Name:	Index Number:	Class:

YIO CHU KANG SECONDARY SCHOOL
O-LEVEL PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS

PHYSICS 6091/02
Paper 2 1 hour 45 minutes

10 September 2024 (Tuesday)

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the cover page.
Write in dark blue or black ink.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
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.

For Examiner's Use

Section A	/ 70
Section B	/ 10
Total	/ 80

Parent's / Guardian's signature

Setter: Mr Brandon Chin

SECTION A

Answer **all** questions in this section in the spaces provided.

1 Fig. 1.1 shows a bungee jumper falling from a bridge above a river.

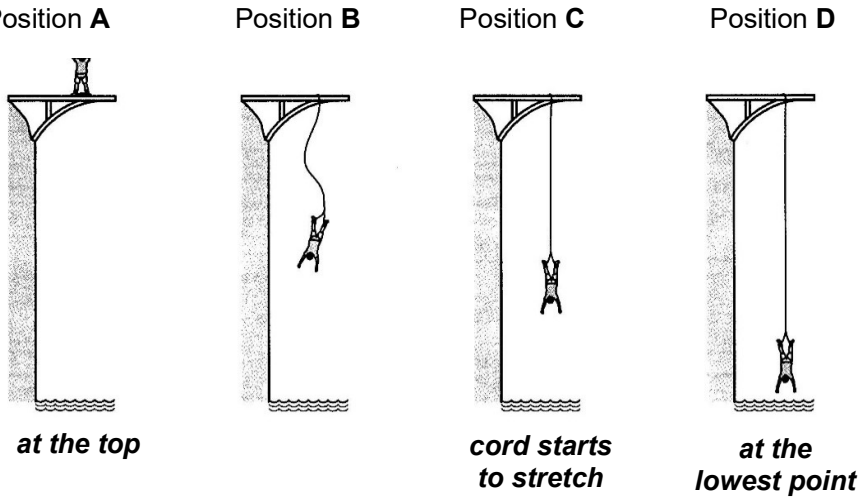

Fig. 1.1

The man starts from position **A**. The elastic cord starts to stretch at position **C** and he stops for the first time at position **D**. He continues to rise and fall.

Fig. 1.2 shows how the velocity of the man varies with time *t*.

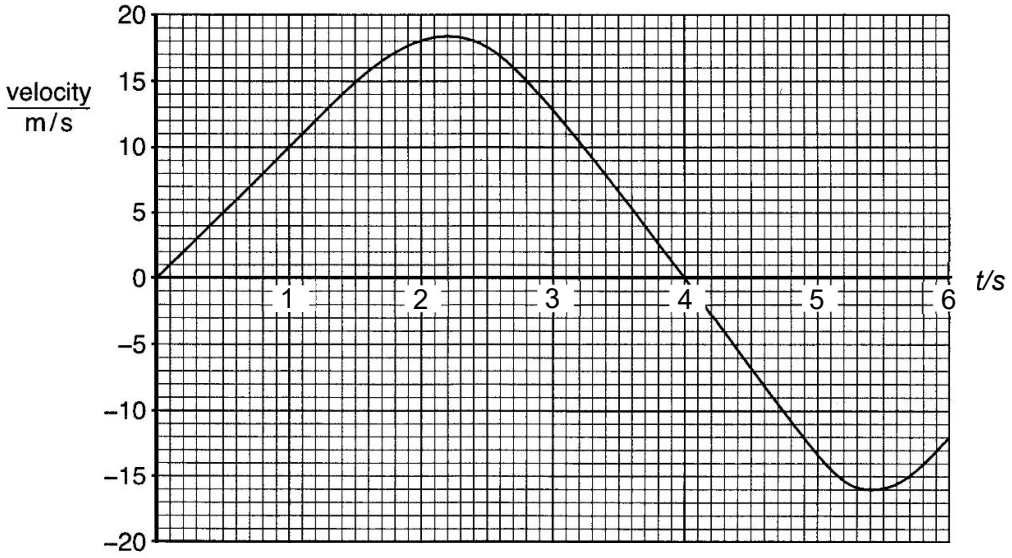

Fig. 1.2

(a) State the difference between the positive velocity and negative velocity of the bungee jumper.

……

…… [1]

1 **(b)** In the first 1.4 s, the acceleration is uniform.

