

Class:	Index No.:	Name:
 CRESCENT GIRLS' SCHOOL SECONDARY FOUR PRELIMINARY EXAMINATION		
PHYSICS Paper 2 Structured and Free Response		6091 / 02 02 September 2025 1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page and on all separate answer sheets used.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluids.

Section A

Answer **all** questions.

Write your answers on the spaces provided.

Section B

Answer **one** question.

Write your answers on the spaces provided.

Candidates are reminded that all quantitative answers should include appropriate units.

The use of an approved scientific calculator is expected, where appropriate.

Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiners Use	
Section	Marks
A	/ 70
B []	/ 10
S.F. penalty	
Total	/ 80

Section A

Answer **all** questions in this section.

- 1 Two small tugboats are pulling a ship in a harbour. Fig. 1.1 represents the view from above and shows the directions of the forces on the ship.

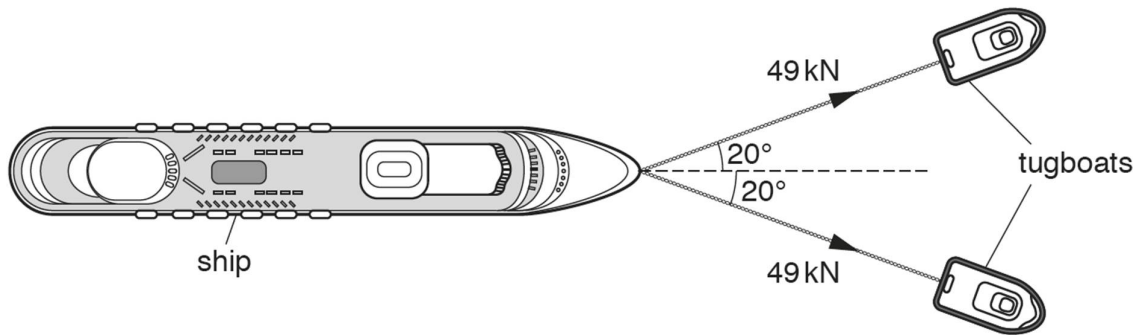


Fig. 1.1 (not to scale)

Each of the tugboats is exerting a horizontal force of 49 kN on the ship.

- (a) By drawing a scaled vector diagram, determine the resultant of these two forces. Label your forces.

resultant = [3]

- (b) The engines of the ship are not operating and the water in the harbour is stationary. The ship is moving at a constant speed in a straight line in the direction of the resultant of the two forces exerted by the tugboats.

Explain, in terms of the forces acting, why the ship is moving in a straight line at constant speed.

.....

.....

.....

.....

..... [3]

- (c) Both cables connecting the tugboats and the ship are detached at the same instant.

The mass of the ship is 2.4×10^7 kg.

Determine the magnitude of the acceleration, and its direction relative to the motion of the ship, at this instant.

magnitude = [1]

direction relative to motion of the ship = [1]

[Total: 8 marks]

- 2 Fig. 2.1 shows a man sitting on a chair resting on four legs. Fig. 2.2 shows the same man with his chair tilted backwards slightly.



Fig. 2.1



Fig. 2.2

The man has a weight of 650 N and the chair has a weight of 20 N. Each base area of each leg is 5.0 cm².

- (a) Calculate the pressure exerted on the floor when the chair is in the position shown in Fig. 2.1.

pressure = [2]

- (b) State and explain, without any calculations, how the pressure of the chair on the floor differs in the two positions.

.....

 [2]

- (c) In Fig. 2.2, the chair and man are about to fall over.

On Fig. 2.2, draw an "X" to indicate the position of the centre of gravity of the chair and man. [1]



- (d) The chair and man fall over if the chair is tilted backwards more than in Fig. 2.2.
Explain why.

.....

.....

.....

..... [2]

[Total: 7 marks]

- 3 Fig. 3.1 shows the plan of a bedroom and part of the main room of a house. Other parts of the house are not shown.

