Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME										
CENTRE NUMBER						CANDIDATE NUMBER				

6559177261

PHYSICS **5054/21**

Paper 2 Theory **May/June 2024**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** 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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

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

DC (LK/FC) 336606/4

1 A ball is released from rest at point A and moves along a smooth track ABCDE as shown in Fig. 1.1. The ball is shown at point A and as it passes point B.

The ball is always in contact with the track and air resistance is negligible.

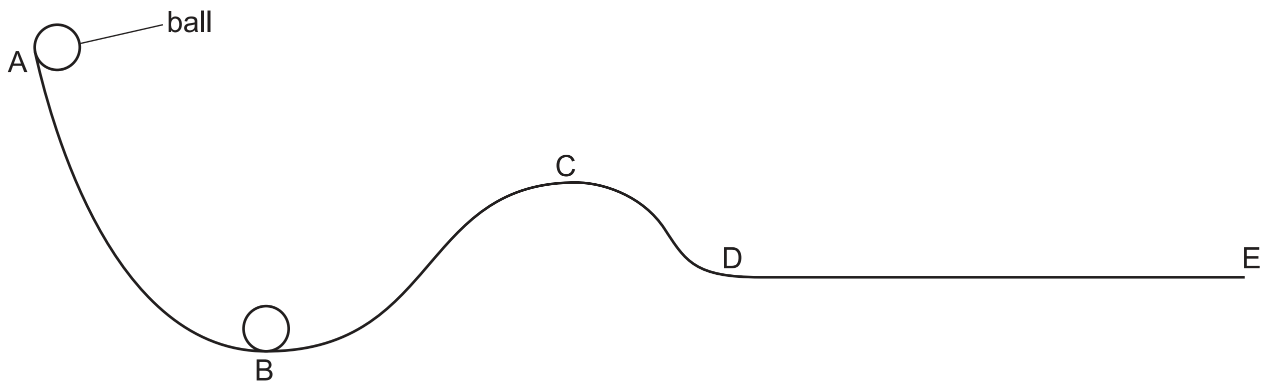

Fig. 1.1

Fig. 1.2 shows the distance−time graph for the ball as it moves from A to E.

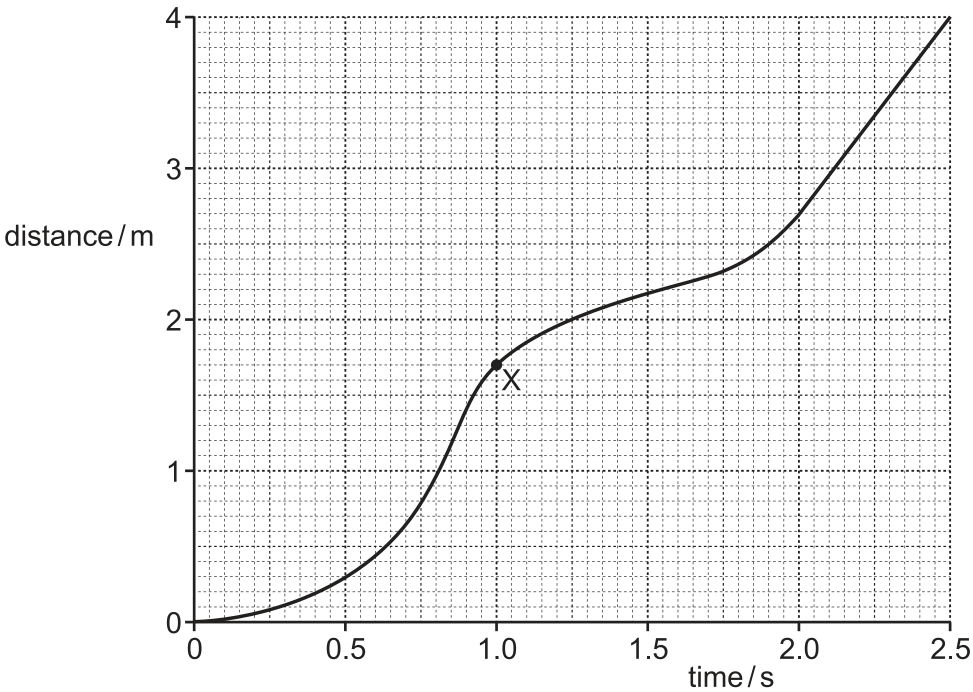

Fig. 1.2

(a) **(i)** On Fig. 1.2, mark:

- with the letter P **one** point where the ball accelerates
- with the letter Q **one** point where the ball has constant speed.

[2]

(ii) Determine the speed of the ball at point X on Fig. 1.2.

