Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

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8696108196

PHYSICS **5054/21**

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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[Turn over

Section A

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

1 Fig. 1.1 shows a model of the human arm. The rubber band represents the muscle that moves part of the arm XY up.

A mass is suspended from XY, as shown in Fig. 1.2. The weight of section XY is negligible and the model is at rest.

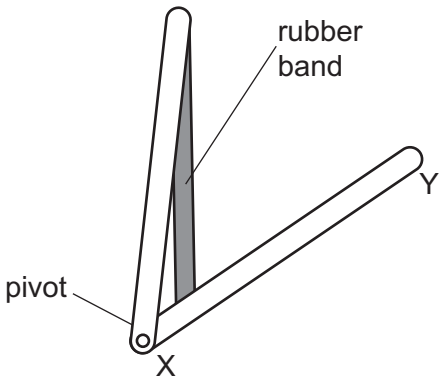


Fig. 1.1

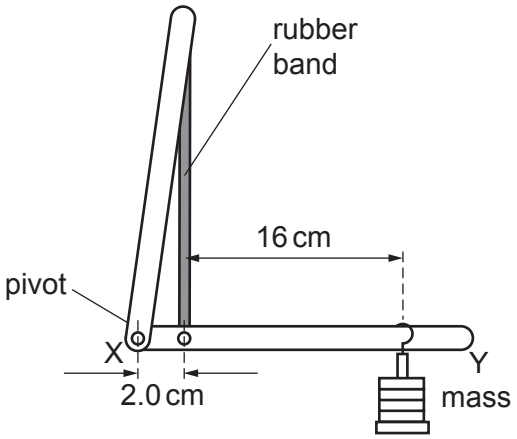


Fig. 1.2 (not to scale)

(a) (i) State **two** ways in which the dimensions of the rubber band change as the mass is added to section XY.

.....

..... [2]

(ii) State the form of energy stored in the stretched rubber band.

..... [1]

(b) (i) State the principle of moments.

.....

.....

.....

..... [2]

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(ii) Explain why the force that the rubber band exerts on section XY is larger than the weight of the mass.

.....

.....

..... [1]

(iii) The mass suspended from section XY in Fig. 1.2 has a weight of 4.0 N.

Calculate the force that the rubber band exerts on section XY.

force = ... [2]

(iv) Explain how your answer to **(b)(iii)** is different if the weight of section XY is **not** negligible.

.....

.....

..... [1]

[Total: 9]

2 Fig. 2.1 shows a wind turbine.

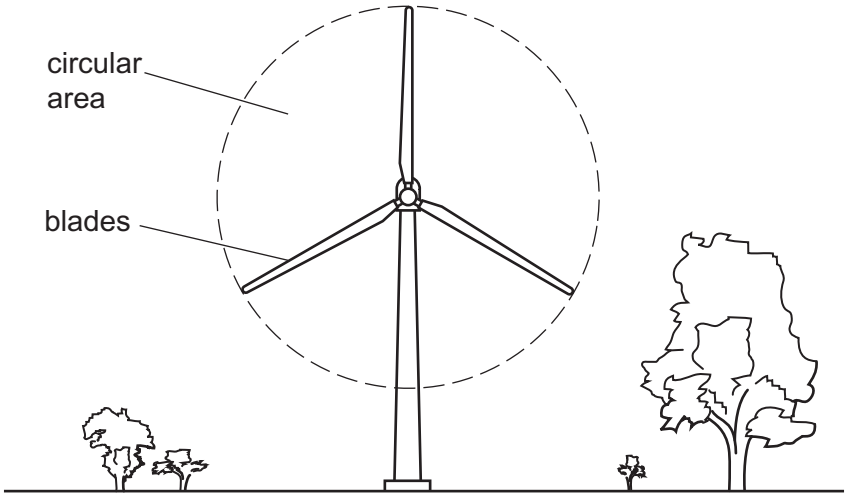


Fig. 2.1

(a) The wind blows directly towards the turbine with a speed of 12 m / s.

In one second, 60 000 kg of air passes through the circular area swept out by the blades.

Calculate the kinetic energy of this mass of air.

kinetic energy = ... [3]

(b) A wind turbine releases no carbon dioxide into the atmosphere while generating electricity. Compared with a coal-fired power station, this is an advantage of using a wind turbine.

