O

JURONG SECONDARY SCHOOL
2022 GRADUATION EXAMINATION 2
SECONDARY 4 EXPRESS

CANDIDATE NAME	

CLASS		INDEX NUMBER	

PHYSICS

6091/02

Paper 2 Theory

26 August 2022
1 hour 45 min

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

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Section A
Answer all questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer all questions. Question 11 has a choice of parts to answer.
Write your answers in the spaces provided on the Question Paper.

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

For Examiner's Use		
Paper 1 (30%)	MCQ [40 marks]	
Paper 2 (50%)	SECTION A [50 marks]	
	SECTION B [30 marks]	
	SUB-TOTAL [80 marks]	
Paper 3 (20%)	PRACTICAL [40 marks]	
OVERALL %	[100 %]	

This document consists of **25** printed pages including this page.

Section A [50 marks]

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

1 A boy rides a sled down a slope.

W is the combined weight of the boy and the sled.
N is the normal reaction force from the slope on the sled and the boy.
R is the resistive force on the boy and the sled.

Fig. 1.1

(a) Describe the force that forms an action-reaction pair with N.

……..... [1]

(b) As the boy descends the slope, his velocity increases.

Using ideas about forces, explain the effect this has on his acceleration.

……

……...

……..…… [2]

(c) The boy wants to go faster down the same slope on his sled.

Without modifying the sled, suggest how he can go faster.

……..…..…

……..…. [1]

(d) The combined weight of the boy and sled is 600 N. The boy is traveling at a constant speed down the slope.

By means of a scaled diagram, determine the magnitude of R.

force R = …… [3]

2 A student is sitting on a chair as shown in Fig. 2.1.

Fig. 2.1

The student tips his chair back to the position shown in Fig. 2.2.

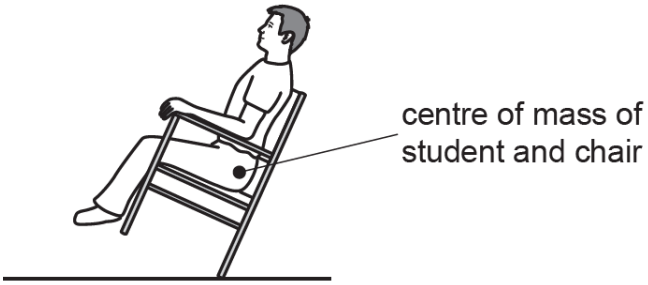


Fig. 2.2

(a) Explain how the pressure exerted by the chair on the floor in Fig. 2.1 compares with the pressure exerted by the chair in Fig. 2.2.

……..……..

……..……..

……..... [2]

(b) Explain why the chair in Fig. 2.2 is unstable.

……...

……..……..

……. [2]

(c) In the second experiment, the student blows into a U-tube manometer to measure

the pressure of his breath.

Atmospheric pressure is 1.0×10^5 Pa.
Density of mercury is 13 600 kg/m^3.
Gravitational field strength is 10 N/kg.

Fig. 2.3 shows the manometer when he is blowing into the manometer.

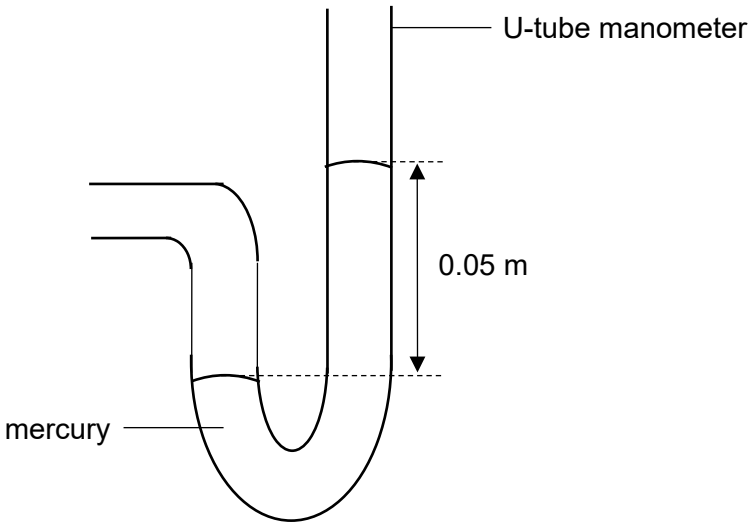


Fig. 2.3

Determine the pressure of his breath.

pressure = …… [2]

3 The setup in Fig. 3.1 can be used to investigate the loss of energy when a ball is dropped

from a certain height.

