O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2022
Secondary Four Express

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

PHYSICS 6091/02

Paper 2 Physics

17 August 2022

1 hour 45 minutes

1110 – 1255 h

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

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 [50]	
Section B [30]	
Total [80]	

This document consists of **26** printed pages.

Setter: Mr Richmond Ang

Section A

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

1 **(a)** Electric charge can be stated to be either positive or negative.

State and explain whether electric charge is a scalar or a vector quantity.

……

…….. [1]

(b) A potential difference is applied between a pair of horizontal metal plates in a vacuum as shown in Fig. 1.1.

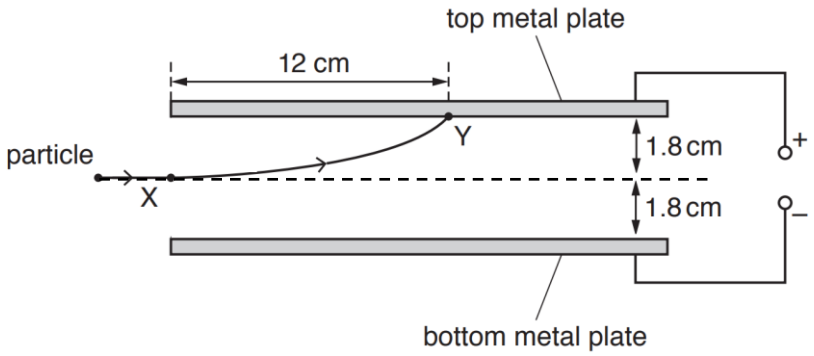

Fig. 1.1

A negatively charged particle enters the electric field at point X with a velocity of 0.75 m/s to the right.

The particle is deflected by the field and hits the top plate at point Y.

(i) Explain why the average velocity of the particle is lower than its average speed as it travels from point X to point Y.

……

……

……

……

…… [2]

(ii) On Fig. 1.2, draw and label all the forces acting on the particle at point X.

Fig. 1.2

[2]

2 A block of weight 15N hangs by a wire from a remotely controlled aircraft, as shown in Fig. 2.1.

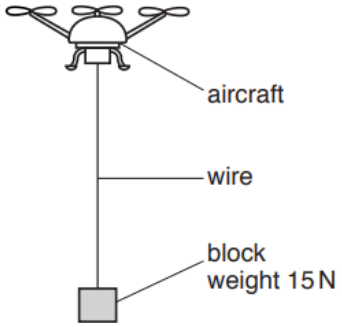

Fig. 2.1

The aircraft is used to move the block only in a vertical direction. The force on the block due to air resistance is negligible.

The variation with time t of the vertical velocity v of the block is shown in Fig. 2.2.

The velocity is taken to be positive in the upward direction.

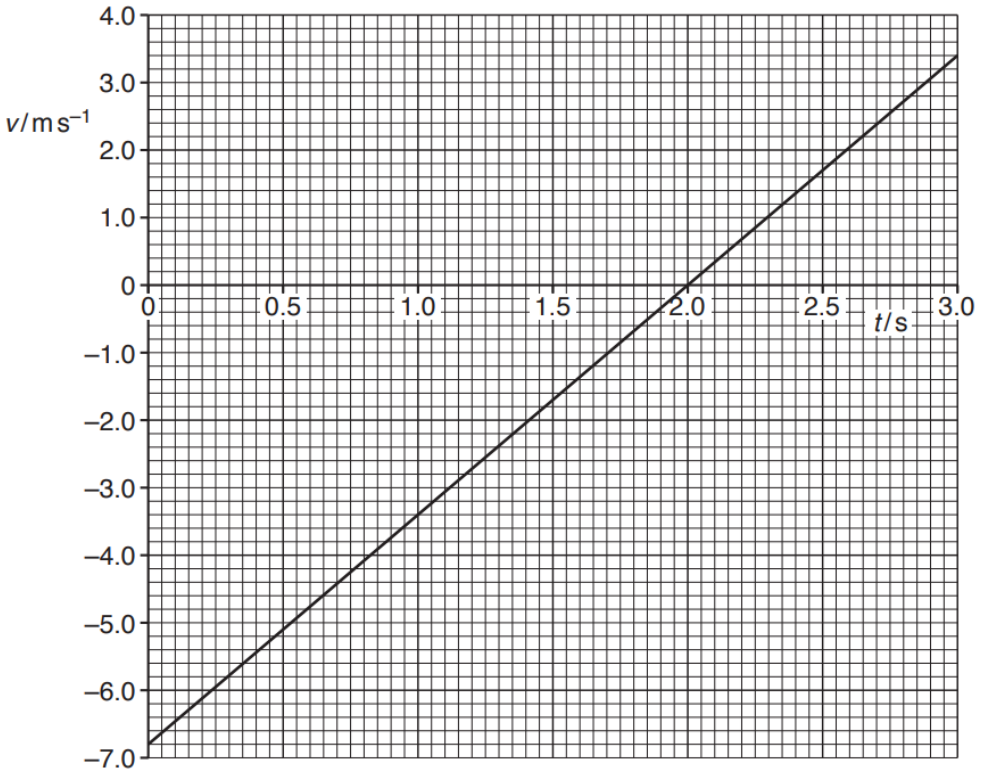

Fig. 2.2

(a) Determine the displacement of the block from time t = 0 to t = 3.0 s.

magnitude of displacement = ……

direction of displacement ……..

