ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2018
(YEAR 4)

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS **6091/02**

Paper 2 **20 August 2018**

1 hour 45 minutes
(08:00 – 09:45)

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper and all the work you hand in. Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions on the Question Booklet

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 formulae and all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Section A									
Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**

Section B			
Q11	**Q12**	**Q13E**	**Q13O**

For Examiner's Use	
Section A	**/ 50**
Section B	**/ 30**
Total	**/ 80**

This document consists of **23** printed pages including this cover page

[Turn Over

Section A

Answer **all** the questions in this section

1 Car A moves from X to Y in a straight road at a constant acceleration of 2.0 m/s^2 from rest. At the same starting time as car A, car B starts to move from Y to X at a speed of 2.0 m/s. Car B maintains the same speed throughout the whole journey.

(a) Describe how the speed of car A changes with time as it moves from X to Y.

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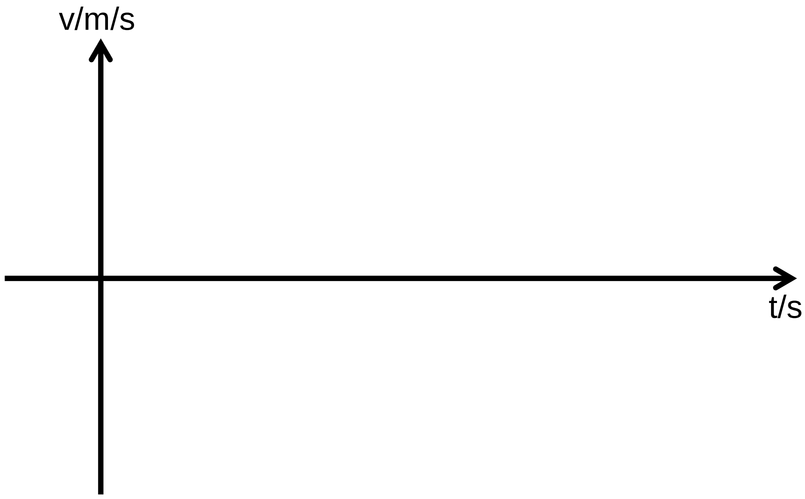
...……………………………………………………………………………………….[1]

(b) Sketch the velocity-time graph of car A and car B. Taking direction from X to Y as the positive direction.



[2]

(c) The distance between X and Y is 1000 m. Both cars meet at time, t.

(i) Express the distance travelled by car A when both cars meet, in terms of t.

distance = ... [1]

(ii) Hence, determine the time, t when both cars meet.

time = ... [1]

2 In a pool game, ball A moves horizontally and simultaneously collides with ball B and ball C as shown in Fig 2.1. Upon collision, ball A exerts a 0.50 N force on ball C at an angle of 30° to the horizontal as shown in Fig 2.2. The resultant force acting on ball A is 0.80 N at an angle of 25° to the horizontal as shown in Fig 2.3.

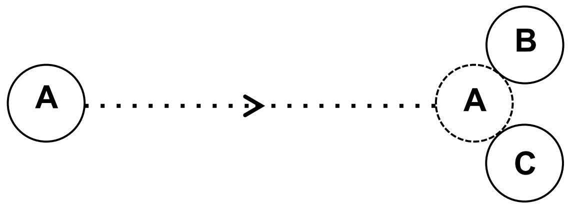


Fig 2.1

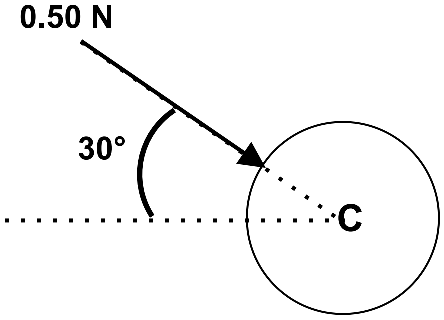


Fig 2.2

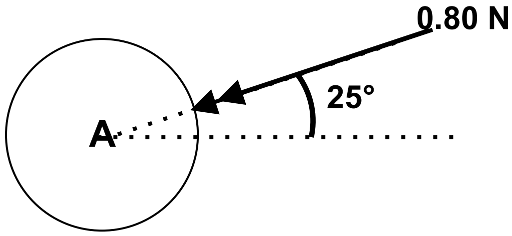


Fig 2.3

(a) Draw free body diagrams to show the action and reaction pair of the 0.50 N force. [1]

(b) In the space below, draw a labelled diagram to show the resultant force acting on ball A due to the forces that ball B and ball C exert on ball A during the collision. Determine the magnitude of the force that ball B exerts on ball A.

force = ... [3]

(c) If the mass of all the balls are 100 g, calculate the acceleration of ball C immediately after the collision. Assume that there is negligible frictional force.

acceleration = ... [1]

(d) It is observed that ball A continues to move forward after the collision. Explain why ball A continues to move forward even though the resultant force is opposite to its direction of motion.

....

....[1]

3 Fig. 3.1 shows a uniform rod XY of length 3.0 m suspended by two identical strings, P and Q. The weight of the rod is 10 N.

