Cambridge Assessment International Education

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3081870437

PHYSICS **0625/41**

Paper 4 Theory (Extended) **October/November 2020**

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 10 N (acceleration of free fall = 10 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. Blank pages are indicated.

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1 Fig. 1.1 shows an ice-hockey player moving on ice. He is preparing to hit the solid disc called a puck.

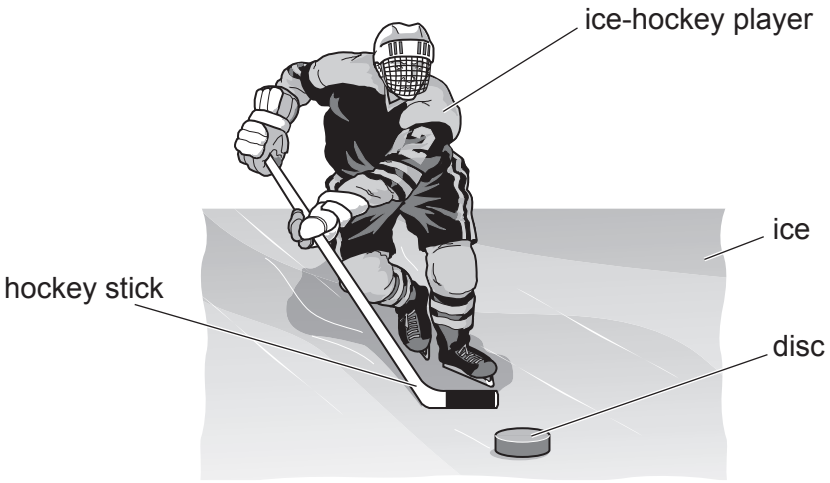


Fig. 1.1

The disc of mass 0.16 kg is moving horizontally across the surface of the ice at a speed of 15 m / s.

(a) Calculate the magnitude of the momentum of the disc.

magnitude of momentum = ... [2]

(b) The hockey player strikes the disc with his hockey stick and the momentum of the disc changes. The disc gains momentum of 3.0 kg m / s at 45° to the original direction of travel of the disc, as shown in Fig. 1.2.

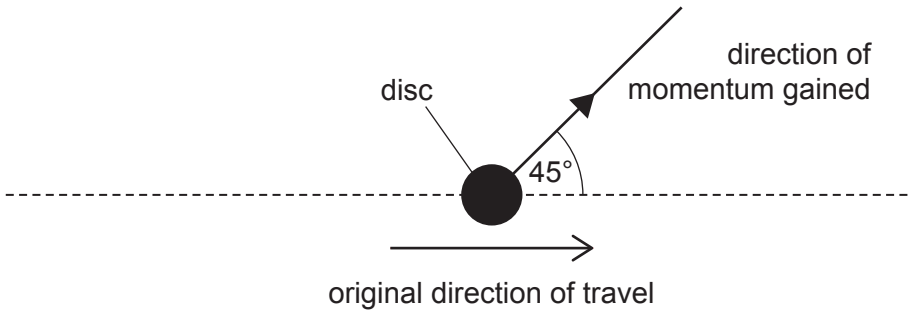


Fig. 1.2 (view from above)

(i) State the magnitude of the impulse exerted on the disc and the direction, in degrees, of the impulse relative to the original direction of travel.

magnitude of impulse = ...

direction of impulse: ..... ° to original direction
[1]

(ii) Determine the magnitude of the new momentum of the disc and its new direction relative to the original direction of travel by drawing a scale diagram.

magnitude of new momentum = ...

direction of new momentum: ..... ° to original direction
[4]

[Total: 7]

2 A vertical tube contains a liquid. A metal ball is held at rest by a thread just below the surface of the liquid, as shown in Fig. 2.1.

