Name:	Class:	Class Register Number:

中正中学

CHUNG CHENG HIGH SCHOOL (MAIN)

PRELIMINARY EXAMINATION 2024
SECONDARY 4

PHYSICS 6091/02

Paper 2 Theory

23 August 2024

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number clearly in the spaces provided at the top of this page.
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 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 workings 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

This document consists of **22** printed pages.

[Turn over

Section A

Answer **all** questions.

1 An aircraft pulls a glider along a runway as shown in Fig. 1.1.

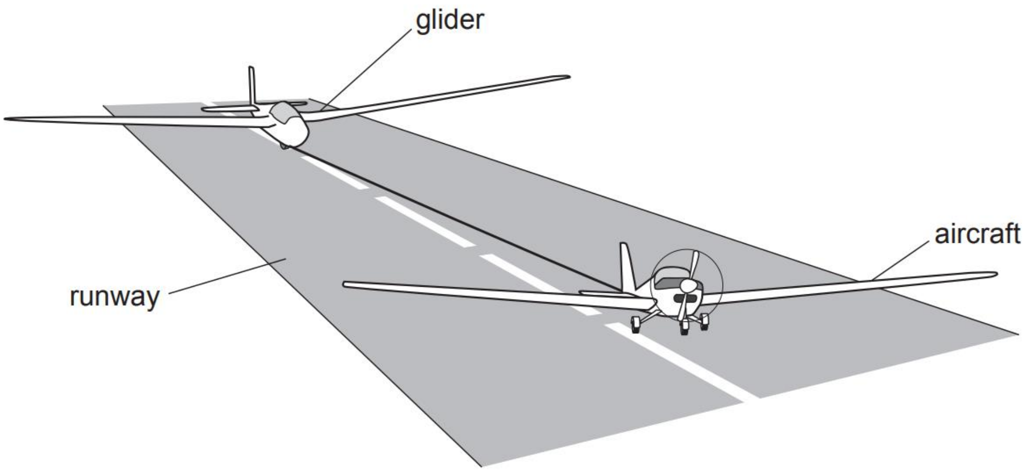

Fig.1.1

Fig. 1.2 shows the speed of the glider during the first 12 s of the motion.

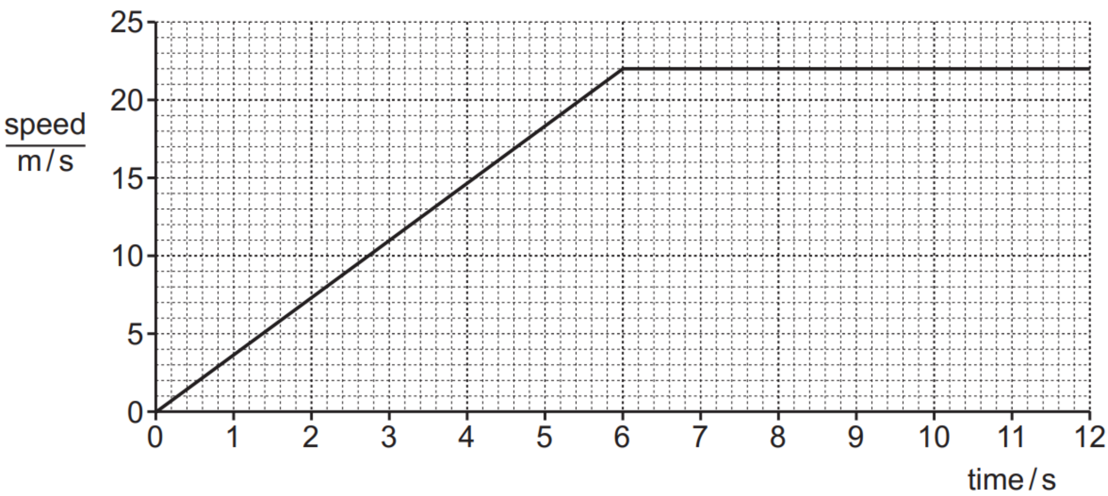

Fig. 1.2

(a) Describe the motion of the glider, in terms of acceleration, in the first 12 s.

