Cambridge Assessment International Education

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PHYSICS **0625/41**

Paper 4 Theory (Extended) **May/June 2024**

1 hour 15 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 **16** pages. Any blank pages are indicated.

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1 A long tube contains oil. A small ball is held at rest at the surface of the oil. At time $t = 0$, the ball is released and begins to fall vertically through the oil.

Fig. 1.1 shows the ball falling through the oil.

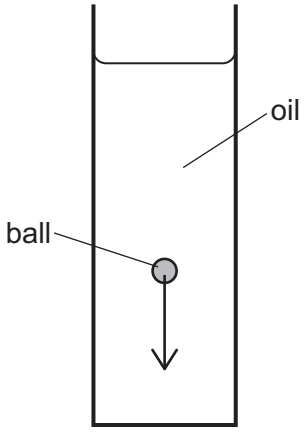


Fig. 1.1

As the ball begins to fall through the oil, it accelerates.

(a) Define acceleration.

.....

..... [1]

(b) The mass of the ball is 0.0075 kg.

Calculate the resultant force acting on the ball when it is accelerating downwards at $2.8\,m/s^2$.

resultant force = ... [2]

(c) As the ball falls, its speed v is recorded. Fig. 1.2 is the speed–time graph for the falling ball.

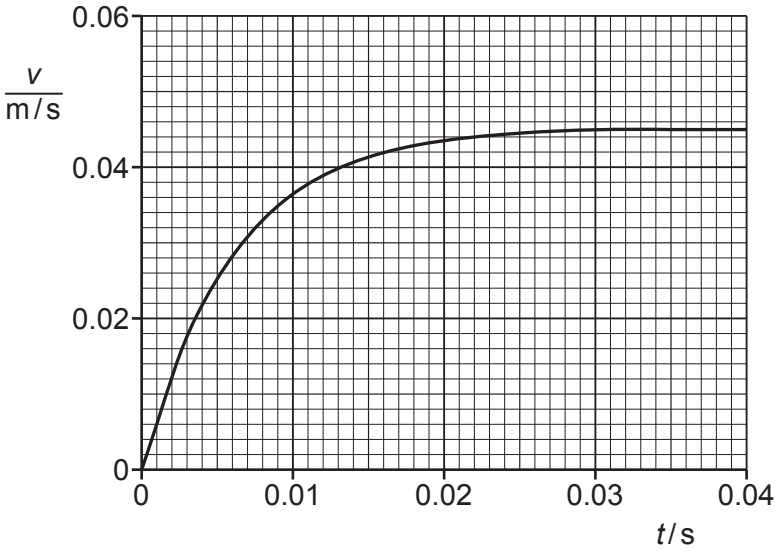


Fig. 1.2

(i) Describe what happens to the acceleration between $t = 0$ and $t = 0.040\,s$.

Explain why this happens.

.....

.....

.....

..... [4]

(ii) By drawing a tangent on Fig. 1.2, determine a value for the acceleration of the ball at $t = 0.010\,s$.

acceleration = ... [3]

[Total: 10]

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2 Fig. 2.1 shows two identical trolleys, P and Q, held at rest on a frictionless horizontal surface. A load is fixed to trolley P.

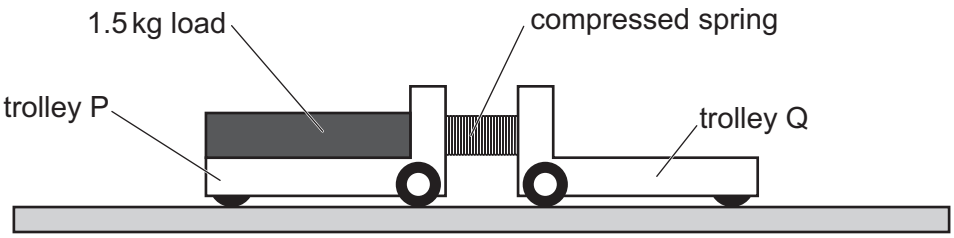


Fig. 2.1

There is a compressed spring between trolley P and trolley Q.