Show your working.

speed = ... m / s [3]

(b) The speeds of the ball at A, B, C and D are v_A, v_B, v_C and v_D respectively.

Arrange these four speeds from slowest to fastest.

slowest ——→ fastest

[1]

(c) Work is done to transfer energy between energy stores as the ball moves from A to B.

Name the force involved in the work done and describe the energy transfer.

....

....

....

.... [3]

(d) The track at point B is circular in shape.

On Fig. 1.1, draw an arrow to show the direction of the resultant force on the ball at point B. [1]

[Total: 10]

2 A small aircraft takes off from the horizontal deck of a ship.

Before taking off, the aircraft is held in place by a holdback bar.

When the holdback bar is released, the aircraft is pulled along the deck by a steam-powered piston as shown in Fig. 2.1.

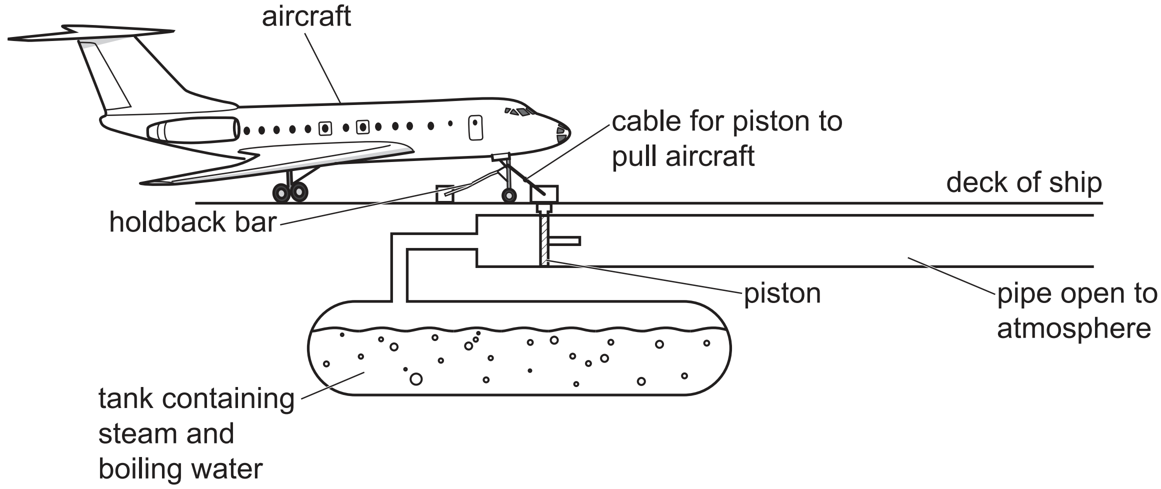

Fig. 2.1 (not to scale)

The steam exerts a high pressure on the piston.

(a) **(i)** Explain, using ideas about particles, how the steam creates a pressure on the piston.

....

....

....

.... [2]

(ii) Explain why the pressure on the piston increases as the temperature of the steam increases.

....

....

....

.... [2]

(b) When the pressure is high enough, the holdback bar is released. The steam pushes the piston along the pipe shown in Fig. 2.1.

The piston has a cross-sectional area of $0.30\,m^2$.

The pressure of the steam in the tank is 2.1×10^6 Pa.

Atmospheric pressure is 1.0×10^5 Pa.

Determine the resultant force on the piston caused by the pressure difference.

Show your working.

force = ... N [2]

(c) The force calculated in **(b)** causes the aircraft to accelerate to a maximum speed of 28 m/s from rest.

The mass of the aircraft is 3.0×10^4 kg.

(i) Calculate the momentum of the aircraft at the maximum speed.

momentum = ... kg m/s [2]

(ii) Calculate the time taken for the aircraft to reach the maximum speed.

time = ... s [2]

[Total: 10]

3 A pan containing ice at –15 °C is placed on a gas heater as shown in Fig. 3.1.

Fig. 3.1

(a) Thermal conduction occurs in the metal from which the pan is made.

By referring to particles, describe the process of thermal conduction in a metal.

....

....

....

.... [2]

(b) Fig. 3.2 shows how the temperature of the contents of the pan varies with time.

Fig. 3.2

(i) State the melting temperature of ice in kelvin.

melting temperature = ... K [1]

(ii) Explain why the temperature of the water is constant as the ice melts.

....

....

....

.... [2]

(iii) The initial mass of ice in the pan is 1.5 kg and the initial temperature is –15 °C.

The specific heat capacity of ice is 2100 J / (kg °C).

Calculate the energy required to warm the ice to its melting temperature.

energy = ... J [2]

(iv) All the energy transferred to the pan comes from the heater.