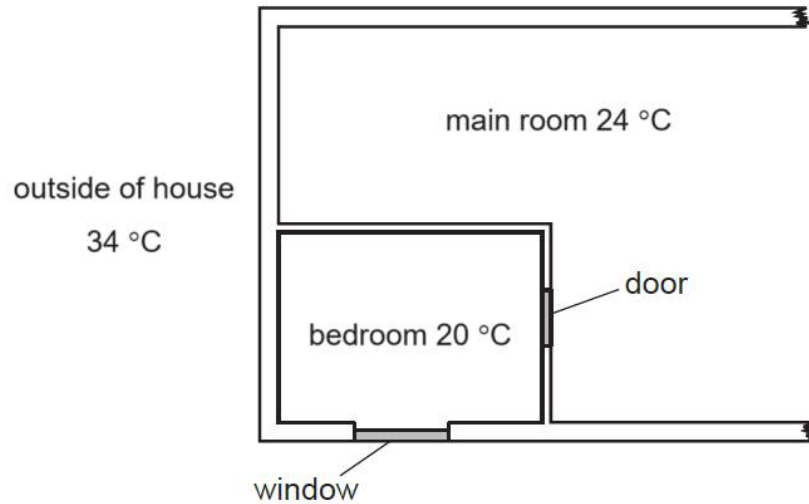


Fig. 3.1

The temperatures of the main room, the bedroom and the outside of the house are shown in Fig. 3.1.

Fig. 3.2 shows the thermal energy transfers to the bedroom in one hour.

through the door and walls from the main room	60 000 J
through the walls from the outside	1 500 000 J
through the window	200 000 J

Fig. 3.2

- (a) State the key process of heat transfer to the bedroom.

..... [1]

- (b) Explain why more thermal energy enters the bedroom from the outside of the house than from the main room.

.....

..... [1]

- (c) Suggest two ways to reduce the different heat transfers into the bedroom through the walls from the outside.

1.

.....

2.

.....

[2]

- (d) An air conditioner is installed in each room to keep the room at the temperatures shown in Fig. 3.1. The air conditioners are installed at the top of each room.

Explain how this set-up helps to cool the air in the rooms.

.....

.....

.....

.....

[3]

[Total: 7 marks]

- 4 Both sound and ultrasound are longitudinal waves that travel in solids, liquids and gases. Both consist of compressions and rarefactions.

(a) (i) State how sound differs from ultrasound.

.....
 [1]

(ii) Explain what is meant by a wave and state the direction of vibration of the wave particles in relation to the wave motion.

.....

 [3]

(b) Fig. 4.1 represents a longitudinal wave of frequency 25 kHz traveling in oil.

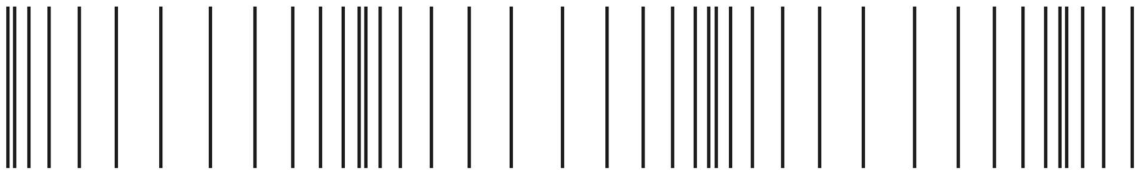


Fig. 4.1 (full scale)

- (i) On Fig. 4.1,
 1. mark one point at the centre of a rarefaction and label it **R**. [1]
 2. draw a double-headed arrow to indicate a distance that is equal to one wavelength of the wave. [1]
- (ii) Measure the length of the arrow drawn in **(b)(i)(2)**. and use it to determine the speed of the wave in the oil.

speed = [2]

[Total: 8 marks]

- 5 A girl rubs a polythene rod with a dry cloth. The polythene rod becomes positively charged and the cloth becomes negatively charged.

(a) Describe, in terms of the movement of electrons, how the polythene rod becomes positively charged.

.....
 [2]

(b) There is an electric field around the charged rod.

(i) Explain what is meant by an *electric field*.

.....
 [1]

(ii) State the direction of this electric field around the charged rod with reference to the rod.

..... [1]

(c) The charged rod is placed near a stream of water from a tap as shown in Fig. 5.1.

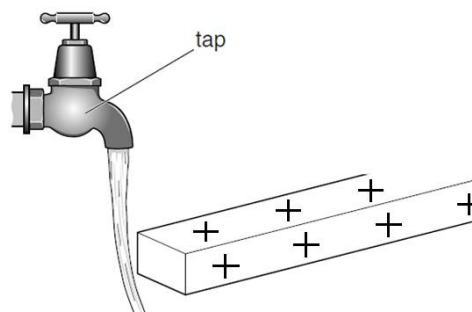


Fig. 5.1

The stream of water bends because the rod is charged.

