YUAN CHING SECONDARY SCHOOL
Secondary Four Express Course
Preliminary Examination 2024

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS

6091/02

Paper 2 Theory

10 September 2024

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A (70 marks)
Answer **all** questions.

Section B (10 marks)
Answer **one** out questions.
Write your answers in 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.
The total number of marks for this paper is 80.

For Examiner's Use	
Section A	
Section B	
Total	

Section A (70 marks)
Answer **all** questions.

1 A stone falls from the top of a cliff into the sea, as shown in Fig. 1.1.
The speed-time graph for the stone is shown in Fig. 1.2.

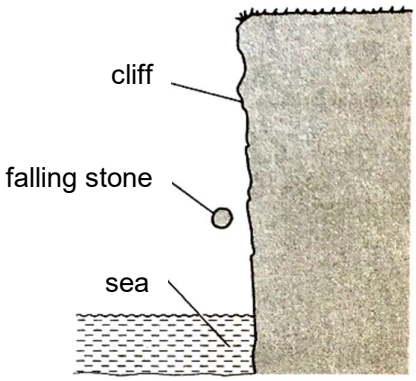


Fig. 1.1

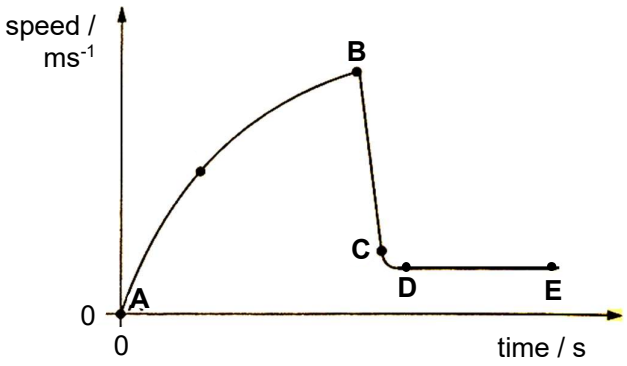


Fig. 1.2

(a) Describe the speed of the stone from **A** to **B**.

……

…… [1]

(b) Explain, in terms of the forces acting on the stone, why

(i) there is a sudden decrease in the speed of the stone from **B** to **C**,

……

……

…… [2]

(ii) the speed of the stone is constant from **D** to **E**.

……

……

…… [2]

2 Fig. 2.1 shows a pendulum of weight 5.0 N suspended from point **P**. A horizontal force **F** pulls on the string to the right such that the string is at rest 40° to the vertical.

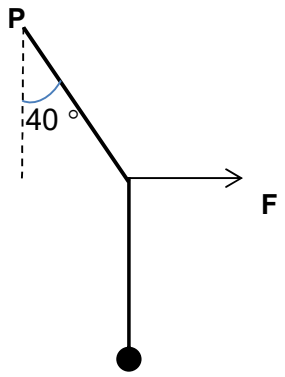


Fig. 2.1

Using scaled vector diagram in the space below, determine the magnitude of the horizontal force **F**.

scale: ……

magnitude of F: …….. [4]

3 Fig. 3.1 shows a large container ship travelling at a constant speed of 9.5 m/s in a straight line.

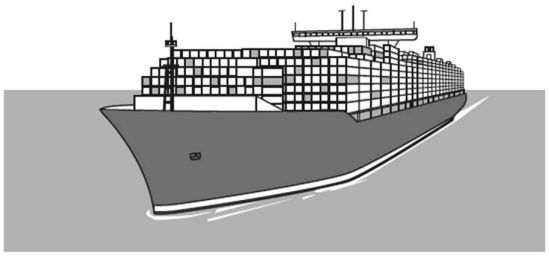


Fig. 3.1

(a) The total resistive force acting on the ship is 3.2×10^6 N.

Calculate the work done against the resistive force on the ship in 1.0 s.

work done = ... [2]

(b) The engines are powered by fuel.

(i) Describe the energy transfer that is taking place when the ship is travelling at constant speed.

.....

.....

..... [2]

(ii) The mass of the ship is 2.4×10^8 kg. The engines are switched off and the resistive force causes the ship to decelerate.

Calculate the initial deceleration of the ship.

deceleration = ... [2]

(iii) Explain why the ship takes a long time to come to a stop despite a large resistive force.

.....

..... [1]

4 A uniform wooden plank **AB** which is 4.0 m long and has a weight of 50 N. It leans with its upper end against a frictionless vertical wall and its lower end on a rough ground as shown in Fig. 4.1.

P is the normal reaction force acting on the top of the plank due to the wall.
Q is the normal reaction force acting on the bottom of the plank due to the ground.

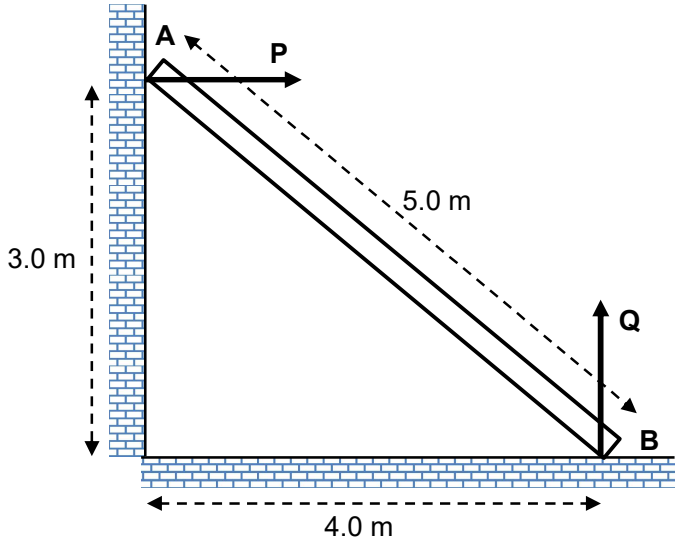


Fig. 4.1

(a) On Fig. 4.1, draw the

(i) gravitational force acting on the ladder, label it **W**, [1]

(ii) frictional force on the ladder, label it **F**. [1]

(b) State the magnitude of the force **Q**.

force **Q** = ... [1]

(c) Taking moments about **A**, calculate the magnitude of the frictional force **F**.

