SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR

CANDIDATE NAME	

CLASS	4					REGISTER NUMBER					
CENTRE NUMBER						INDEX NUMBER					

PHYSICS **6091/2 (Revised)**

Monday **26 August 2024** **1 hour 45 mins**

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

READ THESE INSTRUCTIONS FIRST

Section A

Answer **all** questions.

Section B

Answer **one question only.** Question 11 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.

Take g = 10 ms^{-2} or 10 Nkg^{-1} unless stated otherwise.

For Examiner's Use	
Section A	**70**
Section B	**10**
Total	**80**

This question paper consists of 21 printed pages and a blank page.

SECTION A

Answer all the questions in this section.

1 A car of mass *m* is travelling along a straight, horizontal road at a constant speed *v*. At time *t* = 0, the driver of the car sees an obstruction in the road ahead of the car and applies the brakes. The car does **not** begin to decelerate at *t* = 0.

(a) Explain why the car does **not** begin to decelerate at *t* = 0.

....

....

.... [1]

Fig. 1.1 is the distance–time graph for the car from *t* = 0.

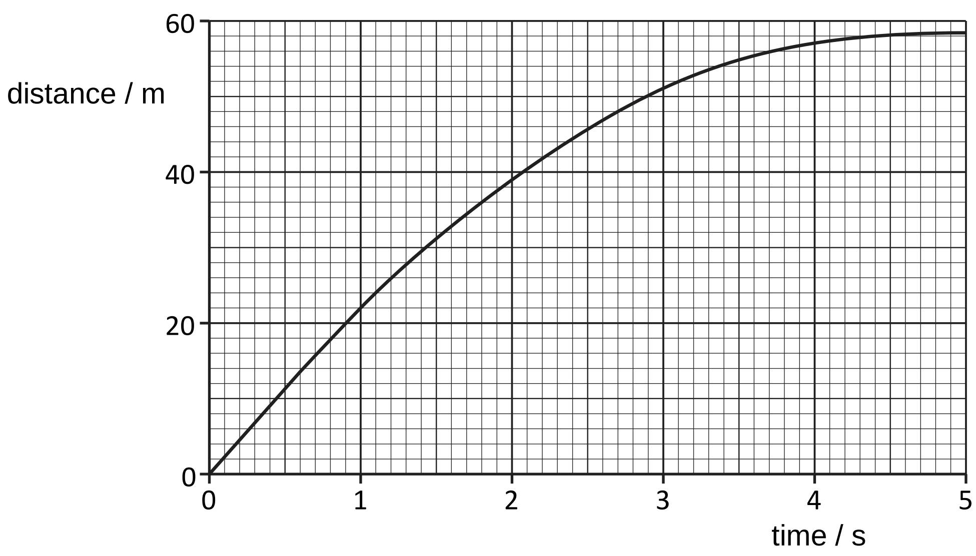

Fig. 1.1

(b) Describe the motion of the car throughout the 5 s of travel.

....

....

.... [3]

(c) Determine the initial speed *v* of the car.

v = ... [2]

(d) When the car is decelerating, there is a constant resistive force F on the car due to the brakes. The deceleration of the car is greater than $\frac{F}{m}$ and is **not** constant.

Explain why

(i) the deceleration of the car is greater than $\frac{F}{m}$,

....

....

.... [1]

(ii) the deceleration is **not** constant.

....

....

.... [1]

[Total : 8 m]