(i) State **one** reason why it is important to reduce the amount of carbon dioxide produced.

.....

..... [1]

(ii) Suggest **one** advantage of using a coal-fired power station compared with a wind turbine.

.....

..... [1]

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(c) A coal-fired power station releases 0.96 kg of carbon dioxide when it generates 1.0 kW h of electrical energy.

(i) Define the kilowatt-hour (kW h).

.....

..... [1]

(ii) Calculate the mass of carbon dioxide saved when the wind turbine has a power output of 2000 kW and operates for 12 hours.

mass = ... [1]

(d) Wind energy is a form of renewable energy.

State the name of **one** other form of renewable energy.

..... [1]

[Total: 8]

3 **(a)** Define latent heat of fusion.

.....

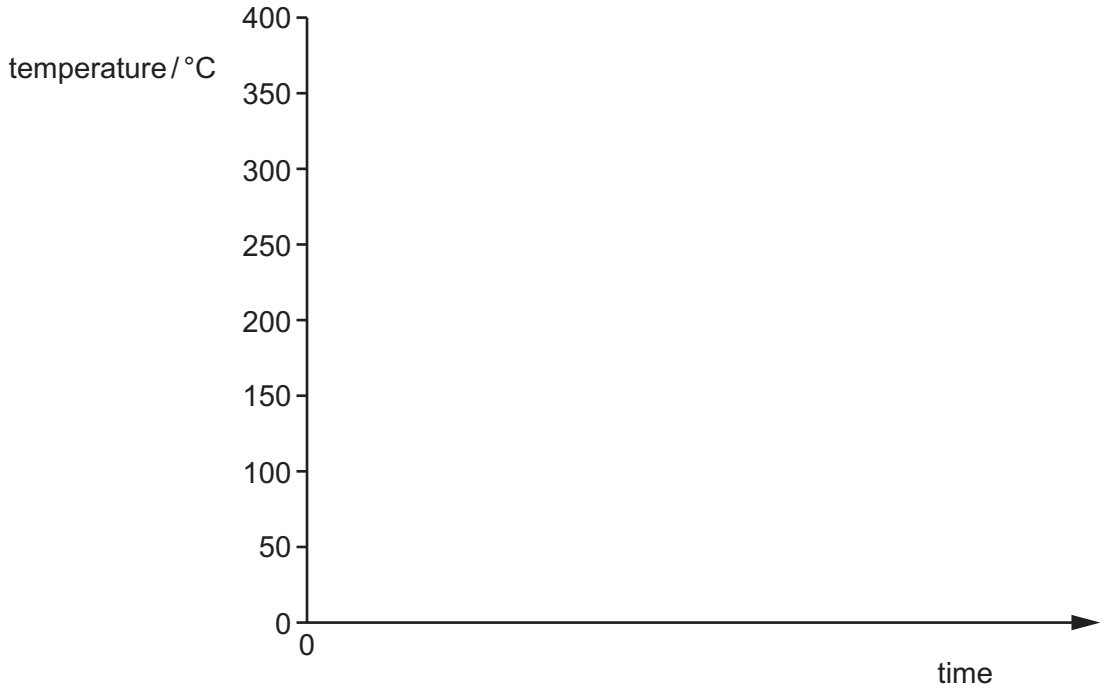
.....

..... [2]

(b) A sample of metal P at 100 °C is heated steadily until its temperature reaches 400 °C.

The melting point of the metal is 250 °C.

(i) On Fig. 3.1, sketch a graph to show how the temperature of the metal changes with time.



[2]

Fig. 3.1

(ii) A sample of a different metal Q has a greater latent heat of fusion than the sample of P.

P and Q are metals with the same melting points and the samples have the same heat capacity.

The experiment is repeated with the sample of Q. This sample is supplied with the same amount of energy per second as is supplied to the sample of P.

Explain how the graph of temperature against time for Q differs from the graph in **(b)(i)**.

.....

.....

.....

..... [2]

[Total: 6]

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4 Two parallel rays of light, one red and one blue, enter a glass prism.

Fig. 4.1 shows both rays of light before they enter the prism. The blue ray is also shown incident on a different side of the prism after passing through the prism.