F = ... [2]

5 Fig. 5.1 shows two glass bulbs with trapped gas inside them. They are connected together by a tube containing liquid mercury.
Take g as 10.0 N/kg and density of mercury as 13 600 kgm^{-3}.

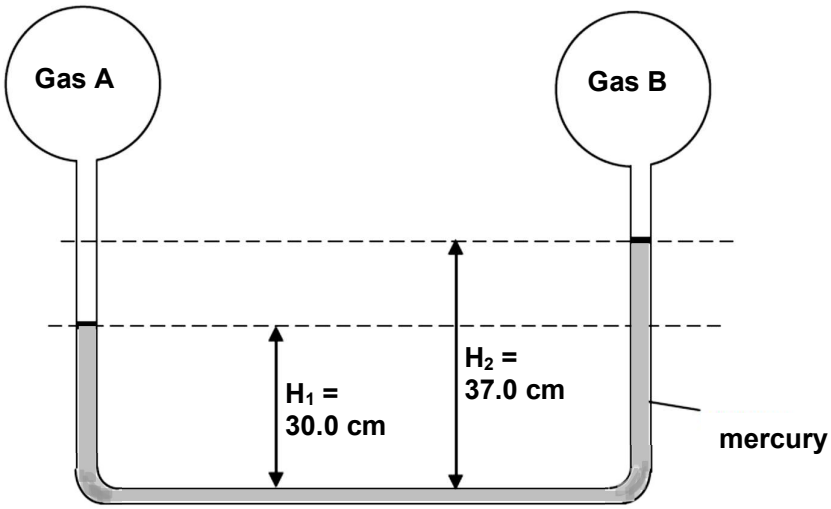


Fig. 5.1

(a) State and explain which gas has a lower pressure.

……...……...

.

……...…….. [1]

(b) Given that H_1 = 30.0 cm, H_2 = 37.0 cm and gas **A** has a pressure of 120 000 Pa, calculate the pressure of gas **B**.

pressure of gas **B** = …… [2]

(c) The whole set up is then placed under the hot sun.

Explain, in terms of the kinetic model of matter, why the pressure of both gases increases.

……..

……..

……..

…… [3]

6 Fig. 6.1 shows the inner vessel of a vacuum flask containing ice cold water.

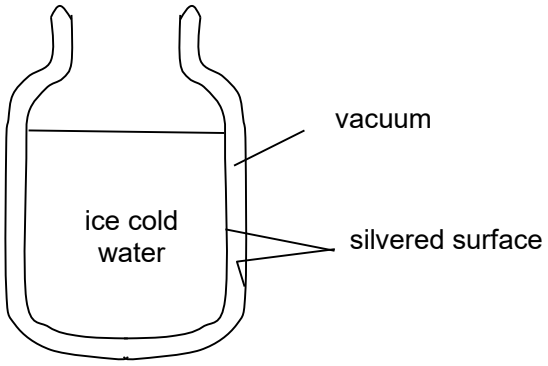


Fig. 6.1

(a) Explain how the vacuum in the vacuum flask prevented energy gained by the ice-cold water.

……

……..

…… [2]

(b) Explain how the air above the ice-cold water reduces energy gained by the water.

……

……

…… [2]

7 Fig. 7.1 shows the positions of particles of a medium at a particular instant when a sound wave, travelling from left to right, passes through the medium.

Before the wave arrived, the particles were all spaced equally apart on the vertical lines shown.

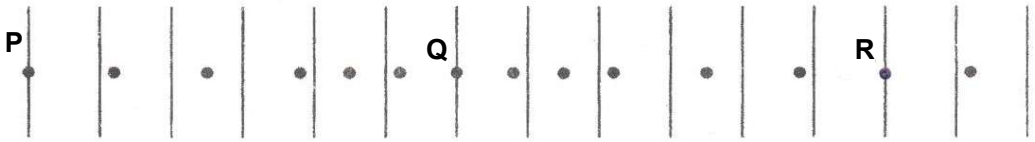


Fig. 7.1

(a) By making measurements on Fig. 7.1, determine the

(i) wavelength of the wave,

wavelength = ... [1]

(ii) amplitude of the wave.

amplitude = ... [1]

(b) On Fig. 7.2, sketch the displacement-distance graph of the particles between **P** and **R**. Take the displacement to the right of equilibrium position as positive. [1]