....

....

.... [2]

(b) In the first 6.0 s of the motion, there is a resultant force of 1880 N on the glider.

Using the increase in speed in the first 6.0 s, calculate the mass of the glider.

mass = ……………………………………………… [2]

(c) Determine the distance travelled by the glider in the first 9.0 s of its motion.

distance = ……………………………………………… [2]

(d) The glider has no engine and stays in the air with the use of convection currents.

(i) State what is meant by a 'convection current'.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(ii) Suggest how the convection currents that support the glider are formed.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

[Total: 8]

2 A plane, irregular lamina has a mass of 40 g. It hangs from a nail that passes through a small hole H near to the edge of the lamina.

The nail acts as a pivot and the lamina can swing about it. The lamina is held in the position shown in Fig. 2.1, a small distance above a horizontal bench.

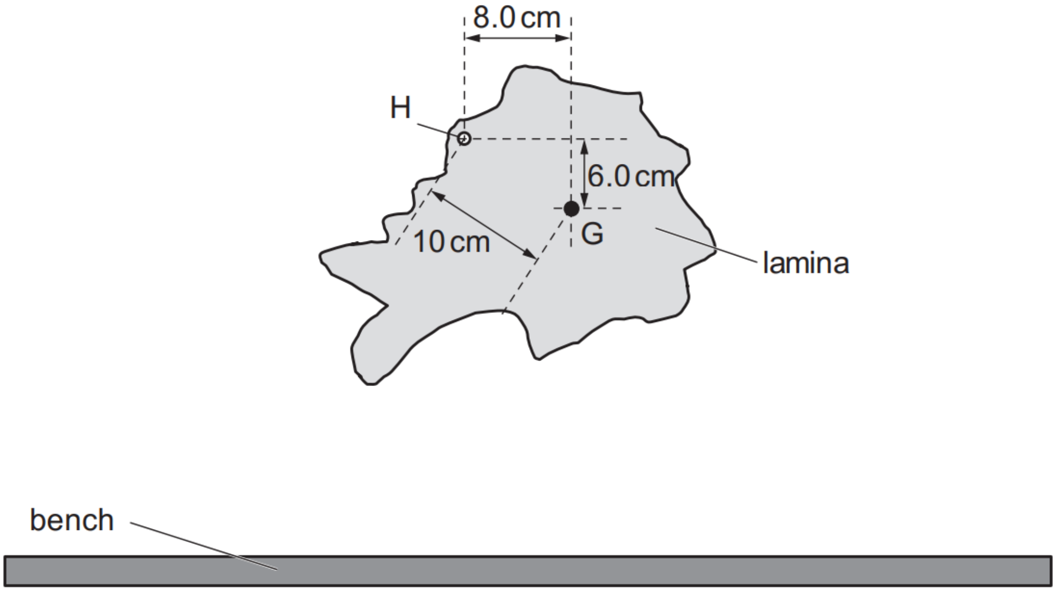

Fig. 2.1 (not to scale)

The centre of gravity of the lamina is at G.

(a) The weight of the lamina is a force that acts downwards.

Explain why the lamina experiences this downward force.

………………………………………………………………………………………………………

……………………………………………………………………………………………………… [1]

(b) The weight produces a moment about the pivot through H.

(i) Using Fig. 2.1, calculate the moment of the weight about the pivot.

moment = ……………………………………………… [2]

(ii) The lamina is now released from the position shown in Fig. 2.1.

Describe what happens to the lamina from the time it is released until it stops moving.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

[Total: 6]

3 A fixed mass of gas in a glass tube is trapped by a seal at one end of the tube and by a column of mercury. The mercury is free to move within the tube.