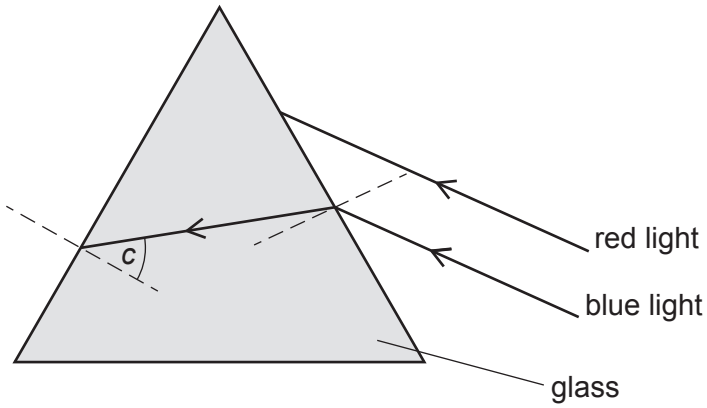


Fig. 4.1 (not to scale)

The ray of blue light strikes the left side of the prism at an angle equal to its critical angle *c*.

(a) (i) On Fig. 4.1, mark and label the angle of incidence *i* and the angle of refraction *r* for the blue light as it enters the prism. [1]

(ii) On Fig. 4.1, continue the path of the blue light after it strikes the left side of the prism. [1]

(iii) The refractive index of glass for red light is smaller than the refractive index for blue light.

On Fig. 4.1, draw the path of the red light as it travels in the prism and after it strikes the left side of the prism. [2]

(b) (i) State what is meant by the critical angle.

.....

..... [2]

(ii) The refractive index of glass for blue light is 1.5.

Calculate the critical angle *c* for blue light in glass. Show your working.

c = ... [2]

[Total: 8]

5 Fig. 5.1 shows a simple d.c. motor used in a toy car.

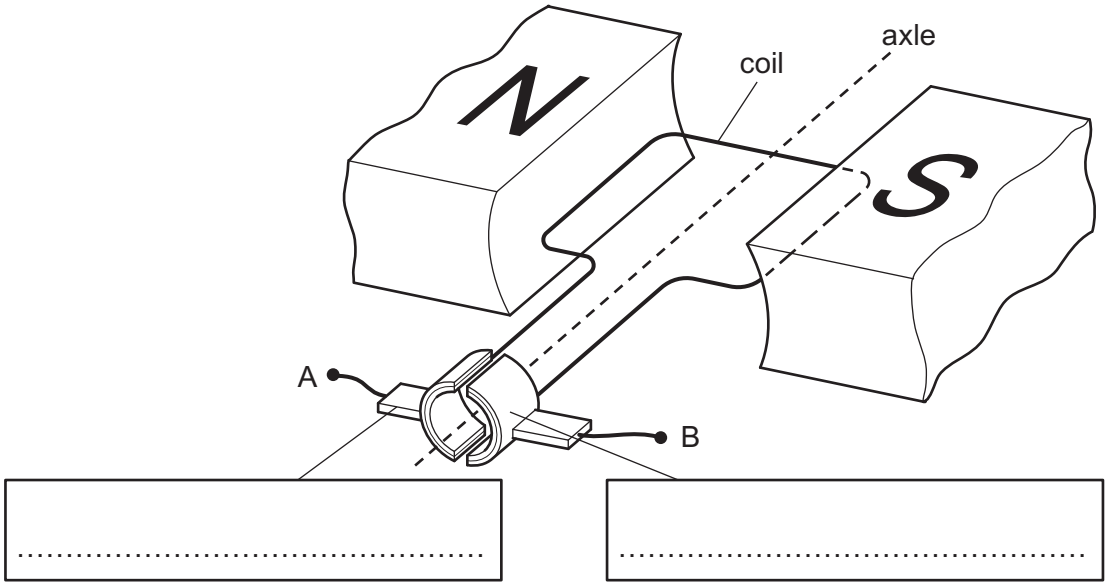


Fig. 5.1

Terminals A and B are connected to a battery and the motor rotates.

(a) On Fig. 5.1, add labels inside the boxes to identify the parts of the motor indicated. [2]

(b) State what happens to the rotation of the coil when:

(i) the number of turns on the coil is increased

..... [1]

(ii) the magnetic field between the poles of the magnet is reversed.

..... [1]

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(c) The power supply to the motor is switched on and off at a steady rate.

Fig. 5.2 shows how the speed of the toy car varies with time as a result of the power supply being switched on and off.

