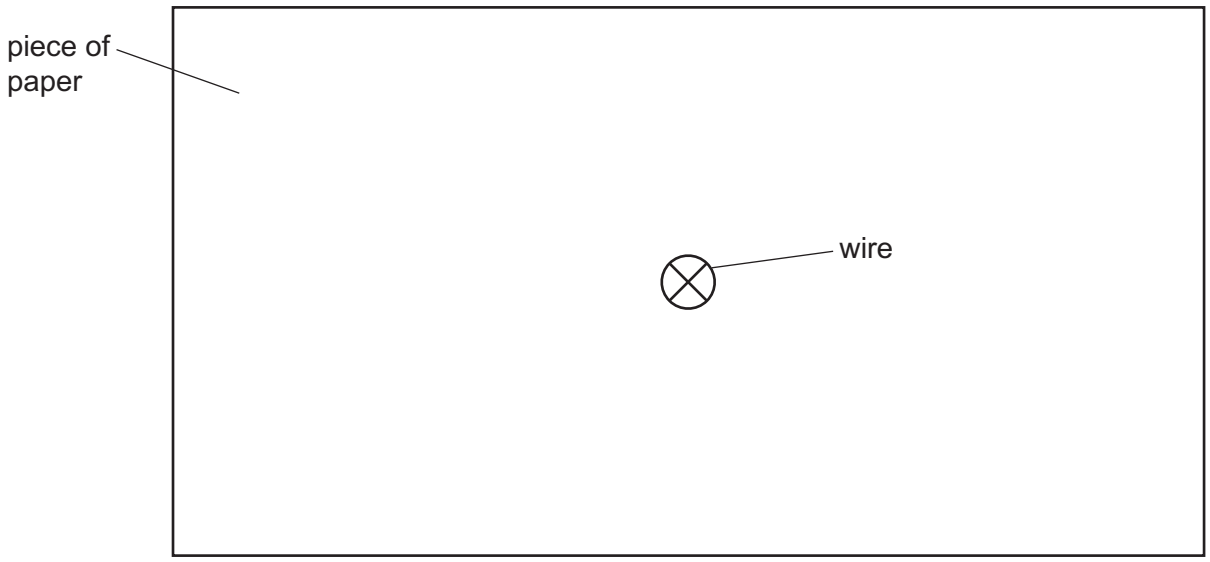


Fig. 6.2

On Fig. 6.2, sketch **three** magnetic field lines to show the magnetic field pattern around the wire.

Show the direction of the field on your sketch. [2]

[Total: 6]

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Section B begins over the page.

Section B

Answer **two** questions from this section. Answer in the spaces provided.

7 Fig. 7.1 shows the speed–time graph for a car travelling on a straight horizontal road.

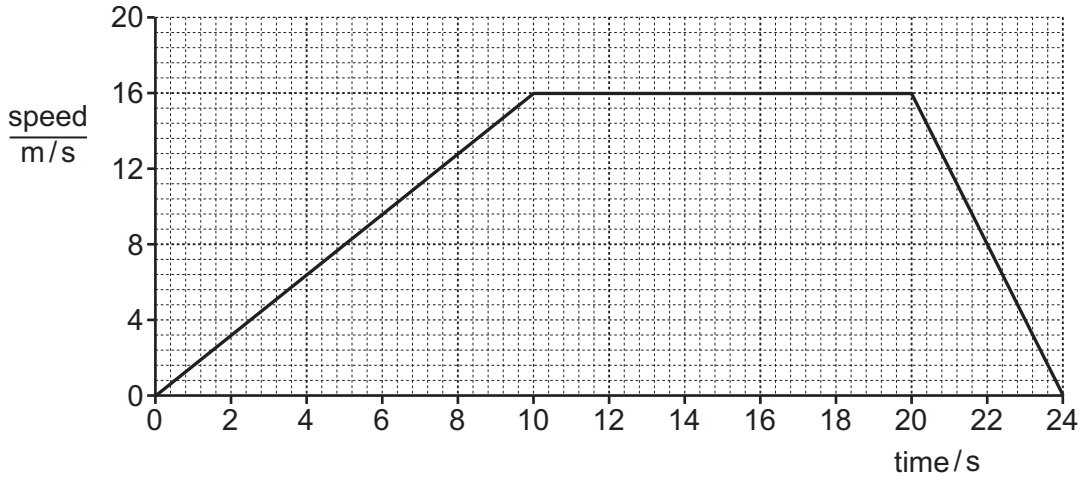


Fig. 7.1

(a) (i) Describe the motion of the car.