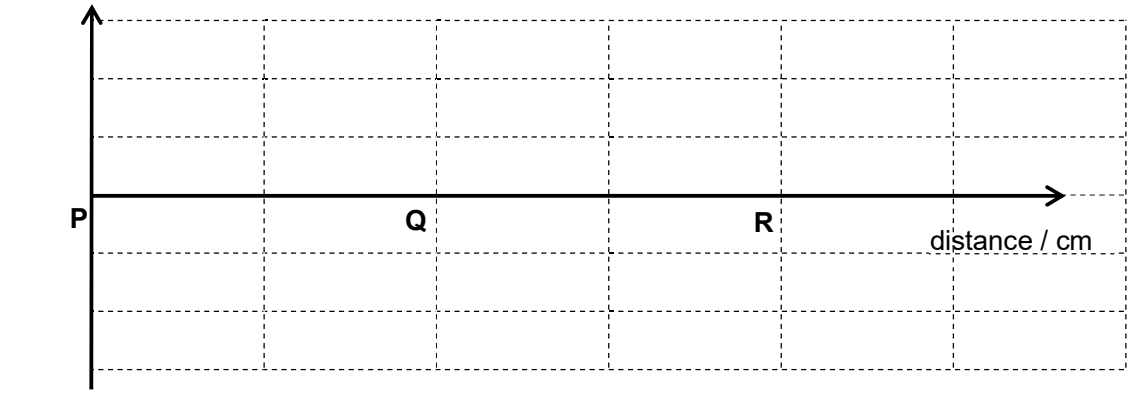


Fig. 7.2

8 The thin converging lens shown in Fig. 8.1 below has a focal length of 3.0 cm.
An object **O** is placed in front of the lens.

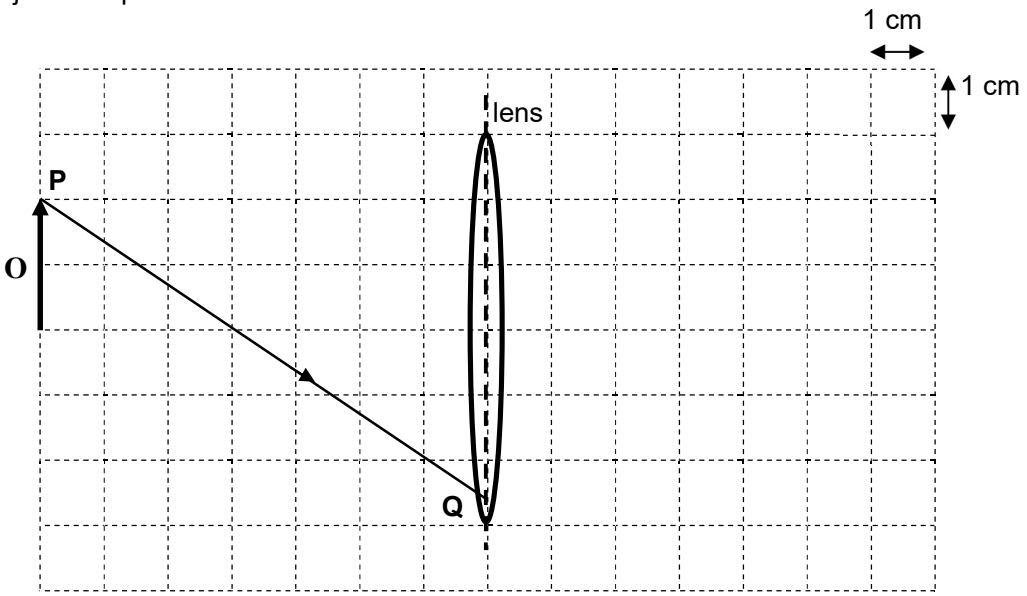


Fig. 8.1

(a) On Fig. 8.1, locate and draw the image formed. Label it as **I**. [3]

(b) On Fig. 8.1, complete the path of the ray **PQ**. [1]

(c) If the upper half of the lens is broken, describe and explain how it will affect, if at all, the position of the image formed.

……

……

…… [2]

9 A light uncharged metal sphere **Q** is suspended on an insulating thread close to a metal plate **P** as shown in Fig. 9.1. The switch **S** is then closed and **P** becomes positively charged.

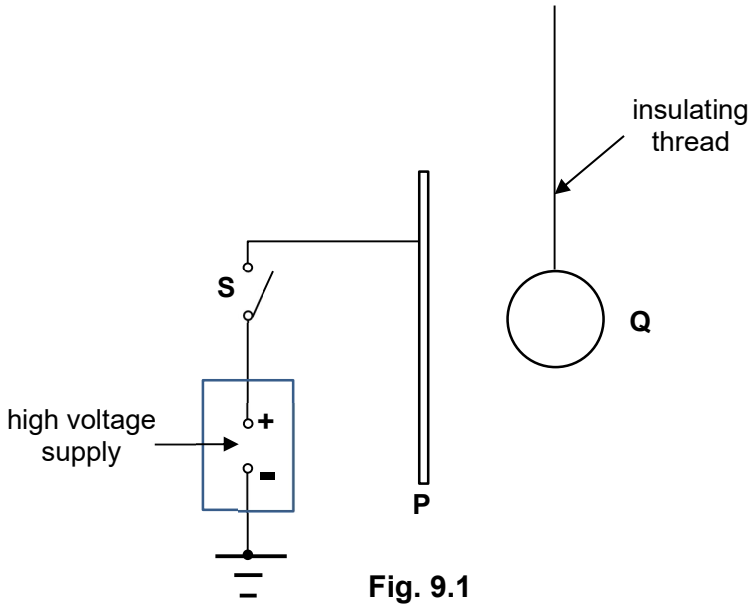


Fig. 9.1

(a) Explain how **P** becomes positively charged.

……

…… [1]

(b) On Fig. 9.1, draw the charge distribution on the sphere **Q**. Explain your answer.