Using your answer to **(iii)** and Fig. 3.2, determine the power of the heater used to warm the ice.

power = ... W [2]

(v) The graph in Fig. 3.2 has a smaller gradient when the water is liquid than when it is solid.

Suggest **one** reason why.

....

.... [1]

[Total: 10]

4 **(a)** Ultrasound of frequency 30 kHz has a wavelength of 0.011 m in air.

(i) State what is meant by ‘frequency’.

....

.... [1]

(ii) Calculate the speed of ultrasound in air.

Show your working.

speed = ... m/s [2]

(iii) State **one** use of ultrasound.

.... [1]

(b) Sound waves are longitudinal waves. Water waves are transverse waves.

(i) Describe, by referring to the movement of the particles in the wave, the difference between a longitudinal wave and a transverse wave.

You may include a labelled diagram to help your description.

....

....

....

....

.... [3]

(ii) State **one** source of waves that generates both longitudinal and transverse waves.

.... [1]

(c) Fig. 4.1 shows radio waves of long and short wavelength passing over the same hill.

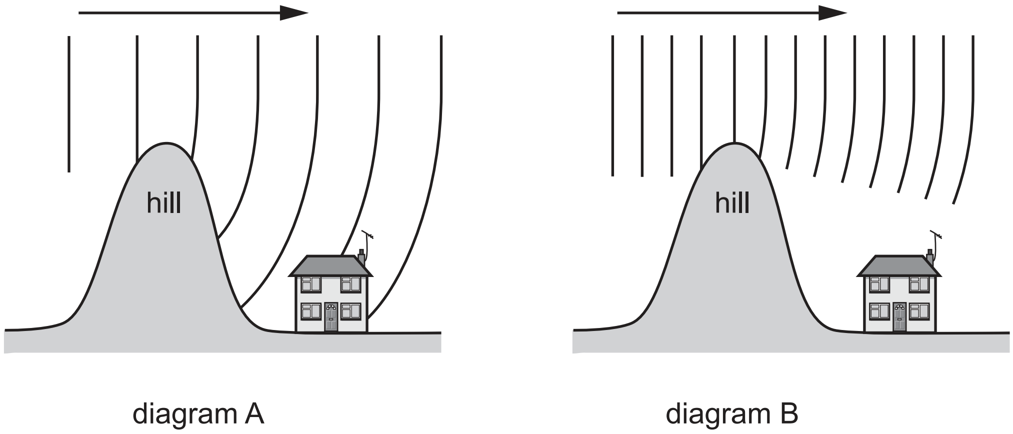

Fig. 4.1 (not to scale)

Explain why the radio waves in diagram A reach the house but the radio waves in diagram B do not reach the house.

....

....

....

.... [2]

[Total: 10]

5 Fig. 5.1 shows part of a circuit containing a 240 V mains supply connected to a lamp and two heaters of resistance 40 Ω and 60 Ω.

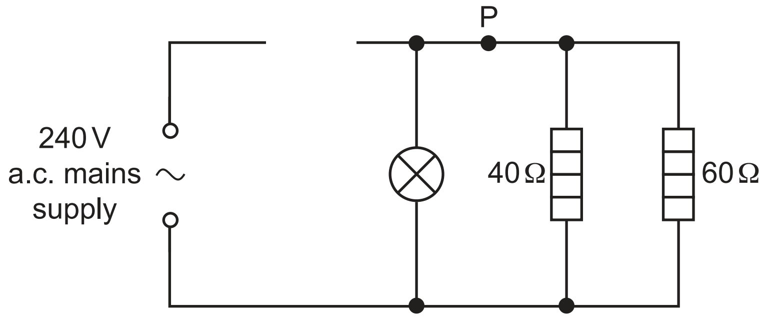

Fig. 5.1

(a) Complete Fig. 5.1 by drawing the symbol for a fuse in the gap in the circuit. [1]

(b) **(i)** On Fig. 5.2 sketch a current−voltage graph for a filament lamp.

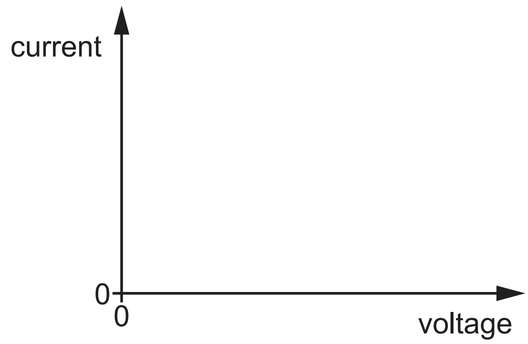

Fig. 5.2

[1]

(ii) Explain the shape of the current−voltage graph drawn in **(i)**.