.....

.....

.....

.....

..... [3]

(ii) Using Fig. 7.1, calculate the distance travelled by the car during the 24 s of its motion.

Show your working.

distance = ... [3]

(iii) Calculate the average speed of the car during its motion.

average speed = ... [2]

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(iv) A second car travels at a steady speed. It travels the same distance as the first car in the 24 s of the journey.

On Fig. 7.1, draw the speed–time graph for the second car. [2]

(b) The thinking distance is the distance travelled by a car between the time that a hazard is seen and the time that the brakes are applied.

The braking distance is the distance travelled while the car slows down to rest.

Table 7.1 shows the thinking and braking distances for an alert driver when the car travels at different speeds.

Table 7.1

$\frac{\text{speed}}{\text{km/h}}$	thinking distance / m	braking distance / m
20	9	2
40	18	9
60		20
80	36	36
100	45	56

(i) Complete Table 7.1. [1]

(ii) The time it takes for the driver to react to the hazard is constant at different speeds.

Explain how the table shows this.

.....

.....

.....

..... [2]

(iii) State what happens to the thinking distance and the braking distance when the driver is tired.

thinking distance .....

braking distance .....
[2]

[Total: 15]

8 **(a)** Fig. 8.1 shows a ripple tank and the crests of the water wave that is produced in it.

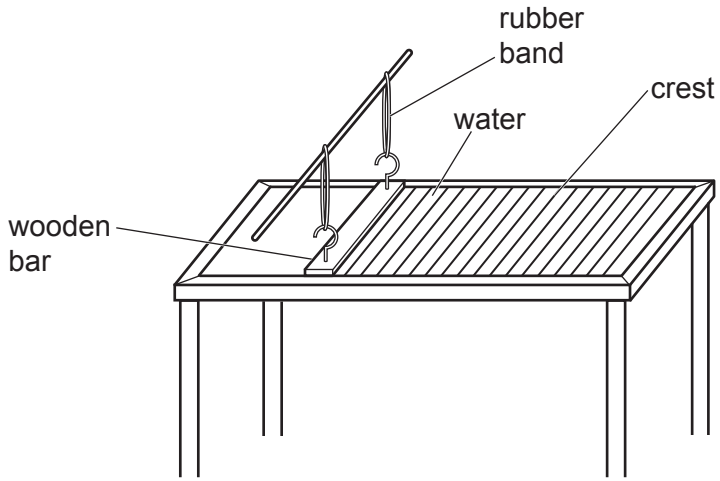


Fig. 8.1

The frequency of the water wave is 2.0 Hz and its amplitude is 3.0 mm.

(i) Calculate the number of crests produced in 1.5 s.

number = ... [1]

(ii) The height of the wave is measured from the level of the undisturbed surface of the water. The height of the wave at one point is 0 at time = 0.

On Fig. 8.2, draw a graph to show how the height of the wave at this point varies with time.