Using values from Fig. 1.2, determine the acceleration of the man in the first 1.4 s.

acceleration = …… [2]

(c) With reference to Fig. 1.2, state the time when the man is at position **D**.

……..…….. [1]

(d) **(i)** State the two forces acting on the man at position **D**.

……... [1]

(ii) Explain, in terms of the forces acting, why the man is accelerating upwards at position **D**.

……

……

……

…….. [2]

2 An aircraft flies at a constant height. The force from the engine of the aircraft and air drag together produce a force of 36 kN on the aircraft due east as shown in Fig. 2.1. The wind produces a force of 12 kN towards the south.

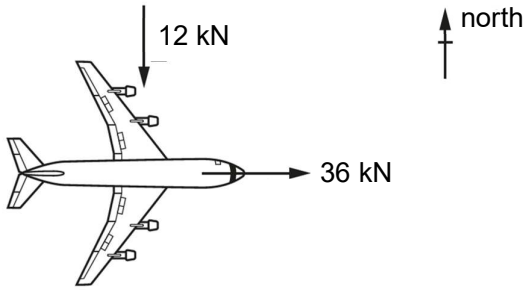

Fig. 2.1

Draw a scale drawing to show the resultant force acting on the aircraft. Use your drawing to determine the size of the resultant force and the angle between the resultant force and east.

scale = ... cm : ..... N

size of resultant force = ...

angle = ...

[3]

3 A student designed a box which can slow down the process of melting for ice-cream cakes as they are delivered from the restaurant to the parties.

The box is made of expanded polystyrene with a cold pack attached to its cover as shown in Fig. 3.1.

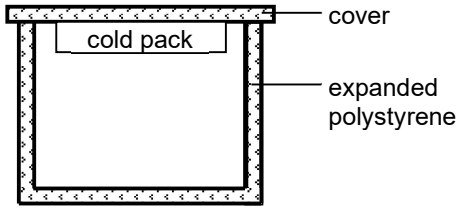

Fig. 3.1

(a) State and explain **two** features of the box which help to slow down the melting of the ice-cream cake.

feature 1: ……..

explanation: ……

……

feature 2: ……..

explanation: ……

……

[4]

(b) Suggest **one** improvement that the student could make to the design of the box to further slow down the melting of the ice-cream cake.

……

…….. [1]

4 Ultrasound and X-rays are both used in medical imaging.

(a) An ultrasound scanner can emit and detect reflected sound waves. To produce an image of an unborn child, an ultrasound scanner is placed on the mother's skin as shown in Fig. 4.1.

Fig. 4.2 shows pulses detected by the ultrasound scanner. Pulse **A** is the emitted pulse and pulse **B** is the first pulse that returns from the unborn child.

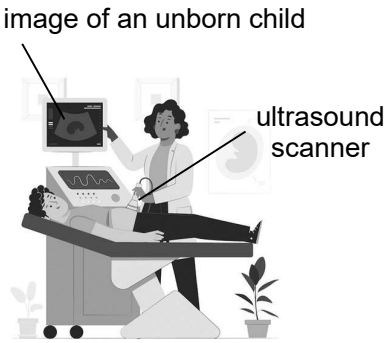

Fig. 4.1

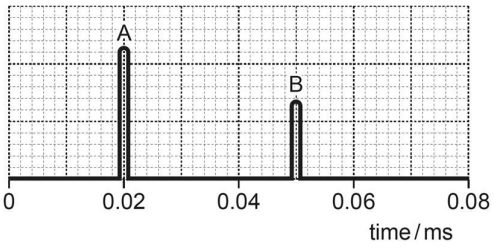

Fig. 4.2

(i) Define what is meant by *ultrasound*.

.....

..... [1]

(ii) The average speed of ultrasound in human tissue is 1500 m/s.

Using the information in Fig. 4.2, calculate the distance between the ultrasound scanner and the unborn child.

distance = ... [2]

4 **(b)** An X-ray detector is placed just below an arm.

Fig. 4.3 shows an X-ray image of the arm with a broken bone and human tissue which are formed on a screen by the detector.

Fig. 4.3

The wavelength of the X-rays used is 2.0×10^{-9} m.

(i) Calculate the frequency of the X-rays.

frequency = ... [2]

(ii) Suggest **one** reason why X-rays are **not** used to form an image of an unborn child.

.....

..... [1]

5 Electrical energy distribution takes place in a country through a network of transmission cables, as shown in Fig. 5.1.