2 Fig. 2.1 shows a sign that extends over a road.

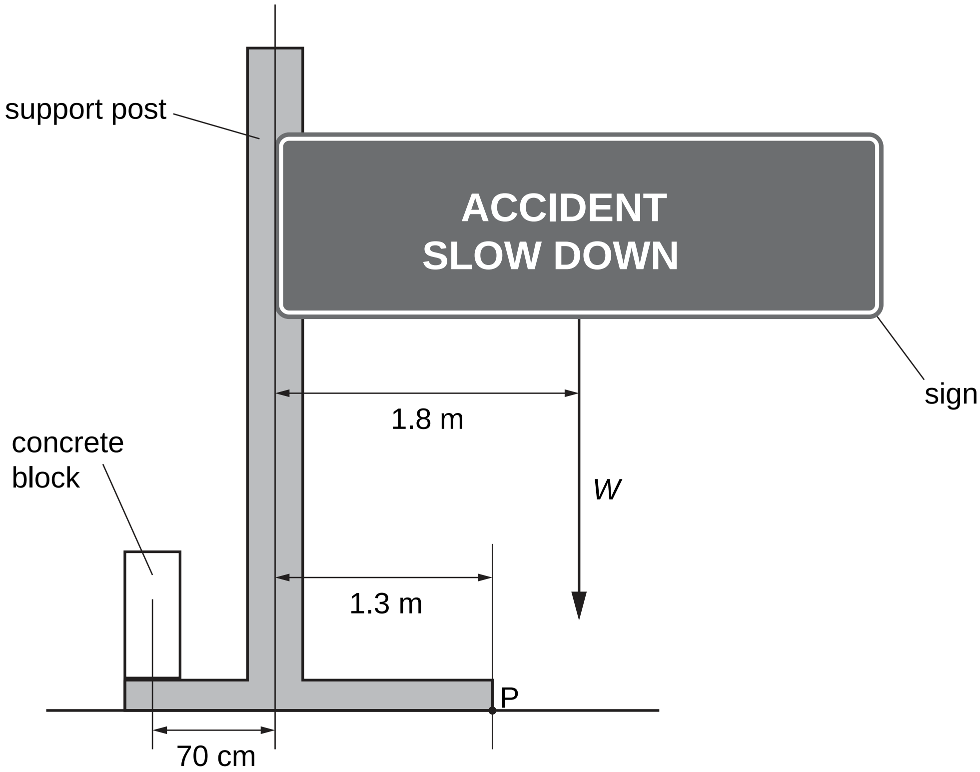

Fig. 2.1

The mass of the sign is 3.4×10^3 kg.

(a) The weight of the sign acts at a horizontal distance of 1.8 m from the centre of the support post. Point P is a horizontal distance of 1.3 m from the centre of the support post.

(i) Calculate the moment about P due to the weight of the sign.

moment = ………………. [2]

(ii) A rectangular concrete block is positioned on the other side of the support post with its centre of gravity a horizontal distance of 70 cm from the centre of the support post.

Given the sign is horizontal, calculate the weight of the concrete block.

weight = ……………. [2]

(b) The concrete block is removed.

Describe and explain what happens to the sign in terms of moments.

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

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

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

(c) A student suggests that the concrete block be placed with its largest face horizontally to increase the stability of the road sign.

Explain if this suggestion is correct.

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

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

[Total : 7 m]

3 A bungee jumper falls from a bridge above a river, as shown in Fig. 3.1.

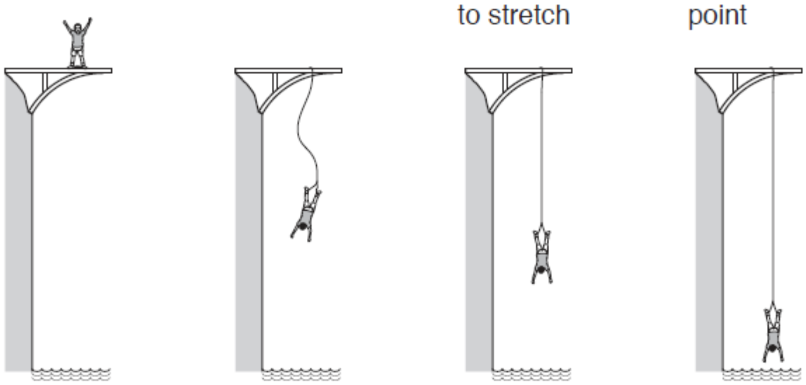

Fig. 3.1 (not to scale)

The man starts from position A in Fig. 3.1. 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.

(a) Explain, in terms of the forces acting, why the man is undergoing increasing deceleration between C and D.

....

....

....