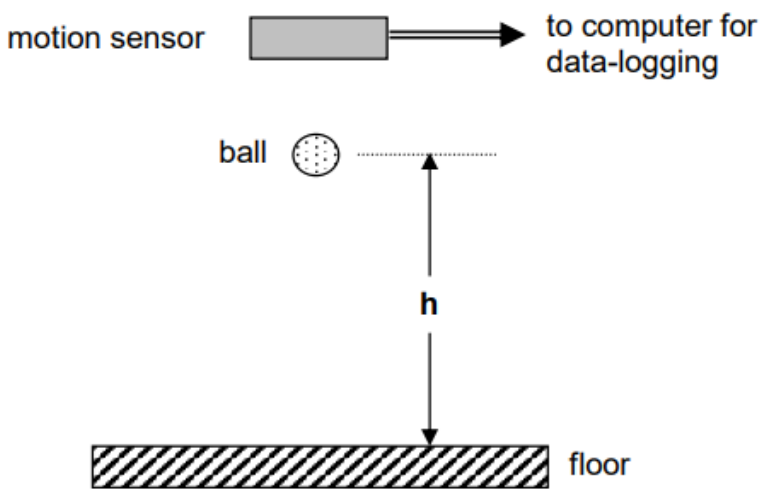


Fig. 3.1

The ball of mass 1.5 kg is dropped from height **h**. The following graph showing the motion of the ball is obtained.

Fig. 3.2

(a) Describe the energy change of the ball between time = 0 to 0.6 s.

……..……..

……..……..

……. [2]

(b) Take gravitational field strength g = 10 N/kg. From Fig. 3.2, determine

(i) the gravitational potential energy of the ball before it is released.

gravitational potential energy = …… [2]

(ii) the power of the ball on its first impact with the floor.

power = ……..…… [1]

(c) Ignoring air resistance, explain why the graph during the fall of the ball is not linear.

……..……..

……. [1]

4 A balloon containing some gas is placed inside a chamber as shown in Fig. 4.1.

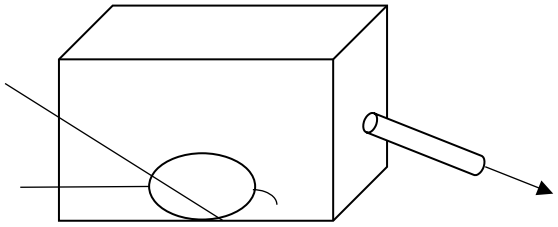


Fig. 4.1

(a) Explain, using ideas about molecules, how the gas inside the balloon exerts a pressure on its inner surface.

……

……

……

…….. [2]

(b) Air is now pumped out.

Explain, using ideas about molecules, why the volume of the balloon increases.

……

……

……

…….. [2]

5 Fig. 5.1 represents the electromagnetic spectrum.

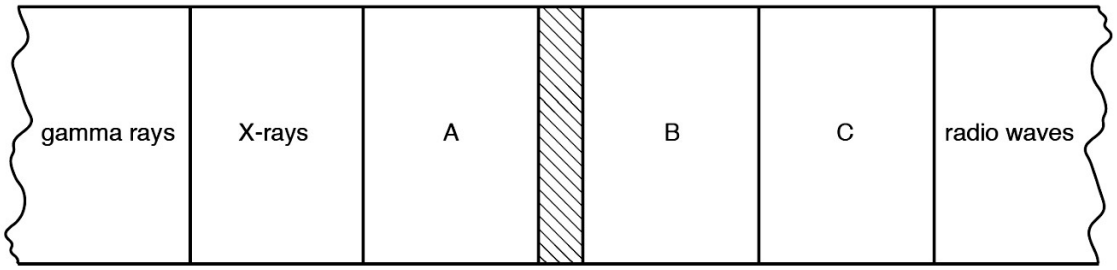


Fig. 5.1

(a) State the name of the component that has a greater frequency than B.