The trolleys are released. As the spring expands, it pushes the trolleys apart.

Trolley Q moves to the right at a constant speed of 0.36 m / s.

The mass of each trolley is 1.2 kg. The mass of the load on trolley P is 1.5 kg.

The spring has negligible mass.

(a) Calculate:

(i) the speed at which trolley P moves to the left

speed of P = ... [3]

(ii) the kinetic energy of trolley Q when it moves at 0.36 m / s.

kinetic energy of Q = ... [3]

(b) State the energy transfer that takes place as the spring expands.

.....

.....

..... [2]

[Total: 8]

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3 Fig. 3.1 shows a small block of ice floating in a beaker of warm water.

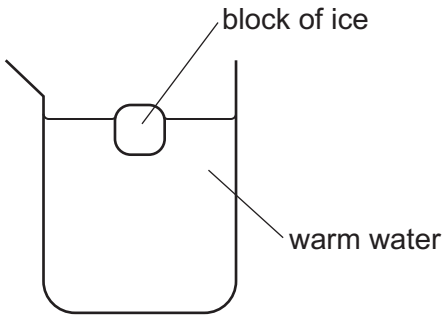


Fig. 3.1

(a) State **one** way in which the motion of the particles in ice differs from the motion of the particles in water.

.....

..... [1]

(b) Energy is transferred from the water to the block of ice.

(i) State the name of the thermal process that transfers energy from the water to the ice.

..... [1]

(ii) Initially, there is 0.34 kg of water in the beaker. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the energy transferred from this water as its temperature decreases from 28 °C to 10 °C.

energy transferred = ... [2]

(iii) The temperature of the water near the ice decreases first.

Explain how convection causes the temperature of all the water in the beaker to decrease.

.....

.....

.....

..... [3]

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(iv) State what happens to the internal energy of the water as the temperature of the water decreases.

Describe the change in terms of the energy of the particles.

.....

.....

..... [2]

[Total: 9]

4 The lens in a magnifying glass is a converging lens.

(a) Fig. 4.1 shows the lens of the magnifying glass, its two focal points, F_1 and F_2, and its principal axis.

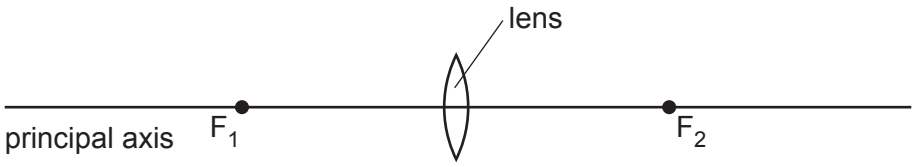


Fig. 4.1

(i) State what is meant by 'focal point'.

.....

.....

..... [2]

(ii) A student using the magnifying glass sees a magnified image of an object.

On Fig. 4.1, mark:

- a point X on the principal axis for a possible position of the object
- a point E for a possible position of the student's eye.

[1]

(iii) Underline **two** words in the list that describe the image produced in **(a)(ii)**.

inverted **real** **upright** **virtual**

[1]

(b) The refractive index of the glass used to make the lens is 1.5.

(i) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in the glass.

speed in glass = ... [2]

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(ii) State what happens to the wavelength of light as it passes into the lens.

.....

..... [1]

(c) Converging lenses are used in spectacles (glasses) to correct one problem with vision.

State the name of the problem and explain how a converging lens is used to correct it. You may draw a diagram.

name of problem: .....

.....

.....

.....

.....

[3]

[Total: 10]

5 **(a)** Describe how a longitudinal wave differs from a transverse wave.

.....

.....

..... [2]

(b) Fig. 5.1 represents a seismic wave produced by an earthquake.