.... [2]

(b) Fig. 3.2 shows the values for the gravitational potential energy of the man, the kinetic energy of the man and the elastic potential energy in the cord at A, C and D. You may ignore the effect of air resistance in this question.

	gravitational potential energy / J	kinetic energy / J	elastic potential energy / J
position A	20 000	0	0
position C	15 000		0
position D	0	0	

Fig. 3.2

Complete Fig. 3.2 to show the kinetic energy of the man at C and the elastic potential energy in the cord at D. [2]

(c) The man has a mass of 50 kg.

Using values from Fig. 3.2, calculate the vertical distance between A and C.

vertical distance = ……………. [2]

[Total : 6 m]

4 A cube of side 0.040 m is floating in a container of liquid. Fig. 4.1 shows that the surface of the liquid is 0.028 m above the level of the bottom face of the cube.

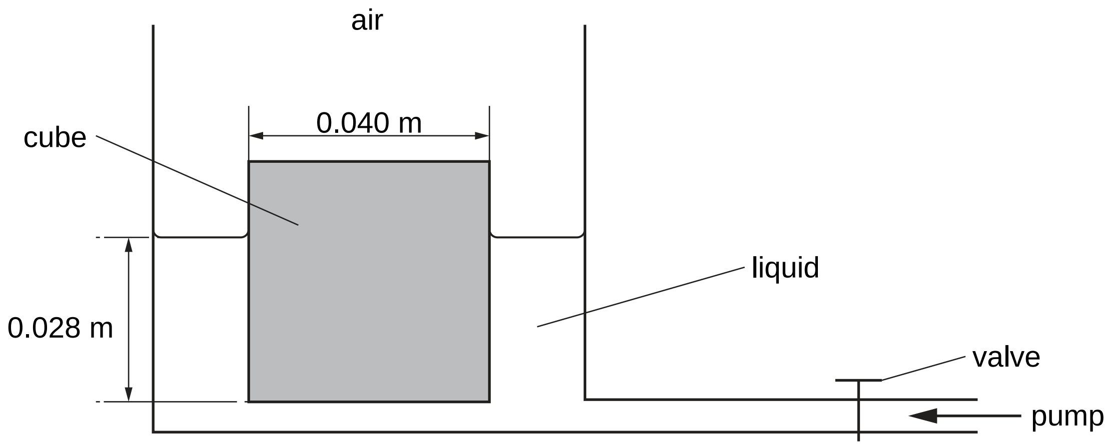

Fig. 4.1

The pressure of the air above the cube exerts a force on the top face of the cube. The valve is closed.

(a) Given that the density of the liquid in the container is 1500 kg/m^3 and the atmospheric pressure is 1.02 x 10^5 N/m^2. Calculate

(i) the pressure at a depth of 0.028 m, and

pressure = ……………………. [2]

(ii) the force on the bottom face of the cube.

force = ………………. [2]

(b) The valve is opened and liquid is pumped into the container. The surface of the liquid rises a small distance but the cube remains with its bottom face 0.028 m below the surface of the liquid.

(i) Explain why the cube is able to remain at the same height in the liquid.

……………………………………………………………………………………………

……………………………………………………………………………………………..

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

(ii) Suggest one reason why this is not an efficient method of lifting up the cube.

……………………………………………………………………………………………..…..

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

[Total : 7 m]

5 **(a)** Explain what is meant by *critical angle*.

....

....

.... [2]

(b) **(i)** Diamonds are attractive because of their ability to reflect light. The critical angle for diamond in air is 24^{o}. Calculate the refractive index of diamond.

Refractive index = ……………… [2]

(ii) Fig. 5.1 shows two diamonds of different shapes. A ray of light enters each diamond, as shown.