…….. [1]

(b) Describe one use of X-rays and its effect on living tissues and cells.

……

……

……

…….. [2]

(c) Ultrasound and X-rays are both used in medical imaging.

To produce the image of an unborn child, an ultrasound emitter and receiver are placed close together on the mother's skin.

Fig. 5.2 shows pulses detected by the receiver.

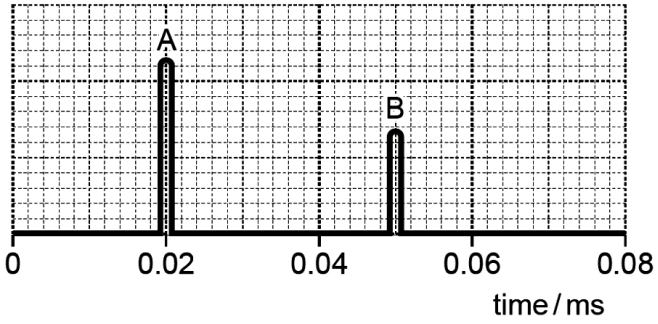


Fig. 5.2

Pulse A is the emitted pulse and pulse B is the first pulse that returns from the unborn child.
The average speed of ultrasound in human tissue is 1500 m/s.

Calculate the distance between the emitter and the child.

distance = ... [3]

6 Fig. 6.1 shows a method of producing sandpaper using static electricity.

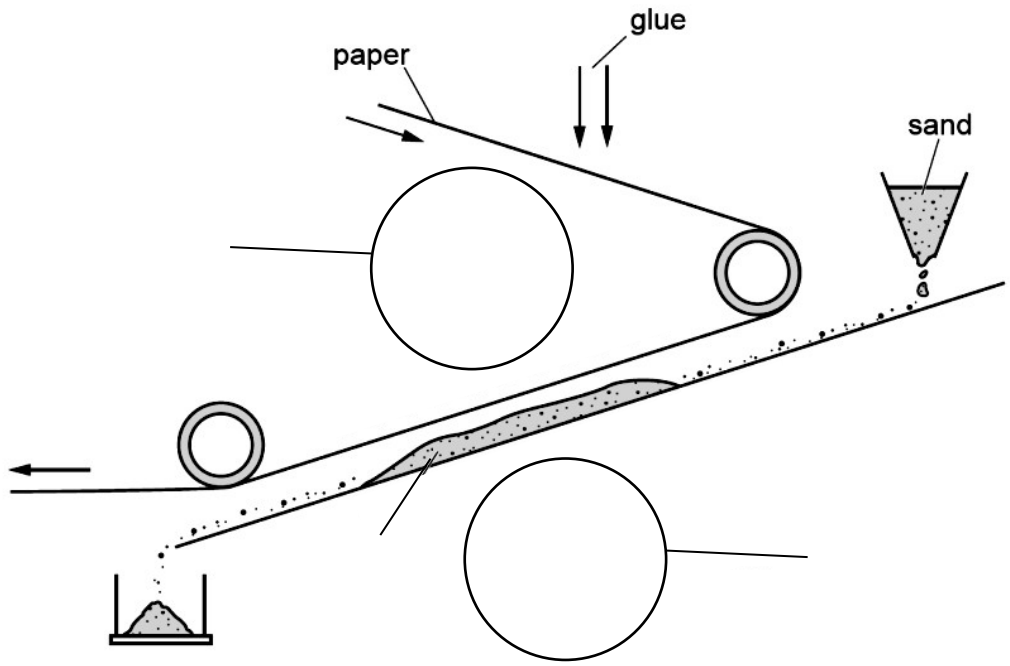


Fig. 6.1

Glue is sprayed on to moving paper. The sticky paper then passes between two metal spheres.
One of the spheres is positive and the other sphere is negative.
There is an electric field between the spheres.

(a) On Fig. 6.2, draw the electric field between the two metal spheres.
Show the direction of the electric field. [2]

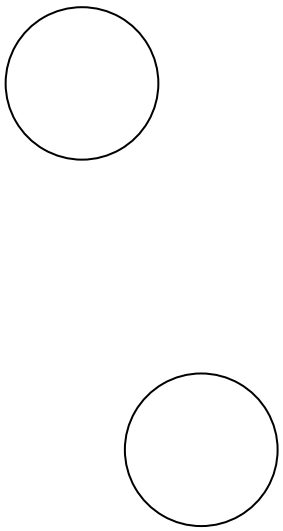


Fig. 6.2

(b) Fig. 6.3 shows two layers of sand grains in the space between the two spheres.
Grains of sand are present just below the sticky paper.
Each grain of sand is a conductor of electricity.