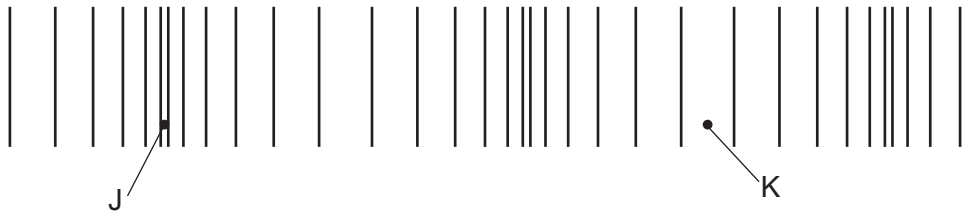


Fig. 5.1

(i) State whether this seismic wave is a P-wave (primary) or an S-wave (secondary). Justify your choice.

.....

..... [1]

(ii) The wave represented in Fig. 5.1 has a wavelength of 1.2×10^4 m.

Calculate the actual distance between point J and point K.

distance = ... [2]

(iii) The wave in **(ii)** travels through the ground at a speed of 4600 m / s.

As the wave passes a certain point, the ground completes 5 oscillations.

Calculate the time that it takes for the wave to pass. Show your working.

time = ... [3]

[Total: 8]

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6 Fig. 6.1 shows an isolated metal sphere suspended by an insulating thread from the ceiling.

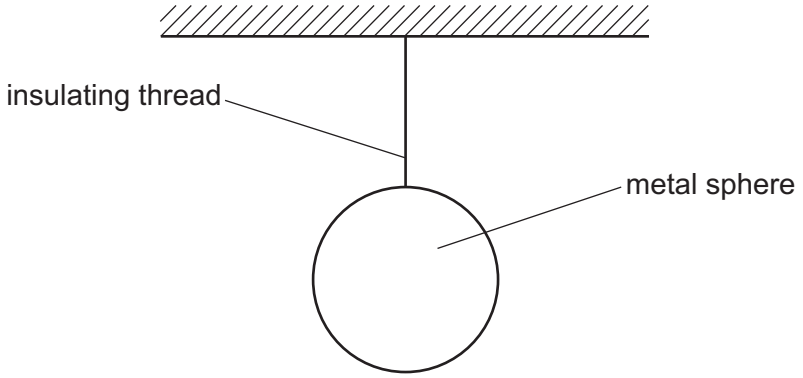


Fig. 6.1

The sphere is negatively charged.

(a) The charge on the sphere produces an electric field in the surroundings.

(i) State what is meant by 'electric field'.

.....

..... [1]

(ii) Draw on Fig. 6.1 to show the pattern and direction of the electric field produced by the charge on the sphere. Draw at least **four** lines. [3]

(b) The magnitude of the charge on the sphere is 3.5×10^{-10} C.

An earthed metal wire is touched against the surface of the sphere and the sphere is discharged.

(i) State what happens in the wire as the sphere is discharged.

.....

.....

..... [2]

(ii) It takes a time of 0.14 ns for the sphere to discharge completely.

Calculate the average current in the earthed wire as the sphere discharges.

average current = ... [3]

[Total: 9]

7 The electromotive force (e.m.f.) of a battery is 7.5 V.

(a) Define the term electromotive force.

.....

.....

..... [2]

(b) The battery is connected in series with a variable resistor and a 30 Ω resistor. The battery is made using 1.5 V cells.

(i) Draw a circuit diagram that shows all the 1.5 V cells connected to produce an e.m.f. of 7.5 V, the variable resistor and the 30 Ω resistor.

[3]

(ii) The resistance of the variable resistor can be varied from 0 Ω to a maximum resistance of 150 Ω.

Using the axes in Fig. 7.1, draw a graph to show how the current in the circuit varies with the resistance of the variable resistor as it increases from 0 Ω to 150 Ω.

Determine and label the value of the maximum current on the *y*-axis.