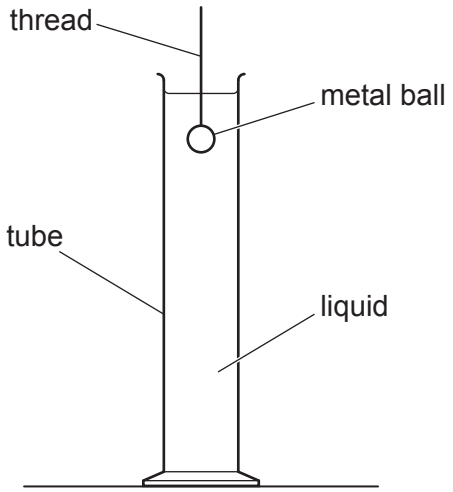


Fig. 2.1 (not to scale)

The diameter of the tube is much greater than the diameter of the ball. The ball is released and it accelerates downwards uniformly for a short period of time.

(a) Describe what happens to the velocity of the ball in the short period of time as it accelerates downwards uniformly.

.....

..... [2]

(b) The ball reaches terminal velocity.

Describe and explain the motion of the ball from when it is released until it reaches terminal velocity.

.....

.....

.....

..... [3]

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(c) The metal ball has a mass of 2.1 g. It falls a distance of 0.80 m between being released and reaching the bottom of the tube.

(i) Calculate the gravitational potential energy transferred from the ball as it falls.

gravitational potential energy transferred = ... [2]

(ii) When the ball reaches the bottom of the tube, it has a speed of 1.2 m / s. Calculate the kinetic energy of the ball at the bottom of the tube.

kinetic energy = ... [3]

(iii) Explain why the value calculated in **(c)(i)** is different from that calculated in **(c)(ii)**.

.....

..... [1]

[Total: 11]

3 A U-shaped tube of constant cross-sectional area contains water of density 1000 kg / m^3. Both sides of the U-tube are open to the atmosphere.

Fig. 3.1 shows that the water levels in the two sides of the tube are equal.

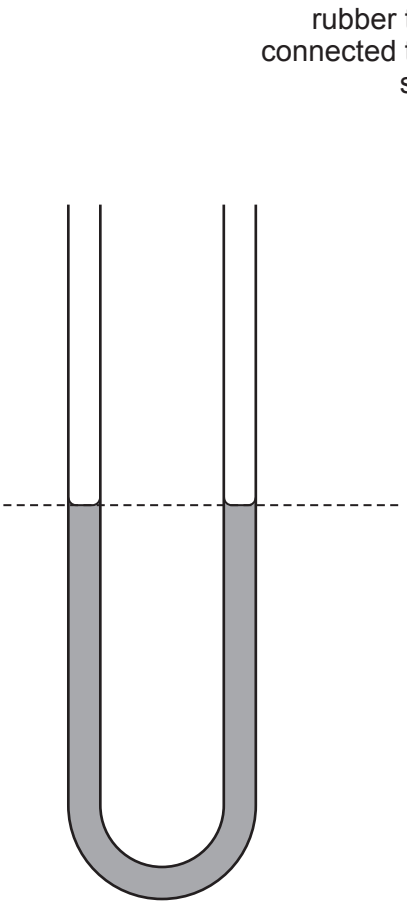


Fig. 3.1

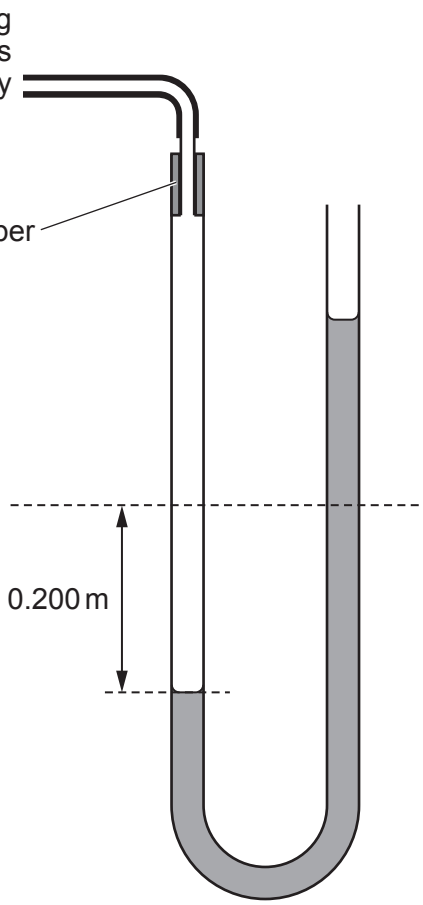


Fig. 3.2

The atmospheric pressure is 1.00×10^5 Pa.