……

……

…… [2]

(c) The sphere **Q** was observed to swing towards **P**, touch **P** and then swing away from **P**.

Explain why it swings away from **P** after touching **P**.

……

……

…… [2]

10 One function of the liver in a body is to remove unwanted substances from the blood. If small amounts of radioactive sulfur are injected into a person's blood, the liver will absorb it. After being absorbed by the liver, the radioactive sulfur can be detected using a camera that only responds to high-speed electrons. In the case of a healthy liver, a bright image should be observed.

The sulfur is made radioactive by the addition of $^{99}_{43}\mathrm{Tc}$, one of the isotopes of technetium.

The half-life of $^{99}_{43}\mathrm{Tc}$ is 6.0 hrs.

(a) State the type of radiation the radioactive sulfur should emit if it is to be detected by the camera.

…… [1]

(b) A sample of sulfur contains 5.0 μg of technetium after some time.

Determine the mass of technetium that was present 24 hours earlier.

mass = …… [2]

(c) Explain whether this technetium used should have a long or short half-life.

……

……

…….. [2]

11 Fig. 11.1 shows a circuit diagram. The circuit uses a light-dependent resistor (LDR) and a fixed resistor of resistance 5.0 kΩ.

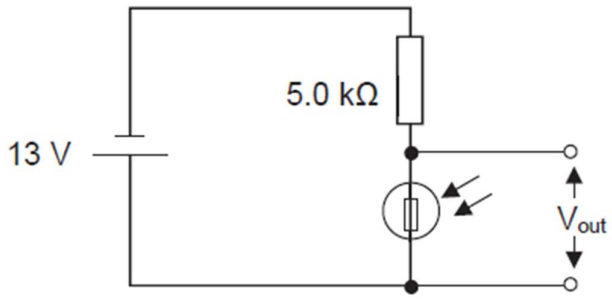


Fig. 11.1

The output voltage, V_{out} is connected to a lamp. Fig. 11.2 shows the V_{out} values and the status of the lamp at different time of a particular day.

time	V_{out} / V	status of lamp	Current flowing in the lamp / mA
6.20 am	8.0	switch on	0.050
6.30 am	7.8	switch on	0.048
6.40 am	7.5	switch on	0.042
6.50 am	5.0	switch on	0.020
7.00 am	4.5	switch off	0
7.10 am	2.0	switch off	0
7.20 am	2.0	switch off	0

Fig. 11.2

(a) At 6.50 am, calculate

(i) the current flowing in the fixed resistor,

current = ... [2]

(ii) the resistance of the LDR.

resistance = ... [2]

(b) The lamp will be switched off whenever V_{out} is less than 5.0 V.

(i) Explain why the lamp switches off after 7.00 am.

……..

……

…….. [3]

(ii) On another day, the lamp switches off only at 7.30 am although the same circuit was used.

Suggest what could have caused this.

……..

…….. [1]

(iii) The fixed resistor is replaced by a 10 Ω resistor and the same 13 V battery is used.

Explain the effect of this change on the battery life.

……..

……..

…… [2]

12 **(a)** Fig. 12.1 shows an electromagnet connected to a switch and batteries.
A permanent magnet is suspended with its north pole close to one end of the soft iron core.

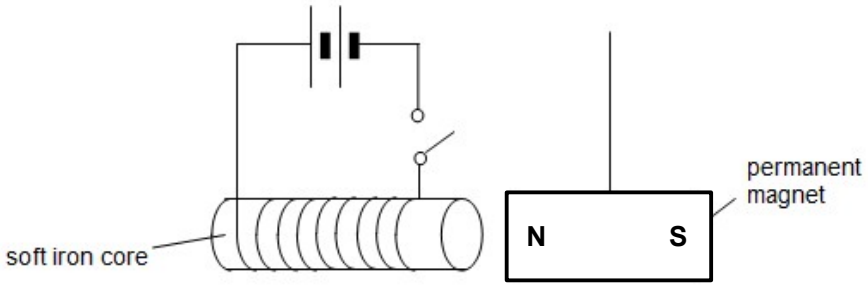


Fig. 12.1

(i) Describe and explain what will happen to the magnet when the switch is open.

……..

……..

……..… [2]

(ii) Describe and explain what will happen to the magnet when the switch is then closed.

……

……

…… [2]

(b) The electromagnet is now connected to a cathode ray oscilloscope (CRO) as shown in Fig. 12.2.
Four small magnets **A**, **B**, **C** and **D** placed on a conveyor belt move steadily under the electromagnet.

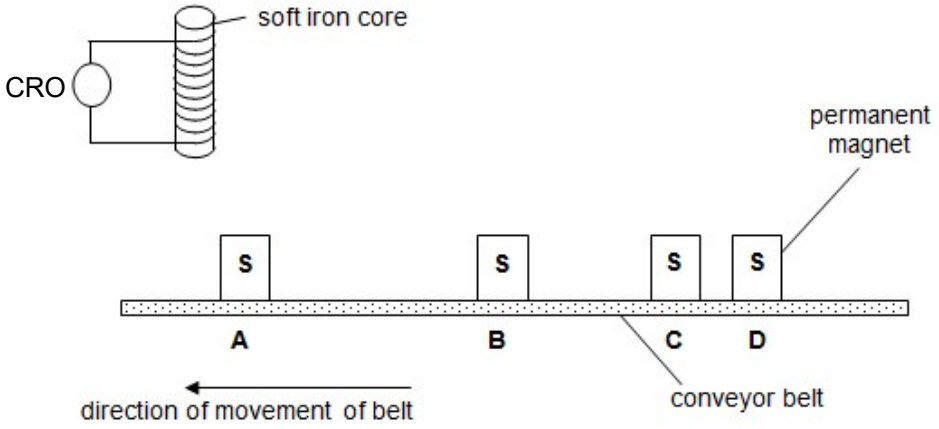


Fig. 12.2

Fig. 12.3 shows the voltage pulses on the CRO screen.