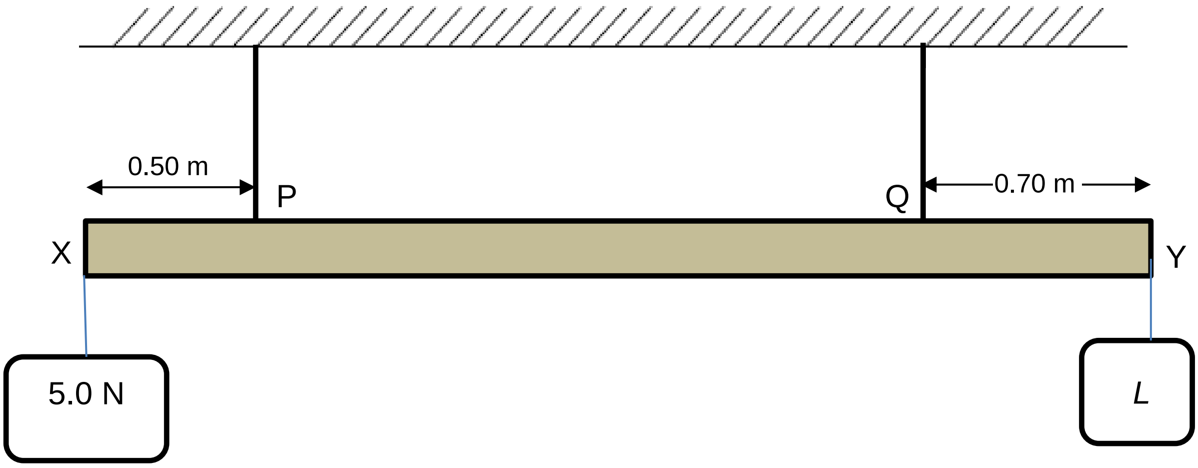


Fig. 3.1

A 5.0 N load and load *L* are hung from the rod at point X and point Y respectively.

(a) Taking moment about P,

(i) calculate the moment due to the weight of the uniform rod.

moment = ... [1]

(ii) calculate the tension of the string, Q when the weight of load L is 15 N.

tension = ………………………………. [2]

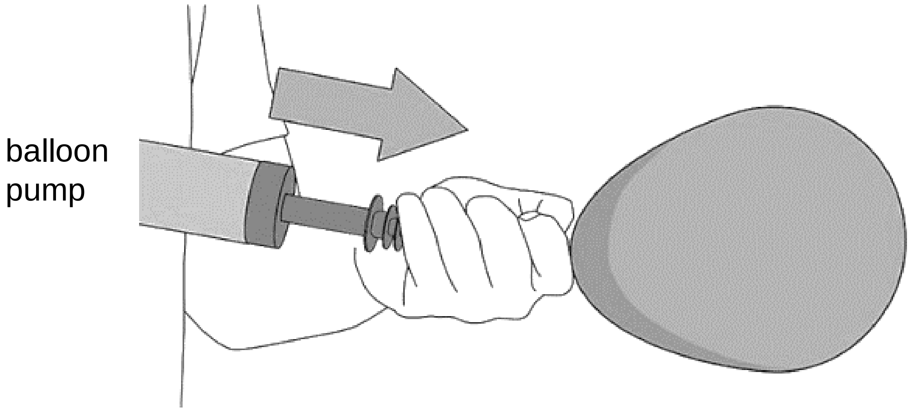
(b) When the weight of load L is increased, using ideas about moment, explain why string Q will break.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………[2]

4 The figure below shows a student pumping air slowly into a balloon. Assume that temperature remains constant throughout the whole process.



https://www.wikihow.com/Blow-Up-a-Balloon

Explain, using ideas about molecules, why the balloon expands as more air is pumped into it.

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

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

5 John visited a water theme park and tried a water slide ABC as shown in Fig 5.1. John's mass was 70 kg and the height of the water slide was 5.0 m. John slid along a horizontal surface AB, and continued down the slide at point B with a speed of 2.0 m/s.

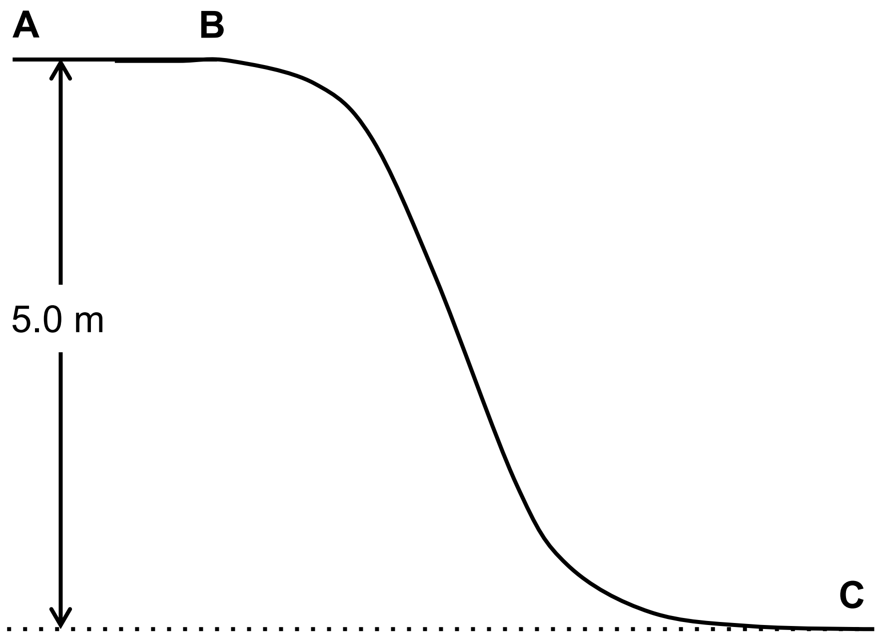


Fig 5.1

(a) Explain how the principle of conservation of energy is applied as John slid down from B to C.

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

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

(b) Calculate the change in John's gravitational potential energy, GPE as he slid from A to C.

change in GPE = ... [1]

(c) The final speed of John at point C was 8.0 m/s.
Calculate the work done by John against friction as he slid down the water slide from B to C.

work done = ... [2]

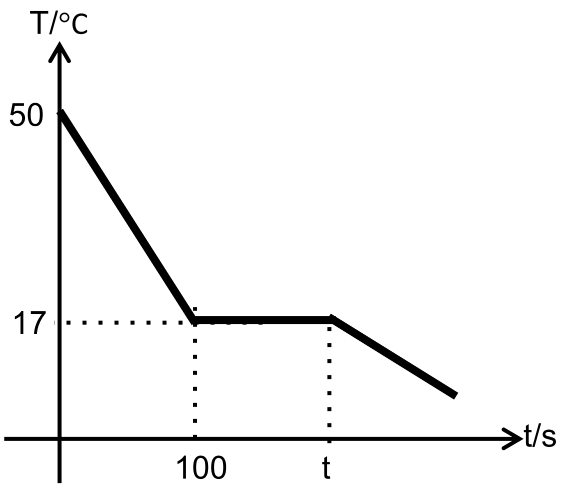
(d) On another try, John slid from point B at the same speed of 2.0 m/s. However this time he noticed that there was less water on the slide along BC.
Explain why John's final speed at point C will be smaller than 8.0 m/s.