A power station generates 100 MW of power at a voltage of 25 kV.

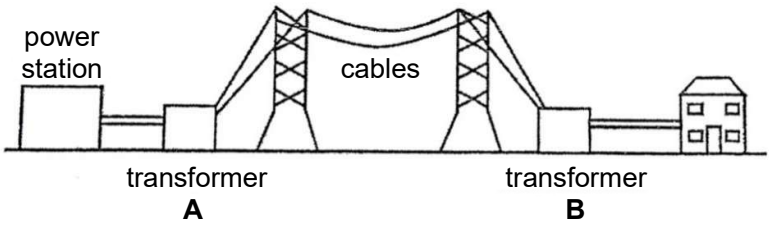

Fig. 5.1

Transformer **A**, which links the power station to the transmission cables, has 4000 turns in the primary coil and 44000 turns in the secondary coil.

(a) Calculate the current in the secondary coil of transformer **A**, assuming the transformer is 100% efficient.

current = …… [3]

(b) Explain why electrical transmission in the cables is typically at a very high voltage.

……

……

…….. [1]

5 **(c)** After transmission through the cables, only 80% of the original power generated at the power station reaches transformer **B**.

Determine the total resistance of the transmission cables.

total resistance = …… [2]

6 Fig. 6.1 shows an uncharged metal sphere hung on an insulated thread between two metal plates **X** and **Y**, which are connected to a circuit.

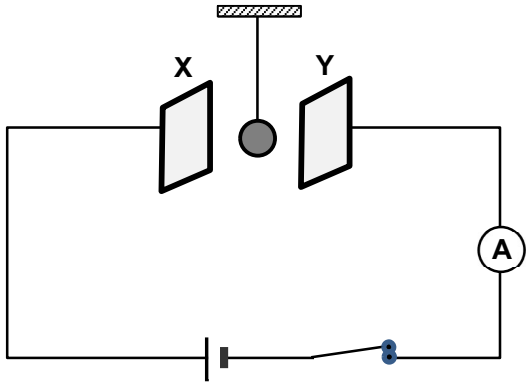

Fig. 6.1

(a) State whether the metal sphere is *positively charged* or *negatively charged* when it is first brought to touch **X**.

…… [1]

(b) Explain what happens to the metal sphere after it is released from **X**.

……

……

……

……

……

…… [3]

7 A student moves a metal bar upwards between the poles of a magnet, as shown in Fig. 7.1.

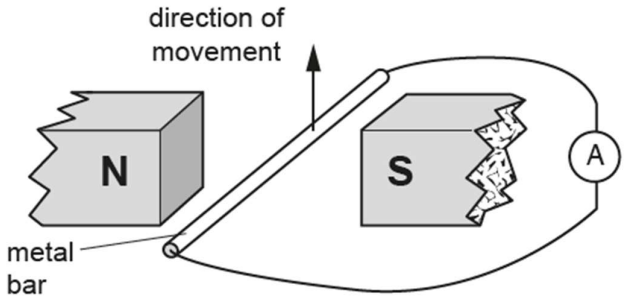

Fig. 7.1

The ammeter connected to the metal bar shows a small **positive reading** as the bar moves upwards.

(a) Explain why there is a reading on the ammeter.

.....

.....

.....

..... [2]

(b) Describe how Lenz's law applies when the bar is moved upwards.

.....

..... [1]

(c) The metal bar is then moved in the direction shown by the arrows in Fig. 7.2.

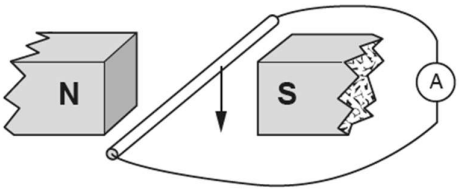

Fig. 7.2(i)

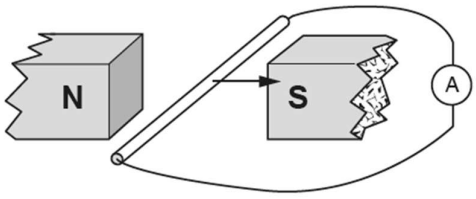

Fig. 7.2(ii)

Describe the ammeter reading as the bar is moved in the directions shown in

- Fig. 7.2(i) ..... [1]
- Fig. 7.2(ii) ..... [1]

[Part (d) continues on the next page.]