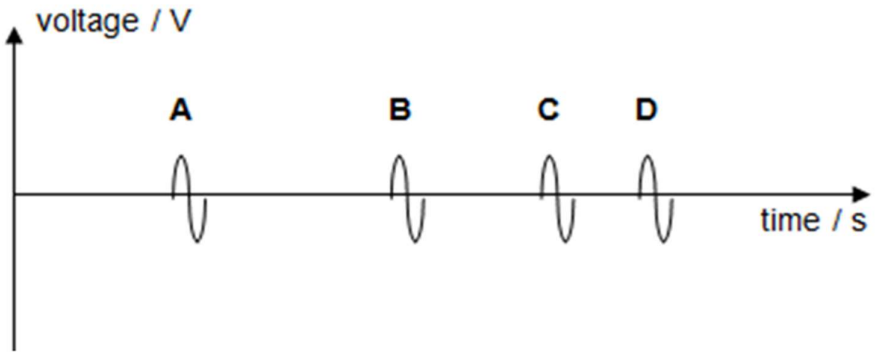


Fig. 12.3

(i) Explain why the voltage pulse is seen each time a magnet passes under the electromagnet.

……

…… [1]

(ii) Explain why the pulse produced by each magnet has a positive and a negative value as it passes the electromagnet.

……...

……

…….. [2]

(c) A rectangular coil can be balanced in a horizontal position when it experiences a force due to the current that flows through it as shown in Fig. 12.4 below. The coil is pivoted at two fulcrums and connected to a d.c. power supply. A weighing pan of 0.10 kg mass is hung on wire **WX**, while wire **YZ** is placed inside a magnetic field.

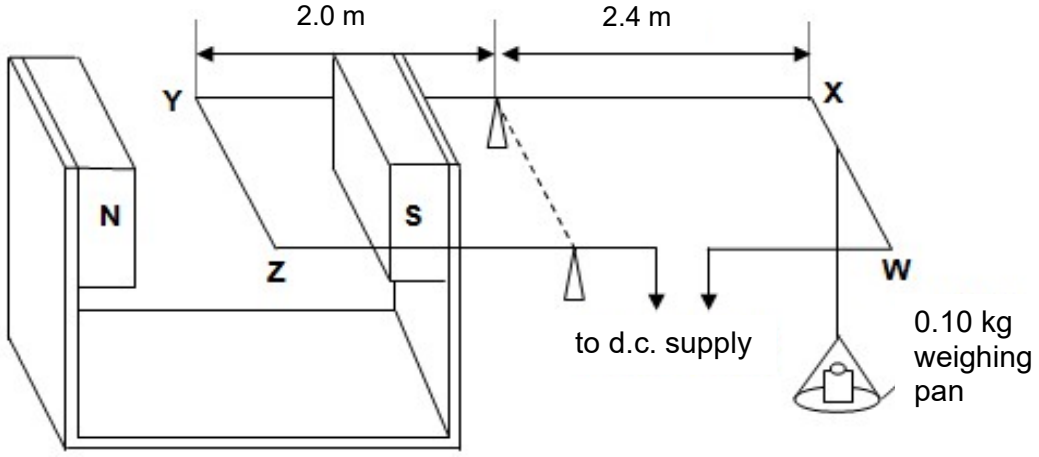


Fig. 12.4

(i) Calculate the force exerted on wire **YZ** due to the current that can balance the coil horizontally.
Take the Earth's gravitational field strength as 10 N/kg.

force = ……..…….. [2]

(ii) State the direction of the current flowing in wire **YZ** that can balance the coil horizontally.

……..…… [1]

Section B (10 marks)

Answer **one** question in from this section.

13 Fig. 13.1 below shows the electrical wiring in a table lamp.

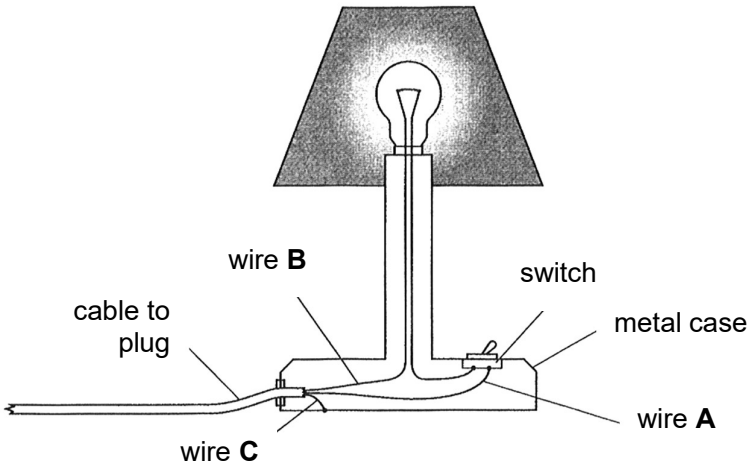


Fig. 13.1

(a) Explain why wire **A** is connected to the live terminal in the plug.

……

……

…… [2]

(b) The cable is connected to a plug which contains a fuse.

Explain the purpose and action of the fuse.