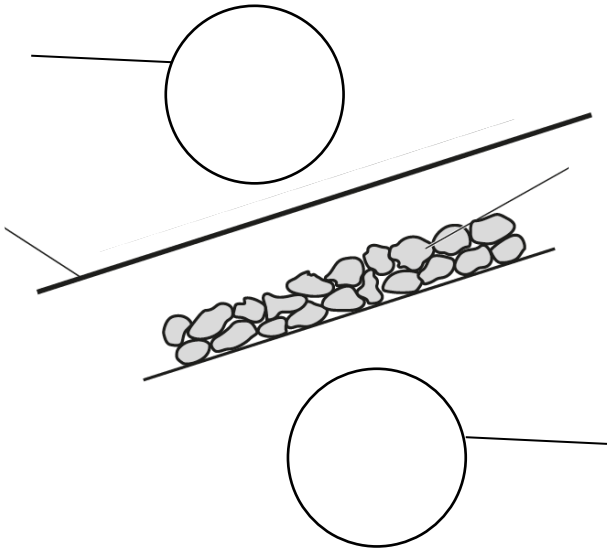


Fig. 6.3

(i) Explain why the top layer of the sand grains is negatively charged.

.....

..... [1]

(ii) Explain why the top layer of sand grains moves towards the sticky paper.

.....

..... [1]

(c) A man who is making the sandpaper accidentally touches the negative metal sphere with his hand and receives an electric shock.

The potential difference between his hand and the metal sphere is 5.0 kV.
The energy transferred when the spark travels from the metal sphere onto his hand is 2.0 J.

Calculate the amount of charge transferred when the man receives the electric shock.

charge = ... [2]

7 Fig. 7.1 shows the *I / V* characteristic graph for a light emitting diode (LED).

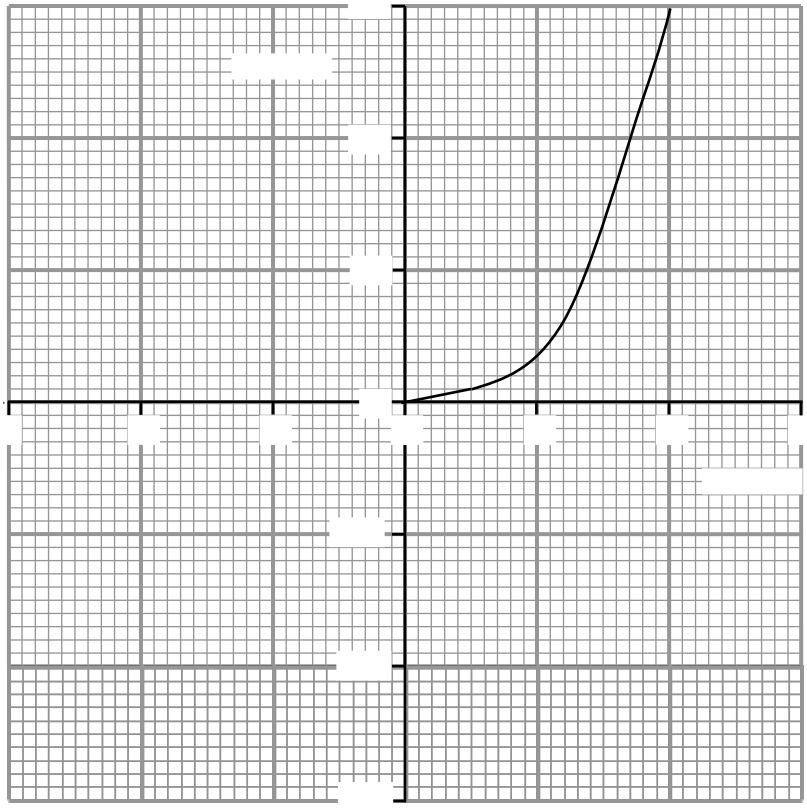


Fig. 7.1

(a) The LED does not obey Ohm's Law.