7 **(d)** A stronger magnet increases the reading on the ammeter.

State **one** other way in which a larger reading can be produced on the ammeter, using the same rod.

.....

..... [1]

8 Fig. 8.1 shows a circuit connecting an electrical heater to a 240 V mains socket.

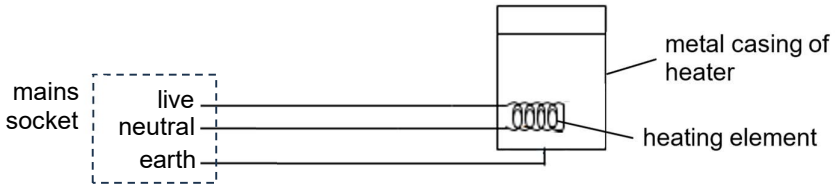

Fig. 8.1

The heating element has a resistance of 60 Ω when in use.

(a) When the switch of the circuit is closed, the heater functions normally.

Determine the current, if any, flowing in the live, neutral and earth wire.

current in live wire = …….

current in neutral wire = …….

current in earth wire = …….
[2]

(b) It is important that the electrical heater is fitted with a fuse of suitable rating.

Explain how a fuse acts as a safety device for the electrical heater.

……

……

…… [1]

(c) Explain why the earth wire is connected to the metal casing of the electrical heater.

……

……

…… [1]

8 (d) The electrical heater is switched on daily for 45 minutes. The cost of electricity is 20 cents per kWh.

Assuming there are 30 days in a month, calculate the monthly cost of switching on the heater.

cost = $…… [3]

9 Radon-222 is an isotope of radon which undergoes a series of radioactive decays. Fig. 9.1 shows the proton number and nucleon number of the nuclei involved in a series of decays.

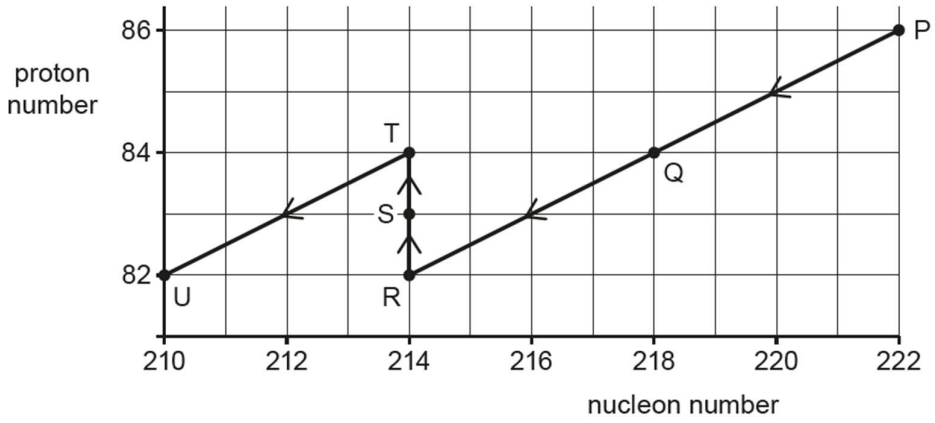

Fig. 9.1

The point **P** represents a nucleus of radon-222. Starting at **P**, a nucleus of radon-222 decays to **Q**; then from **Q** to **R**; then from **R** to **S**; then from **S** to **T**; and finally from **T** to **U**.

(a) **(i)** Different isotopes of the same element have different atomic compositions. State what is meant by isotopes.

.....

..... [1]

(ii) State **two** points on Fig. 9.1 which represent isotopes of the same element.

..... [1]

(b) In nuclide notation, radon-222 is written as $^{222}_{86}Rn$. When a nucleus of radon-222 emits an alpha-particle (α), it decays to an isotope of polonium (Po).

Complete the equation below for this decay process.

$$^{222}_{86}Rn \rightarrow {}^{W}_{X}Po + {}^{Y}_{Z}\alpha$$

W: …….. X: ……..

Y: …….. Z: ……... [1]

(c) **(i)** Using information from Fig. 9.1, state the name of the particle emitted as a nucleus of **R** decays to a nucleus of **S**.

..... [1]

(ii) Describe the change in the composition of a nucleus of **R** as it decays to a nucleus of **S**.

.....

.....

..... [2]

10 A measuring cylinder of substance **X** in its liquid state is placed inside a freezer where the temperature is –18 °C. Fig. 10.1 shows how the temperature of the liquid varies with time *t*.