[3]

(b) **(i)** Calculate the magnitude of the acceleration of the block at time t = 2.0s.

acceleration = …… [2]

(ii) Use your answer in **(b)(i)** to calculate the tension in the wire at time t = 2.0s.

The gravitational field strength acting on the block is 10 N/kg.

tension = ……[2]

(c) The block is removed and replaced by a disc. The force on the disc due to air resistance is not negligible.

On Fig. 2.2, draw a possible velocity-time graph of the disc as the aircraft is lifting it until its velocity reaches zero. [1]

3 Fig. 3.1 below shows a device that can be used to ignite small pieces of combustible material. The device consists of a cylinder containing trapped air and a piston.

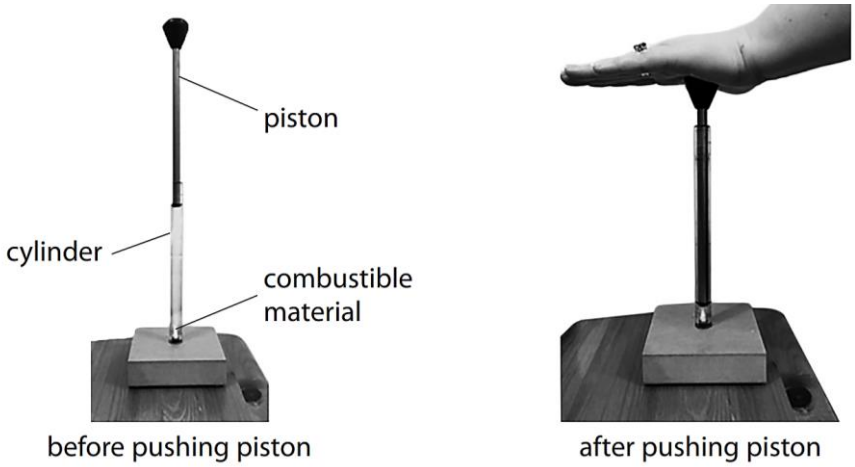

Fig. 3.1

A small piece of combustible material is placed at the bottom of the cylinder. When the piston is pushed quickly into the cylinder, the trapped air is compressed and heats up.

This increase in temperature is enough to ignite the combustible material.

The piston is quickly pushed down a distance of 14.5 cm.

The average force exerted on the piston is 4.7 N.

(a) Calculate the work done on the trapped air when the piston is quickly pushed down.

work done = …….. [2]

(b) Suggest why the trapped air does not reach a high enough temperature to ignite the combustible material if the piston is slowly pushed into the cylinder.

……

……

…….. [1]

4 Fig. 4.1 shows a diver using a canister of compressed air so that he can breathe underwater.

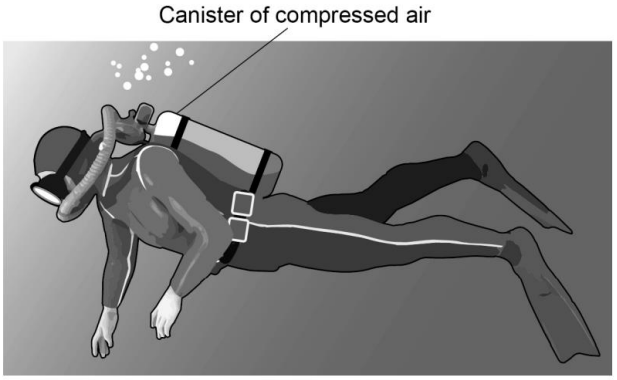

Fig. 4.1

(a) Describe the motion of the air particles in the canister.

……

…….. [1]

(b) A canister of air was tested to find out how the pressure changed when it was used by a diver.

- Air was allowed to escape from the canister
- The pressure of the air inside the canister was recorded every 5 minutes for 80 minutes.

Fig. 4.2 shows the results.

