Candidate Name	Form Class	Index Number

ANG MO KIO SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS

PHYSICS **6091(Revised)/02**
Paper 2 Theory **23 August 2024**
1 hour 45 minutes

Setter: Mdm Jessica Lew

Candidates answer on the Question Paper.

No Additional Materials are required.

SECTION A

READ THESE INSTRUCTIONS FIRST
Write your Name, Class and Index Number in the spaces at the top of this paper.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer only one question.

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	
Section B	
TOTAL	

This document consists of **19** printed pages and **1** blank page

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Answer **all** the questions.

1. Fig 1.1 shows the vertical forces acting on a helium-filled weather balloon just before lift-off.

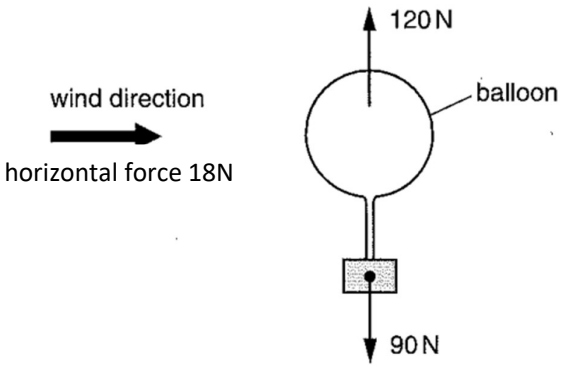


Fig 1.1

The balloon experiences an upward vertical force equal to 120 N. The weight of the balloon and its contents is 90 N. The amount of horizontal force provided by the wind is 18 N.

(a) By means of a scaled diagram, determine the resultant force acting on the balloon and the angle this resultant makes with the horizontal.

Scale…….

Resultant Force……..

Direction……[5]

(b) The same setup is brought to the moon.

State and explain the change (if any) to the resultant force calculated in (a).

……

…… [2]

(c) The balloon experiences resistive forces as it falls through air on earth. Suggest a factor to increase this resistive force.

……

……..[1]

2. Fig 2.1 shows a human arm lifting an object.

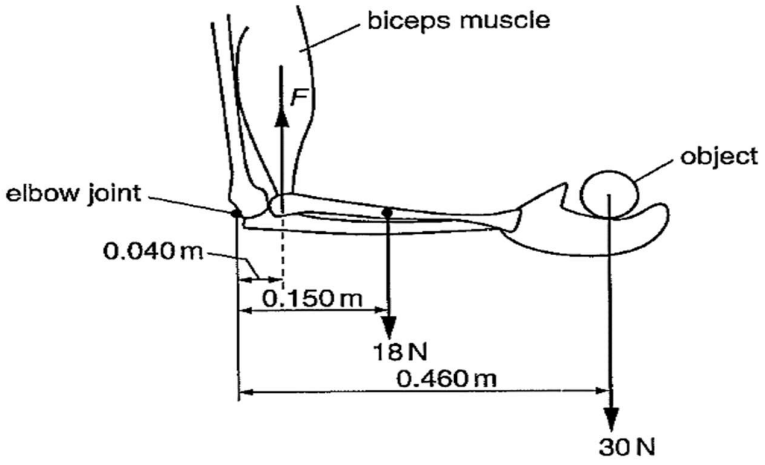


Fig 2.1

(a) The lower arm is horizontal and its centre of gravity is 0.150 m from the elbow joint. The weight of the lower arm is 18 N. The biceps muscle exerts a vertical force F on the arm. The lower arm bone is 0.040 m. The weight of the object held in the hand is 30 N and its centre of gravity is 0.460 m from the elbow joint. The arm is in equilibrium.

(i) Calculate the total clockwise moments.

clockwise moments……..[1]

(ii) Hence, calculate force F.

Force F……[1]

(b) As the lower arm is moved away from the body, the force F exerted by the biceps muscles acts at an angle θ to the vertical as shown in Fig 2.2. The lower arm remains horizontal and remains in equilibrium.
State and explain what happens to the following quantities as angle θ is increased.
No calculations are required.