(i) State how Fig. 7.1 shows that the LED does not obey Ohm's Law.

.....

..... [1]

(ii) State what happens to the resistance of the LED as the voltage increases from 0.0 V.

..... [1]

(iii) On Fig. 7.1, draw the *I / V* characteristic graph for the LED from -3.0 to 0.0 V. [1]

(b) Using Fig. 7.1, determine the resistance of the LED when the current in it is 20 mA.

resistance = …… [2]

(c) The LED is connected to a battery of electromotive force (e.m.f.) 6.0 V and a variable potential divider of resistance R, as shown in Fig. 7.2.

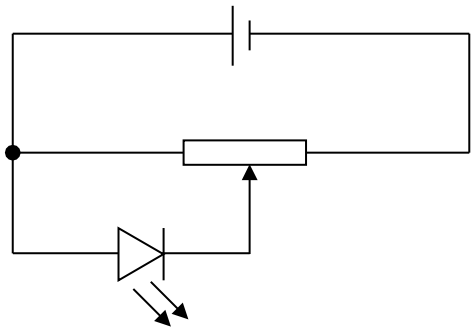


Fig. 7.2

The slider J is moved towards A.

State and explain what happens to the brightness of the LED.

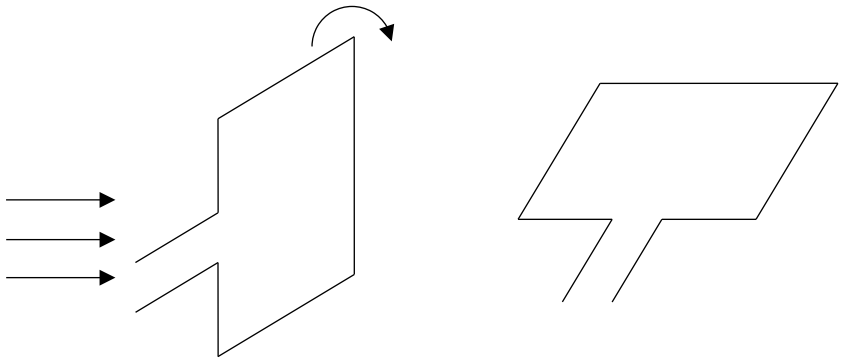
……

……

……

…… [2]

8(a) Fig. 8.1 shows a single-turn rectangular coil rotating clockwise in a magnetic field B.



In Fig. 8.1a, the coil is vertical and is the start of the rotation.
Fig. 8.1b is the position of the coil after rotating 270°.

The rotating coil in the magnetic field causes an induced electromotive force (e.m.f.) across its ends. The graph of the variation of the induced e.m.f. with time, displayed by a cathode-ray oscilloscope (c.r.o.) is shown in Fig. 8.2.

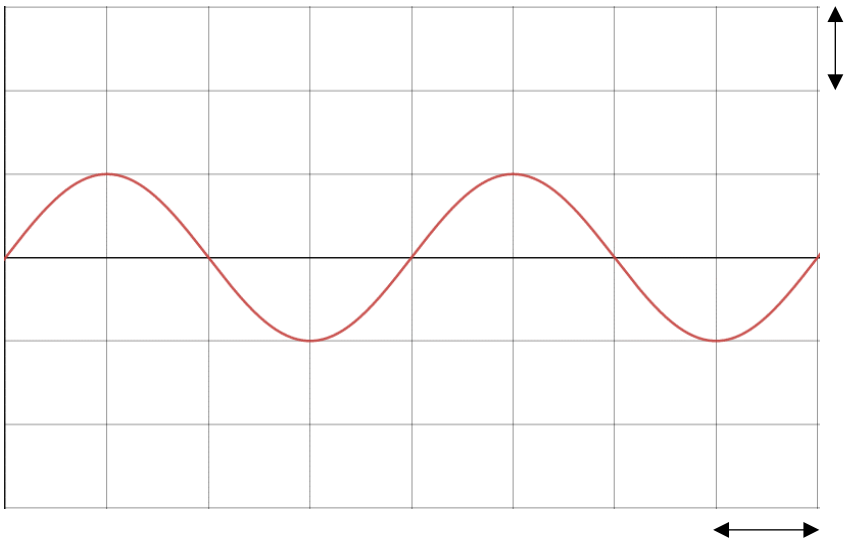


Fig. 8.2

The time base of the c.r.o. is set at 2 ms/division and the Y-gain is set at 50 mV/division.