The tube is rotated slowly from the vertical as shown in Fig. 3.1 to the horizontal as shown in Fig. 3.2. The volume of the gas increases and its temperature remains constant.

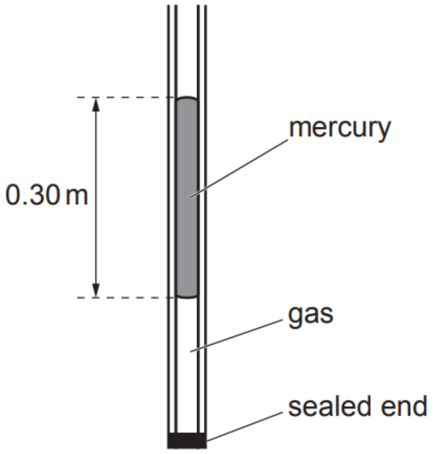

Fig. 3.1 (not to scale)

Fig. 3.2 (not to scale)

(a) **(i)** Describe why rotating the tube changes the pressure of the gas in the sealed end.

....

.... [1]

(ii) Using ideas about particles, explain why the particles of the gas trapped inside the tube by the mercury exert a pressure on the glass tube.

....

....

.... [2]

(b) In Fig. 3.1, the length of the mercury column is 0.30 m.

The density of mercury is 13600 kg / m^3. Atmospheric pressure is 101 kPa.

Calculate the pressure of the gas in the tube.

pressure = ... [2]

[Total: 5]

4 Fig. 4.1 shows a rider on an electric scooter.

Fig. 4.1

The scooter contains a battery and a motor to drive the back wheel.

(a) **(i)** State the name of the energy store in the battery.

.... [1]

(ii) Describe, in terms of work done, the stages of energy transfer from the energy store in the battery to the kinetic store of the scooter.

....

....

.... [2]

(b) The total weight of the scooter and the rider is 800 N.

Calculate the total energy in the kinetic store of the rider and scooter when the scooter has a speed of 5.5 m / s.

total energy = ... [2]

(c) The battery is marked 'energy capacity 0.45 kilowatt-hour (kW h)'.

(i) Define what is meant by a kilowatt-hour.

....

.... [1]

(ii) The scooter stops working because the battery is totally discharged (flat).

This means that there is no more energy stored in the battery. The battery is then recharged using a 75 W power supply.

Calculate the time taken to fully recharge the battery.

time taken = ... [2]

[Total: 8]

5 A student investigates the efficiency of a filament lamp. Fig. 5.1 shows the filament lamp with its glass bulb immersed in water in a beaker.

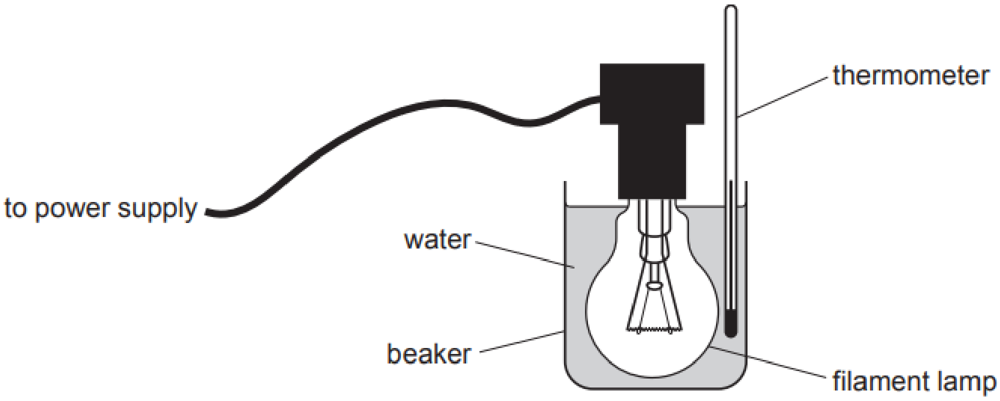

Fig. 5.1

The reading on the thermometer in the water is 28.0 °C.

