Name:	Class:	Class Index No.:

Anglo-Chinese School
(Barker Road)

PRELIMINARY EXAMINATION 2023

SECONDARY FOUR EXPRESS

PHYSICS 6091

PAPER 2

TIME: 1 HOUR 45 MINUTES

READ THESE INSTRUCTIONS FIRST

Write your name, class & exam index number in the box provided at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 13 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 the sound use of Physics than 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	
Section B	
Total	/ 80

*This question paper consists of **24** printed pages.*

SECTION A (50 marks)

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

1 Fig. 1.1 shows a 58 g ball being thrown vertically upwards from the top of a building with an initial velocity of 20 m/s. It reaches the highest point and begins to fall. It lands on the ground when time is 6.0 s. The velocity-time graph is shown in Fig. 1.2. Air resistance is negligible.

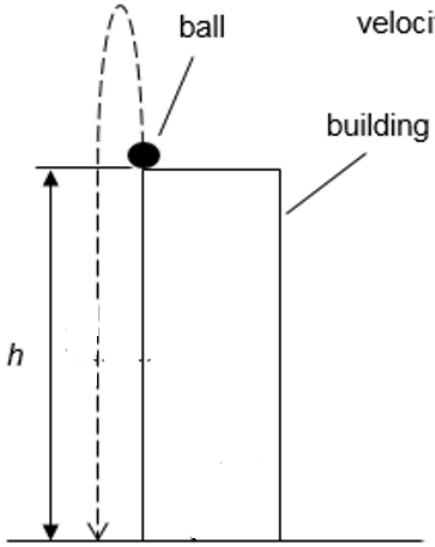

Fig. 1.1

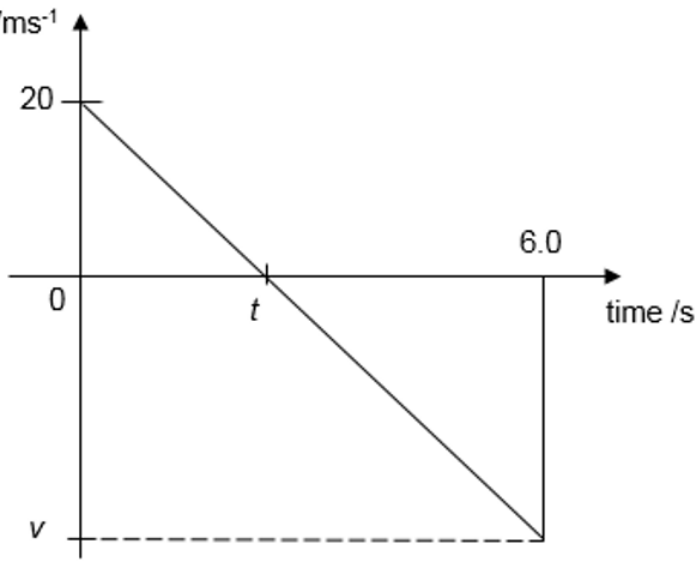

Fig. 1.2

(a) Explain how Fig. 1.2 shows that the ball is moving in the opposite direction after a period of time.

……

…… [1]

(b) Determine the time *t* for the ball to reach its highest point.

t = …… [1]

(c) Calculate the velocity *v* of the ball just before it touches the ground.

v = …… [1]

(d) Calculate the height *h* of the building.

h = …… [2]

2 Fig. 2.1 shows a car being lifted by two ropes. The car remains horizontal and moves vertically upwards at a constant speed.

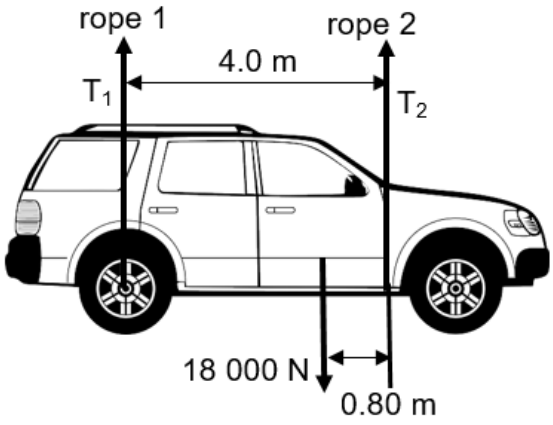

Fig. 2.1

The weight of the car is 18 000 N and the tensions in rope 1 and rope 2 are T_1 and T_2 respectively.