(i) On Fig. 8.2, mark with an **X**, the point corresponding to the position of the coil shown in Fig. 8.1(b). [1]

(ii) Calculate the frequency of the induced e.m.f.

frequency = …….. [2]

(iii) The rate of rotation of the coil is doubled.

On Fig. 8.2, draw the graph of the variation of the induced e.m.f. with time. [2]

8(b) Fig. 8.3 shows the basic parts of a transformer.

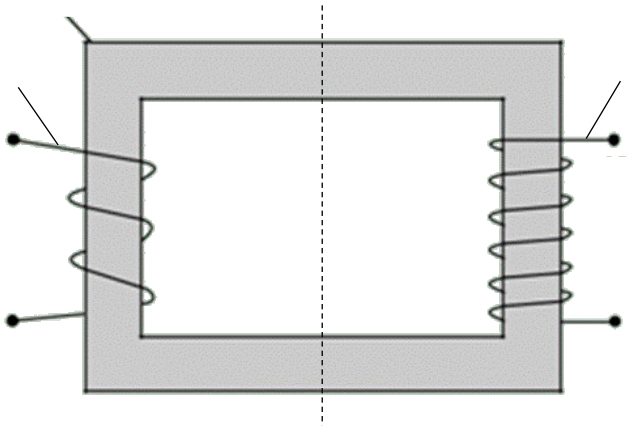


Fig. 8.3

(i) The 100% efficient transformer is used to step up the voltage of a supply from 100 V to 200 V. A resistor is connected to the output. The current in the primary coil is 0.4 A.

Calculate the current in the resistor.

current = …….. [2]

(ii) The core of the transformer is split along XY.

Explain why the transformer would not work if the two halves of the core are separated by about 30 cm.

……

…….. [1]

Section B [30 marks]

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows a periscope that is used in a submarine to view a ship.

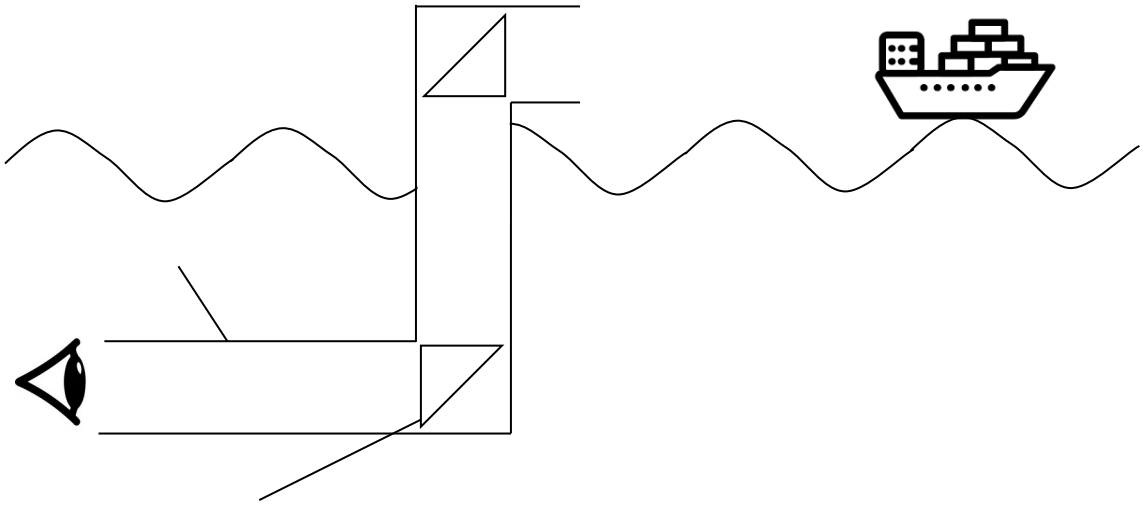


Fig. 9.1

The periscope uses two identical right-angled glass prisms.