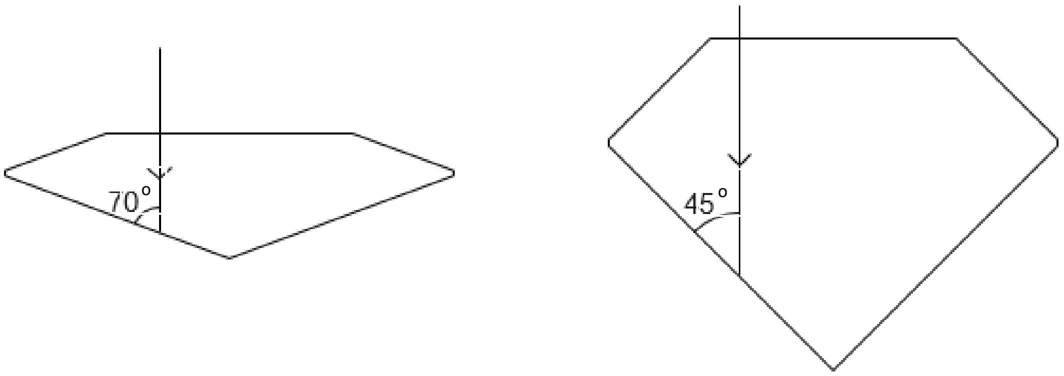

Fig. 5.1

Continue the path of each ray of light until it emerges into the air. Indicate all necessary angles in your drawing. You do not need to show any calculation. [3]

[Total : 7 m]

6 Fig. 6.1 shows a road next to the sea

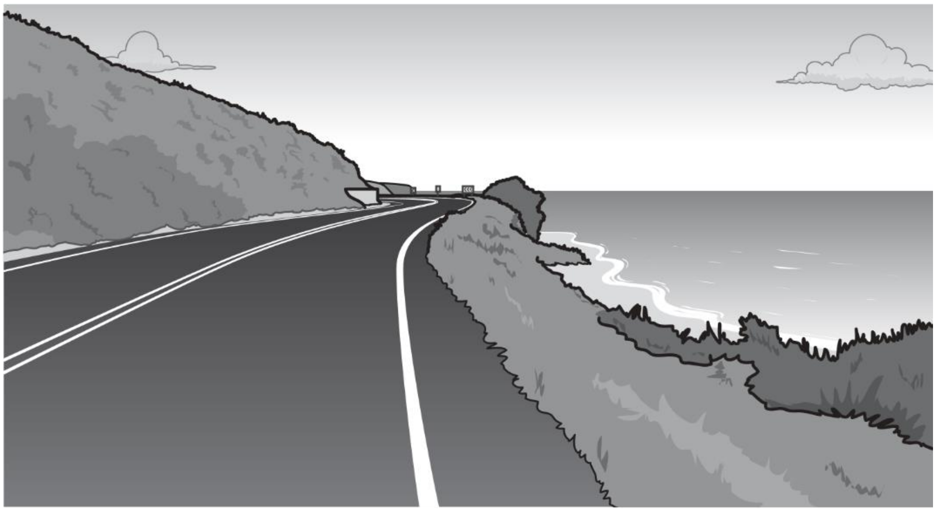

Fig. 6.1

(a) On a sunny day, the Sun warms the road.

Describe how energy from the Sun reaches the Earth and warms the road.

....

....

....

....

.... [3]

(b) The air above the road is heated by the warm road. Describe how this affects the molecules of the air.

....

....

.... [2]

[Total : 5 m]

7 Fig. 7.1 shows a kitchen tap that supplies instant boiling water.

Fig. 7.1

Cold water passes over an electric immersion heater inside the tap. The boiling point of water is 100 °C.

(a) State what is meant by *boiling point*.

.... [1]

(b) **(i)** The immersion heater is powered by the mains at a voltage of 230 V. When the tap is opened, the heater switches on and the current in the heater is 13 A.

Calculate the thermal energy produced by the heater in 60 s.

thermal energy = ... [2]

(ii) The specific heat capacity of water is 4200 J / (kg °C). The cold water that enters the tap is at 22 °C. Calculate the rate at which water at its boiling point emerges from the tap.

rate = ... [2]

(c) The metal tap is earthed and there is a fuse in the cable that connects the heater to the mains.

(i) Explain how the earth wire protects the user.

....

.... [1]

(ii) Explain how the fuse protects the circuit.

....