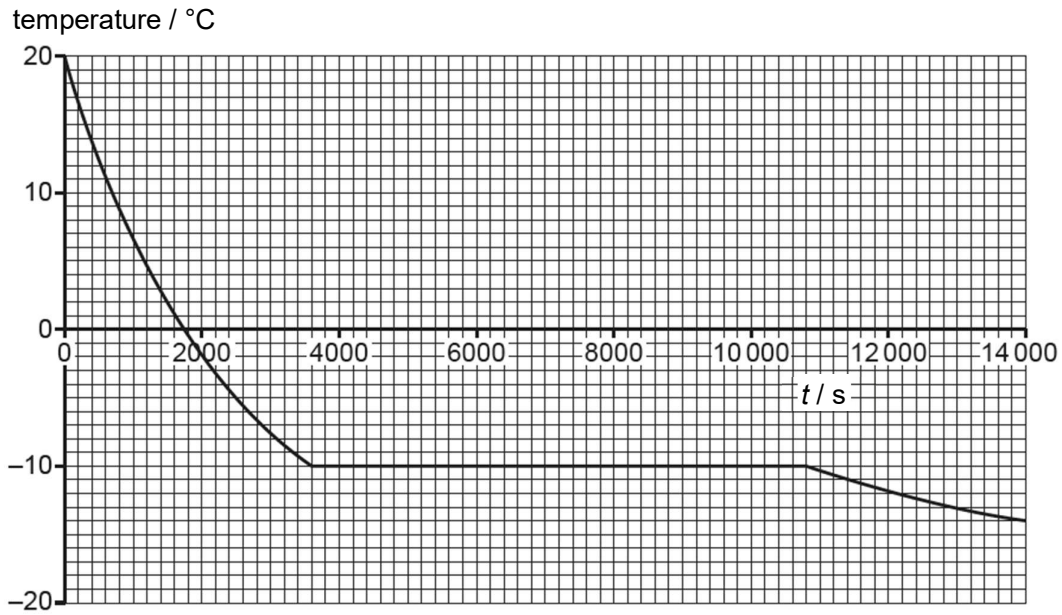

Fig. 10.1

(a) Fig. 10.1 shows that it takes 700 s for the temperature of substance **X** to decrease from 20 °C to 10 °C but that it takes 1900 s to decrease from 0 °C to –10 °C.

Explain why these timings are different.

.....

.....

.....

..... [2]

(b) Explain, using the kinetic model, what happens to the energy in the internal store of the molecules of substance **X** as the temperature decreases from 20 °C to 0 °C.

.....

.....

.....

..... [2]

10 **(c)** There is 45 g of substance **X** in the measuring cylinder and the specific latent heat of fusion of substance **X** is 5.7×10^4 J/kg.

(i) Explain, in terms of molecules, why the temperature of substance **X** does not change between t = 3600 s and t = 10800 s.

.....

.....

.....

..... [2]

(ii) Calculate the amount of energy transferred from substance **X** between t = 3600 s and t = 10800 s.

energy = ... [2]

(iii) Calculate the average rate at which energy is transferred from substance **X** between t = 3600 s and t = 10800 s.

rate = ... [1]

(d) The graph in Fig. 10.1 is steeper before the horizontal section than it is after.

Use this observation to compare the specific heat capacity of substance **X** in its different states.

.....

..... [1]

11 Fig. 11.1 shows a circuit. The circuit includes three resistors and two open switches, S_1 and S_2. The power supply in the electric circuit is a battery of electromotive force (e.m.f.) 12 V.

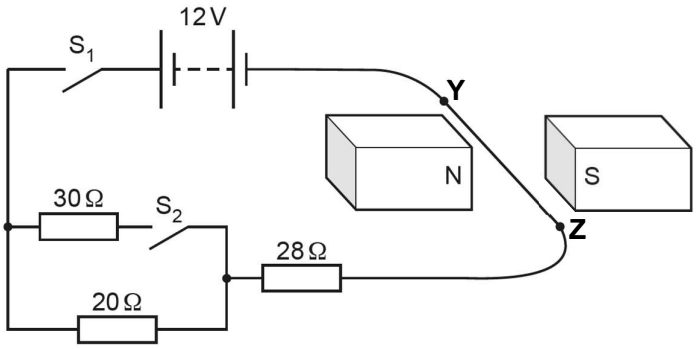

Fig. 11.1

YZ is a straight, horizontal section of connecting wire that lies between two magnets.