....

....

.... [2]

(c) Calculate the current at point P in the circuit shown in Fig. 5.1.

current = ... A [3]

(d) The current in the lamp is 1.5A.

(i) Suggest a suitable fuse rating for the fuse.

.... [1]

(ii) Explain why a fuse rating much larger than the value in **(i)** is **not** suitable.

....

....

....

.... [2]

(iii) Explain why it is necessary to connect a fuse in the live wire rather than the neutral wire or earth wire.

....

.... [1]

[Total: 11]

6 Fig. 6.1 shows the structure of a simple electric motor.

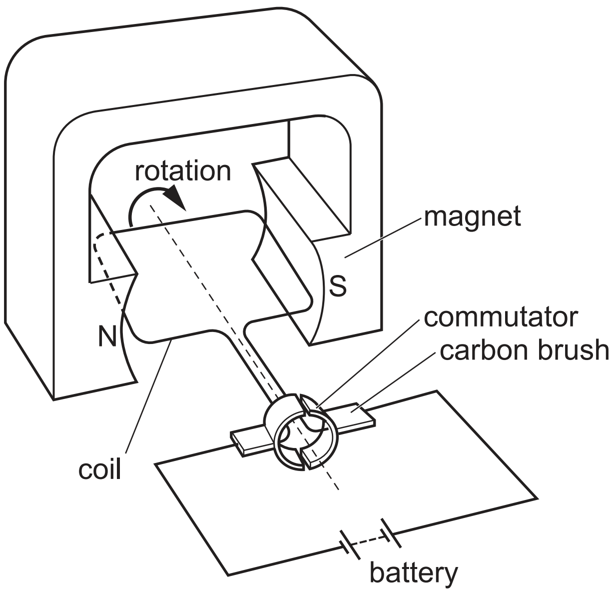

Fig. 6.1

The current in the coil causes the coil to rotate.

A student notices that the coil turns in the direction shown by the curved arrow in Fig. 6.1.

(a) **(i)** State what happens to the motor if a stronger magnet is used.

.... [1]

(ii) On Fig. 6.1 mark and label:

- the direction of the current in the coil
- the direction of the magnetic field.

[1]

(iii) Explain why the coil turns.

....

....

....

.... [2]

(b) Two vertical wires carry equal currents in opposite directions. They pass at right angles through a piece of card as shown in Fig. 6.2.

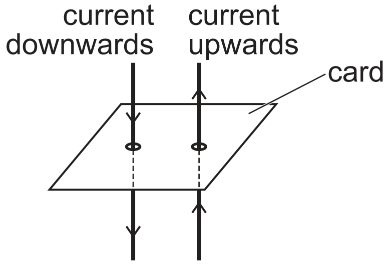

Fig. 6.2

Fig. 6.3 is a view of the card from above.

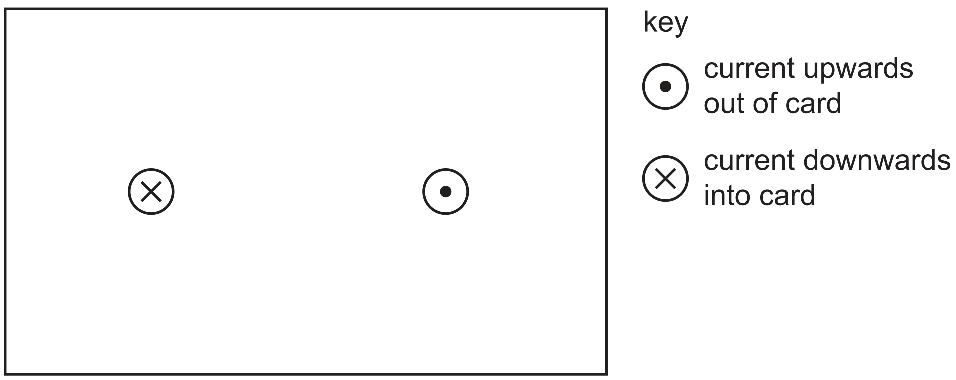

Fig. 6.3

(i) On Fig. 6.3 sketch the pattern of the magnetic field produced.

Indicate the direction of the magnetic field on the pattern that you draw.

[3]

(ii) The currents in the two wires cause the wires to repel each other.

Explain how the current in one wire causes a force on the other wire.

....

....

....

.... [2]

[Total: 9]

7 **(a)** Table 7.1 shows four different nuclei.