Explain how the stream of water bends in Fig. 5.1.

.....
 [2]

[Total: 6 marks]

- 6 (a) Fig. 6.1 and Fig. 6.2 show views of a wire carrying a current downwards through a horizontal board.

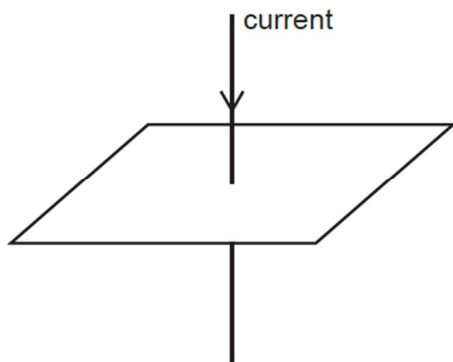


Fig. 6.1

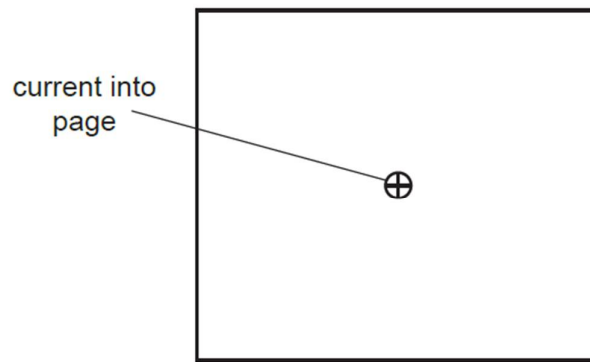


Fig. 6.2 (viewed from above)

On Fig. 6.2, draw the magnetic field due to the current in the wire.

[3]

- (b) The wire is coiled around an iron core and is connected to a power source to form an electromagnet, as shown in Fig. 6.3. With the switch open, a beam of electrons is projected between the poles of the electromagnet and produces a bright spot on a special screen. The whole set-up is enclosed in a vacuum.

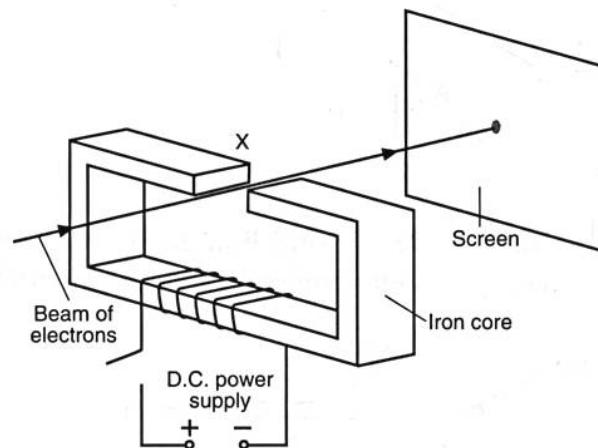


Fig. 6.3

The switch of the circuit is subsequently closed.

- (i) State the magnetic pole produced at the end marked X.

[1]



- (ii) State and explain the movement of the spot on the screen.

.....

.....

.....

..... [3]

- (iii) State what would be the effect on the position of the spot on the screen if the polarity of the d.c. power supply is reversed.

..... [1]

[Total: 8 marks]

- 7 Fig. 7.1 shows two coils of insulated wire wound on an iron ring. Coil A is connected to a power source and a switch. The switch is open. Coil B is connected to a sensitive centre-zero voltmeter.

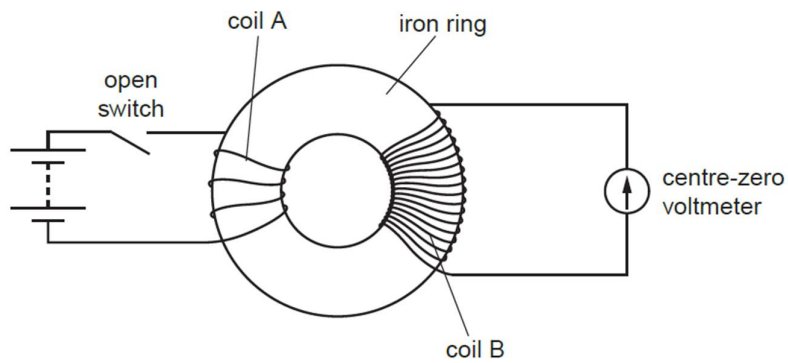


Fig. 7.1

The switch is closed. There is a current in coil A.