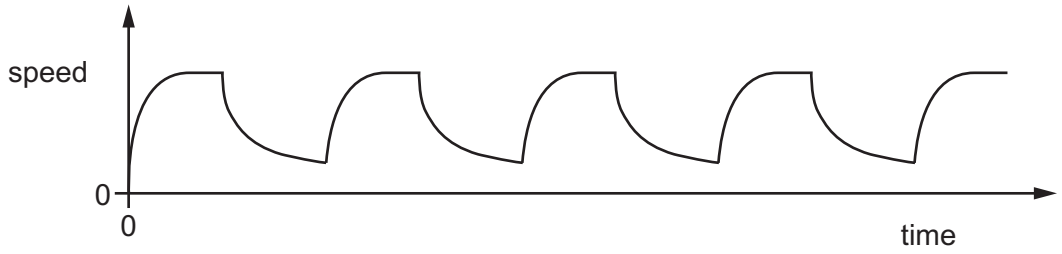


Fig. 5.2

(i) Describe the motion of the toy car.

.....

.....

.....

..... [2]

(ii) The voltage supplied to the motor is switched on for a longer period of time and off for a longer period of time, at a steady rate.

Suggest what happens to the motion of the toy car.

.....

.....

..... [1]

[Total: 7]

6 **(a)** A light-dependent resistor (LDR) is used to sense the amount of light in a room.

Fig. 6.1 shows part of the circuit used. The LDR is not shown.

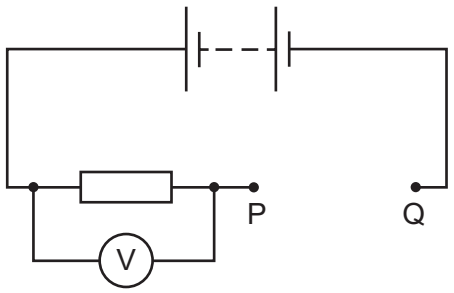


Fig. 6.1

(i) Complete Fig. 6.1 by drawing the circuit symbol for an LDR between points P and Q. [1]

(ii) Explain how the voltmeter reading changes as the amount of light falling on the LDR increases.

.....

.....

..... [2]

(b) Fig. 6.2 shows part of a circuit containing three resistors.

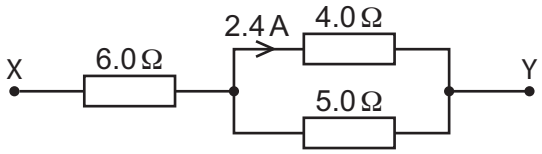


Fig. 6.2

The current in the 4.0 Ω resistor is 2.4 A.

(i) Show that the current in the 5.0 Ω resistor is 1.9 A.

[2]

(ii) Calculate the potential difference (p.d.) between points X and Y.

p.d. = ... [2]

[Total: 7]

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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 a toy helicopter. It can hover and travel through the air.

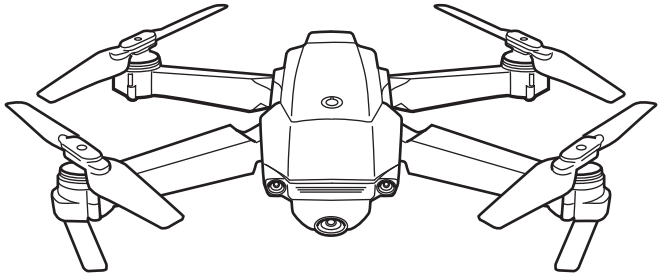


Fig. 7.1

A student flies the toy helicopter on a journey from A to B to C to D at a constant height.

Fig. 7.2 is a scale drawing of the path of the helicopter, viewed from above.