Only the glass of the lamp is in contact with the water and the electrical connections are completely insulated. The lamp is switched on.

At the end of the experiment, the temperature of the water is 31.5 °C.

(a) The mass of the water in the beaker is 500 g and the specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the increase in the internal energy of the water.

increase in internal energy = ... [2]

(ii) In the experiment, the lamp is switched on for 600 s. The power supplied to the filament lamp is 13 W. The useful energy from the lamp is transferred as light. The energy that increases the temperature of the water is wasted energy.

Determine the maximum possible efficiency of the filament lamp.

efficiency = ... [3]

[Turn over

(b) The efficiency of the lamp is less than the value determined in (a)(ii).

Suggest one reason for this.

....

.... [1]

[Total: 6]

6 The virtual reality headset in Fig. 6.1 contains a display and a lens, as shown in Fig. 6.2.

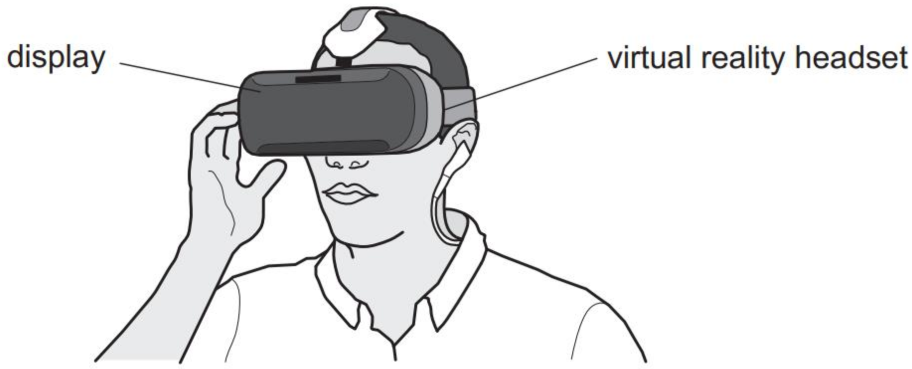

Fig. 6.1

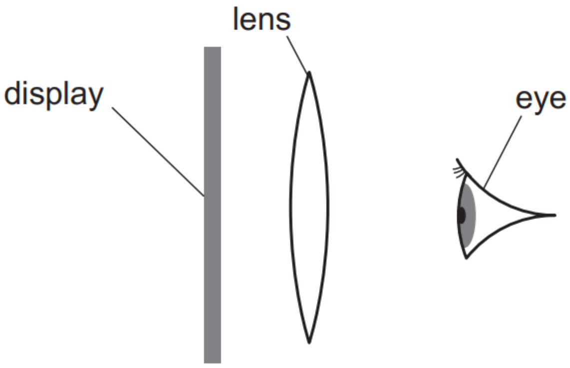

Fig. 6.2 (not to scale)

The display is the object for the lens.

The lens acts as a magnifying glass and forms a virtual image of the display.

(a) **(i)** Describe where the display must be positioned relative to the focal length of the lens for the lens to act as a magnifying glass for the image on the display.

....

.... [1]

(ii) Explain how a virtual image is formed.

....

.... [1]

(b) An arrow on the display is 3.4 cm from the lens. The virtual image of the arrow is 22 cm from the lens.

Fig. 6.3 shows the arrow O, the lens L and the virtual image of the arrow I, drawn on a grid with a scale of 1:2.