The left-hand side of the tube is now connected to a gas supply using a length of rubber tubing. This causes the level of the water in the left-hand side of the tube to drop by 0.200 m, as shown in Fig. 3.2.

(a) Calculate the pressure of the gas supply. Give your answer to 3 significant figures.

pressure = ... [3]

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(b) Fig. 3.3 shows that the gas supply is now connected to a cylinder that contains a piston.

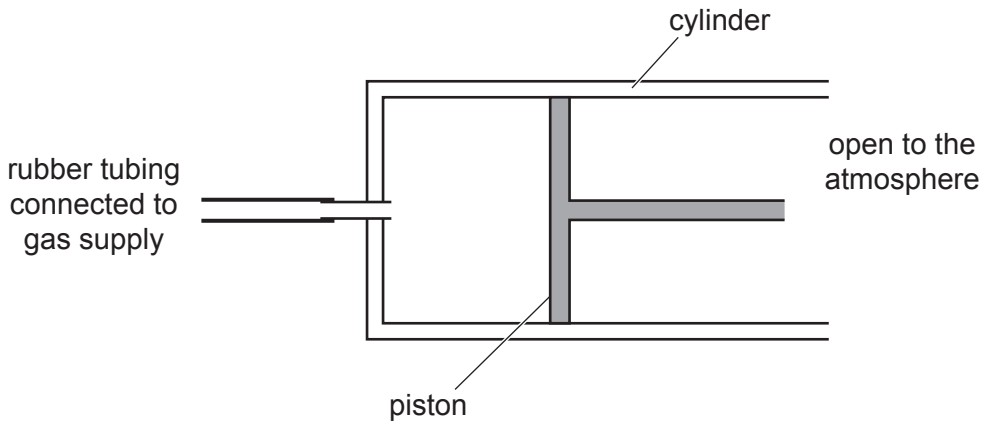


Fig. 3.3

The pressure of the gas moves the piston to the right.

(i) The area of the piston in contact with the gas is $0.025\,m^2$.

Calculate the resultant force on the piston.

resultant force = ... [2]

(ii) The pressure of the gas causes the piston to move a distance of 0.50 m to the right.

Calculate the work done by the gas from the supply on the piston.

work done = ... [2]

[Total: 7]

4 A large test-tube contains a liquid at room temperature. An electric heater is immersed in the liquid and is switched on. Thermal energy is supplied to the liquid by the heater. The temperature of the liquid increases until it reaches its boiling point. The liquid then starts to change into gas.

(a) Describe, in terms of molecules and their motion, how a liquid differs from a gas.

.....

.....

.....

.....

..... [3]

(b) Describe what happens to molecules of the liquid as its temperature begins to increase.

.....

.....

..... [2]

(c) **(i)** Explain, in terms of molecules, why a supply of thermal energy is needed to change the liquid into a gas.

.....

..... [1]

(ii) The density of the liquid in the test-tube is $0.86\,g/cm^3$. The volume of liquid in the test-tube is $50\,cm^3$.

The liquid reaches its boiling point. It now absorbs 18 000 J of thermal energy and all of the liquid changes into a gas.

Calculate the specific latent heat of vaporisation of this liquid.

specific latent heat = ... [3]

[Total: 9]

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5 A metal container is used to cook food. The metal container has thick walls. Hot cooking oil at a temperature of 120 °C is poured into the container.

(a) The outside surface of the container gets hot. Some thermal energy passes through the metal because vibrating atoms in the metal collide with neighbouring atoms and transfer energy to them.

Explain how the rest of the thermal energy is conducted through the metal container to the outside surface by another process.

.....

.....

.....

..... [3]

(b) The outside surface of the container is brightly polished and shiny.

Explain how this reduces the power that needs to be supplied to keep the oil at the correct temperature.

.....

.....

.....

.....

..... [3]

(c) The metal container is spherical. The spherical container has a smaller surface area than a long, thin container of the same volume.

Explain the advantage of using a spherical container.

.....

.....