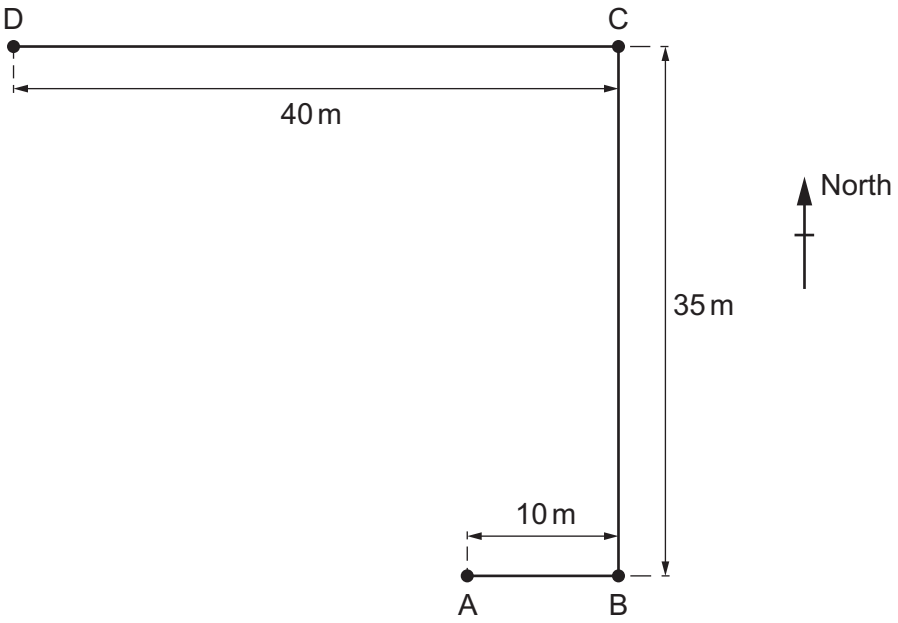


Fig. 7.2 (to scale)

(a) (i) Determine the total distance travelled by the toy helicopter.

..... [1]

(ii) The toy helicopter makes the journey in 40 s.

Calculate its average speed during the journey.

speed = ... [2]

(b) (i) State the difference between distance and displacement.

.....

..... [1]

(ii) Determine the scale used to construct Fig. 7.2 and complete the sentence.

1 cm on the diagram represents ..... on the path. [1]

(iii) Using Fig. 7.2, determine the size of the displacement of point D from point A.

Show your working.

size of displacement = ... [2]

(iv) Determine the angle between North and the direction of the displacement of point D from point A.

angle = ... [1]

(v) State what is meant by velocity.

..... [1]

(vi) Another toy helicopter flies directly from point A to point D in 40 s.

Explain why the magnitude of the velocity of this toy helicopter is smaller than the answer in **(a)(ii)**.

.....

..... [1]

(c) When the toy helicopter hovers at D, its motor fails and it falls. It reaches terminal velocity as it falls.

Explain, in terms of the forces and acceleration, what happens as the helicopter falls and reaches terminal velocity.

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 15]

Question 8 begins over the page.

8 Fig. 8.1 shows a water manometer.

When the water manometer is connected to a sealed container of gas and the tap is opened, the water levels change, as shown in Fig. 8.2.