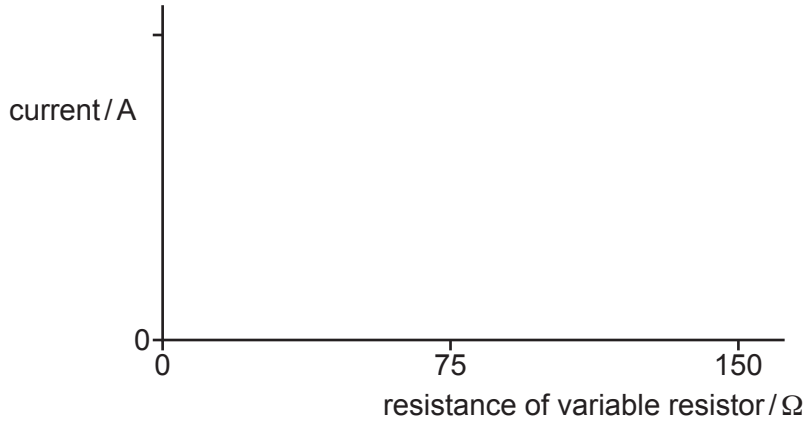


Fig. 7.1

[4]

[Total: 9]

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8 The isotope thallium-208 ($^{208}_{81}Tl$) is radioactive. It decays by β-decay.

(a) Thallium-208 decays to an isotope of lead (Pb).

(i) Complete the equation for this decay.

$$^{208}_{81}Tl \longrightarrow \text{.....}^{\text{.....}}_{\text{.....}}Pb + \text{.....}^{\text{.....}}_{\text{.....}}\beta$$

[3]

(ii) The β-emission of thallium-208 is accompanied by γ-emission from the nucleus.

Explain why this γ-emission does **not** affect the numbers in the equation in **(a)(i)**.

.....

..... [1]

(iii) Suggest **one** reason why a nucleus of thallium-208 is unstable.

.....

..... [1]

(b) A sample of thallium-208 is placed in a thick lead container. Fig. 8.1 shows a narrow beam of β-particles and γ-radiation emerging from a small hole in one side of the container.

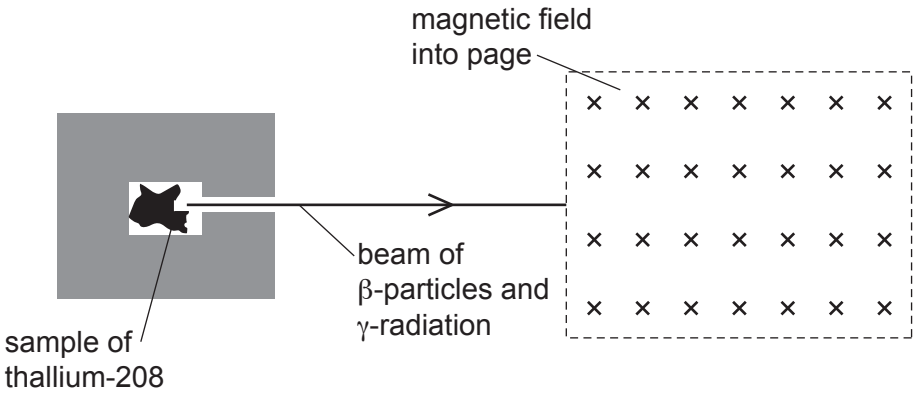


Fig. 8.1

The narrow beam enters a region where there is a magnetic field that is directed into the page.

On Fig. 8.1:

- draw a line **labelled β** to indicate the path of the β-particles in the magnetic field
- draw a line **labelled γ** to indicate the path of the γ-radiation in the magnetic field.

[3]

[Total: 8]

9 The Sun is one of many billions of stars in the Milky Way. The Sun emits a very large quantity of energy as electromagnetic radiation.

(a) State the **three** regions of the electromagnetic spectrum in which the Sun emits the most energy.

1 .....

2 .....

3 .....
[2]

(b) Electromagnetic radiation from the Sun travels at a speed of 3.0×10^8 m/s. The radiation takes 500 s to reach the Earth.

Calculate the distance from the Sun to the Earth.

distance = ... [2]

(c) Approximately 4.6 billion years ago, the Sun formed from an interstellar cloud of gas and became a stable star.

(i) Describe and explain what happens as an interstellar cloud of gas forms a protostar.

.....

.....

..... [2]

(ii) Describe and explain what happens as a protostar becomes a stable star.

.....

.....

.....

..... [3]

[Total: 9]

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