(a) State the two conditions for the car to be in a state of equilibrium while it is moving upwards at a constant speed.

…….

…….

…….

……. [2]

(b) Taking moments about the rear wheel, calculate T_1 and T_2.

T_1 = …….

T_2 = ……. [3]

3 Fig. 3.1 shows a manometer joined to a cylinder containing a gas. The piston has a cross-sectional area of 0.012 m^2.

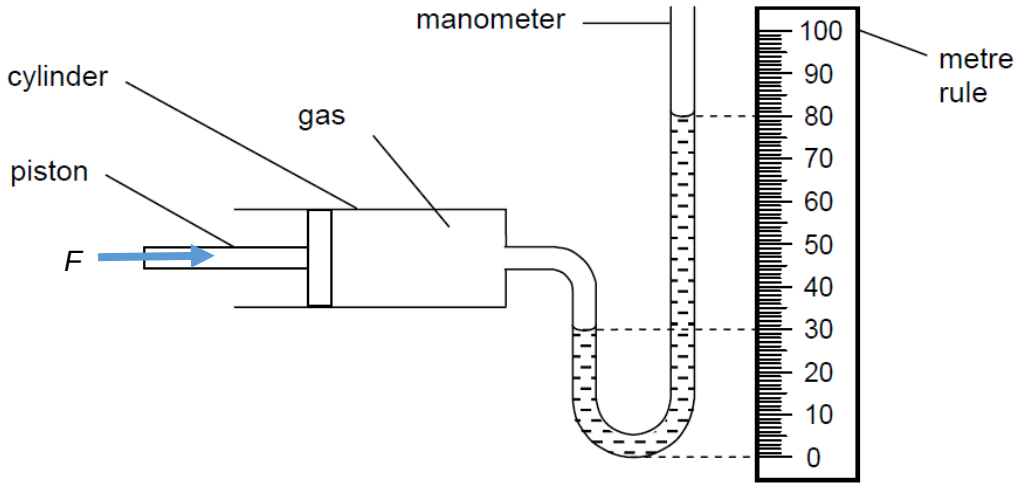

Fig. 3.1

Atmospheric pressure is 100 kPa.
The pressure exerted by the piston on the gas is 140 kPa.
Force *F* is the force of the piston acting on the gas.

Calculate

(a) the force *F*,

F = ... [2]

(b) the density of the liquid.

density = ... [2]

(c) With the same force *F* still exerting on the piston, the gas in the cylinder is now heated. It is observed that the piston moves to the left.

Explain, using ideas about molecules, why the piston moves to the left.

……

……

……

……

……

…… [3]

4 Fig. 4.1 shows a 0.50 kg ball sliding down a rough incline from position A which is 7.5 m above the ground with an initial speed of v_0. Friction along the incline produces 10.7 J of heat energy. The ball leaves the incline at position B moving vertically upward and reaches a height of 13.0 m above the ground at position C.

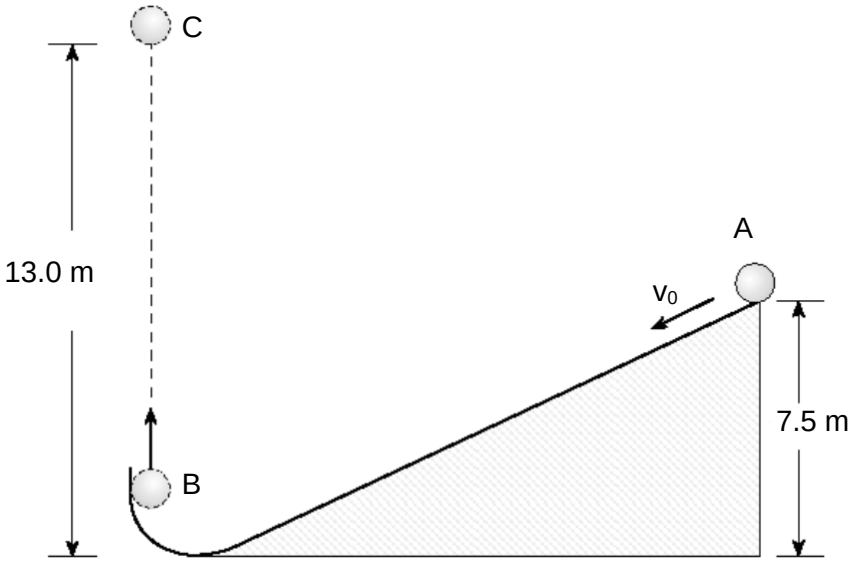

Fig. 4.1

(a) State the principle of conservation of energy.