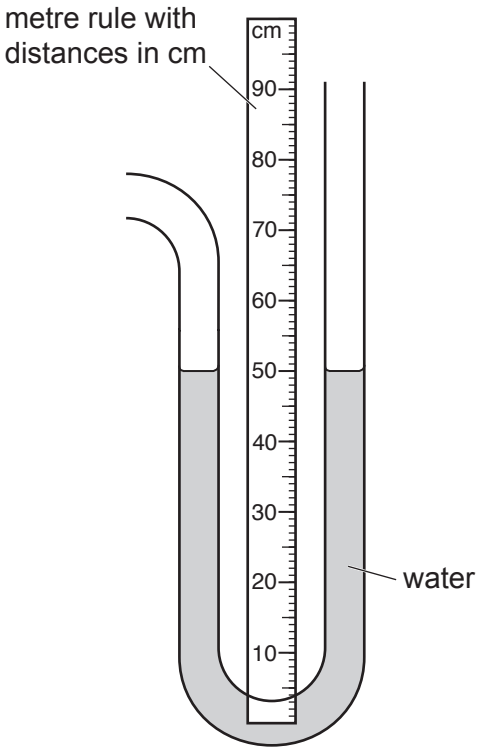


Fig. 8.1

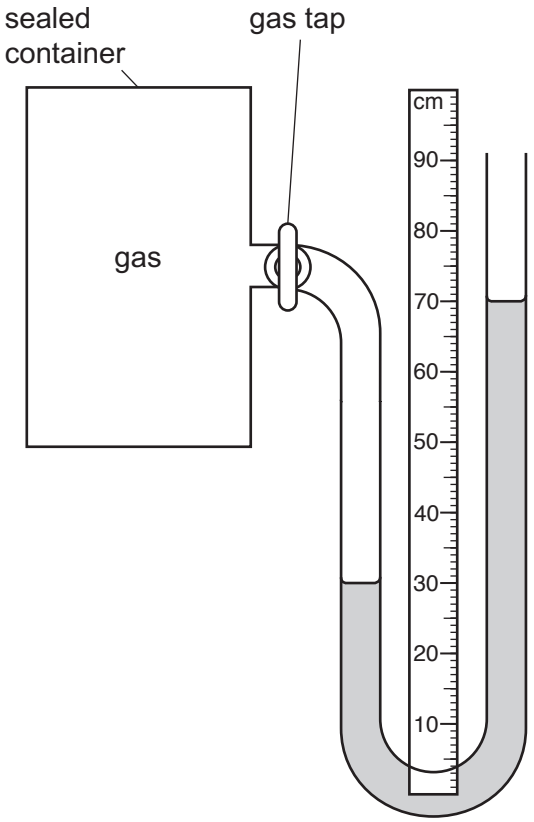


Fig. 8.2

(a) Define pressure.

.....

..... [1]

(b) **(i)** Explain why the water levels are the same on both sides of the manometer in Fig. 8.1.

.....

..... [1]

(ii) Explain why the water levels change when the gas tap is opened with the manometer connected as in Fig. 8.2.

.....

..... [1]

(iii) Explain why the water levels stop changing at the levels shown in Fig. 8.2.

.....

..... [1]

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(c) The water in the manometer has a density of $1000\,kg/m^3$.

Atmospheric pressure is 1.00×10^5 Pa and the gravitational field strength g is $10\,m/s^2$.

Calculate the pressure of the gas inside the sealed container.

Give your answer to 3 significant figures.

pressure = ... [4]

(d) The temperature of the gas inside the sealed container increases.

Using ideas about molecules explain why the water levels change.

.....

.....

.....

.....

.....

..... [4]

(e) This manometer is not suitable for measuring a gas pressure of 2.5×10^5 Pa.

(i) Explain why.

.....

.....

..... [2]

(ii) State **one** change to this manometer that allows it to measure a gas pressure of 2.5×10^5 Pa in a normal school laboratory.

.....

..... [1]

[Total: 15]

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[Turn over

9 Table 9.1 shows details of seven different nuclides.

Table 9.1

nuclide	radiation emitted	half-life
hydrogen-2	none	–
hydrogen–3	beta	12 year
francium-223	beta	22 min
iridium-192	gamma	74 day
phosphorus-32	beta	14 day
radon−222	alpha	4 day
technetium-99	gamma	6 hour

(a) (i) Hydrogen-2 and hydrogen-3 are isotopes of the element hydrogen.

Define the term isotope.

.....

..... [2]

(ii) The equation for the decay of phosphorus-32 (P-32) as it emits a beta particle is:

$$^{32}_{15}\mathrm{P} \rightarrow {}^{0}_{-1}\beta + {}^{32}_{16}\mathrm{Q}$$

Explain whether the equation shows that Q is another isotope of phosphorus. Q is not the chemical symbol for the atom.

.....

..... [1]

(b) One of the sources in Table 9.1 is used in a medical procedure to detect unusual bone structures. It is injected into a patient and the radiation emitted is detected outside the body.

(i) State which source in Table 9.1 is most suitable for this type of medical use.

..... [1]

(ii) Explain **two** reasons for your choice

.....

.....

..... [2]

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(c) Radon gas is one natural source of background radiation.

Some causes of background radiation are man-made, for example, X-rays.

(i) State one other **natural** source of background radiation.

..... [1]

(ii) State one other **man-made** source of background radiation.

..... [1]

(iii) State one **harmful** effect of background radiation.

..... [1]

(d) One fusion reaction that occurs is:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{\cdots\cdots}_{\cdots\cdots}X$$

(i) Complete the equation to show the missing proton and nucleon numbers. [1]

(ii) Deduce the name of particle X.

..... [1]

(iii) Suggest where this fusion reaction takes place.

..... [1]

(e) Compare the properties of alpha-particles and beta-particles in terms of their:

- ability to penetrate through materials
- ionising effects
- deflection in a magnetic field.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 15]

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