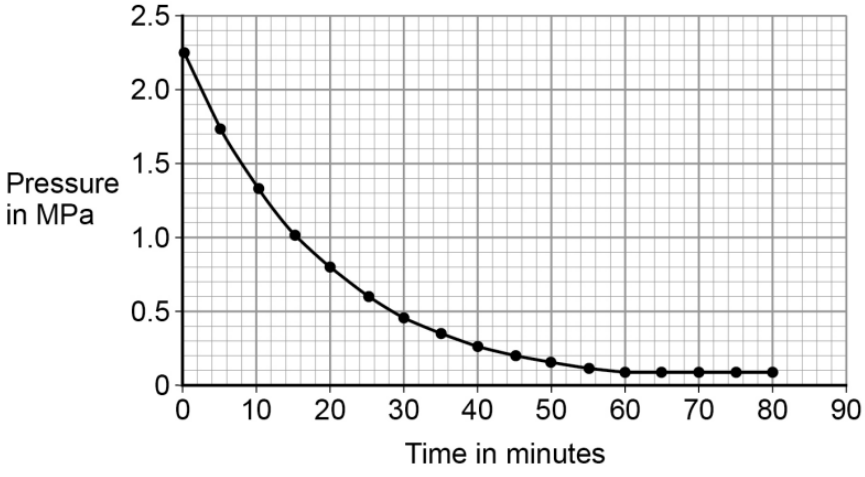

Fig. 4.2

(i) Using Fig. 4.2, estimate the atmospheric pressure.

atmospheric pressure = …….. [1]

(ii) Divers can safely stay underwater as long as the pressure of the air in the canister is higher than the surrounding pressure.

Determine the maximum amount of time a diver can stay safe at 40 m below the surface of the sea.

The density of sea water is 1025 kg/m^3.

maximum amount of time= …… [2]

5 (a) State the principle of moments.

……

……

…… [2]

(b) In a bicycle shop, two wheels hang from a horizontal uniform rod AC, as shown in Fig. 6.1.

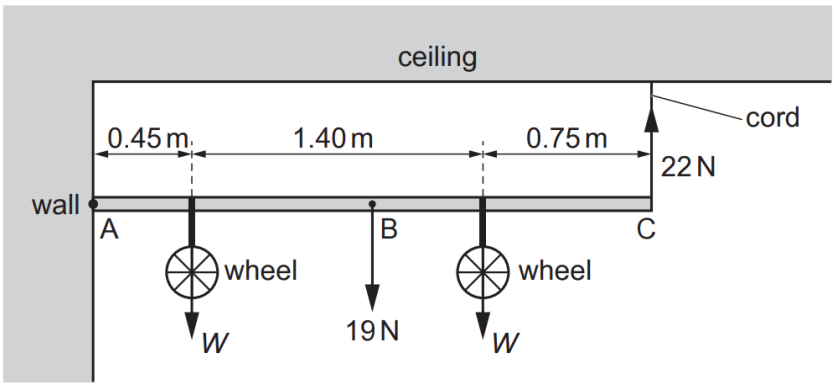

Fig. 6.1

The rod has weight 19N and is freely hinged to a wall at end A. The other end C of the rod is attached by a vertical elastic cord to the ceiling. The centre of gravity of the rod is at point B.

The weight of each wheel is W and the tension in the cord is 22N.

(i) By taking moments about end A, show that the weight W of each wheel is 14N.

[2]

(ii) Determine the magnitude and the direction of the force acting on the rod at end A.

force at end A = ... [1]

6 (a) In an experiment, a student inserts a wooden rod into the end of a brass tube as shown in Fig. 6.1.

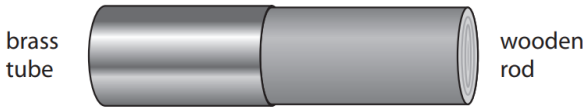

Fig. 6.1

She then wraps a paper collar around the joint and heats the apparatus, as shown in the Fig. 6.2.

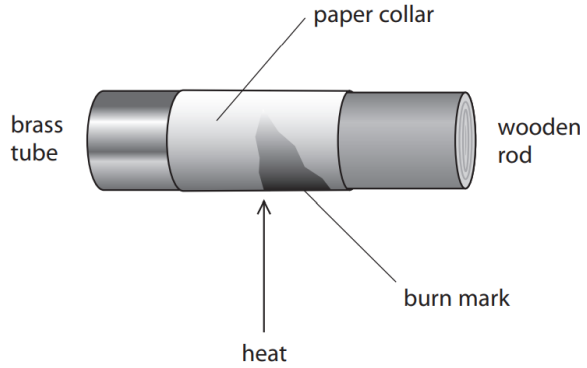

Fig. 6.2

Explain why the paper burns on the wooden rod, but not on the brass tube.

……..

……..

……..

……..… [2]

(b) A man closes a plastic bag with some ice cubes inside, as shown in Fig. 6.3.

Fig. 6.3

(i) Describe briefly the processes on how the ice cubes inside the plastic bag gain thermal energy as they melt.

……...

……..….

……...

……..... [2]

7 A ray of white light enters into a plastic tube which has a refractive index of 1.55 as shown in Fig. 7.1.

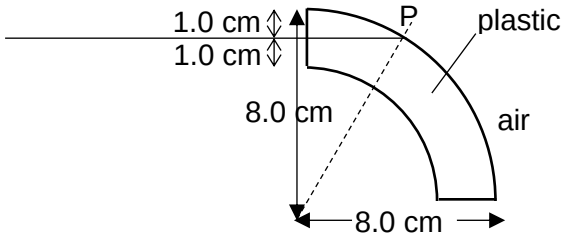

Fig. 7.1

(a) What is meant by a *refractive index of 1.55*?