(a) State how the e.m.f. of the battery differs from that of an alternating current (a.c.) power supply.

.....

..... [1]

(b) S_1 is now closed.

(i) Calculate the current flowing through **YZ**.

current = ... [2]

(ii) Explain why **YZ** experiences a force.

.....

.....

.....

..... [2]

(iii) On Fig. 11.1, draw an arrow to indicate the direction of the force on **YZ**. [1]

11 **(c)** Switches S_1 and S_2 in the circuit in Fig. 11.1 are now closed at the same time.

(i) Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) State and explain how the force on **YZ** will change as both switches are closed, as compared to the force on **YZ** when only S_1 was closed.

.....

.....

.....

..... [2]

Section B

Answer **one** question from this section.

12 A hydraulic press is used at a recycling centre to compress waste material. Fig. 12.1 is a side view of the press.

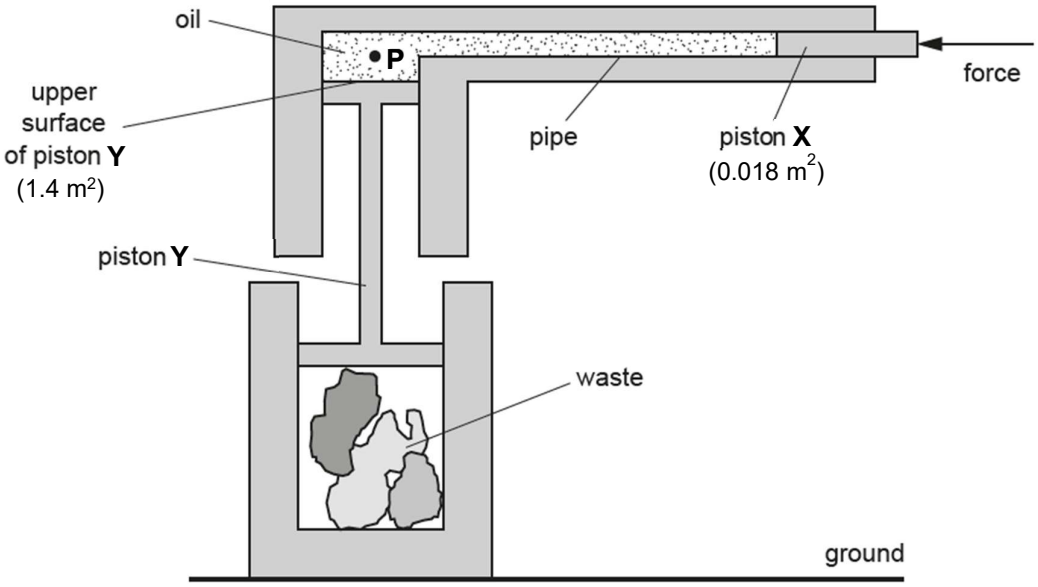

Fig. 12.1

A force to the left is exerted on piston **X**. Oil is pushed along the pipe and this moves piston **Y** downwards. Piston **Y** compresses the waste.

(a) Oil is a liquid.

State the property of the oil that makes it suitable for use in a hydraulic system.

..... [1]

(b) The cross-sectional area of piston **X** is 0.018 m^2. Piston **X** exerts a force of 4500 N on the oil.

(i) Define pressure.

……..

……..… [1]

(ii) Calculate the pressure of the oil due to the force by piston **X**.

pressure = ... [2]

12 **(b)** **(iii)** The area of piston **Y** that is in contact with the oil is 1.4 m^2. Initially, the upper surface of piston **Y** is level with point **P**.

Calculate the force exerted on piston **Y** due to the pressure calculated in **(b)(ii)**.

force = ... [1]

(c) As piston **X** moves along the pipe:
- the pressure of the oil at point **P** due to the force by piston **X** remains constant
- piston **Y** moves downwards
- the pressure of the oil at the upper surface of piston **Y** increases

(i) Explain why the pressure at the upper surface of piston **Y** increases as it moves downwards.

……...

…… [1]

(ii) The density of the oil is 900 kg/m^3. The upper surface of piston **Y** is now 0.50 m below the level of the pipe. The gravitational field strength g = 10 N/kg.