.... [1]

[Total : 7 m]

8 Fig. 8.1 shows a circuit diagram that includes component X.

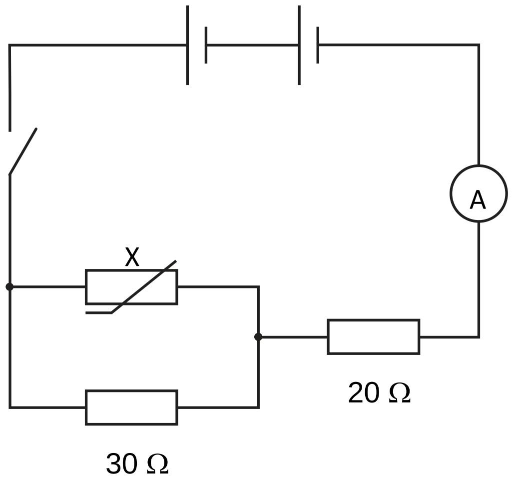

Fig. 8.1

(a) State the name of component X.

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

(b) The e.m.f. of the battery is 6.0 V and the resistance of component X is 15 Ω..

Calculate

(i) the total resistance of the circuit,

total reistance = ……………….. [2]

(ii) the ammeter reading.

reading = ……………… [2]

(c) The temperature of component X increases.

State and explain what happens to the ammeter reading.

………………………………………………………………………………………………..

………………………………………………………………………………………………..

………………………………………………………………………………………………..

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

[Total : 7 m]

9 Fig. 9.1 shows a radiation detector placed on a laboratory bench.

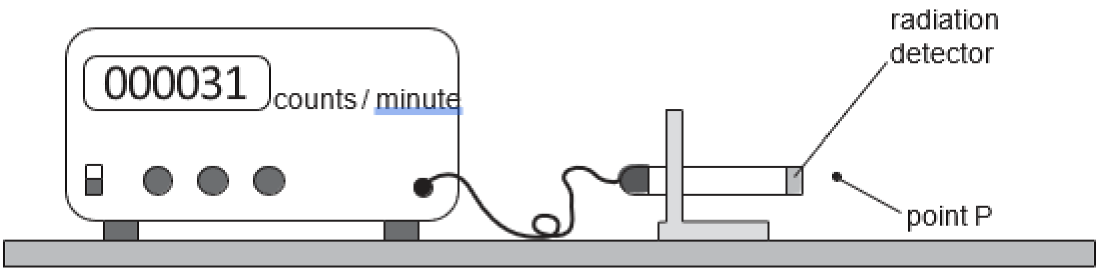

Fig. 9.1

The detector is switched on and six readings of the count rate for background radiation are recorded. Fig. 9.2 shows the readings obtained.

Reading number	1	2	3	4	5	6
Count rate / Counts /minute	31	36	29	32	35	33

Fig. 9.2

(a) **(i)** State what is meant by *background radiation.*

....

.... [1]

(ii) Explain why the six readings are different from each other.

....

.... [1]

(iii) Using all the readings obtained, determine the average value for the background count rate.

background count rate = ... [1]

(b) Fig. 9.1 shows a point P which is a very short distance from the end of the radiation detector. A sample of the radioactive isotope cobalt-60 is placed at P. The average value of the count rate is now 975 counts per minute.

The average count rate is determined with different objects placed between the radiation detector and the sample. Fig. 9.3 shows the results obtained.

Object	Average count rate / counts/minute
No object	975
Four sheets of paper	976
Aluminium sheet of 0.50 mm thickness	117
Lead sheet of 2.0 cm thick	52

Fig. 9.3

(i) Deduce the radiation emitted by cobalt-60. [1]

…………………………………………………………………………………………

(ii) Explain how you arrived at your answer to **(i)** above.

…………………………………………………………………………………………

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

…………………………………………………………………………………………..

(iii) This radiation is produced when a nucleus of cobalt-60 ($^{60}_{27}Co$) decays into a nuclide X. The nuclide X is not radioactive.

Write a nuclear equation to show the decay of $^{60}_{27}Co$. [1]

…………………………………………………………………………………………

(c) The *half-life* of cobalt-60 is 5.3 years.

(i) State what is meant by the term in italics.

…………………………………………………………………………………………

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

(ii) When there is a lead sheet between the detector and the sample, the average count rate is obtained from six readings taken at one-minute intervals. The six readings are given in the table in Fig. 9.4.

Reading number	1	2	3	4	5	6
Count rate / Counts /minute	61	46	43	56	49	57

Fig. 9.4

There are reasons for suggesting that the variation in these readings is random and not because the number of cobalt-60 atoms in the sample is decreasing.