……

……... [1]

(b) Determine the critical angle of the plastic tube.

critical angle = …….. [2]

(c) Find the angle of incidence at P.

angle of incidence = …… [2]

(d) On Fig. 7.1, complete the path of the light ray. [1]

8 Fig. 8.1 shows a charged rod brought towards a gentle stream of water from a tap.

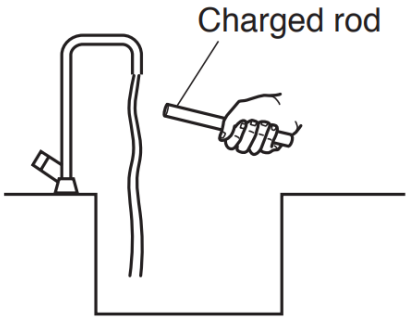

Fig. 8.1

(a) Explain how the charged rod affects the stream of water.

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..... [3]

(b) Fig. 8.2 shows the electric field between two charges, A and B.

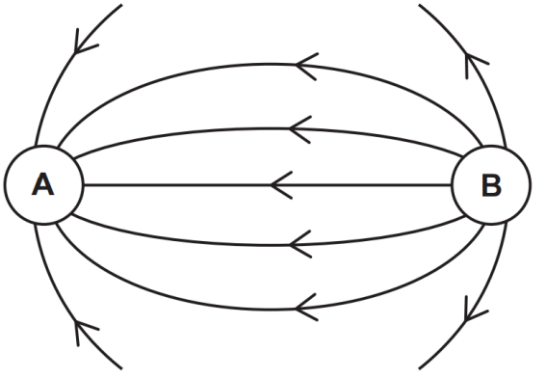

Fig. 8.2

(i) State and explain the charges of A and B.

……....

……....

……....

……..…… [2]

(ii) Describe one similarity between the electric field line diagram and a magnetic field line diagram.

……....

……..…… [1]

9 Fig. 9.1 shows a reed switch in the magnetic field of a strong permanent magnet.

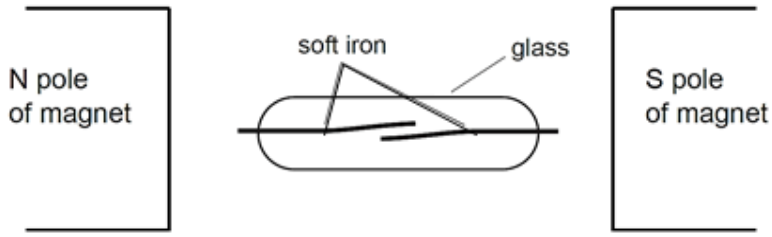

Fig. 9.1

(a) State and explain what happens to the soft iron in the reed switch.

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…… [2]

(b) Fig. 9.2 shows two separate electrical circuits containing the reed switch.

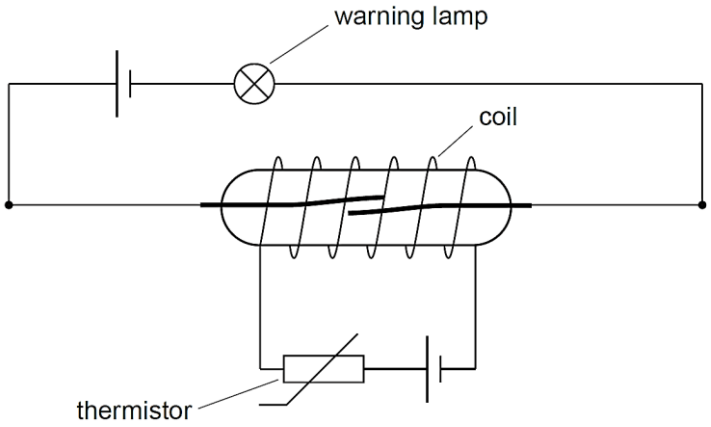

Fig. 9.2

Explain why the warning lamp lights up when the air temperature rises.

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…… [2]

10 Fig. 10.1 shows the parts of an ammeter.

The pointer is connected to the coil so they can move together.

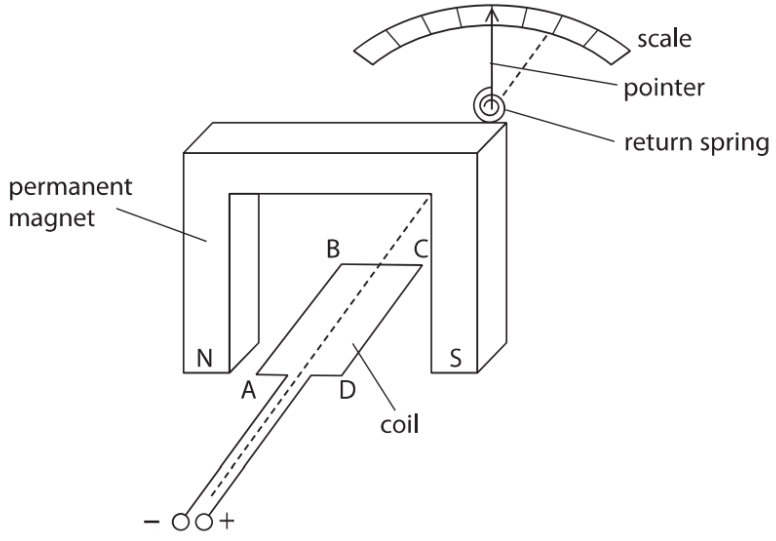

Fig. 10.1

(a) Explain how a current in the coil leads to a reading on the ammeter.