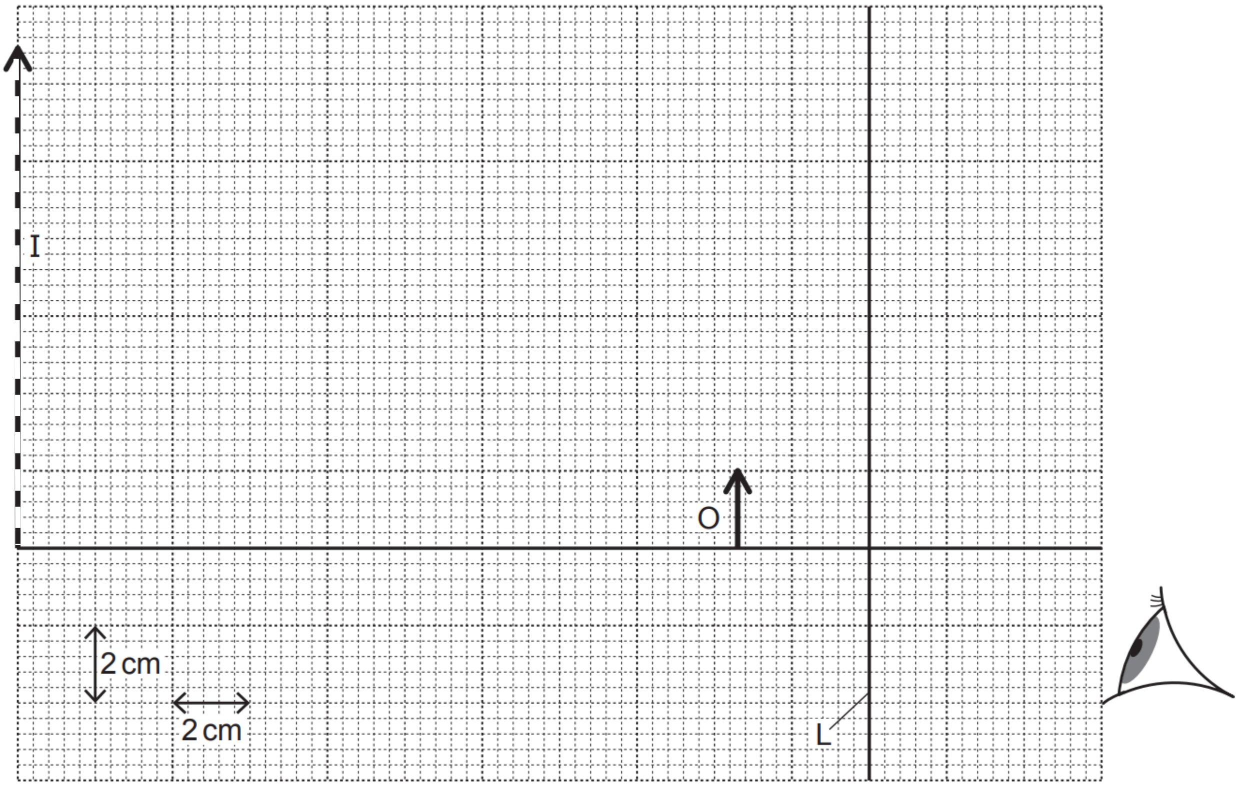

Fig. 6.3

(i) On Fig. 6.3, draw a ray diagram to show the formation of the virtual image I. [3]

(ii) Determine the focal length of the lens.

focal length = ... [1]

[Total: 6]

7 **(a)** A glass rod is uncharged.

When the rod is rubbed with a silk cloth, the rod becomes positively charged.

Explain, in terms of particles, why the rod becomes positively charged.

....

.... [1]

(b) Fig. 7.1 shows a negatively charged metal sphere S.

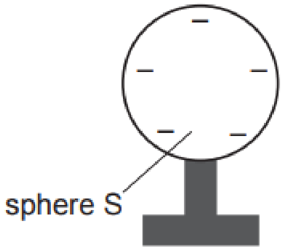

Fig. 7.1

There is an electric field surrounding S.

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

....

.... [1]

(ii) On Fig. 7.1, draw the pattern of the electric field surrounding sphere S and indicate its direction. [2]

(c) Fig. 7.2 shows a small negative charge X placed near to sphere S.