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

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

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

6 A test-tube containing 100 g of glycerol at 50 °C is placed in a large container containing ice. The graph below shows how the temperature of the glycerol changes with time.



The specific heat capacity of glycerol = 2.4 J/(gK) and the specific latent heat of fusion of glycerol = 420 J/g.

(a) Calculate the amount of thermal energy released by the glycerol as its temperature dropped from 50 °C to 17 °C.

energy = ... [1]

(b) If the rate of heat transfer remains the same throughout the whole cooling process, calculate the time, t for the temperature of the glycerol to drop again.

time = ... [2]

(c) Explain why in real-life, the rate of heat transfer will not be constant throughout the whole cooling process.

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

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

7 Fig 7.1 shows three light rays as they enter a Pyrex glass block.

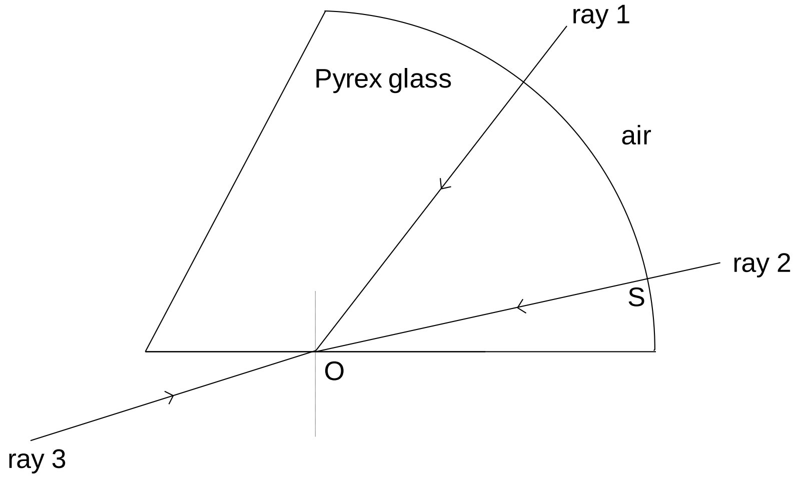


Fig 7.1 (drawn to scale)

The refractive index of Pyrex glass is 1.47.

(a) Explain why ray 2 does not bend as it enters the Pyrex glass block at S.

……………………………………………………………………………………………….

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

(b) Calculate the critical angle of the Pyrex glass.

critical angle = ……………….. [1]

(c) State and explain which ray(s) do not undergo total internal reflection at point O.

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

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

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

8 Fig. 8.1 shows the graph of a wave motion produced by a sound that is captured by a microphone.

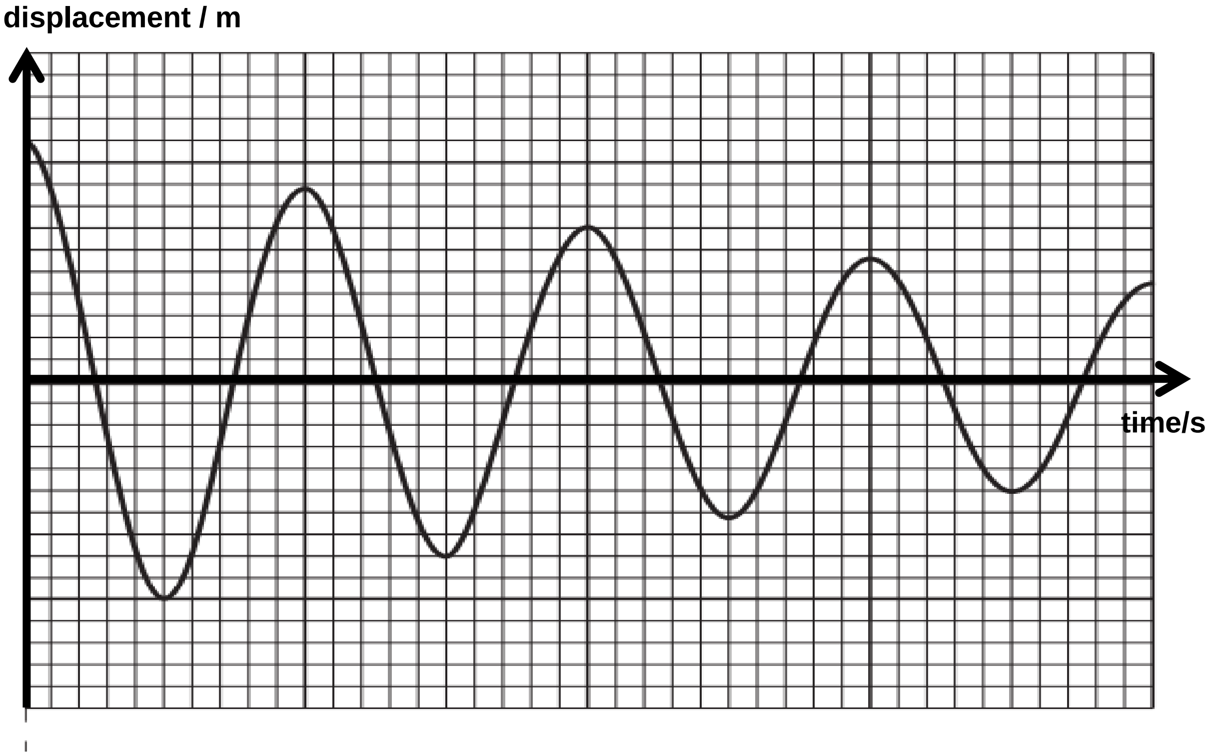


Fig 8.1

(a) State and explain how the waveform indicates how the loudness and pitch of the sound changes (if any) with time.