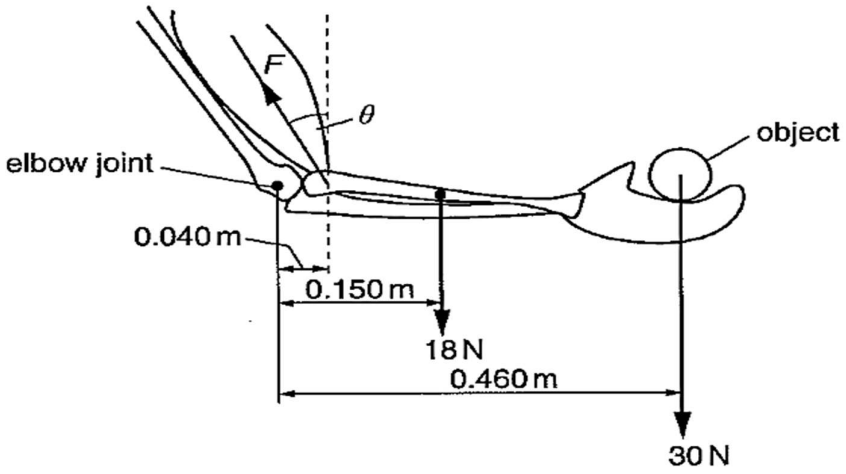


Fig 2.2

(i) The total anticlockwise moments;

……
……
……[2]

(ii) force F.

……
……
……[2]

3. A car races from the starting line to the finishing line.

Fig 3.1 shows the graph of velocity v against time t for the car.

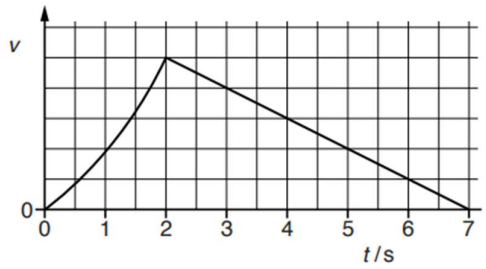


Fig 3.1

(a) Describe the motion of the car from

(i) t = 0 s to t = 2 s

……[1]

(ii) t = 2 s to t =7 s

……[1]

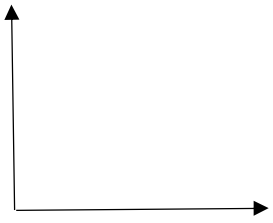
(b) Explain how Fig 3.1 shows that the distance travelled by the object from t = 0 s to t = 2 s is shorter than the distance travelled from t = 2 s to t = 7 s.

……

……[1]

(c) The ventricle is one of the two chambers in the heart that collects and expels blood. The left ventricle of the heart expels blood around the body accelerates blood from rest to a velocity of 0.26 m/s. The distance travelled by the blood during this period of constant acceleration is 0.02 m/s^2.

(i) Sketch a speed-time graph (indicate all relevant values clearly) to depict the motion,



[1]

(ii) With the aid of the sketch in (i), calculate the time taken for the motion.

time taken……[1]

(iii) Hence, calculate the acceleration of the blood.

acceleration……[1]

4. Fig 4.1 shows a roller coaster which has a mass of 250 kg. The roller coaster starts with a speed of 2.0 m/s at A which has a height of 45 m above the ground. It passes through a dip and finishes at B with a height of 30 m above the ground. The gravitational field strength is taken to be g = 10 N/kg.