Fig. 7.2

Charge X experiences a force due to the electric field surrounding S.

On Fig. 7.2, draw an arrow to show the direction of this force on X. [1]

[Total: 5]

[Turn over

8 The isotope iodine-131 emits two types of nuclear radiation. Gamma radiation is one of the types emitted.

A sample of iodine-131 produces a narrow beam of radiation which passes into a magnetic field.

Fig. 8.1 shows some of the paths taken in the magnetic field by the radiation emitted from the sample.

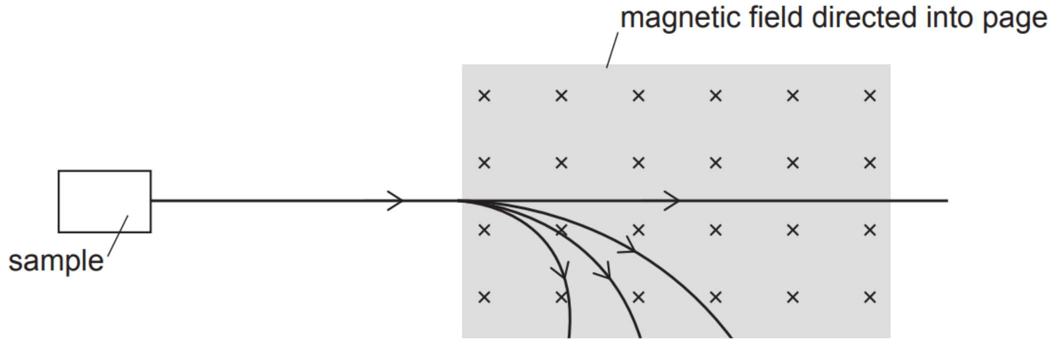

Fig. 8.1

The direction of the magnetic field is into the page.

(a) On Fig. 8.1, mark with a gamma symbol (γ) any of the paths taken by the gamma radiation. [1]

(b) Determine the other type of radiation emitted by iodine-131. Explain how you obtain your answer.

....

....

....

.... [3]

(c) In another experiment, the beam of radiation from the sample is incident on a 5 mm thick sheet of lead.

State what happens to the two types of radiation in the beam.

....

....

.... [2]

[Total: 6]

9 The issue of haze generated from forest fires has become a problem for many Southeast Asian countries. This is not only an expensive problem but has become a critical health hazard for many who are exposed to its effect. Moreover, the generation of greenhouse gases from these fires has caused alarm as it will most likely further contribute to changes in the world's climate and weather pattern. One way in which the regional government has sought to combat this problem of forest fire is through the use of infra-red thermal imaging. Satellites equipped with infra-red sensors are used to detect problem spots. With this information, the local authorities are then mobilised to put out the fire before it spreads and worsens.

Visible light is unable to pass through clouds and haze, but infra-red radiation can.

How does the infra-red (IR) sensor work?

The infra-red (IR) sensors mounted on satellites detect the relative thermal energies emitted by objects like burning trees, fields, and streams. With the aid of a signal processor, this information is converted into a coloured coded visual presentation showing regions with varying range of temperature. The IR band is often subdivided into smaller sections, coded as shown in Fig. 9.1.

Section Code	**NIR**	**SWIR**	**MWIR**	**LWIR**	**FIR**
Wavelength / μm	0.75 – 1.4	1.3 – 3	3 – 8	8 – 15	15 – 1000

Fig. 9.1

IR radiations that fall into individual sections are assigned colour codes by the signal processor. Forest fires which are normally detected in the range of 3 to 4.5 μm and hence falls under the MWIR section may be assigned the colour red.

Bodies of water which are cooler like rivers fall in the range of 10+ μm and as such fall under the LWIR section, may be assigned the colour blue.