(i) loudness

…………………………………………………………………………………………

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

(ii) pitch

…………………………………………………………………………………………

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

(b) Another sound wave is captured by the microphone. Fig 8.2 shows how the output voltage of the microphone varies with time.

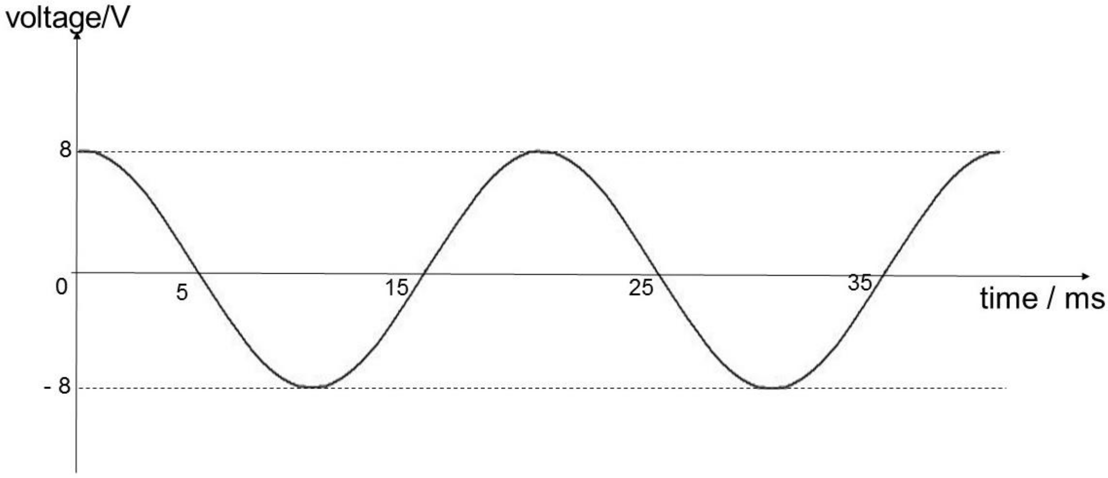


Fig 8.2

The microphone is connected to a cathode-ray oscilloscope (c.r.o.). The Y-gain of the oscilloscope is set at 4 V/division and the time base is set at 4 ms/division.

On Fig 8.3, draw the waveform(s) of the sound as seen on the screen of the oscilloscope.

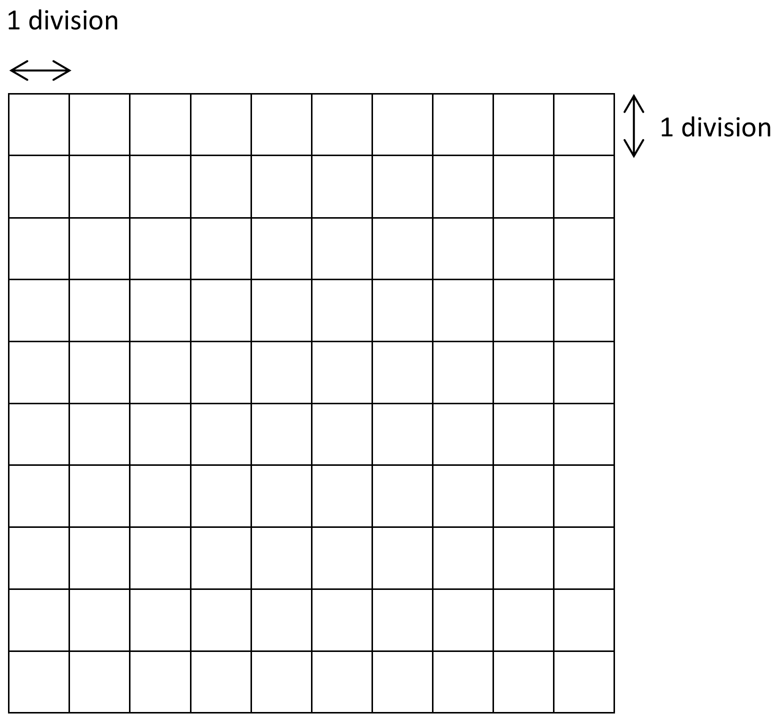


Fig 8.3

[2]

9 An electrostatic air filter is used to remove dust particles from the air. A fan causes dusty air to flow through several metal rods and plates as shown in Fig 9.1.

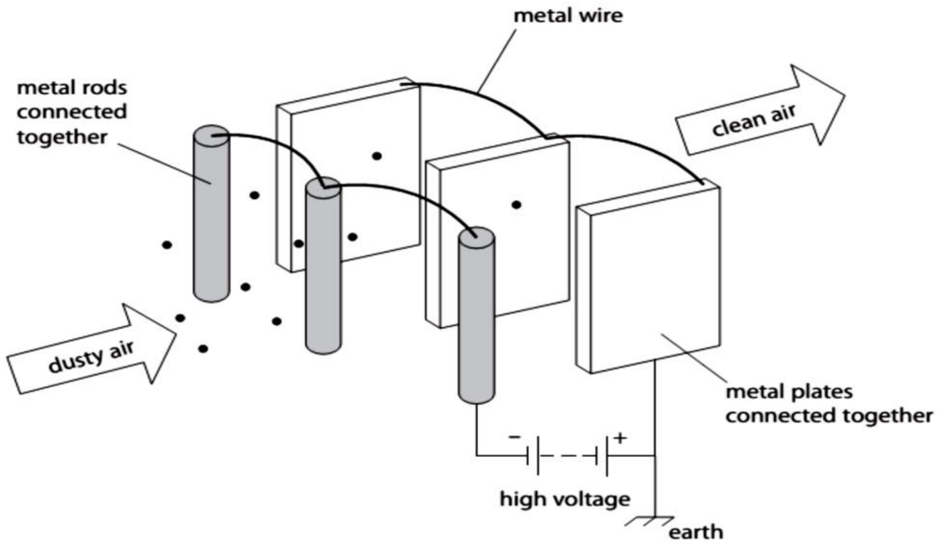


Fig 9.1

(a) When the dusty air flows past the metal rods, the dust particles become negatively charged. Explain how this happens.