……

…… [1]

(b) **(i)** Calculate the gravitational potential energy of the ball at position C.

Take gravitational field strength g is 10 N/kg.

gravitational potential energy = ……. [2]

(ii) Calculate the initial speed v_0, at position A.

v_0 = ……. [2]

(c) State one assumption for your calculations in **(b)(ii)**.

……

…… [1]

5 In a company that manufactures frying pans, a researcher wishes to select a new material that can be used for the base of the pan. Fig. 5.1 shows four possible materials and their properties.

material	melting point / °C	specific heat capacity / J/(kg °C)
A	2350	900
B	950	480
C	1600	480
D	7800	130

Fig. 5.1

(a) **(i)** The researcher carries out a series of experiments on the materials.

In one of the experiments, a 2 kg sample of material A is heated by an electrical heater of power 450 W. The initial temperature of the sample is 25 °C.

Calculate the time taken for the temperature of the sample to rise to 100 °C.

time taken = …… [2]

(ii) Using the data in Fig. 5.1, discuss which material is the most suitable to be used for the base of the frying pan. Give two reasons to support your choice.

……

……

……

…… [2]

(b) 2.3 kg of hot water at boiling point is poured into the frying pan.
5 190 000 J was supplied to convert all the water into steam at boiling point.

Calculate the specific latent heat of vaporisation of water.

specific latent heat of vaporisation= …….. [1]

6 In Fig. 6.1 the vertical lines represent the crests of a wave in a ripple tank. The distance between the first crest and last crest is 35.0 cm.

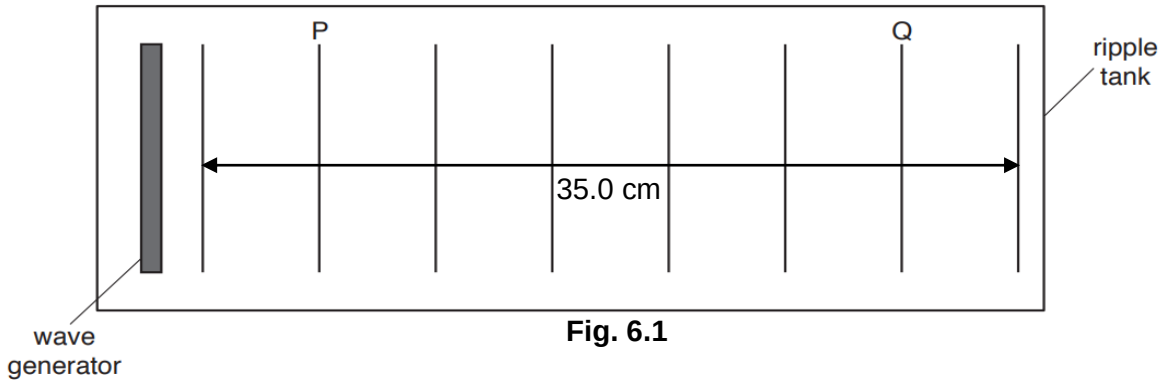

Fig. 6.1

It takes 2.5 s for the wave to travel from P to Q.

(a) Determine the wavelength of the wave in the ripple tank.

wavelength = ... [1]

(b) Determine the frequency of the wave.

frequency = ... [2]

7 A battery of electromotive force (e.m.f.) 4.5 V and negligible internal resistance is connected to two filament lamps P and Q and a resistor R, as shown in Fig. 7.1.

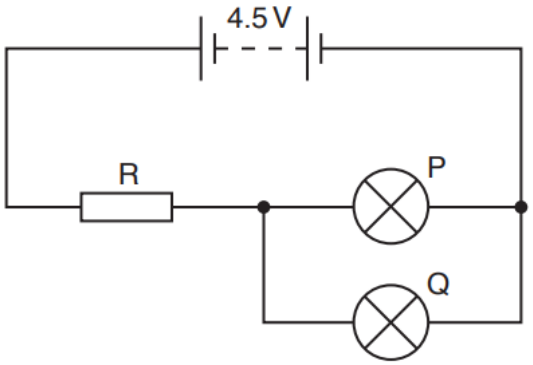

Fig. 7.1

The I–V characteristic graph of the filament lamps are shown in Fig. 7.2.