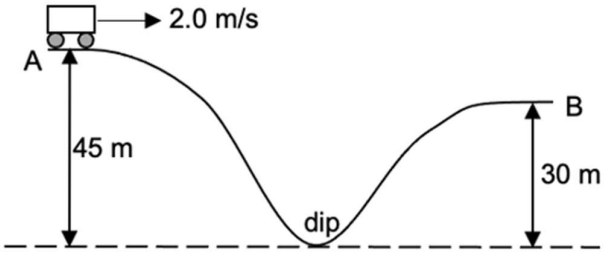


Fig 4.1

(a) What is the total work done by the gravitational force of the roller coaster to move from A to B?

work done……..[1]

(b) The speed of the roller coaster at the end of the ride B is 13 m/s. Determine the work done by friction.

work done by friction……..[2]

(c) Suggest with a reason, one effect on the ride if the depth of the dip is increased.

……

……

……[2]

(d) State the law of conservation of energy.

……

……

……[1]

5. A longitudinal wave is travelling in a medium from left to right. Fig 5.1 shows the variation of the displacement y of the particles with distance x in the medium. The solid line and the dotted line show the displacement at t= 0 and t =0.882 ms respectively. The displacement at t= 0.882 ms is positive.

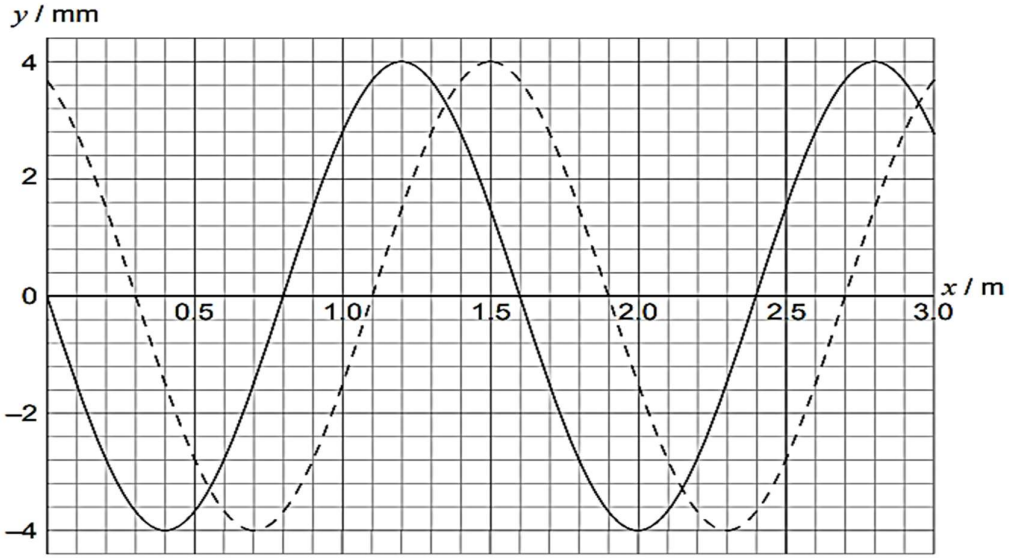


Fig 5.1

(a) Explain what a longitudinal wave is. Give an example of a longitudinal wave.

……

……[2]

(b) Using data from Fig 5.1,

(i) State the horizontal displacement of the wave at t=0 s and t =0.882 ms.

……[1]

(ii) Using your answer from b(i), calculate the speed of the wave.

speed……[2]

6. Fig 6.1 shows a force applied at a corner of the structure to topple it.

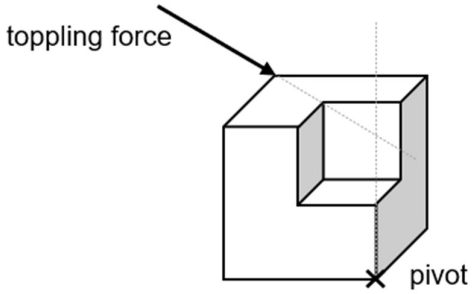


Fig 6.1

Describe how the stability of the structure shown is different from the stability of the cube when it was whole (no cut out).

Explain your answer.

Change in stability……

Explanation……...

[2]

7. Fig 7.1 shows two liquids A and B of densities 1.0 g/cm^3 and 0.80 g/cm^3 are poured into an U-tube. The experiment is conducted on earth.