………………………………………………………………………………………...

………………………………………………………………………………………...

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

(b) Explain how the air filter is able to remove the dust particles from the air.

………………………………………………………………………………………...

……………………………………………………………………………………….[1]

(c) Fig 9.2 shows an enlarged negatively charged dust particle next to one of the metal plates in the air filter.

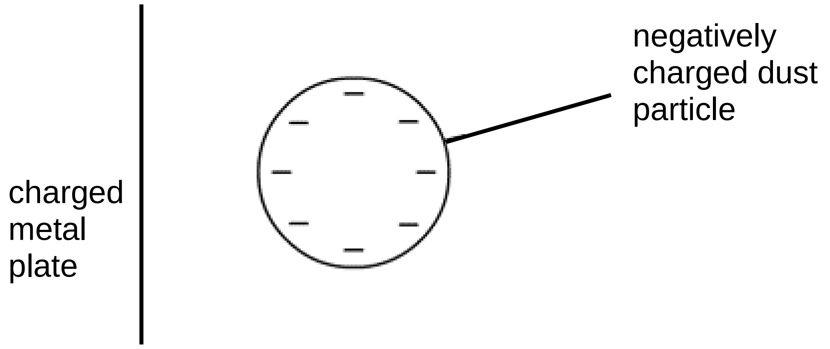


Fig 9.2

On Fig 9.2, draw the electric field pattern between the dust particle and the charged metal plate. [1]

10 **(a)** Fig 10.1 shows a type of electromagnetic lock, which can be operated from a remote switch. When the switch is closed, the door can be opened.

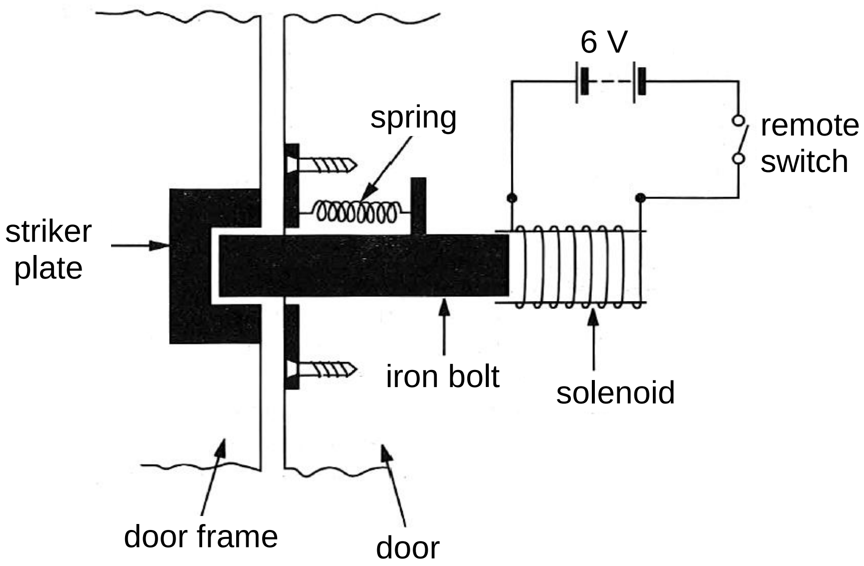


Fig 10.1

(i) Explain why the door can be opened when the switch is closed.

....

....

....[2]

(ii) State the purpose of the spring.

....

....[1]

(iii) Explain why the lock will not work if the e.m.f. of the battery is reduced.

....

....[1]

(b) Fig. 10.2 shows a diagram of a simple d.c. motor.

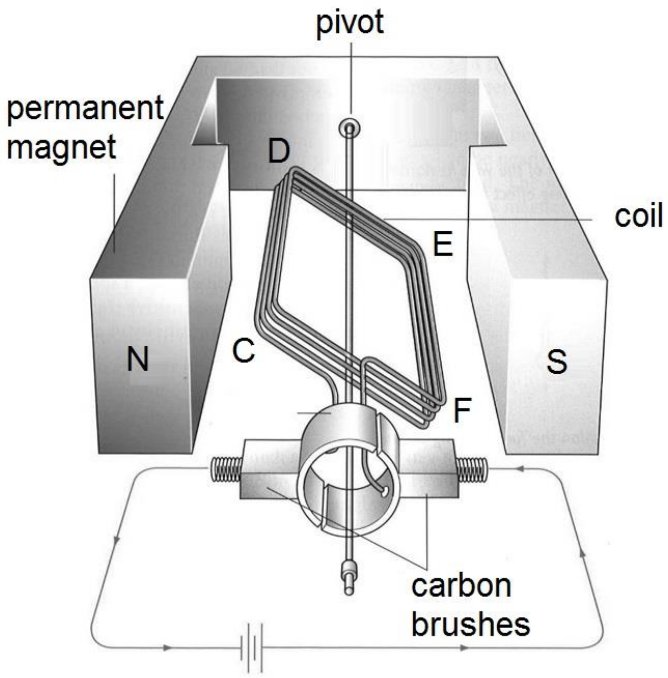


Fig. 10.2

(i) When current flows through the coil, explain why side CD experiences an upward force.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[2]

(ii) Fig. 10.3 shows how the resultant force on wire CD, F, varies with time.