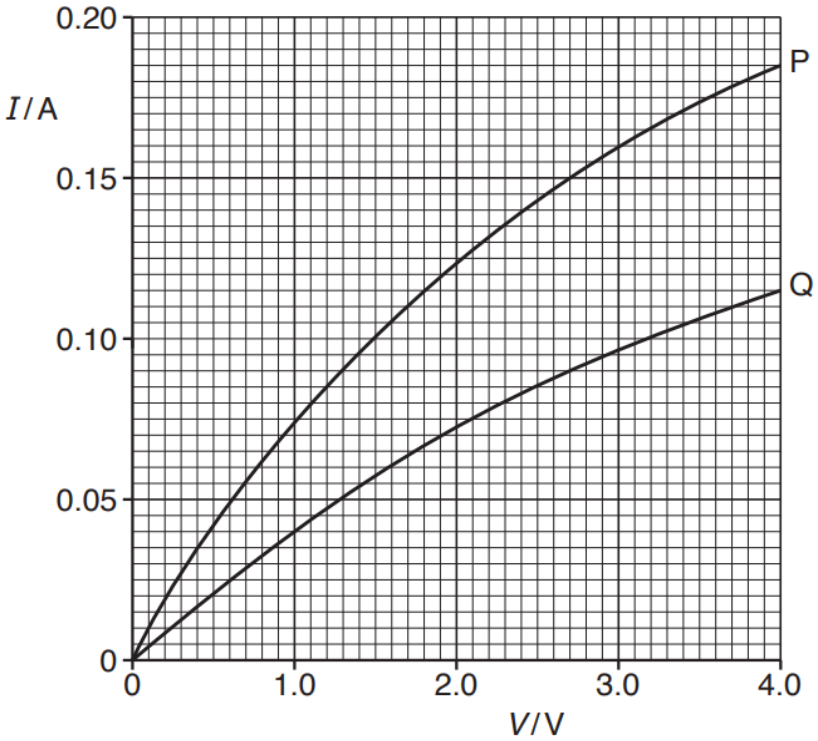

Fig. 7.2

The setup in Fig. 7.1 will give a current of 0.15 A flowing in lamp P.

(a) Use Fig. 7.2 to determine the current in the battery. Show your working clearly.

current = ... [2]

(b) Calculate the potential difference across resistor R.

potential difference = …… [1]

(c) The filament wires of the two lamps are made from a material with the same resistivity at their operating temperature in the circuit.

The diameter of the wire of lamp P is twice the diameter of the wire of lamp Q.
The resistances of the wires of lamp P and lamp Q are 18 Ω and 3 Ω respectively.

Show that the ratio of the length of wire of lamp P to the length of wire of lamp Q is 24:1.

[2]

8 Fig. 8.1 shows an electrical circuit.

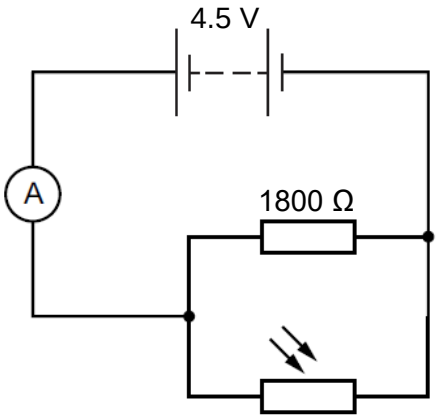

Fig. 8.1

(a) The light incident on the light dependent resistor causes its resistance to be 9000 Ω.

Calculate

(i) the total resistance of the circuit,

resistance = ... [1]

(ii) the reading on the ammeter.

reading = ... [1]

(b) A very bright lamp near the circuit is switched on and the intensity of the light incident on the LDR increases.

State and explain what happens to the ammeter reading.

……

……

……

……

…… [2]

9 Fig. 9.1 shows a simple d.c. motor. A rectangular coil PQRS is connected to a power supply and is placed between two solenoids.