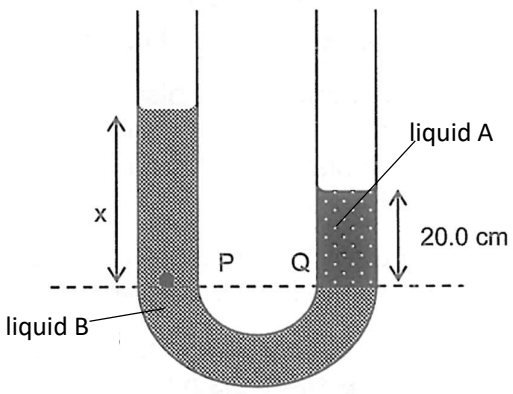


Fig 7.1

(a) Calculate the height x of the liquid B above point P.

x=……[2]

(b) Explain if your answer to (a) would be different if the experiment is conducted on the moon instead.

……

……[1]

8. Fig 8.1(not drawn to scale) shows a ray of light travelling from air into a glass prism. The glass prism has a refractive index of 1.50. The pathway of the light is incomplete.

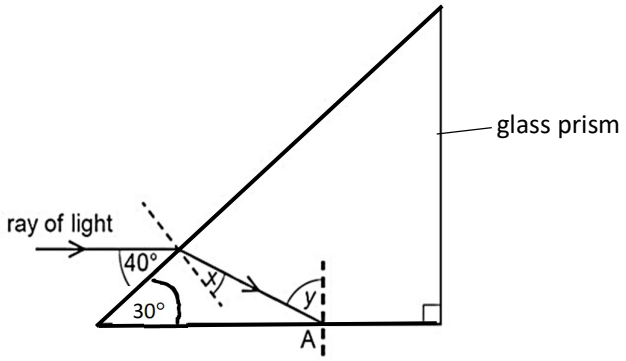


Fig 8.1

(a) Calculate

(i) angle x,

angle x……[1]

(ii) angle y,

angle y=……[1]

(iii) critical angle of glass.

critical angle=……[1]

(b) State if the light ray at A will go through refraction or total internal reflection.

……

…… [1]

9. Fig 9.1 shows a circuit which has a emf value of E. The current passing through the 18 Ω resistor is I.

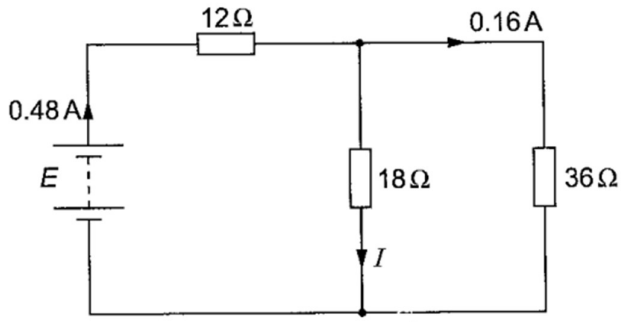


Fig 9.1

(a) Determine the value of I.

I=……..[1]

(b) Hence, calculate the value of E.

E=……[2]

(c) Distinguish between electromotive force and potential difference.

……

……

…….[1]

10. Fig 10.1 shows a neutral conducting ball placed at the centre between two oppositely charged plates. The ball is given a slight push towards the positively charged plate.