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……

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…… [3]

(b) Fig. 10.2 shows two metal rods **A** and **B** placed on two fixed smooth conducting rails.

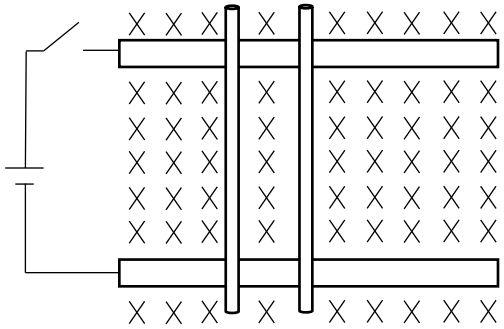

Fig. 10.2

There is a magnetic field pointing into the page.

Describe and explain the motion of the rods once the switch is closed.

……

……

……

……

…… [2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 A student wishes to determine the efficiency of an electric kettle that she has just bought.

Details about the experiment she conducted are shown in Table 11.1.

Mass of water poured into the kettle: 0.75 kg Starting temperature of water: 25.5 °C Time taken for the electric kettle to automatically switch 'OFF' after being switched 'ON' is 2 min 38 seconds. Mass of water remaining in the kettle after boiling: 0.74 kg A sticker at the bottom of the electric kettle shows the following Model SG-620 240V ~ 50 Hz 2000W DO NOT IMMERSE IN ANY LIQUID    She also found the following information while doing research for her experiment: • Specific heat capacity of water = 4200 J/kg°C • Specific latent heat of fusion = 334 kJ/kg • Specific latent heat of vaporization = 2260 kJ/Kg

Table 11.1

(a) (i) Calculate the total energy transferred to the kettle while it was switched 'ON'.

total energy = …….. [1]

(ii) Determine the efficiency of the kettle based on the information in Table 11.1

efficiency = …….. [2]

(b) The student knows that her calculated efficiency is not accurate as thermal energy is lost by the water and the kettle during heating.

She decides to conduct a second experiment by placing 800 g of shaved ice at 0 °C into the kettle. She then switched 'ON' the kettle for the same amount of time as her earlier experiment. At the end of the experiment, she measured that 11.2 g of shaved ice remained in the kettle.

(i) Suggest a method for the student to ensure the shaved ice is at 0 °C without the use of a thermometer.

……

…….. [1]

(ii) Determine the efficiency of the kettle based on her second experiment.

efficiency = …… [2]

(iii) Explain why the efficiency of the kettle is higher for her second experiment.

……

……

…….. [1]

(c) **(i)** The sticker label at the bottom of the kettle indicates that it has double insulation as shown by the logo.

Explain what is meant by double insulation.

……

……

……

…….. [2]

(ii) Suggest why the sticker label indicates “DO NOT IMMERSE IN ANY LIQUID” despite the electric kettle having double insulation.

……

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…….. [1]

12 (a) Fig. 12.1 shows the inside parts of the alternator.

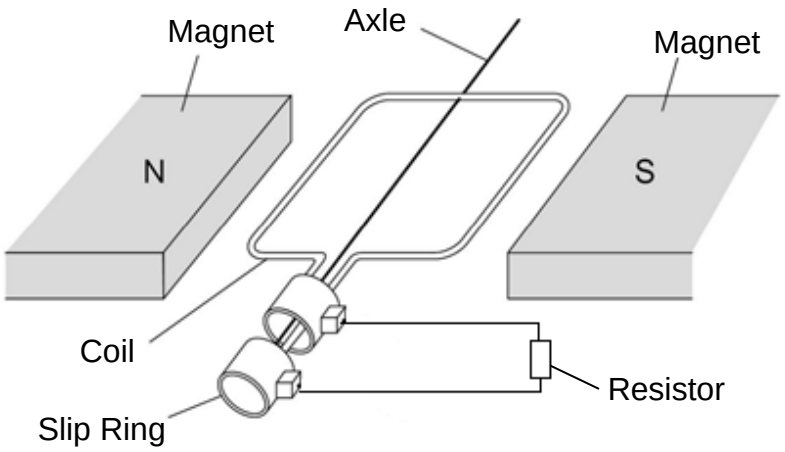

Fig.12.1

(i) The handle of the alternator is turned, causing the coil to rotate.

Explain why an alternating current is induced in the coil.

……

……

……

……

……

……

……..… [3]

(ii) State the purpose of the slip rings.