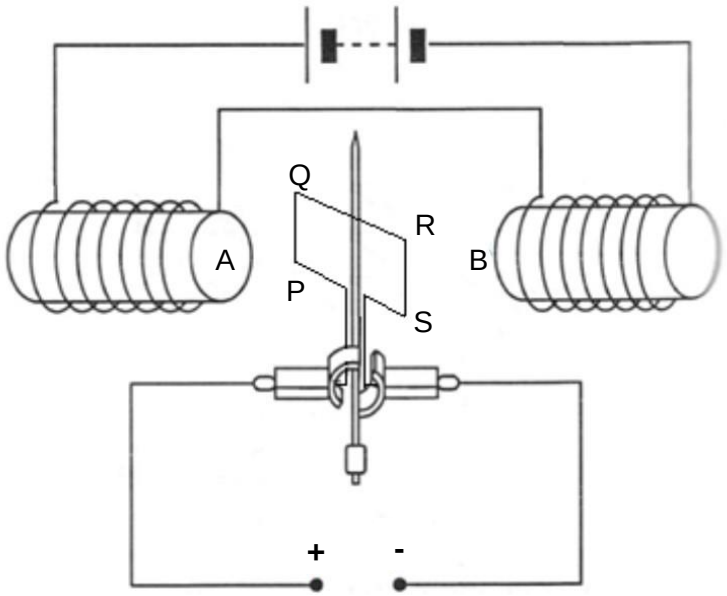

Fig. 9.1

(a) Identify the magnetic poles at A and B.

A: ……

B: …… [1]

(b) Explain why the coil turns and state the direction of its rotation

……...

……...

……...

……... [2]

(c) Describe the action of the split-ring commutator in the d.c. motor.

……...

……... [1]

(d) When the coil is vertical, the split-ring commutator is not in contact with the carbon brushes and no current flows through the coil.

Explain why the coil continues to turn even though no current is flowing.

……...

……... [1]

10 Fig. 10.1 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

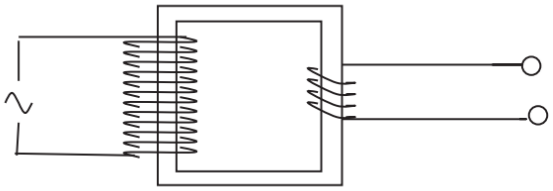

Fig. 10.1

coil	number of turns
J	50
K	100
L	1 000
M	1 500

Table 10.2

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 10.2 above.

(a) Based on Table 10.2, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer.

Show your workings.

primary coil: ……

secondary coil: …… [2]

(b) Assume that the transformer is 75 % efficient and the power output is 15 kW, calculate the current flowing in the primary coil.

current = …… [2]

(c) Soft iron is used for the core of the transformer.

Explain why a soft iron core is used.

……...……...

……...……... [1]

SECTION B (30 marks)

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

11 (a) Two light signals, green light and violet light, are sent from a transmitter to a receiver by two different methods in Fig. 11.1.

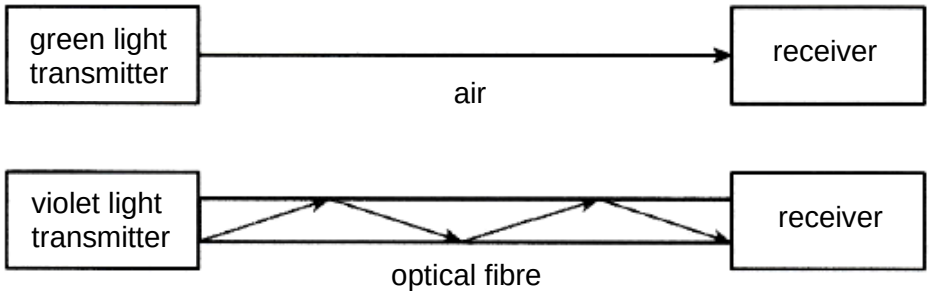

Fig. 11.1

The structural composition of the optical fibre through which the violet light travels is as shown in Fig. 11.2.

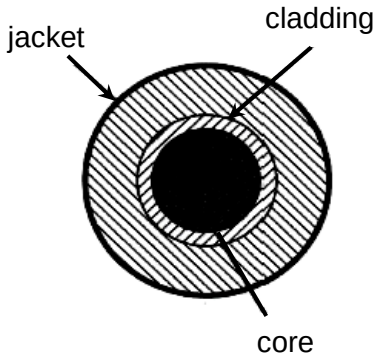

Fig. 11.2

(i) State what is meant by refractive index.

……

…… [1]

(ii) Name the phenomenon which prevents the violet signal from escaping from the optical fibre.

…… [1]

(iii) State and explain whether the core or cladding has a lower refractive index.

……

…… [1]

(iv) Compared to the green light, the violet light takes a longer time to arrive at the receiver.