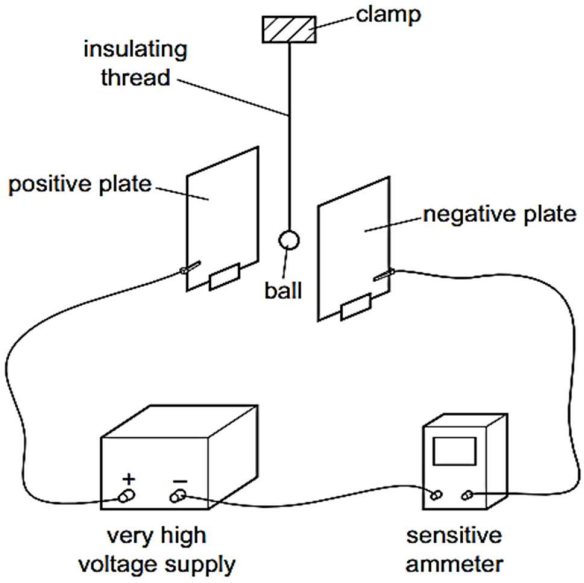


Fig 10.1

(a) State and explain the subsequent motion of the conducting ball.

……

……

……..[2]

(b) The conducting ball is replaced with a neutral plastic ball. Compare the difference (if any), the subsequent motion of the plastic ball if it is also given a slight push towards the positively charged plate. Explain your answer.

……

……

……..[2]

(c) For each complete oscillation of the ball moving between the plates, a charge of 8.5×10^{-10} C is transferred from one plate to the other. The frequency of oscillation is 4.0 Hz. Calculate the current shown on the sensitive ammeter on Fig 10.1.

current……..[2]

11. Fig 11.1 shows a machine that dispenses boiling water. The machine has a power rating of 400 W and is connected to a 230 V supply.

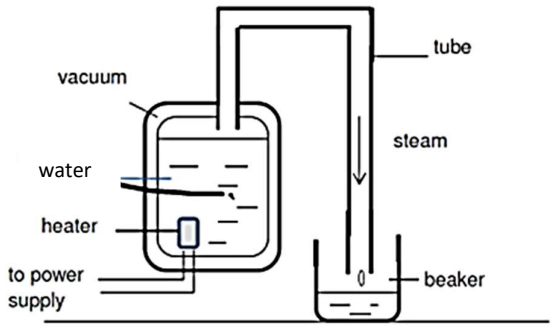


Fig 11.1

(a) Explain why the heater is placed at the bottom of the flask.

……

……

……..[2]

(b) State the purpose of the vacuum in the flask.

……

……[1]

(c) The machine initially contains 400 g of water at 25°C. The water is heated to 100 °C. The heater switches off when a certain amount of water is collected in the beaker at the end of 20 minutes.

The specific heat capacity of water is 4.2 J/(gK) and the specific latent heat of vaporisation of water is 2250 J/g.

(i) Calculate the amount of thermal energy to heat up 400 g of water from 25 °C to 100 °C.

thermal energy=……[2]

(ii) Calculate the mass of water collected in the beaker.

mass of water=……[2]

(iii) Suggest a reason why the machine should not have a dark coloured outer covering.

……

……..……[1]

(d) When the steam passes through the tube, it condenses.

Using the ideas of molecules, describe what happens to the steam as it condenses.

……

……

……

……[2]

12. Americium is a synthetic chemical element which is radioactive.

(a) An Americium (Am) nucleus decays by the emission of an α- particle into a Neptunium (Np) nucleus.

Complete the nuclear equation for this decay.

$^{241}_{95}Am \rightarrow$

[2]

(b) Americium is used in smoke detectors.

Explain why beta β or gamma(γ)) emitters are not used in smoke detectors.

……

……..……[1]

(c) The half-life of this Americium nuclide is 470 years. A sample of this nuclide contains 8.0×10^{14} atoms. After some time, 6×10^{14} americium atoms have decayed.

Calculate the time taken for this decay.

time taken……..[3]

(d) At a nuclear power station, a radiation detector is connected to a data logger. Fig 12.1 shows the readings taken.