- (a) As the switch is closed, the voltmeter deflects to the right and then returns to zero. Explain why there is a deflection on the voltmeter.

.....

.....

.....

.....

..... [3]

- (b) The switch is then opened. State and explain what happens to the deflection on the voltmeter.

.....

.....

..... [2]

- (c) Without changing coil A, suggest one change to the apparatus that causes a greater deflection on the voltmeter.

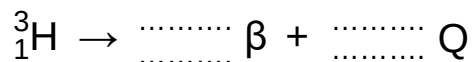
..... [1]

[Total: 6 marks]

- 8 (a) The nuclide notation for the radioactive isotope hydrogen-3 is ${}^3_1\text{H}$.

Hydrogen-3 has a half-life of 12.3 years and decays by the emission of beta particles to an isotope of a different element. This element is represented in the equation by Q.

- (i) Complete the nuclide equation for the decay of hydrogen-3.



[2]

- (ii) A sample of hydrogen-3 is placed on a laboratory bench next to a Geiger-Müller tube and a counter.

The count rate is recorded at the same time on four successive days and data obtained are as shown in Table 8.1.

Table 8.1

day	1	2	3	4
count rate (counts / s)	154	149	156	150

State why the count rate decreases and increases.

.....
 [1]

- (b) Leaks in shallow underground water pipes are detected using hydrogen-3 as a radioactive tracer.

- (i) Explain why alpha emissions are not suitable for use in this situation.

.....
 [1]

- (ii) Explain why the radioactive tracer must **not** have a very **short** half-life in this situation.

.....
 [1]

- (iii) Before hydrogen-3 is added to the water, the detector measures the background radiation above the pipe. The average background radiation is 40 counts / minute.

Suggest one source of radiation that may make a significant contribution to the background count rate.

..... [1]

- (iv) Hydrogen-3 is added to the water and the detector shows a count rate of 79 counts / second above the leak in the water pipe.

Determine the count rate due to the tracer.

count rate = [2]

[Total: 8 marks]

- 9 An object of mass 1.5 kg is released from a stationary hot air balloon at time $t = 0$ s. Fig. 9.1 shows how the velocity of the object varies with time.

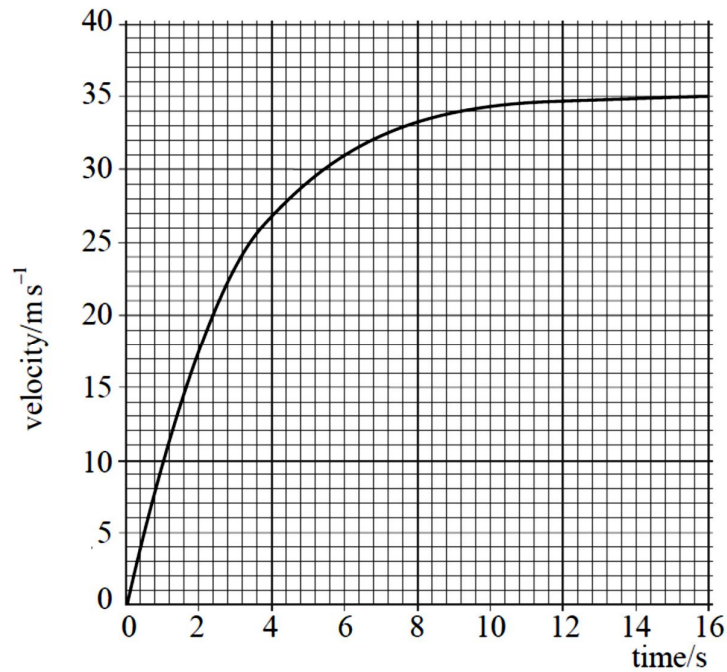


Fig. 9.1

- (a) Define *velocity*.

..... [1]

- (b) Describe the motion of the object from

- (i) $t = 0$ s to $t = 1$ s

.....
 [1]

- (ii) $t = 4$ s to $t = 12$ s

.....
 [1]

- (c) Using Fig. 9.1, determine the acceleration of the object at 6.0 s after it was released.

acceleration = [3]

(d) The object falls through a height of 450 m in the first 16 s after it was released.