The table in Fig. 9.2 gives the refractive indexes of some types of glass that could be used to make the glass prisms.

type of glass	refractive index
crown glass	1.606
flint glass	1.925
borosilicate glass	1.470
plate glass	1.520
cubic zirconia	2.180

Fig. 9.2

(a) **(i)** Define the term *refractive index* in terms of the speed of light.

……..……

…….... [1]

(ii) State the type of glass in which green light travels the fastest.

…….... [1]

(iii) Fig. 9.3 shows a ray of green light passing through a rectangular glass block made of plate glass.

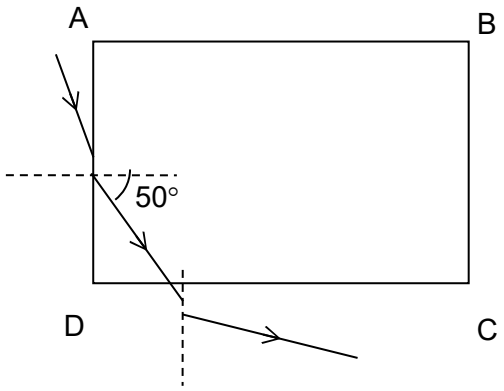


Fig. 9.3

Calculate the angle of refraction of the green light at surface CD of the plate glass block.

angle = ... [2]

(b) The critical angle of the prism is 31.3°.

Determine the type of glass used for the prism.

type of glass = ... [2]

(c) A light ray travels into the periscope from the ship.

(i) On Fig. 9.1, draw the path of the light ray to show how the eye sees the image of the ship. [2]

(ii) Explain for the path of the light ray in one of the prisms.

……..……

……..……

……..……

……..…….. [2]

10 Table 10.1 shows some electrical appliances that are used in a house.

Table 10.1

appliance	number of appliances	power of each appliance / W
refrigerator	1	600
standing fan	3	50
air-conditioner	2	1200
lights	15	20

(a) State a safety feature of a typical household circuit and describe how it works.

……..……..

……..……..

……..……..…… [1]

(b) In the household circuit, all appliances are connected parallel to each other and to the mains supply. The voltage of the mains supply is 230 V.

(i) Calculate the total current when all the appliances in Table 10.1 are switched on.

current = …… [3]

(ii) The owner of the house connects a single fuse to all the appliances in Table 10.1.

Discuss if this connection is safe.

……

……

…….. [2]

(c) The standing fan uses a d.c. motor to rotate the fan blades. Fig. 10.1 shows the coil of the motor placed between the poles of a magnet.

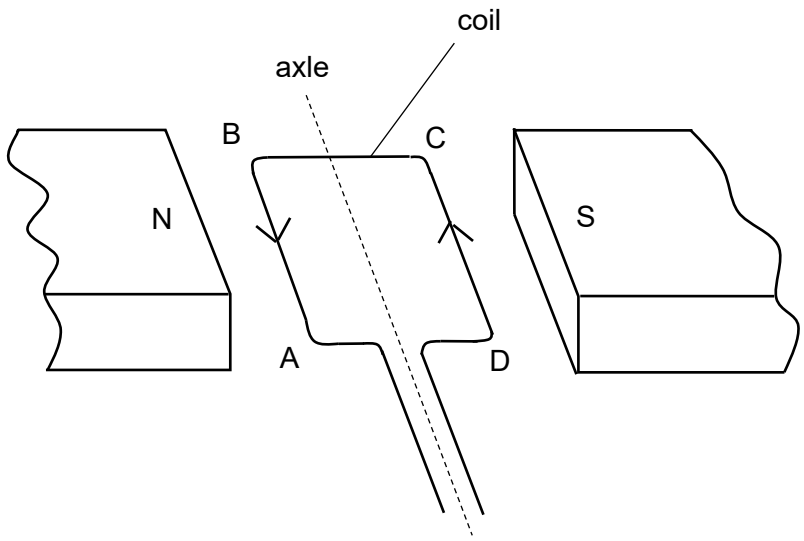


Fig. 10.1

(i) On Fig. 10.1, draw the forces that act on side AB and CD of the coil. [1]

(ii) State the rule you used to determine the direction of the force.

…….. [1]

(iii) The coil begins to rotate about the axle with the help of a split-ring commutator, which is not shown.