Suggest two reasons for this.

……

……

……

…… [2]

(b) Fig. 11.3 shows the graph of the angle of refraction *r* against the angle of incidence *i*, when a light ray travels from the material indicated in the graph into air.

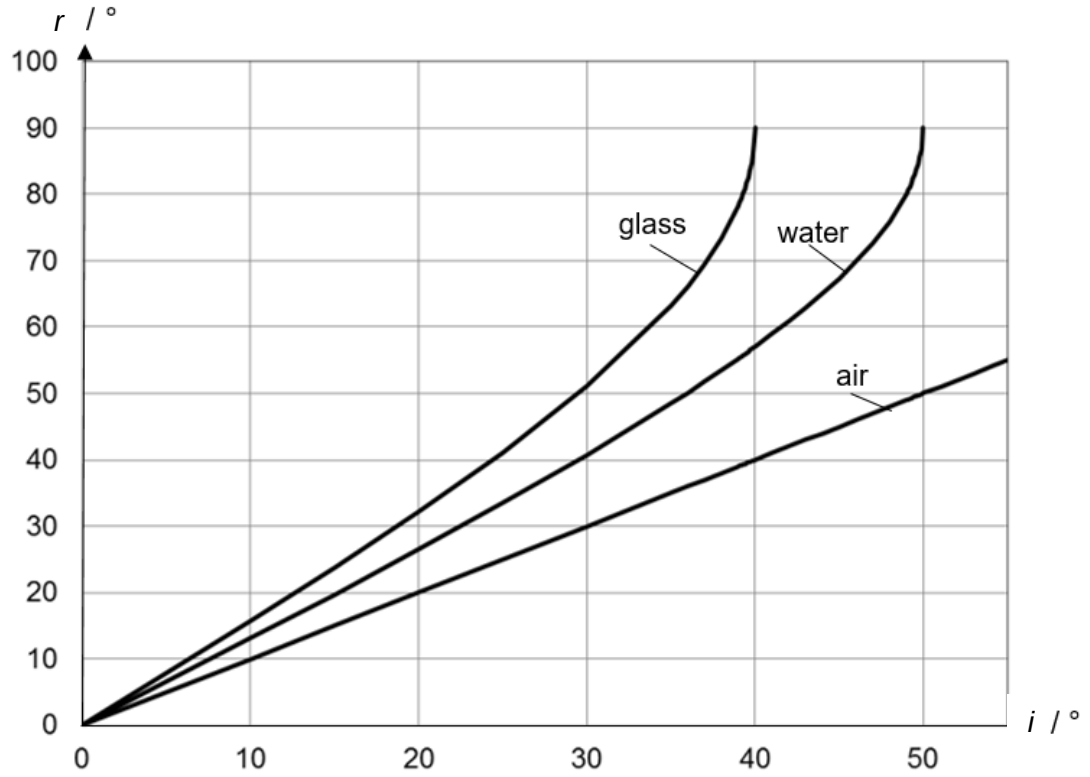

Fig. 11.3

(i) Using the data from Fig. 11.3, explain what happens to the light ray if the angle of incidence exceeds 40° in glass.

……

……

……

…… [2]

(ii) Determine the refractive index of water.

refractive index = …….. [2]

(iii) State and explain how the graph for glass in Fig. 11.3 would change if the light ray that travels through the glass now emerges into water instead of air.

……

…… [1]

12 Ultrasound is used in quality control to detect cracks in a piece of metal.

Pulses of ultrasound are sent into the piece of metal from a transmitter. A detector is placed next to the transmitter on the front surface of the metal as shown in Fig. 12.1.

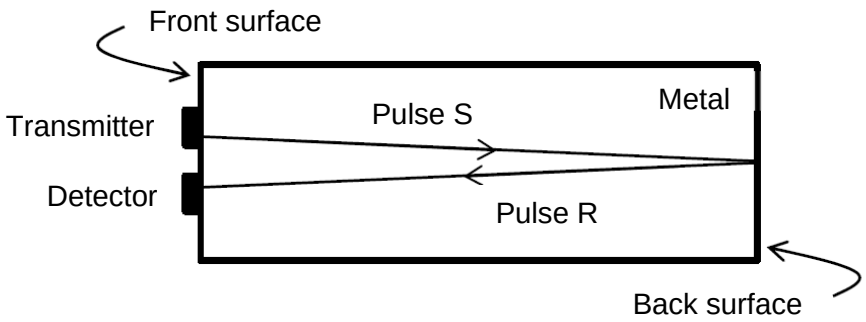

Fig. 12.1

Fig. 12.2. shows the cathode-ray oscilloscope (c.r.o.) trace of the ultrasound pulses produced if the metal contains no cracks.