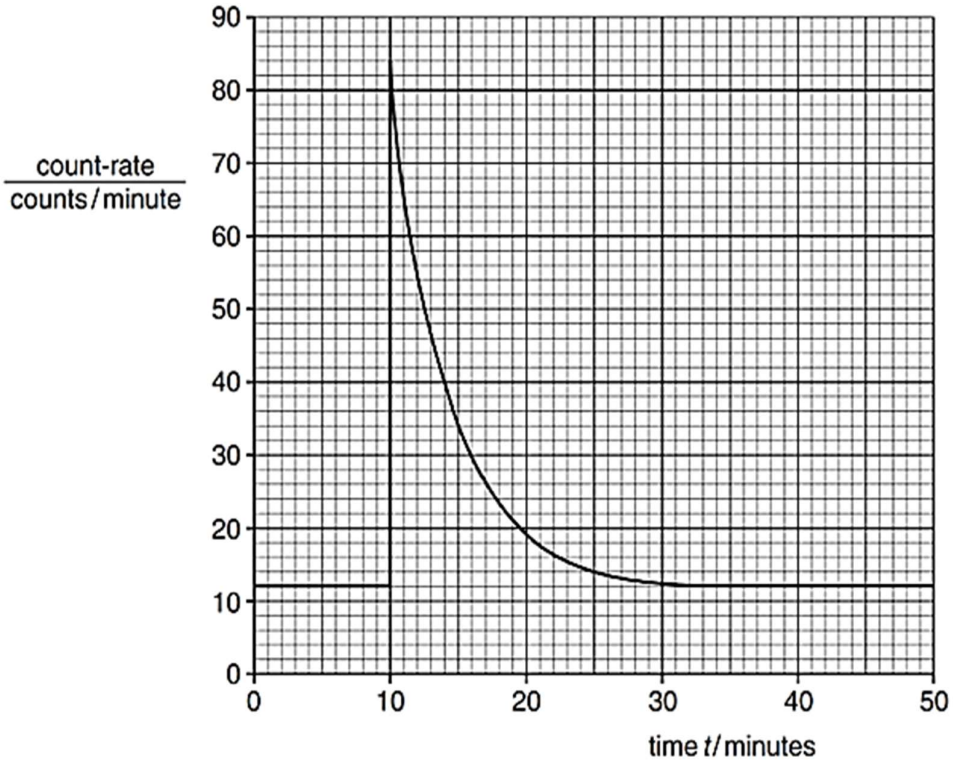


Fig 12.1

(i) Determine the background count rate from Fig 12.1.

background count rate……..[1]

(ii) Give a reason why the count rate remains constant after 30 minutes.

……

……..[1]

(iii) Determine the half-life of the sample shown in Fig 12.1

Half-life……..[2]

Section B

Answer only one question in this section.

13. Fig 13.1 shows a rotating permanent magnet in an alternating current generator("dynamo"). The dynamo is used to power a lamp.

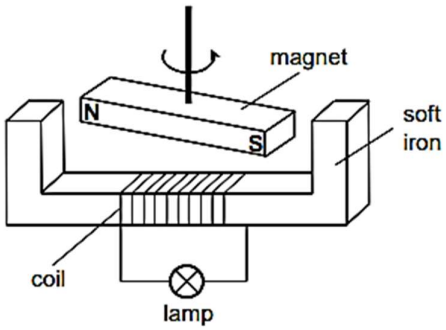


Fig 13.1

(a) The dynamo is used to power a lamp.

(i) Explain how current is induced in the coil of the dynamo and why it is alternating.

……

……

……

……..[3]

(ii) A student wishes to increase the brightness of the lamp. Suggest 2 ways that the induced current can be increased.

……

……...……...[2]

(b) The primary input voltage for a transformer is 23000 V and the secondary output voltage is stepped up to 660000 V before it is transmitted over a long distance.

(i) Explain why the voltage needs to be stepped up for transmission.

……

……..[1]

(ii) The current in the primary coil is 100 A. Find the power generated in the primary coil.

power generated=……..[1]

(iii) Assuming that the transformer is ideal, find the current in the secondary coil.

current in coil=……..[1]

(iv) The transmission cable has a resistance of 2000 Ω.
Find the power loss in the transmission cable.

power loss……..[1]

(v) A transformer will not be able to step up or step down direct current sources.
Explain why this is so.