..... [1]

[Total: 7]

6 Fig. 6.1 shows a shallow tank viewed from above. The depth of the water is different in the two parts of the tank. Fig. 6.1 shows the crests and the troughs of a wave that pass from left to right.

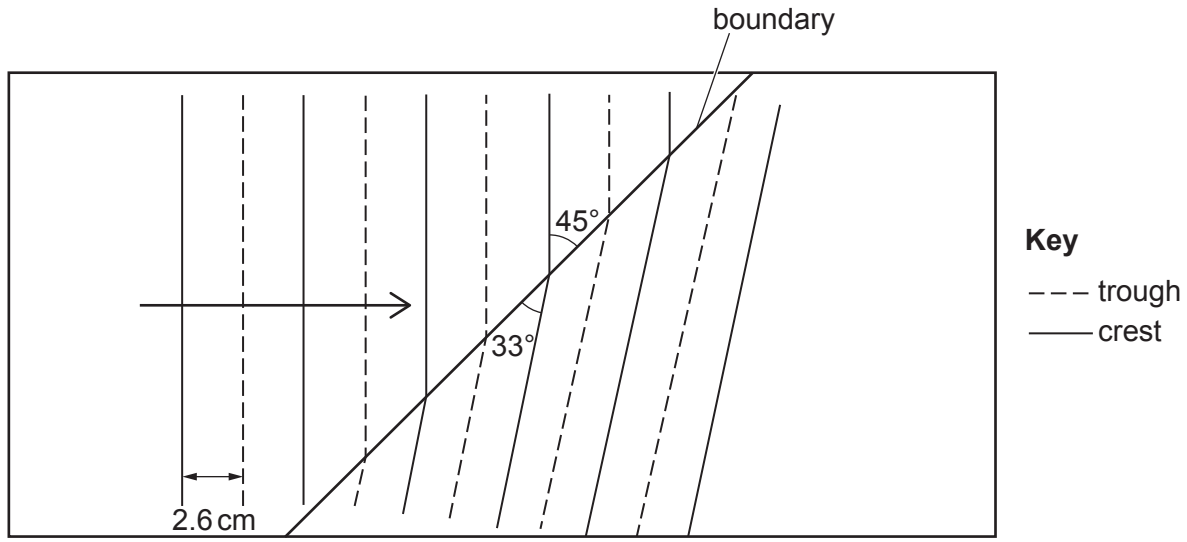


Fig. 6.1 (not to scale)

As the wave passes from one side to the other, the direction of the wavefronts changes.

(a) Explain why the direction of the wavefronts changes in the way shown in Fig. 6.1.

.....

.....

.....

.....

..... [3]

(b) The speed of the wave in the left-hand part of the tank is 0.39 m / s.

(i) Using information from Fig. 6.1, determine the frequency of the wave.

frequency = ... [3]

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(ii) Determine the speed of the wave in the right-hand side of the tank.

speed = ... [3]

[Total: 9]

7 **(a)** A permanent magnet is made from only one material.

Underline the material from which it is possible to make a permanent magnet. [1]

aluminium **copper** **soft iron** **mercury** **plastic** **steel** **uranium**

(b) An electron source produces a narrow beam of electrons that all travel at the same speed.

The electron source is placed in a vacuum and the beam of electrons travels vertically downwards. Fig. 7.1 shows the beam of electrons before it passes between the N-pole and the S-pole of a magnet.