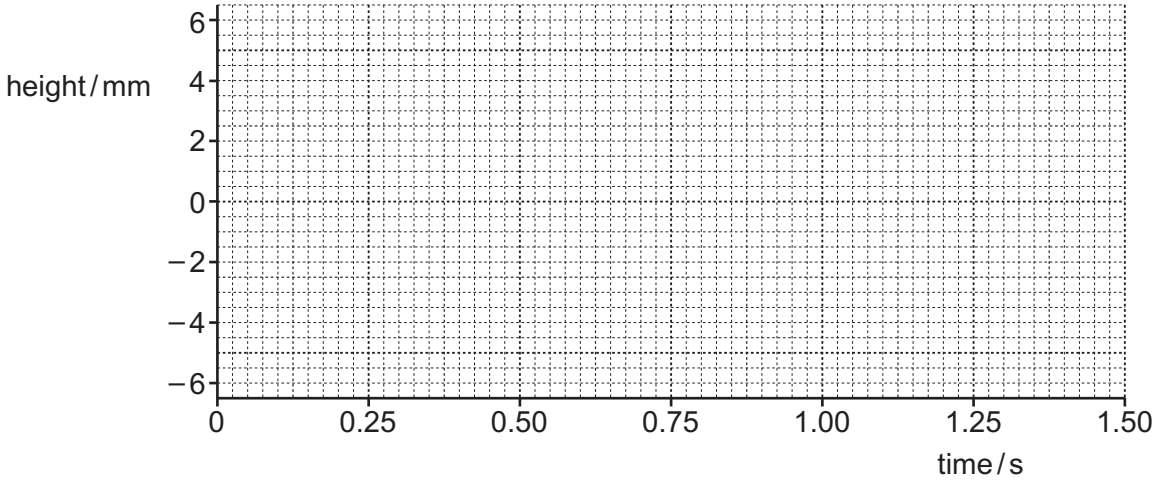


Fig. 8.2

[2]

(b) (i) The frequency of the wave is increased.

Describe how the apparatus shown in Fig. 8.1 is adjusted so that the frequency of the wave is increased.

.....

..... [1]

(ii) State what happens to the speed and wavelength of the wave as the frequency increases.

speed .....

wavelength .....
[2]

(c) The apparatus shown in Fig. 8.1 can be used to demonstrate refraction.

(i) State the additional apparatus needed to demonstrate refraction.

..... [1]

(ii) Draw on Fig. 8.3 to show the refraction of the water wave.

Label a boundary where the refraction occurs.

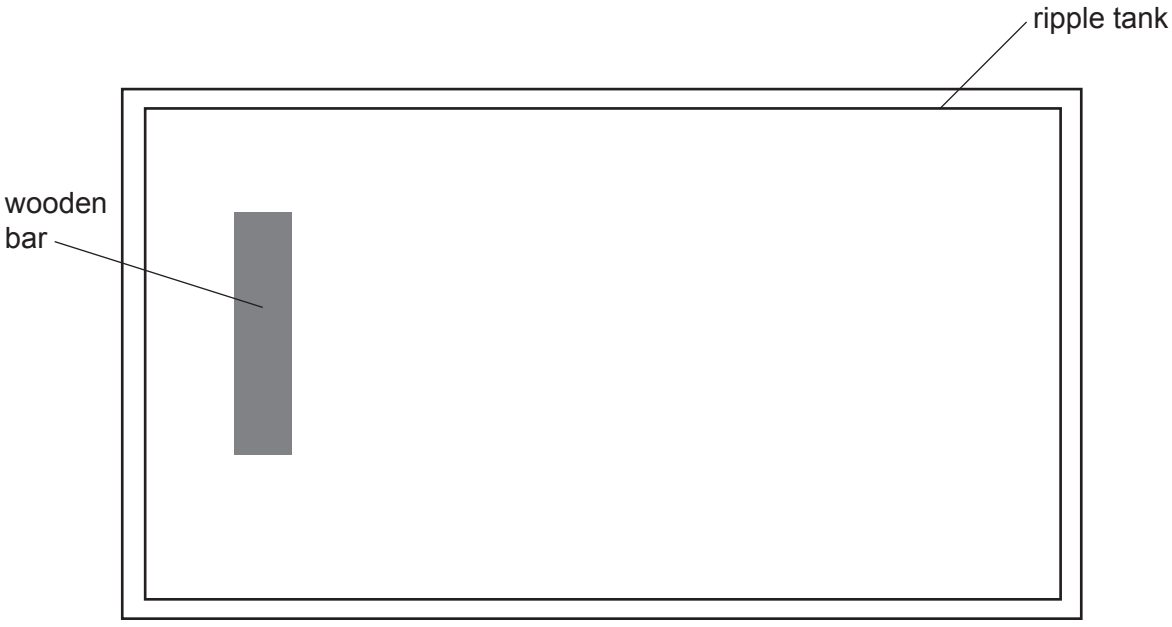


Fig. 8.3

[3]

(d) Fig. 8.4 shows a connection to the internet made from a remote station A using a satellite above the Earth's surface.