Calculate the increase in the pressure at the upper surface of piston **Y** due to the oil.

increase in pressure due to oil = ... [2]

(d) There is air trapped in the plastic bags that contain the waste. The temperature of the air in the bags remains constant.

Explain, in terms of molecules, why the pressure of the trapped air increases as it is compressed.

.....

.....

.....

..... [2]

13 **(a)** Fig. 13.1 shows a regular hexagonal glass piece of refractive index 1.42. A light ray enters the glass piece at **P**, at a direction parallel to its top surface.

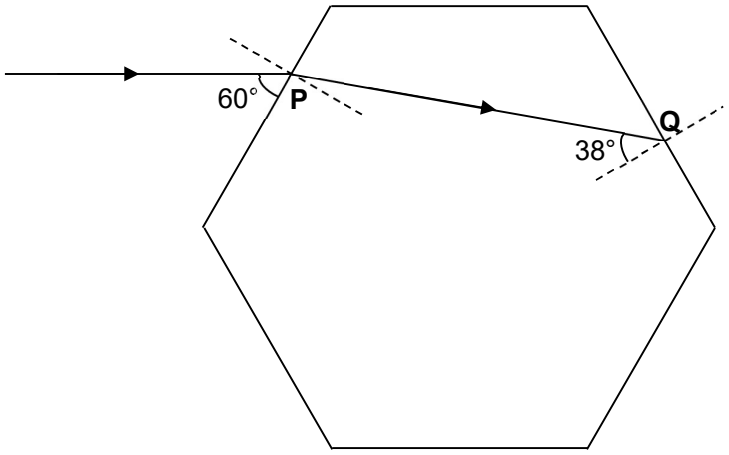

Fig. 13.1 (not drawn to scale)

(i) Determine the angle of refraction of the light ray at **P**.

angle of refraction = ... [2]

(ii) State what is meant by *critical angle*.

.....

..... [1]

(iii) Determine the critical angle of glass.

critical angle = ... [2]

(iv) On Fig. 13.1, complete the path of the light ray after it strikes the surface at **Q.** [1]

13 (b) Fig. 13.2 shows an object placed in front of a converging lens. The image of the object is shown on the other side of the lens.

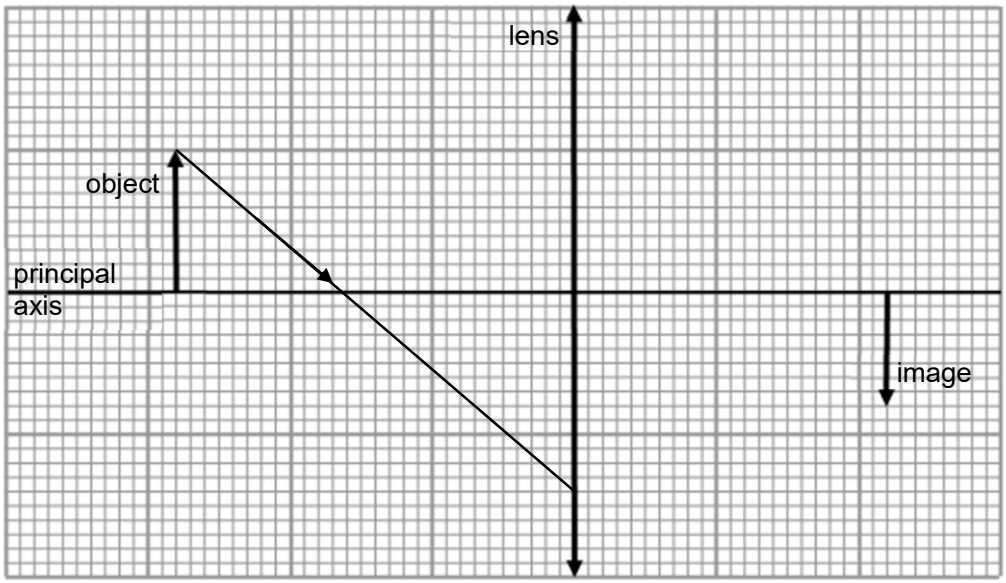

Fig. 13.2

An incomplete light ray has been given.

(i) Complete the ray diagram and determine the focal point of the lens. Mark and label the focal point with "**F**". [3]

(ii) The object is now placed at a distance nearer to the lens than the focal length of the lens.

Describe the characteristics of the image formed.

……

…….. [1]

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