……

……

…… [2]

(c) Wire **A** becomes loose and accidentally touches the metal case.

Explain why a person who touches the metal case will not get any electric shock.

……

……

…… [2]

(d) The lamp has a specification label “220 V, 40 W”.

Calculate the resistance of the lamp when it is working normally.

resistance = ……..…….. [2]

(e) A similar lamp has no wire connected to the casing.
Suggest, with reason, how else the lamp could be modified to be made safe to use.

……..…….....

……..…….....

……..…….... [2]

14 Water in a tank is kept warm by an electric heater placed close to the base of the tank as shown in Fig. 14.1. The heater switches on automatically when the temperature of the water is 40 °C or lesser, and switches off when the temperature of the water is 45 °C or more. The tank contains 3000 g of water. The specific heat capacity of water is 4 200 J kg^{-1} K^{-1}.

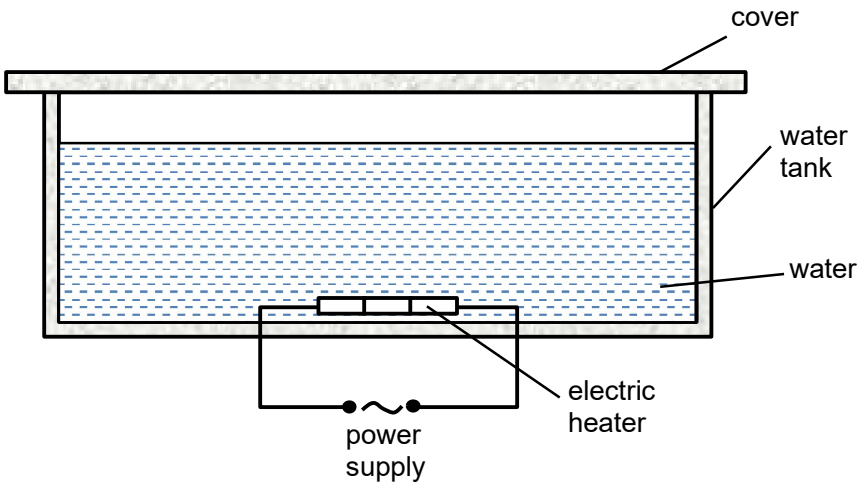


Fig. 14.1

(a) Explain why the electric heater is placed close to the base of the tank.

.....

.....

..... [2]

(b) Fig.14.2 shows how the temperature of the water in the tank varies with time.

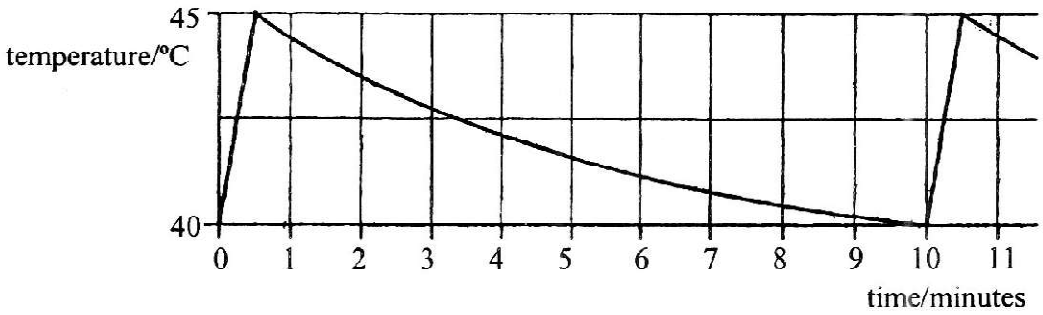


Fig. 14.2

(i) Explain why the temperature of the water is observed to be decreasing at a decreasing rate from 0.5 minute to 10 minute.

……

……

…… [2]

(ii) Calculate the amount of energy needed to warm the water from 40 °C to 45 °C.

energy = …….…….. [2]

(iii) Calculate the rate of energy produced by the heater.

rate of heat produced = …….…….. [2]

(iv) State and explain whether the calculated value in **(b) (iii)** is lesser or greater than the actual value.

……

……

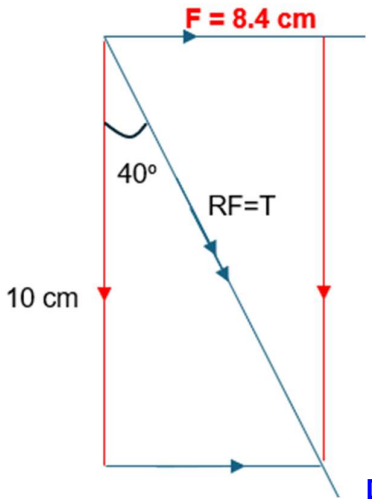
…… [2]