Table 7.1

thorium-236	protactinium-236	uranium-235	uranium-238
$^{236}_{90}\text{Th}$	$^{236}_{91}\text{Pa}$	$^{235}_{92}\text{U}$	$^{238}_{92}\text{U}$

(i) State which two nuclei have the same number of protons.

.... [1]

(ii) State which two nuclei have the same number of neutrons.

.... [1]

(iii) State which two nuclei have the same number of nucleons.

.... [1]

(b) A teacher uses a Geiger-Müller tube and a counter to measure the background radiation in the laboratory.

The counter records 20 counts per minute.

A radioactive source is then placed in front of the tube and the counter records 420 counts per minute.

(i) State what is meant by 'background radiation'.

....

.... [1]

(ii) The measured count rate of 420 counts per minute can be corrected for background radiation.

Calculate the corrected count rate from the source.

count rate = ... counts per minute [1]

(iii) The radioactive source has a half-life of 45 minutes.

Determine the reading on the counter 90 minutes later.

reading on counter = ... counts per minute [2]

(iv) Suggest why your answer to **(iii)** is only an estimate.

....

....[1]

(c) Fig. 7.1 shows different uses of three different types of radiation.

Draw a line on Fig. 7.1 from each use of radiation to the type of radiation used. One line has been drawn for you.

Each type of radiation can be used once, more than once or not at all.

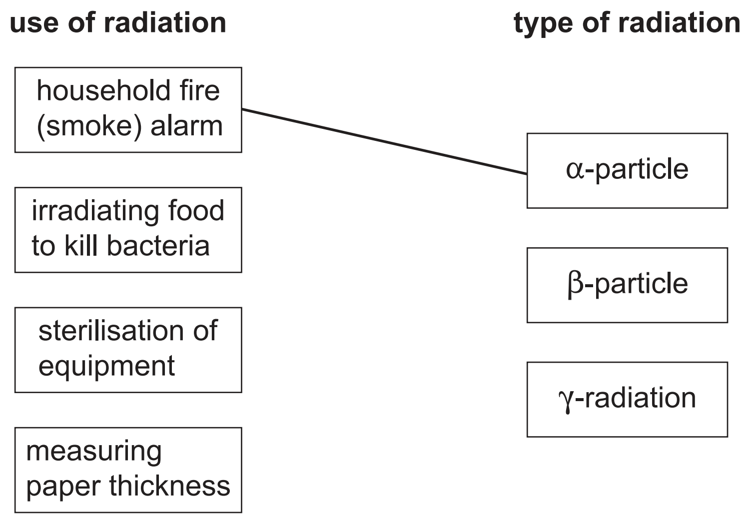

Fig. 7.1

[2]

[Total: 10]

8 Table 8.1 shows data about three planets, Mercury, Venus and Earth.

Table 8.1

	time for one orbit of Sun / days	distance from Sun / km	average density / kg/m^3	gravitational field strength at surface / N/kg
Mercury	88	5.8×10^7	5400	3.7
Venus	220	1.1×10^8	5200	8.9
Earth	365	1.5×10^8	5500	9.8

(a) Fig. 8.1 shows these planets in alignment with the Sun. They rotate around the Sun in the direction shown.

Mark and label on Fig. 8.1 the positions of the three planets 110 days after the position shown in Fig. 8.1.

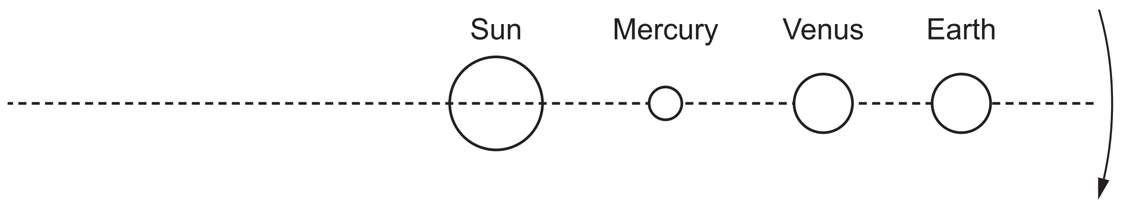

Fig. 8.1 (not to scale)

[3]

(b) **(i)** Each of the three planets has a similar average density.

Suggest why the gravitational field strength at the surface of Mercury is much smaller than at the surface of Venus.

....

.... [1]

(ii) An object has a weight of 37 N on the surface of Mercury.

Calculate its weight on the surface of the Earth. Show your working.

weight = ... N [2]

(c) State what is meant by a 'moon'.

.... [1]

(d) The Sun will eventually run out of hydrogen.

Describe what happens to the Sun when the hydrogen runs out.

....

....

....

....

.... [3]

[Total: 10]

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