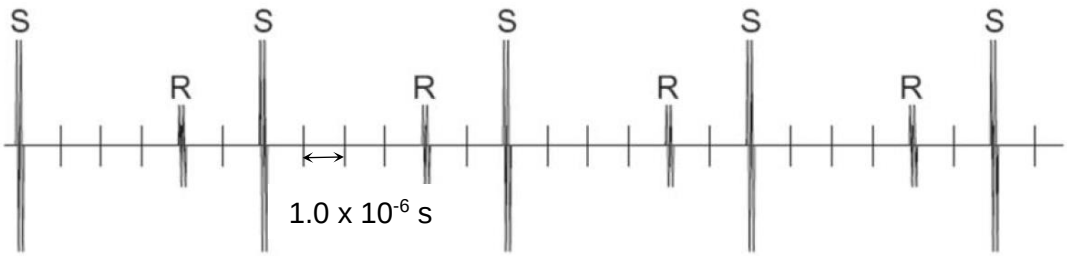

Fig. 12.2

The time-base of the c.r.o. is set at 1.0×10^{-6} s/division.

Pulses labelled S are pulses initially sent out by the transmitter. Each pulse labelled R is the reflection from the back surface of the metal of the previous pulse S.

(a) State what is meant by ultrasound.

……...……...

……...…….. [1]

(b) Determine the period of pulses sent out by the transmitter using Fig. 12.2.

period = ……. [1]

(c) Suggest two reasons why the amplitude of R is less than the amplitude of S.

……..

……..

……

…….. [2]

(d) Sometime later, the piece of metal is tested again. It now has a small crack halfway between the front surface and the back surface as shown in Fig. 12.3.

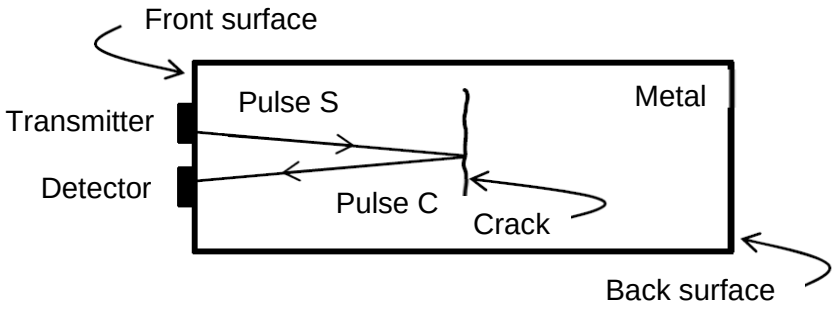

Fig. 12.3

On **Fig. 12.2**, draw the position and size of the pulses produced by this crack.
Label each of these pulses **C**. [2]

(e) A second beam of ultrasound has a frequency of 8.0×10^6 Hz and a speed of 4000 m/s in the metal.

Calculate the wavelength of this ultrasound in the metal.

wavelength = ……. [2]

(f) State one property that ultrasound and microwave have in common.

…….. [1]

(g) Name one medical application of ultrasound.

…….. [1]

13 EITHER

A positively charged metal sphere X is moved towards a neutral metal sphere Y as shown in Fig. 13.1. Metal sphere Y is attached to a solenoid P which is grounded through wire R. Solenoid Q is connected to a galvanometer and is positioned near solenoid P.