……

……..… [1]

(iii) The alternator from the portable power supply is disconnected from the resistor.

Explain why the handle of the alternator becomes much easier to turn.

……

……

……

……

…… [2]

(b) A small coil is placed close to one end of a solenoid connected to a power supply. The plane of the small coil is normal to the axis of the solenoid, as illustrated in Fig. 12.2.

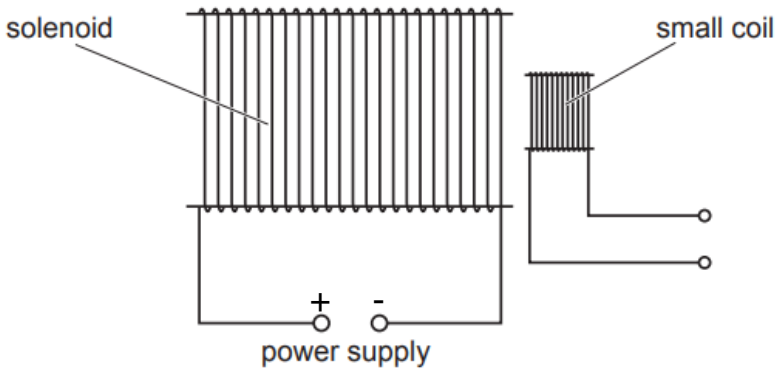

Fig.12.2

The power supply causes the current *I* in the solenoid to vary with time *t* as shown in Fig. 12.3.

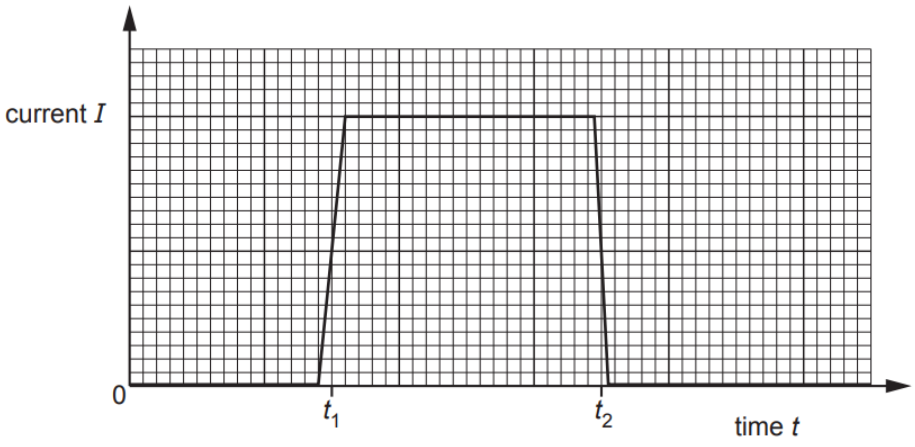

Fig. 12.3

(i) On Fig. 12.2, draw the magnetic field lines produced in the solenoid when the current is flowing. [1]

(ii) On the axes of Fig. 12.4, sketch a graph to show the variation with time *t* of the electromotive force (e.m.f.) induced in the small coil. (No values required)

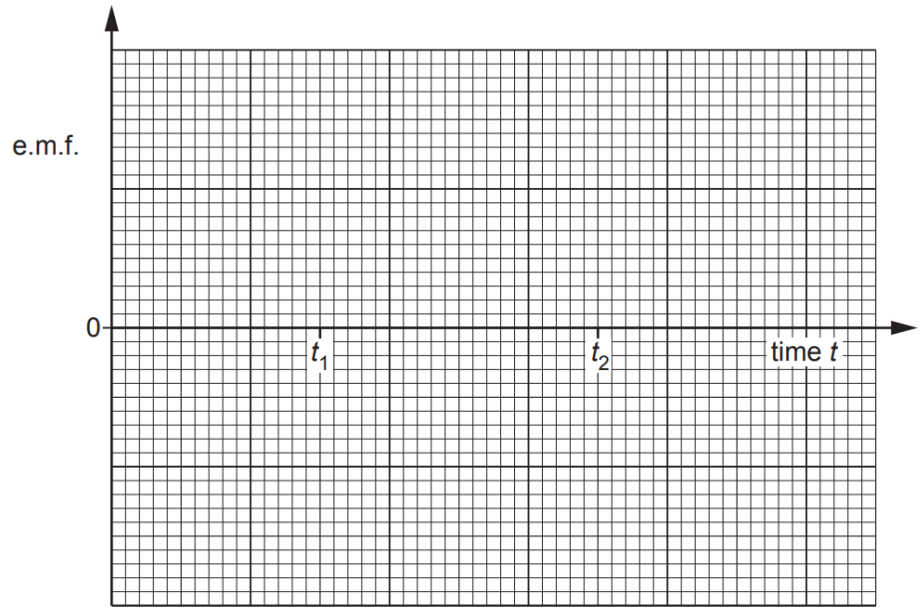

Fig. 12.4

[2]

(iii) Suggest how Fig.12.4 would be different if an iron core was placed inside the solenoid.