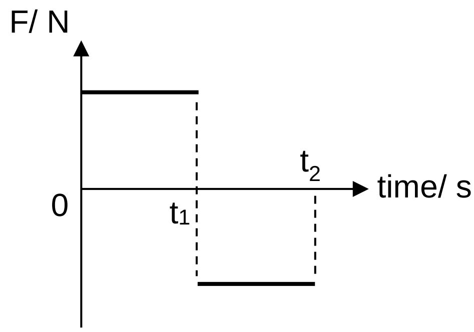


Fig. 10.3

Explain the shape of the graph.

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……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[2]

(iii) As the coil CDEF rotates faster in the magnetic field, there is an opposing voltage known as “back emf” in the coil. Explain how this “back emf” is produced and why it is an “opposing” voltage.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

Section B

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

11 A student conducted an experiment to investigate how the thickness of a resistance wire affects the potential difference across it. The set-up of his experiment is shown in Fig. 11.1. The length of all the copper wires used is 0.050 m.

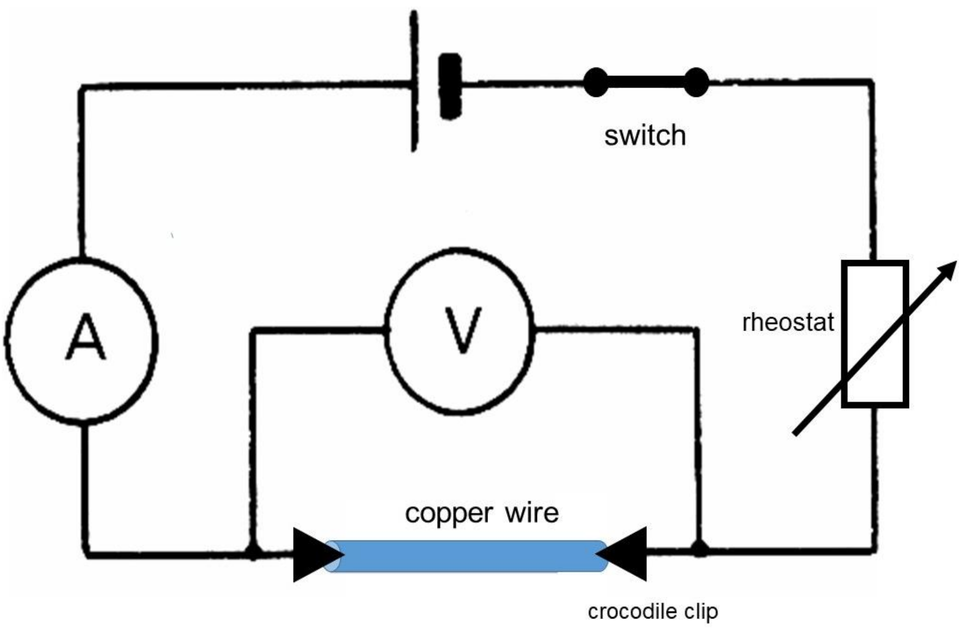


Fig. 11.1

(a) Each piece of copper wire is clamped, in turn, between two crocodile clips. When the ammeter reading is set to 2.0 A, the voltmeter reading is recorded. Fig. 11.2 shows the cross-sectional areas of the different copper wires and their corresponding voltmeter readings.

wire	cross-sectional area /m^2	voltmeter reading / V
K	0.0020×10^{-6}	0.85
L	0.0040×10^{-6}	0.43
M	0.0080×10^{-6}	0.21
N	0.016×10^{-6}	0.11
O	0.032×10^{-6}	
P	0.064×10^{-6}	0.028

Fig. 11.2

(i) State the relationship between the cross-sectional area of the wire and the potential difference across it.

……………………………………………………………………………………[1]

(ii) Explain how the data in Fig 11.2 suggest the relationship stated in **(i).**

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………[1]

(iii) Using data from Fig 11.2, predict the voltmeter reading when wire O is connected to the circuit.

voltmeter reading = ………………… [1]

(iv) Calculate the resistivity of the copper wires.

resistivity = ………………………. [2]

(v) Explain the function of the rheostat in the circuit.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(b) Another copper wire, **Q** with a different cross-sectional area is cut into 3 pieces of identical length. Each piece has a resistance of 0.20 Ω. The wires are arranged in a circuit as shown in Fig 11.3.

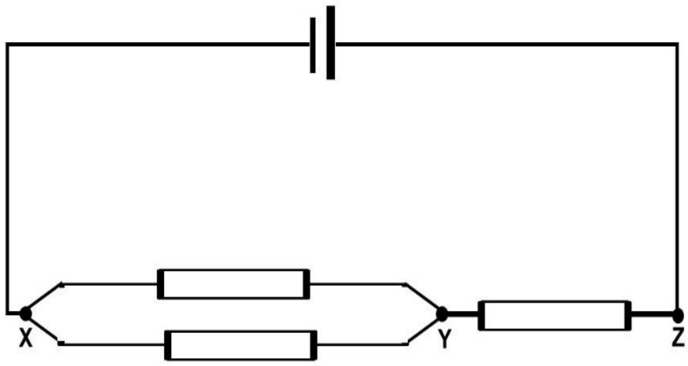


Fig 11.3

(i) The potential difference across YZ is 1.0 V.
Calculate the e.m.f. of the cell.

e.m.f.= ……………………… [2]

(ii) Another identical piece of wire Q is connected in parallel to XY.
Explain why the potential difference across YZ increases.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

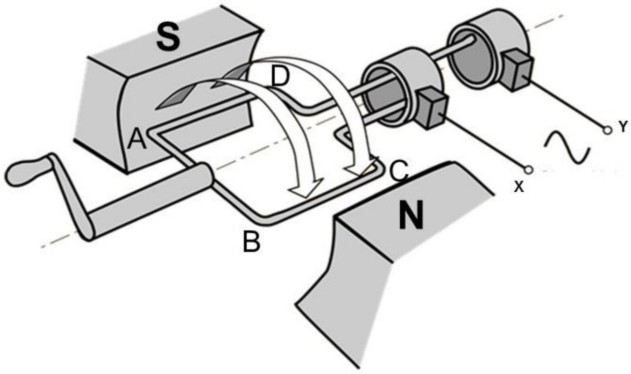
………………………………………………………………………………………[1]

(iii) A voltmeter is connected in parallel to measure the p.d. across XY.
Explain why the potential difference across YZ remains the same.