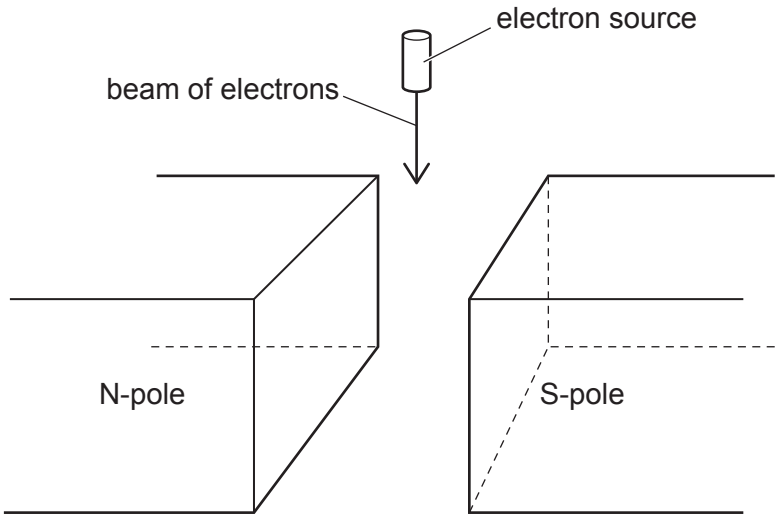


Fig. 7.1

(i) Describe what is meant by the direction of a magnetic field. State the direction of the magnetic field between the two poles in Fig. 7.1.

.....

.....

..... [1]

(ii) Describe and explain what happens to the beam of electrons in the magnetic field between the poles of the magnet in Fig. 7.1.

.....

.....

.....

..... [3]

(c) A beam consists of α-particles, β-particles and γ-rays.

Explain how a uniform magnetic field may be used to separate the α-particles, the β-particles and the γ-rays.

.....

.....

.....

..... [3]

[Total: 8]

8 **(a)** Explain what is meant by *electromotive force* (*e.m.f.*).

.....

.....

..... [2]

(b) An electric heater contains two heating elements R_1 and R_2. An electric motor operates a fan. The fan blows cool air over the heating elements.

Fig. 8.1 shows the circuit.

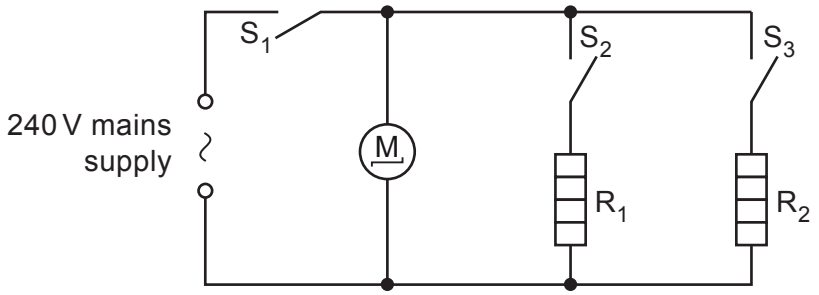


Fig. 8.1

The heater is powered by a mains supply of e.m.f. 240 V.

Switches S_1 and S_2 are closed. Heating element R_1 gets hot. The resistance of R_1 is 30 Ω.

(i) Calculate the current in heating element R_1.

current = ... [1]

(ii) Calculate the power produced in heating element R_1.

power = ... [2]

(iii) The resistance of heating element R_2 is 60 Ω.

Switches S_1, S_2 and S_3 are closed.

1. State and explain how the current in R_2 compares with the current in R_1.

.....

.....

..... [2]

2. The current in the motor is 0.10A. The cable from the electric heater to the plug for the mains socket is safe when the current in it is less than 20A.

Suggest and explain a suitable fuse rating for this circuit.

.....

.....

.....

..... [2]

[Total: 9]

9 **(a)** **(i)** Describe what is observed during *total internal reflection*.

.....

..... [1]

(ii) State **two** conditions required for light to be totally internally reflected.

1. .....

.....

2. .....

.....

[2]

(b) Describe and explain the action of optical fibres in communication technology. You may draw a diagram in your answer.

.....

.....

.....

..... [3]

[Total: 6]

10 A radiation detector is placed on the bench in a laboratory. It detects a background count rate of 40 counts / minute.

(a) State what is meant by background radiation. Suggest one source for it.

.....

.....

..... [2]

(b) A sample containing atoms of the radioactive isotope polonium-208 is removed from a lead container and brought close to the detector. The average count rate increases to 890 counts / minute.

When two sheets of paper are inserted between the sample and the detector, the average count rate returns to 40 counts / minute.

Polonium-208 is represented by the symbol $^{208}_{84}Po$. It decays to an isotope of lead (Pb).

(i) Deduce the type of radiation emitted by polonium-208. Explain your answer.

.....

.....

.....

..... [2]

(ii) Write down the nuclide equation for the decay of polonium-208.

[3]

[Total: 7]

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