State two of these reasons.

1. ……………………………………………………………………………………………..

……………………………………………………………………………………………...

2. ……………………………………………………………………………………………...

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

[Total : 10 m]

10 A student turns the handle of an alternating current (a.c.) generator and the coil rotates. Fig. 10.1 shows the structure of the a.c. generator.

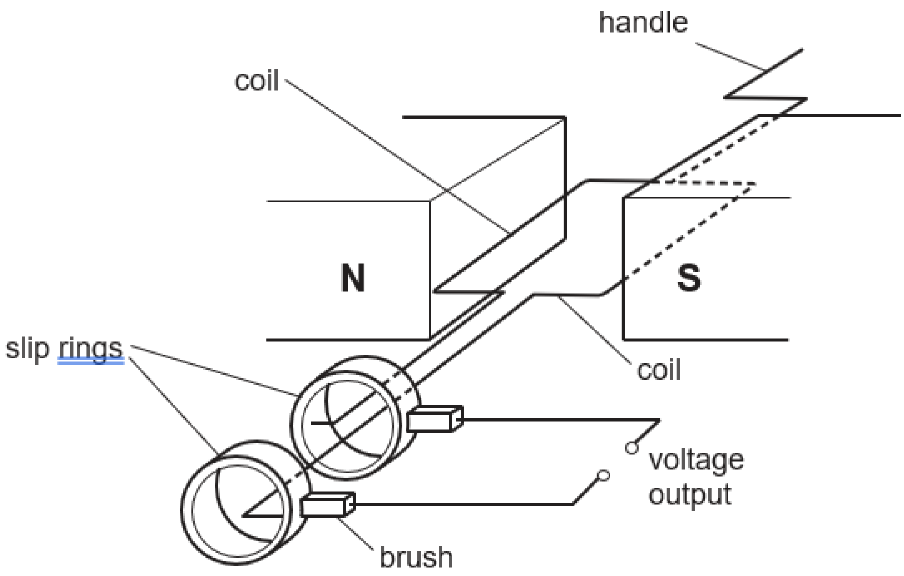

Fig. 10.1

(a) There is an alternating voltage output between the two terminals.

Explain why rotating the coil produces an output voltage.

……………………………………………………………………………………………………...

……………………………………………………………………………………………………...

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

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

(b) State the position of the rotating coil when the alternating output is at a maximum value. Explain why the maximum output occurs at this position.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) A lamp and an open switch are connected in series to the output terminals of the a.c. generator. The switch is closed and the lamp lights up. The student has to apply a greater force on the handle.

Explain why a greater force is needed to keep the lamp lit.

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

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

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

[Total : 6 m]

SECTION B

Answer any one of the two alternative questions in Question 11.

EITHER

11 Fig. 11.1 shows the cut-out section of the handle and cradle of an electric toothbrush. The figure on the right of the cut-out section shows the actual handle and cradle.