……

……[1]

14. Fig 14.1 shows a simple d. c motor connected to a power supply. The coil is connected to P and Q of the split ring commutator.

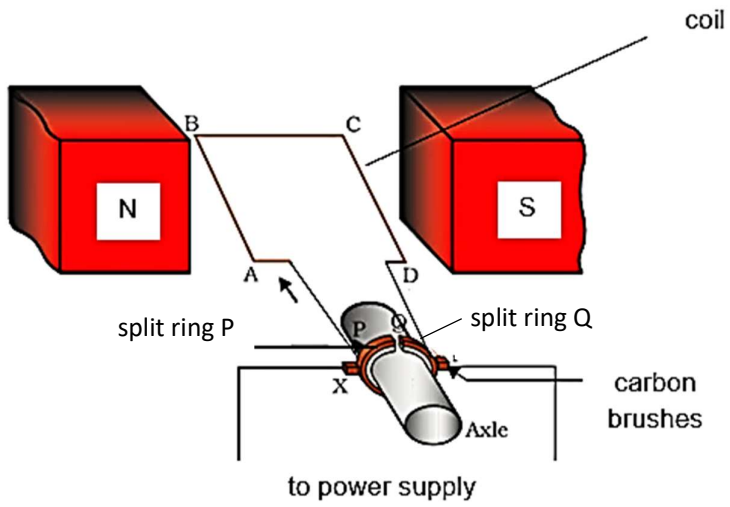


Fig 14.1

(a) Explain why sometimes the motor needs a little push to get it in operation (You may assume that the motor is frictionless).

……

……[1]

(b) Explain why the coil can continue turning in the same direction after it has turned 180 °.

……

……[2]

(c) Indicate on Fig 14.1, the direction of the force induced along CD. [1]

(d) Fig 14.2 shows the power supply circuit connected to an a.c supply. A diode (indicated in Fig14.2) is placed in the circuit. The diode converts the amount of current flowing in the opposite direction to zero.

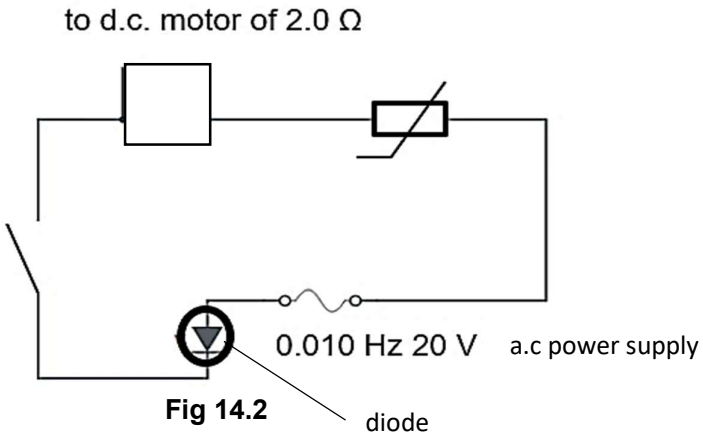


Fig 14.2

The d.c motor has resistance of 2.0 Ω. After switching on the circuit, the following measurements were recorded in Table 14.3.

Table 14.3

Temperature of thermistor /°C	Resistance of thermistor / Ω
0	3.90
5	3.15
10	2.60
15	2.15
20	1.75
25	1.50
30	1.25
35	1.00

(i) The circuit is closed with a.c supply maintained at 0.010 Hz, 20 V. At this moment, the temperature is kept constant.

Describe and explain the motion of the motor with reference to time .

……

……

……..[2]

(ii) State and explain the effects of the motor as the temperature increases.

……

……

…… [2]

(iii) During the operation of the motor, the current passing through the thermistor is 5.7 A, using suitable calculations and information from Table 14.3, estimate the temperature of the thermistor.

Temperature=……..[2]

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END OF PAPER

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