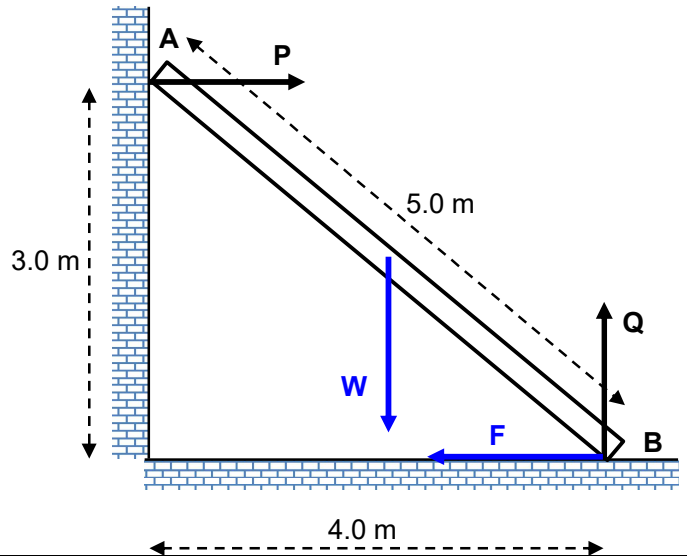
~~~ End of Paper 2 ~~~

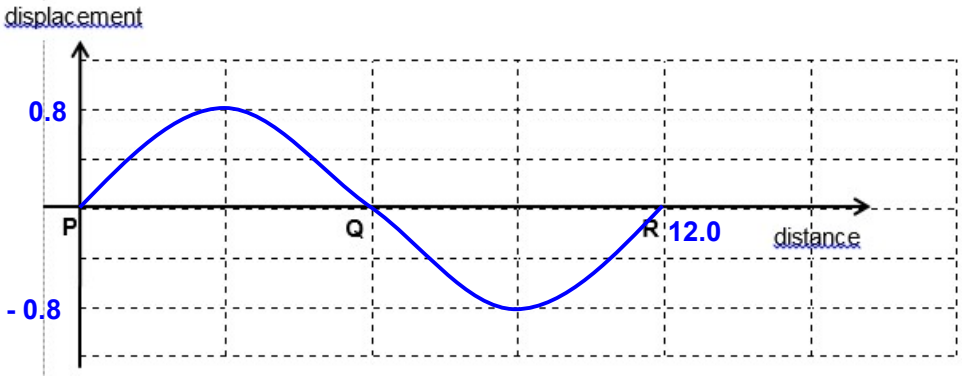
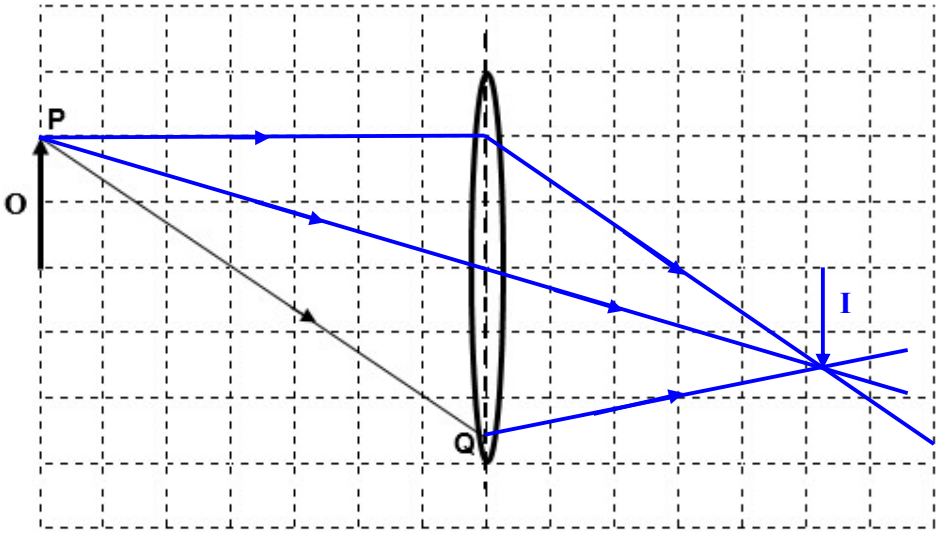
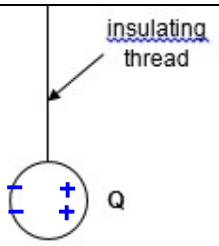
ANSWERS

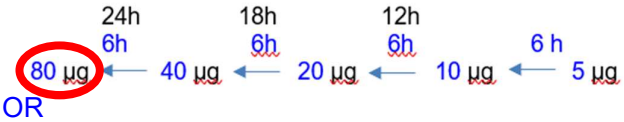
YCSS 2024 PRELIMINARY EXAM SEC 4 PURE PHYSICS (6091)

Paper 2

	SECTION A [50 marks]	
1a	The speed is increasing at a decreasing rate OR The acceleration is decreasing.	**1**
1bi	The water resistance is greater than the weight of the stone. [1] Resultant force is opposite to the downward motion. [1] Thus the speed decreases.	**2**
1bii	Water resistance is equal to the weight of the stone. [1] Resultant force is zero. [1] Hence, acceleration is zero (constant speed).	**2**
2	 **Diagram [1]** **Correct arrow [1]** **Scale [1]** **Magnitude [1]** **Scale: 1N : 0.5 N** **Or 1cm : 2N** **Magnitude of F: 8.4 cm x 0.5** **= 4.20 N (3.78 N to 4.62 N)**	**4**
3a	Work done = force x distance Work done = $3.2 \times 10^6 \times 9.5$ M1 Work done = 3.04×10^7 J A1	**2**
3bi	Energy in the chemical potential store is transferred mechanically to the kinetic store of the water (or to the internal store of the surrounding).	**2**
3bii	- net F = ma $-3.2 \times 10^6 = 2.4 \times 10^8 \times a$ a = - **0.0133 m/s²** **hence, decel = 0.0133 m/s²**	**2**
3biii	**Large** mass of ship → **large inertia**, **OR** Acceleration is very small. a = (v-u) / t, so t = (v-u) /small a, hence time taken is very long.	**1**

4a		**2**
4b	**Q = 50 N**	**1**
4c	**CM = ACM** **F x 3 + 50 x 2 = 50 x 4** **[1]** **F = 33.3 N** **[1]**	**2**
5a	**B has lower pressure** **Because H_2 is higher than H_1.**	**1**
5b	**P_B = P_A – ρ g (H diff)** **= 120000 – 13600 x 10 x (0.37 – 0.30)** **[1]** **= 110480** **= 110000 Pa (3 s.f.)** **[1]**	**2**
5c	The gases gained thermal energy from the sun. [1] Gas molecules move faster. [1] The molecules collide more frequently and with greater force on the wall. [1] The total force on the wall increases. Pressure increases as P = F/A.	**3**
6a	There is no molecules in the vacuum. [1] Thus conduction and convection cannot take place. [1] Thus rate of heat gained by the water through conduction and convections is prevented.	**2**
6b	The cold air above the water is denser than the surrounding air. It will not rise. Thus the rate of heat gained through convection is not possible. [1] The cold air above the water is poor conductor of heat. Thus the rate of heat gained through conduction is reduced. [1]	**2**
7ai	Wavelength = 12.0 cm	**1**
7aii	Amplitude = 0.8 cm	**1**

7b		1
8ab		4
8c	No effect on the position. [1] The focal length remain the same. [1] OR the light rays can still pass through the lower half of the lens.	2
9a	The positive terminal of the supply attracts the electrons out from P, leaving P with excess positive charge.	1
9b	 Diagram [1] The positive charge in P attracts the electrons in Q to the left as unlike charges attract. The right side of Q will have excess positive charge. [1]	2
9c	Upon touching, the electrons in Q flow into P, Q has excess positive charge. [1] Q is repelled away from P as like charges repel. [1]	2

10a	**Beta particle**	[1]
10b	 OR 24 h = 4 half-life = 2^4 = 16 times earlier 16 x 5.0 = **80 µg**	[1]
10c	**It should have a short-half life** **so that it does not remain in the body for too long. Staying too long in the body will cause damages to the body cells.**	[1] [1]