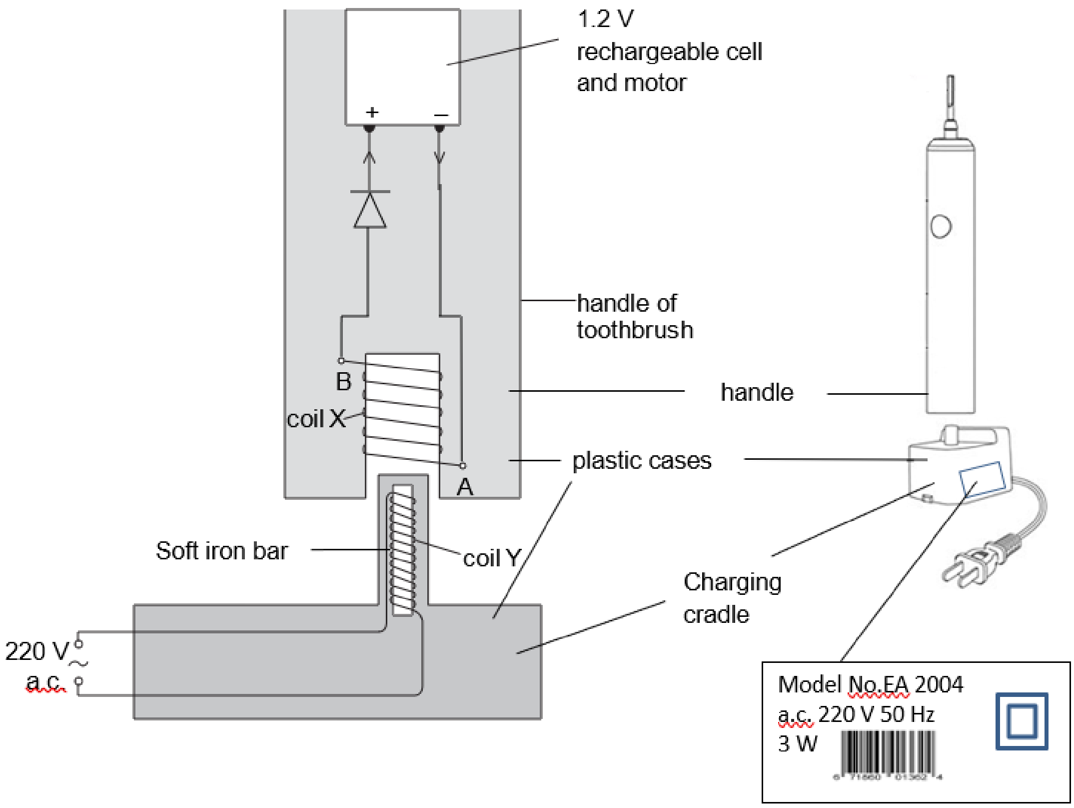

Fig. 11.1

The handle consists of a 1.2 V rechargeable cell and a motor. The cell is connected to coil X located at the bottom of the unit. The cradle consists of a short projection which houses a coil Y wound round a soft-iron bar. The cradle is connected to a 220 V a.c. mains supply. When the handle is inserted into this short projection, the battery is recharged.

The handle and the charging cradle are completely covered by plastic cases and there is no metal contact between them. A label is also pasted at the side of the charging cradle.

(a) Explain how an electromotive force (e.m.f.) is produced in the brush unit to recharge the cell.

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

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

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

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

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

(b) A student said that this method of charging is not ideal as it is not efficient.

Do you agree ? Explain.

……..

……..

…….. [2]

(c) Explain how this set-up demonstrates the working of a simple transformer.

……..

…… [1]

(d) Determine the turns ratio of this simple transformer. Express your answer in decimals.

turns ratio = ……………….. [2]

(e) The charging unit is fitted with a two-pin plug.

Suggest one reason why it is safe for the charging unit to be fitted with a two-pin plug.

……..

…….. [1]

(f) When the toothbrush is in operation, the current flowing through the motor is 1.8 A. Calculate the power consumed by the motor.

power = ……………… [2]

[Total : 10 m]

OR

11 **(a)** Fig. 11.2 shows part of a loudspeaker. A coil is attached to a paper cone and is suspended freely within a cylindrical magnet.

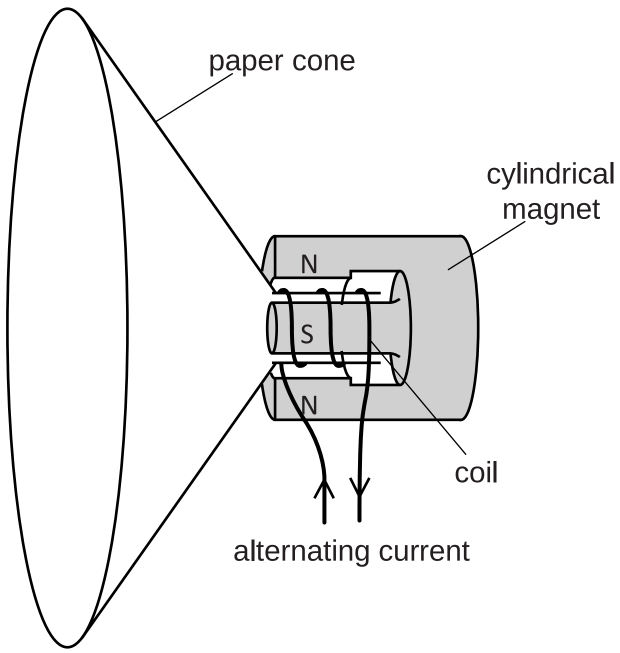

Fig. 11.2

(i) Explain why an alternating current in the coil causes the cone to move.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………