……..…

……..……[1]

13 EITHER

(a) In Fig. 13.1, a potential divider is made from a light-dependent resistor (LDR) and a 6.0 kΩ fixed resistor. The potential divider is connected in series with a 12 V d.c. power supply and a voltmeter is connected across the 6.0 kΩ resistor.

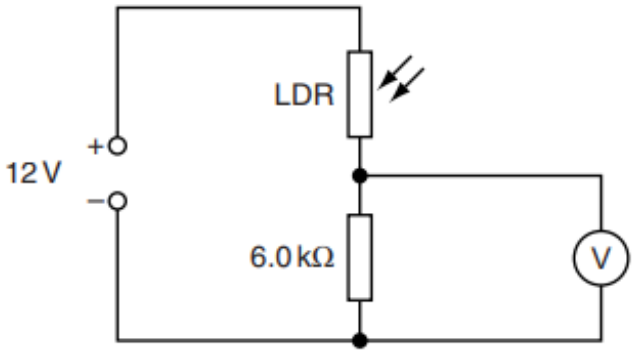

Fig. 13.1

(i) The circuit is placed on a rooftop at sunrise and left there until 12 noon on a clear sunny day.

Explain why the reading on the voltmeter increases.

……

……

……

……

…… [2]

(ii) A buzzer, which produces a sound when the potential difference across it goes above 4.5 V, is placed in parallel to the 6.0 kΩ resistor as shown in Fig. 13.2

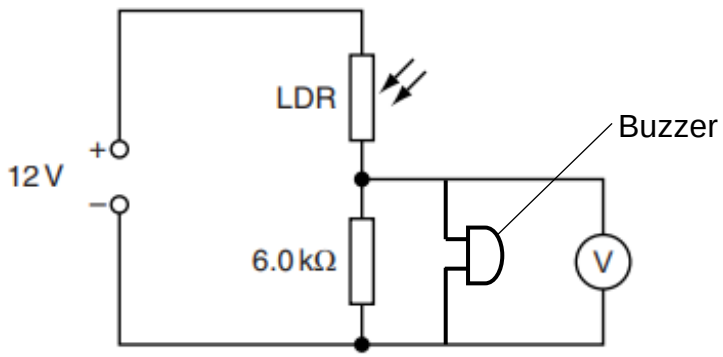

Fig. 13.2

The buzzer has a resistance of 1440 Ω.

Determine the minimum resistance of the LDR before the buzzer sounds.

minimum resistance = …… [3]

(b) A student obtains the current–potential difference (p.d.) (I-V) graphs for a resistor, a thermistor and a filament lamp as shown in Fig. 13.2.

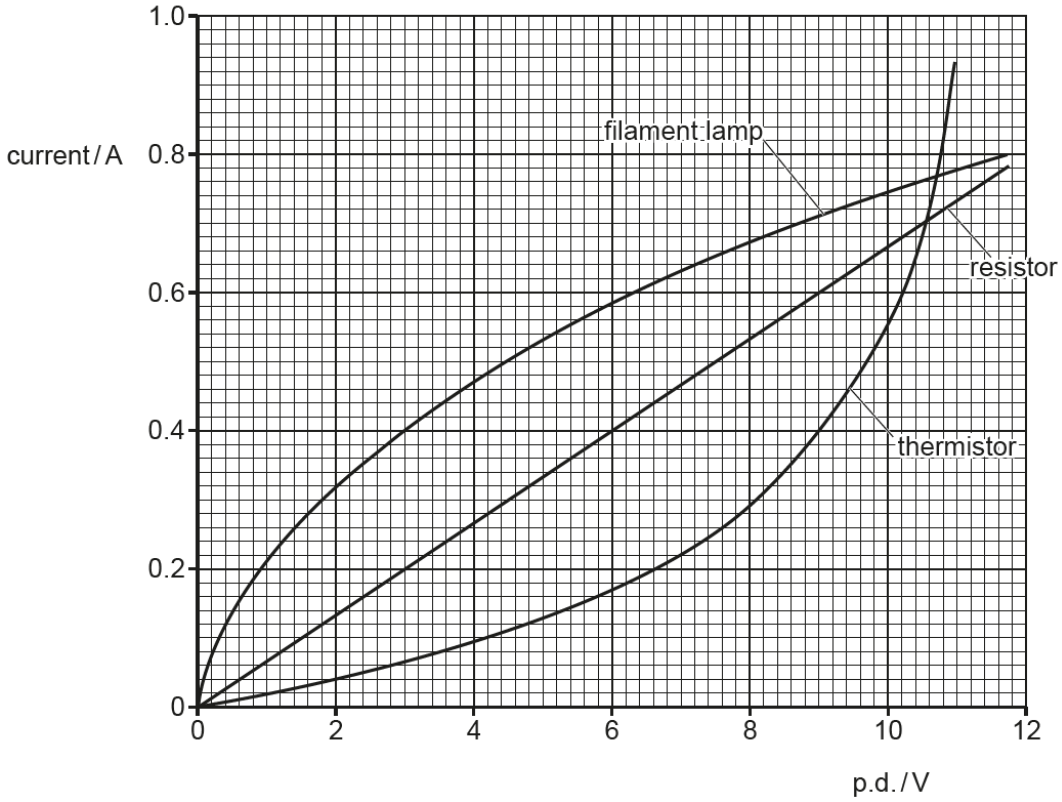

Fig. 13.2

(i) State what is meant by potential difference.