11ai	Current in fixed resistor = 8 / 5000 = **0.0016 A**	[1] [1]
11aii	Resistance of LDR = 5.0 / (0.0016 – 0.000020) = 3164 Ω = **3160 Ω**	[1] [1]
11bi	At 7:00 am, the light intensity on LDR increases. The resistance of the LDR decreases. Since V_{out} = ($\frac{R}{R+50}$) 13V , V_{out} across the LDR drops. When the pd across the LDR is less than 5.0 V, the lamp switches off.	[1] [1] [1]
11bii	The sky could be cloudy / the sun rises at a later time.	[1]
11biii	The total resistance of the circuit will decrease. This will lead to a larger current to flow in the circuit. Hence the battery life will shorten. Or LDR will be switched on for longer period each day or permanently on since $R_{LDR} > R_{10Ω}$, $V_{LDR} > 5.0$ V. Battery will be drained out faster.	[1] [1]
12ai	The magnet will swing towards the soft iron core. [1] Because the iron core is induced with S-pole on the right. The magnet is attracted to iron core as unlike poles attract. [1]	**2**
12aii	The magnet will swing away from the iron core. [1] The current in the coil will magnetised the iron core with the right end as N-pole. [1] The N-pole of the iron core will repel the N-pole of the magnet as like poles repel.	**2**
12bi	There is a change in magnetic field lines cutting the coil of the electromagnet. Thus voltage is induced in the coil.	**1**
12bii	As the magnet approaches the electromagnet, there is an increase in magnetic field lines cutting the coil. Thus induced the voltage in a positive direction. [1] As the magnet moves away from the electromagnet there is a decrease in the magnetic field lines cutting the coil. Thus induced voltage is in the negative direction. [1]	**2**

12ci	ACM = CM F x 2.0 = (0.1 x 10) x 2.4 F = 1.2 N	**2**
12cii	Current is flowing from Z to Y	**1**
	SECTION B [10 marks]	
Either		
13a	Because A is connected to the switch. [1] So when the switch is open, the lamp will be disconnected from the high voltage live wire. [1] Thus preventing the user from getting electric shock.	**2**
13b	Fuse is to prevent overheating of the cables. [1] When the current exceeded the fuse rating the fuse will blow and break the circuit. [1]	**2**
13c	The metal case is earthed (wire C). Large current will flow through the earth wire (wire C) instead of the user. As this current is larger than the fuse rating, the fuse will blow and break the circuit. Thus preventing the user from getting electric shock.	**2**
13d	P = V^2 / R 40 = 220^2 / R R = 1210 Ω = 1.21 kΩ	**2**
13e	This lamp's casing can be made from an insulator such as plastic. So when the live wire touches the casing, current could not flow through the casing to the user. Thus the user will not get electric shock.	**2**
OR		
14a	This is so that the water at the base, when heated up, becomes less dense and rises. Meanwhile the cooler water from the top, being denser, will sink. [1] This process repeats to form the convection current that will heat up the water efficiently. [1]	**2**
14bi	The temperature difference between the water and the surrounding is decreasing. [1] Thus the rate of heat lost from the water to the surrounding decreases. [1] Hence the rate of temperature drop decreases.	**2**
14bii	E = m c θ = 3 x 4200 x 5 = 63000 J	**2**
14biii	P = E / t = 63000 / (0.5 x 60) = 2100 W	**2**
14biv	Lesser. [1] Because some of the energy supplied by the heater is lost to the surrounding. [1]	**2**