With reference to side AB of the coil, explain how the split-ring commutator ensures that the rotation continues.

……

……

……

…….. [2]

11 EITHER

Fig. 11.1 shows the velocity-time graph of a car on a horizontal surface.

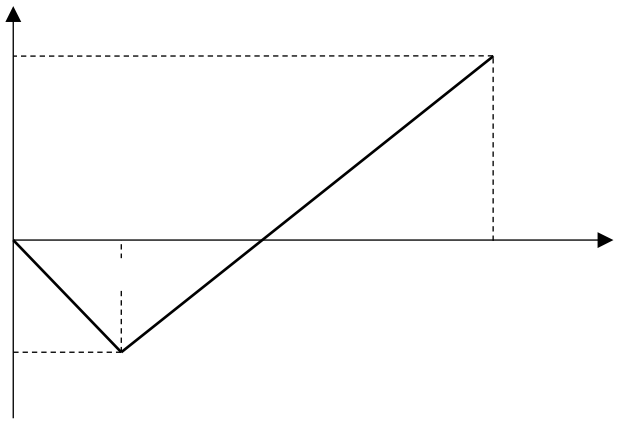


Fig. 11.1

(a) Define *velocity*.

…….. [1]

(b) Describe the motion of the car.

……

……

……

……

……

…….. [3]

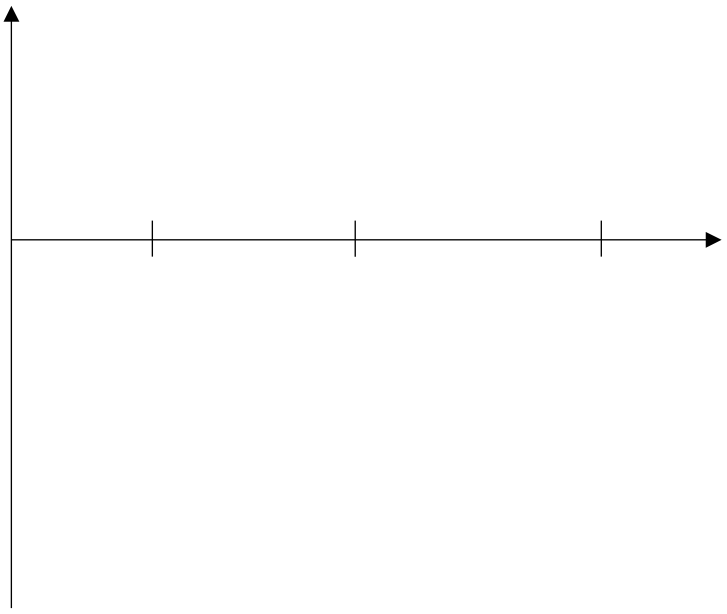
(c) Calculate the deceleration of the car.

deceleration = …….. [2]

(d) State how the displacement of the car can be determined from Fig. 11.1.

…….. [1]

(e) Sketch the displacement-time graph of the car.



[3]

11 OR

A kettle has a heating element that supplies thermal energy at a rate of 3000 W. The kettle has a heat capacity of 200 J/°C and it contains 2.0 kg of water.

The water is heated from room temperature of 25 °C to 100 °C.

The specific heat capacity of water is 4200 J/(kg °C) and the specific latent heat of vaporisation of water is 2200 kJ/kg.

(a) Define what is meant by the *specific latent heat of vaporisation* of water is 2200 kJ/kg.

……

…….. [1]

(b) Determine how long it will take to heat up the kettle of water to 100 °C.

time = …….. [3]

(c) The kettle switches off when the water in the kettle boils and the escaping steam heats up a bimetallic strip. The bimetallic strip bends when it is heated, breaking the electrical contact to switch off the kettle.

(i) The steam condenses after being in contact with the bimetallic strip.

Explain, in terms of energy transfer, how the steam heats up the bimetallic strip within the kettle.

……..

……..

……..

…… [2]

(ii) State the final temperature of the bimetallic strip.

…… [1]

(iii) 5 g of water is converted to steam. Effectively, 20% of the steam heats up the bimetallic strip.

Calculate the amount of thermal energy absorbed by the bimetallic strip.

thermal energy = …….. [3]

END OF PAPER