(i) Explain how the distance of 450 m may be determined from Fig. 9.1.

.....
 [1]

(ii) The gravitational field strength g is 10 N kg^{-1}

For the 16 s after the object was released, calculate

1. the loss in energy in the gravitational potential store of the object ΔE_p , and

$$\Delta E_p = \dots\dots\dots [1]$$

2. the gain in energy in the kinetic store of the object ΔE_k .

$$\Delta E_k = \dots\dots\dots [1]$$

(iii) Using your answers to (ii), determine the average air resistance f_{air} acting on the object for the 16s after it was released.

$$f_{air} = \dots\dots\dots [3]$$

[Total: 12 marks]

Section B

Answer **one** question from this section.
 Answer either **Question 10** or **Question 11**.

- 10** A student sets up the circuit shown in Fig. 10.1.

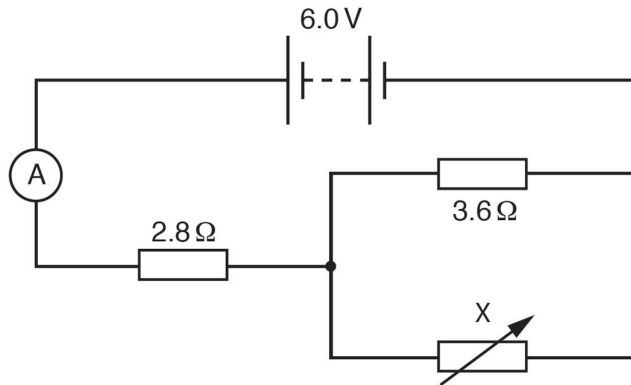


Fig. 10.1

The electromotive force (e.m.f.) of the battery is 6.0 V.

- (a)** State what is meant by the *electromotive force* of a battery.

.....
 [1]

- (b)** The resistance of the variable resistor X is set to 1.8 Ω.

Determine

- (i)** the total resistance of the circuit,

resistance = [2]

- (ii)** the reading on the ammeter,

reading = [1]



(iii) the potential difference across the $3.6\ \Omega$ resistor.

potential difference = [2]

(c) The resistance of X is increased.

State and explain how this affects the current through

(i) the $2.8\ \Omega$ resistor, and

.....

.....

.....

..... [2]

(ii) the $3.6\ \Omega$ resistor

.....

.....

.....

..... [2]

[Total: 10 marks]



- 11** A student investigates the effects of heating on evaporation by using a setup with a small electrical heater is placed inside a cup of water, as shown in Fig. 11.1. The mass of water is 200 g.

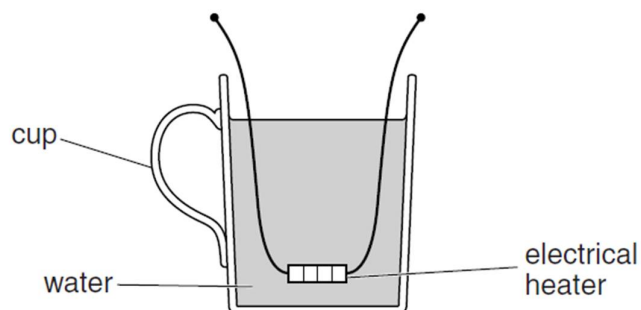


Fig. 11.1

The heater has an output power of 480 W. The water is heated from 30 °C and the temperature of water rises to 60 °C after 8.0 minutes. The specific heat capacity of water is 4.2 J / (g °C) and the specific latent heat of vaporisation for water is 2.26×10^6 J/kg. Assume that there are no other heat losses.

- (a)** Calculate the amount of energy needed to raise the temperature of water from 30 °C to 60 °C.

amount of energy = [2]

- (b)** It is noticed that some of the water evaporates during heating.

- (i)** Calculate the mass of the water that has evaporated during heating.

mass of water evaporated = [2]



(ii) State two differences in the process between evaporation and boiling.

1.

.....

2.

.....

[2]

(iii) Describe, using ideas about molecules of water, what happens during evaporation.

.....

.....

.....

..... [2]

(iv) Suggest and explain one change that could reduce the rate of evaporation.

.....

.....

..... [2]

[Total: 10 marks]