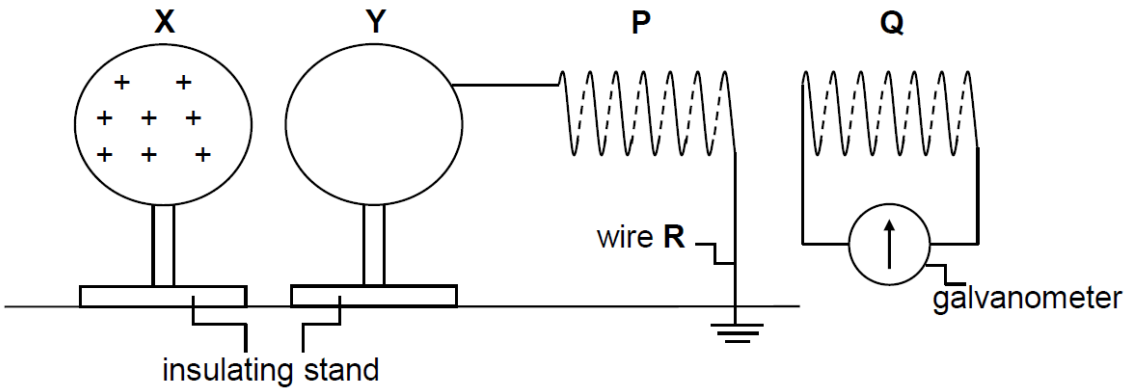

Fig. 13.1

(a) X is moved but not touching Y.

Describe and explain the subsequent movement of charges in solenoid P and sphere Y.

……

……

……

…… [2]

(b) Indicate with an arrow on wire R, the direction of the current flow during the movement of charges. [1]

(c) It is observed that during the movement of charges, the galvanometer deflects to the right, then to the left before going back to zero.

Explain

(i) why the galvanometer deflects.

……

……

……

…… [2]

(ii) why the galvanometer finally goes back to zero.

……

…… [1]

(iii) why solenoid Q experiences a force when the galvanometer deflects.

……

…… [1]

(d) Explain, in terms of magnetic properties, why solenoids are made of copper instead of steel.

……..

…….. [1]

(e) State and explain how the experiment can be modified to create a larger deflection in the galvanometer.

……...

……...

……... [2]

13 OR

Fig. 13.1 shows a part of the main electrical circuit in a house.

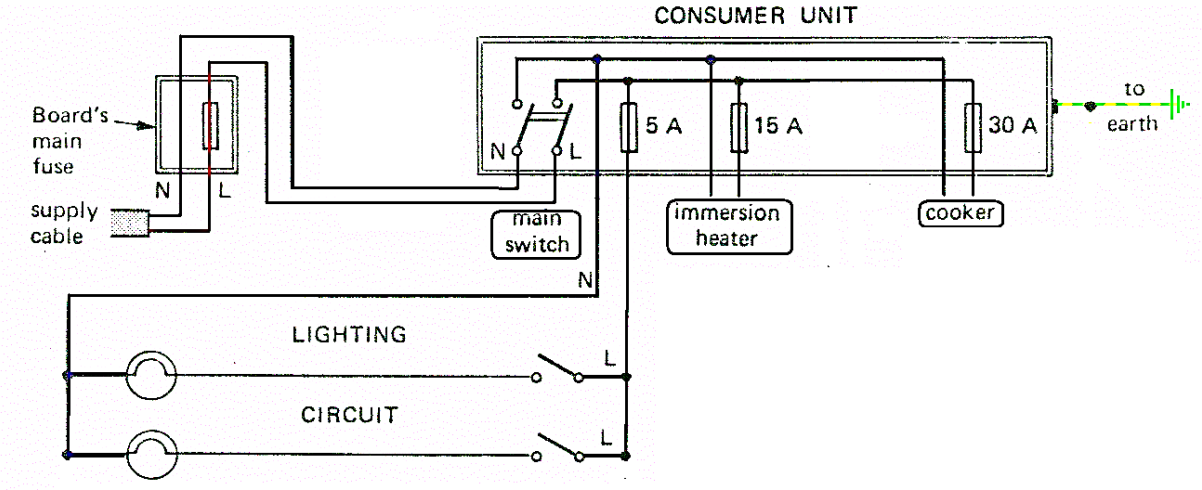

Fig. 13.1

(a) State the function of the neutral wire in a circuit.

……

……

…… [1]

(b) Explain why the lamps are connected in this arrangement.

……

……

…… [1]

(c) The consumer unit is earthed.

Describe and explain how this makes the consumer unit safe.

……

……

……

……

…… [2]

(d) Calculate the maximum current that can flow in the live wire of the board's main fuse.

Suggest a suitable fuse rating.

current = ……

suitable fuse rating = ……. [2]

(e) With all the appliances being switched on, the live wire touches the neutral wire at the main switch.

(i) Describe and explain the effect on the lamps, immersion heater, cooker and fuses when this fault happens.

…….

…….

…….

……. [3]

(ii) Suggest another device that can replace the board's main fuse in the circuit. State the advantage of using the device instead of the fuse.

…….

……. [1]

END OF PAPER