Data is sent between stations A and B using microwaves which travel to and from the satellite.

Station B is connected directly to the internet using optical fibre.

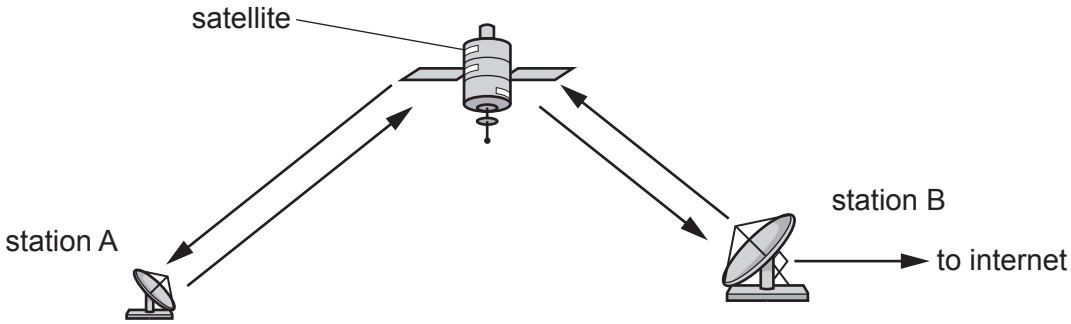


Fig. 8.4 (not to scale)

The speed of microwaves is 3.0×10^8 m/s.

Stations A and B are each 560 km from the satellite.

(i) Calculate the time taken for data to travel from A to B using microwaves.

time = ... [3]

(ii) The same data can be sent from A to B in a shorter time along the surface of the Earth using infrared waves to carry the information in optical fibres.

State **one** property that infrared waves and microwaves have in common.

.....

..... [1]

(iii) Suggest **one** other advantage of using optical fibres to connect stations A and B directly.

.....

..... [1]

[Total: 15]

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Question 9 begins over the page.

9 Thorium-229 is a radioactive isotope used in several medical applications that involve alpha-particles and beta-particles.

(a) During ionisation, a helium atom becomes a helium ion.

Fig. 9.1 shows a diagram of a helium (He^+) ion.

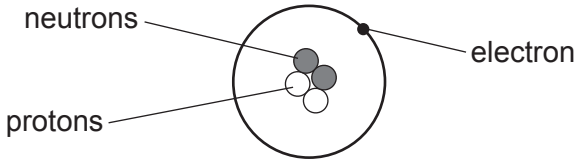


Fig. 9.1

(i) State how the structure of a helium atom differs from the structure of the helium ion.

.....

..... [1]

(ii) State how the structure of an alpha-particle differs from the structure of the helium ion.

.....

..... [1]

(iii) A nucleus of thorium-229 ($^{229}_{90}Th$) decays by alpha (α) emission to a nucleus of element X.

$$^{229}_{90}Th \rightarrow X + {}^{4}_{2}\alpha$$

The nucleus of X then decays to a nucleus of Y by beta (β) emission.

$$X \rightarrow Y + {}^{0}_{-1}\beta$$

Complete Table 9.1 to show the number of protons and neutrons in a nucleus of X and in a nucleus of Y.

Table 9.1

nucleus	number of protons	number of neutrons
X		
Y		

[4]

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(b) Experiments can show that a sample of a material is radioactive.

Describe the apparatus and the procedure used to show that a sample emits **both** alpha-particles and beta-particles.

You may draw a diagram of the apparatus, if you wish.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) **(i)** State what is meant by the half-life of thorium-229.

.....

..... [2]

(ii) A sample of pure thorium-229 contains 4.0×10^{14} atoms. After 22 000 years, the number of atoms of thorium-229 in the sample is 5.0×10^{13}.

Determine the half-life of thorium-229.

Show your working.

half-life = ... [3]

[Total: 15]

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