As a result, a coloured image of red for hot and blue for cold objects can be constructed and used to detect hot spots.

(a) State the IR section code that has the highest energy level.

.... [1]

(b) State the IR section code that is nearest to the electromagnetic band of microwaves.

.... [1]

(c) List one property of Infra–red (IR) radiation.

....

.... [1]

(d) Calculate the range of IR frequencies for the MWIR section code.

range = ………………………………………………………… [3]

(e) Explain why the method of IR imaging is more useful in detecting spots of forest fire as compared to a normal coloured photograph taken from a satellite.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(f) Besides the application mentioned above, state two other applications of infra-red radiation.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

[Total: 10]

10 Fig. 10.1 shows an electric circuit.

Component P has a resistance of 900 Ω and component Q has a resistance of 3000 Ω.

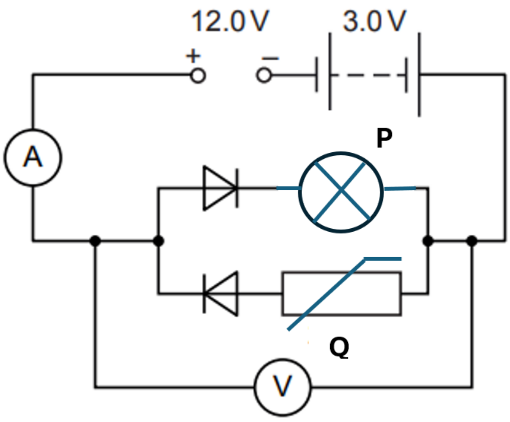

Fig. 10.1

(a) Determine the reading on the voltmeter.

voltmeter reading = ... [1]

(b) Calculate the current in component P.

current = ... [2]

(c) Calculate the current in component Q and hence determine the reading on the ammeter.

current = ... [1]

ammeter reading = ... [1]

[Turn over

(d) As the surrounding temperature rises, describe how the resistance of component Q in Fig. 10.1 and the current through it changes.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

……………………………………………………………………………………………………… [2]

(e) On Fig. 10.2, sketch the current–voltage graph of component P and explain its shape.

Fig. 10.2

………………………………………………………………………………………………………

……………………………………………………………………………………………………… [3]

[Total: 10]

Section B

Answer **one** question from this section.

11 A student has a mini hifi system that connects to the 240 V a.c. mains electrical supply.

Fig. 11.1 shows the mini hifi system.

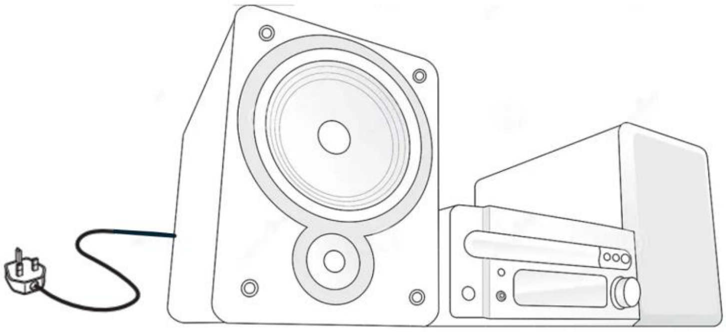

Fig. 11.1

(a) The mini hifi system has an on-off switch in one of the wires that connects it to the mains supply. State and explain which wire includes the switch.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [2]

(b) The mini hifi system uses a transformer to change the 240 V a.c. voltage to a 12 V a.c. voltage.

(i) State the name of this type of transformer.

……………………………………………………………………………………………… [1]

(ii) Describe the construction of this transformer. You may include a labelled diagram.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [3]

(c) There are 2 loudspeakers included in the mini hifi system. The student wonders about how the loudspeakers work and asks his teacher.

The teacher then demonstrates how a loudspeaker works by using the equipment shown in Fig. 11.2.