……

…… [1]

(ii) The student claims that the thermistor and filament lamp has the same resistance when a potential difference of 10.7 V is applied across them as their graphs intersect.

Using data from Fig. 13.2, explain whether this claim is correct.

……

……

……

…… [2]

(iii) The resistor, the thermistor and the filament lamp are connected in series with a d.c. power supply.

Using the graph in Fig. 13.2, determine the p.d. across the terminals of the power supply when the p.d. across the resistor is 6.0 V.

p.d. across terminals of power supply = ... [2]

13 OR

(a) Fig. 13.4 shows the pressure-distance graph of the particles at a particular instant when a sound wave passes through the particles.

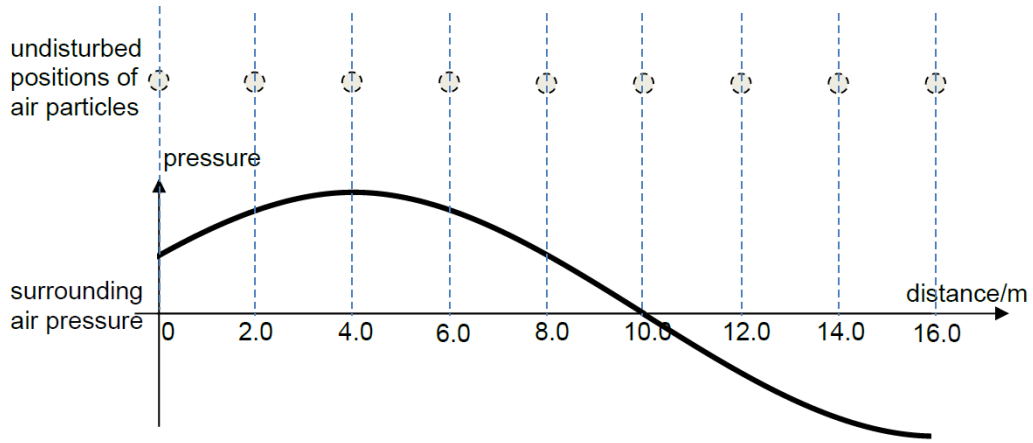

Fig. 13.4

(i) In the space above Fig. 13.4, draw the displaced positions of the particles corresponding to the pressure-distance graph.

The original undisturbed positions of the air particles are shown as a guide. [1]

(ii) The speed of sound in air is 330 m/s. Explain whether a person with normal range of audibility will be able to hear the sound in Fig. 13.4.

……

……

……

…… [2]

(iii) The same sound wave is played next to a swimming pool.

Describe the changes in the wave as it enters the water and explain whether a swimmer underwater will be able to hear the sound.

……

……

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…… [2]

(b) Ultrasound waves can be used to create an image of part of the inside of a body.

Doctors can use an ultrasound scan to measure the diameter of a person's kidney as shown in Fig. 13.5.

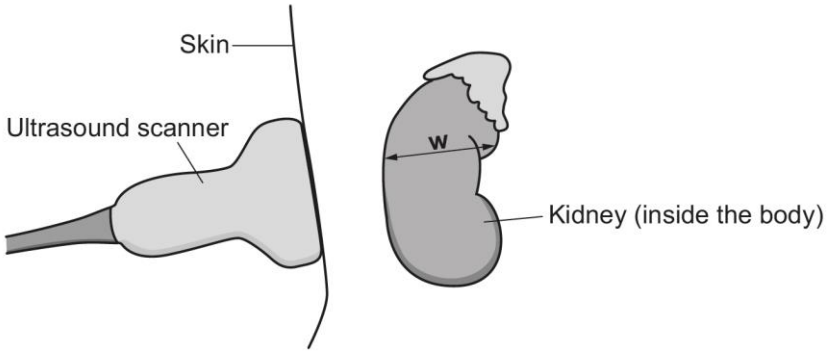

Fig. 13.5

(i) Explain how ultrasound waves are used to measure the diameter **w** of the kidney.

……

……

……

…… [2]

(ii) The typical speed of sound in different tissues of the human body are shown below in Table 13.6.

Medium	Speed of sound (m/s)
fat	1450
kidney	1560
blood	1570
muscle	1580
bone	4080

Table 13.6

Using ideas about particles, explain why the speed of sound in bone is much higher than the speed of sound in other tissues.

……

……

……

…… [2]

(iii) A doctor uses an ultrasound scan instead of X-rays to measure the kidneys.

Explain why.

……..……

……..……[1]

End of Paper