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

(ii) The loudspeaker produces sound of frequency 500 Hz. The speed of sound is 320 m / s. Calculate the wavelength of the sound produced.

wavelength = ………………… [2]

(b) Loudspeakers are placed in swimming pools to ensure swimmers can hear sounds both in air and in water.

Fig. 11.3 shows four loudspeakers in a swimming pool.

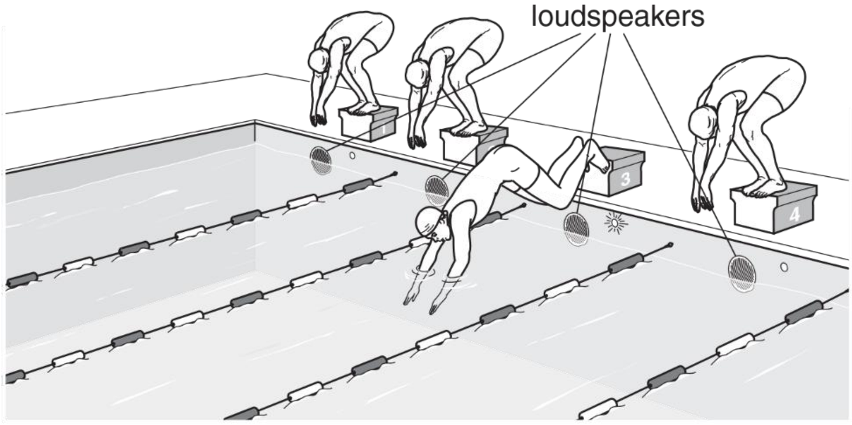

Fig. 11.3

The loudspeakers all produce the same sound of frequency 500 Hz.

(i) Describe, using ideas of molecules, how sound is transmitted through air and water.

....

....

....

.... [2]

(ii) Although a swimmer underneath the water and a swimmer on the platform heard the same sound, there are some differences. List two differences between the sound heard by the two swimmers.

1 ....

....

2 ....

.... [2]

(c) A swimmer reaches the end wall of a swimming pool and turns around under the water.

Fig. 11.4 shows the swimmer immediately after turning around.

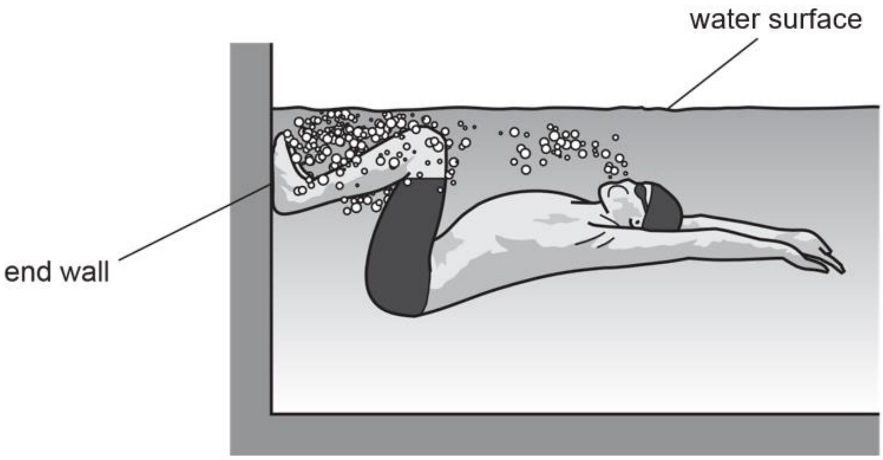

Fig. 11.4

The swimmer pushes against the end wall of the pool with his legs and accelerates away.

Explain, in terms of forces, why the swimmer accelerates away from the end wall.

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

……………………………………………………………………………………………………..

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

[Total: 10 m]

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