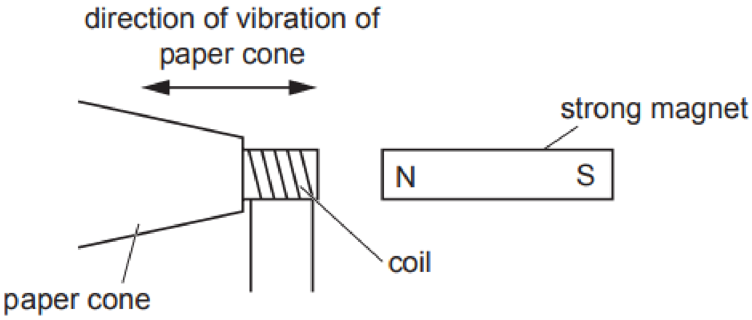

Fig. 11.2

There is an alternating current in the coil. The paper cone and coil vibrate as shown in Fig. 11.2.

(i) Describe what is meant by alternating current (a.c.).

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(ii) Explain why the paper cone vibrates. Use your ideas about magnetism.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(iii) When the paper cone vibrates, the teacher hears a sound. Suggest a value for the frequency of the alternating current.

…………………………………………………………………………………………………… [1]

[Total: 10]

12 **(a)** Fig. 12.1 is a voltage–time graph showing the output of a simple alternating current (a.c.) generator at times t_0, t_1, t_2 and t_3.

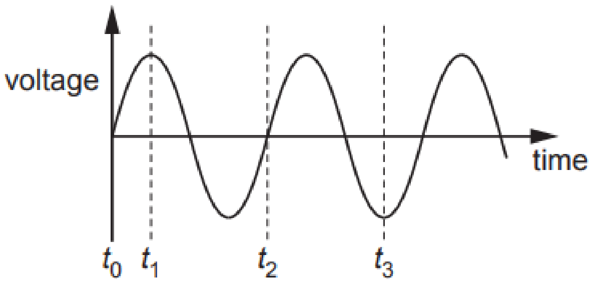

Fig. 12.1

Fig. 12.2 is an end view of the plane of the coil of the generator at time t_0. The coil is rotating clockwise.

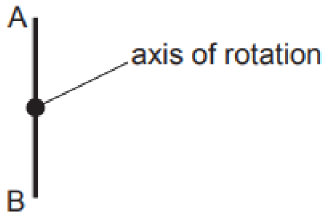

Fig. 12.2

(i) Explain why there is a voltage induced in the coil when the coil is rotated.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) Draw an end view of the position of the plane of the coil at time t_1. Include the labels A and B. [1]

(iii) Draw an end view of the position of the plane of the coil at time t_2. Include the labels A and B. [1]

[Turn over

(iv) Draw an end view of the position of the plane of the coil at time t_3. Include the labels A and B. [1]

(b) Fig. 12.3 shows the single turn coil of a simple direct current (d.c.) motor.

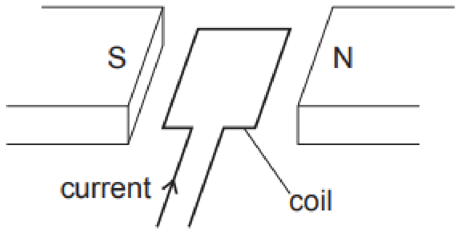

Fig. 12.3

(i) Both an a.c. generator and a d.c. motor contain a coil and brushes.

Draw on Fig.12.3 to show how brushes are connected to the coil in a d.c. motor. [2]

(ii) Explain why there are forces on the sides of the coil in a d.c. motor.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

(iii) The coil in Fig.12.3 is replaced by an otherwise identical new coil with three turns and the same current in the coil.

State how this change affects the d.c.motor.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

(iv) A third coil is identical to the coil in Fig.12.3 except that its resistance is three times greater. The potential difference (p.d.) across the coil is the same as before.

State how this change affects the d.c.motor.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

[Total: 10]