………………………………………………………………………………………

………………………………………………………………………………………[1]

12 Fig 12.1 shows a simple hand-wound AC generator. The generator consists of a rotating single coil of wire ABCD.



http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/motorac.html

Fig 12.1

A bulb is connected to the output X and Y and the coil is rotated. An e.m.f. is induced in the coil and the bulb lights up.

(a) On Fig 12.1 draw an arrow to indicate the direction of the induced current at wire AD. [1]

(b) Explain how the direction of current in **(a)** produces a resistive force on the hand that is winding the coil.

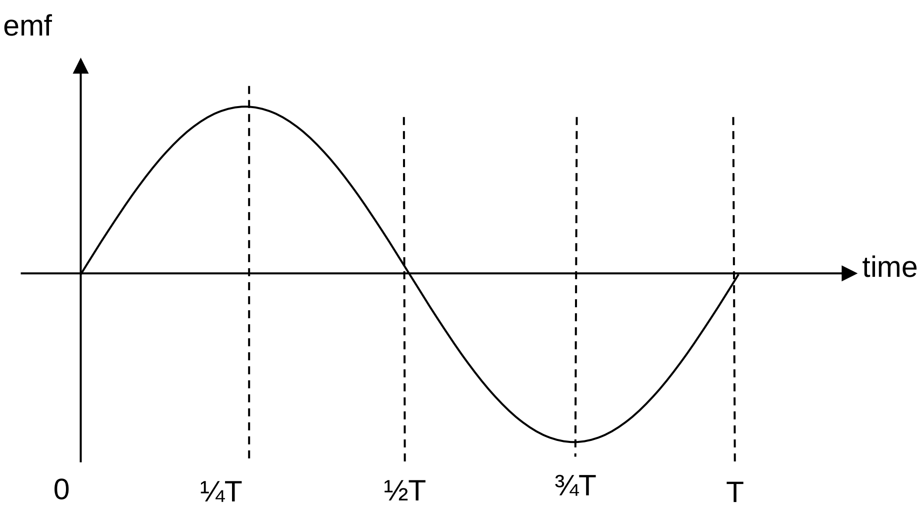
……………………………………………………………………………………………...

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

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

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

(c) Fig 12.2 shows how the output voltage of the a.c. generator varies with time for one complete rotation of the coil. Sketch on the same axis how the output voltage will change if the speed of rotation of the coil is halved.



[2]

Fig. 12.2

(d) The a.c. generator in Fig 12.1 is connected to an ideal step-up transformer as shown in Fig. 12.3. At a constant rotation speed, the voltage produced by the a.c generator is 6.0 V. Two identical light bulbs are connected to the secondary coil of the transformer.

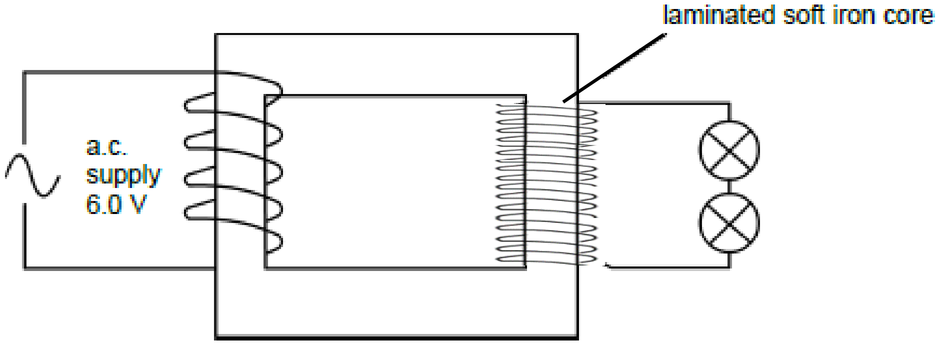


Fig. 12.3

(i) Given that the turns ratio of the transformer is 5.
Calculate the voltage across one light bulb.

voltage = ………………………………. [2]

(ii) The alternating current supply at the primary coil is replaced by a direct current supply. Explain why the bulbs will only light up momentarily when the switch is closed.

………………………………………………………………………………………

………………………………………………………………………………………[1]

(iii) Step up transformers are usually used to produce high voltages for the transmission of electrical energy over long distances.
Explain briefly why this is so.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………[2]

Either

13 A metallic casing electric kettle and air-conditioner unit are connected to the same power socket in Singapore. The rating of the electric kettle is “240 V, 100 W” while the rating of the air conditioner unit is “10 A, 240 V”.

(a) Fig 13.1 shows how the wires of the kettle are connected to the 3-pin plug of the electric kettle.

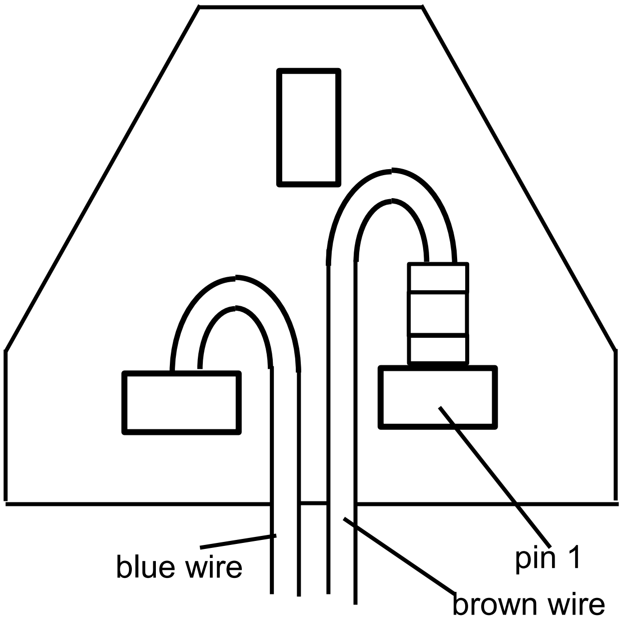


Fig 13.1

(i) State and explain one mistake in the wiring of the 3-pin plug of the electric kettle.

…………………………………………………………………………………….....

…………………………………………………………………………………….....

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

(ii) Suggest a fuse rating for the fuse in the 3-pin plug of the electric kettle.

fuse rating = ... [1]

(iii) Explain why the brown wire is connected to pin 1 of the 3-pin plug.

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

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

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

(b) The kettle was brought to the USA and the voltage supply is 110 V.
Calculate the current that flowed through the kettle when it was used in the USA.

current = ... [2]

(c) Thicker copper wires are used to connect to air-conditioner units while thinner copper wires are usually used to connect to electric kettles.

(i) An electrician mistakenly took the wires meant for the kettle and connected it to the air-conditioner unit. State and explain what hazard may occur.

………………………………………………………………………………………...

………………………………………………………………………………………...

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

(ii) The resistance per metre of the copper wire used to connect to the kettle is 0.050 Ω/m. If the ratio of the radius of the copper wire connected to the air-conditioner unit to the radius of the copper wire connected to the electric kettle is 2.0, calculate the resistance per metre of the copper wire used to connect to the air-conditioner unit.

resistance per metre = ... [1]

Or

13 An oscillating dipper is used to create water wave in a Physics lesson demonstration. Fig 13.2 shows successive wavefronts of the wave produced by the oscillating dipper. The time for the water wave to move from point A to point B is 30 s. The distance between point A and B is 60 cm.

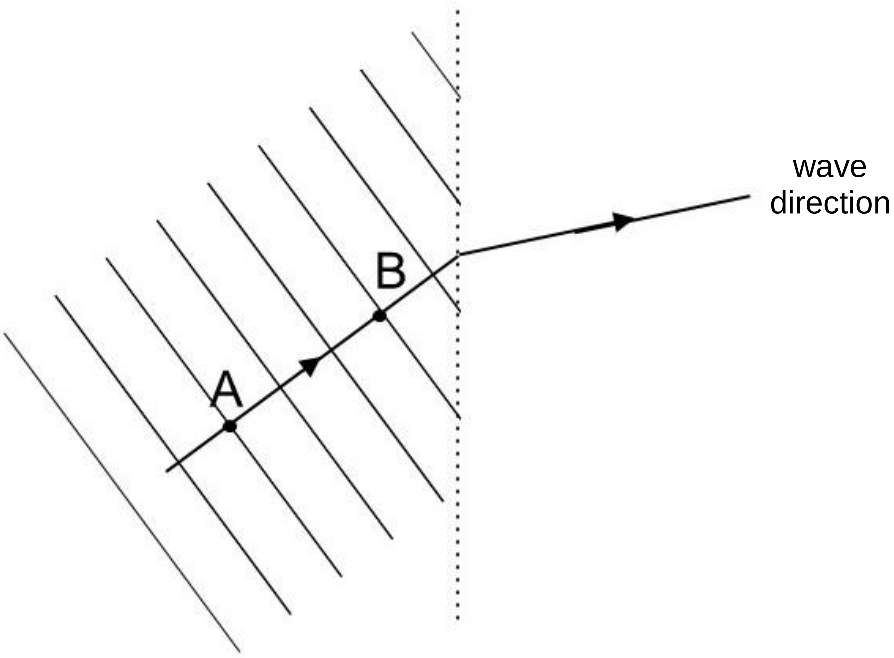


Fig 13.2

(a) Calculate wavelength of the water wave.

wavelength = ... [1]

(b) Calculate frequency of the oscillating dipper.

frequency = ... [2]

(c) Fig 13.2 shows that the water wave refracts.

(i) State the main reason why the water wave refracts.

……………………………………………………………………………………

……………………………………………………………………………………..[1]

(ii) Complete Fig 13.2 to show at least 3 wavefronts of the refracted water wave. [1]

(iii) If Fig 13.2 is drawn to scale, determine the horizontal distance between the crest and the adjacent trough of the refracted water wave.

distance = ... [1]

(d) Water wave and electromagnetic waves are transverse waves.

(i) Explain why water wave and electromagnetic waves are transverse waves.

……………………………………………………………………………………

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

(ii) X-ray which is part of the electromagnetic wave spectrum, enters into a magnetic field as shown in Fig 13.3. Complete the path of the x-ray after it enters into the magnetic field.

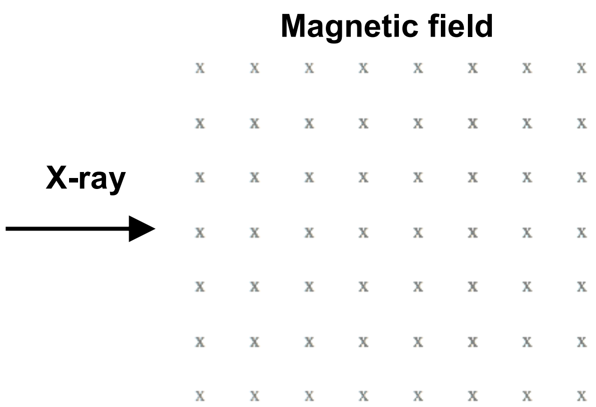


Fig 13.3

Explain your answer.

………………………………………………………………………………………

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

(iii) State one other property of electromagnetic waves.

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

- END OF PAPER -