Name: _____ Index Number: _____ Class: _____

TEMASEK SECONDARY SCHOOL
Preliminary Examination 2024
Secondary 4 Express

PHYSICS **6091 / 02**

Paper 2 Structured and Free Response **1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

You are <u>required</u> to submit this booklet at the end of the paper.

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units. 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.

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

Take gravitational field strength as 10 N/kg.

For official use only:

1		**4**		**7**		**10**		**13**		**16**		**Total:**
2		**5**		**8**		**11**		**14**				
3		**6**		**9**		**12**		**15**				

This document consists of **22** printed pages and **0** blank page.

Section A

Answer **all** questions.

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 3.0 m/s along the same straight road. 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.

……..……...[1]

(b) In Fig. 1.1, sketch the velocity-time graphs of car A and car B from t = 0 s to t = 5 s. Label the graph with the appropriate values. Take direction from X to Y as the positive direction. [3]

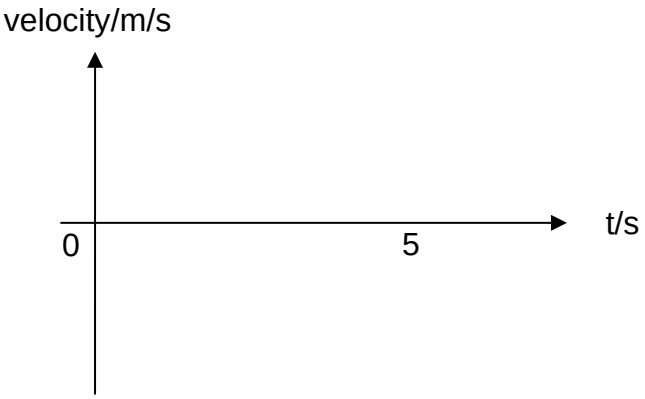


Fig. 1.1

(c) The distance between X and Y is 1000 m.

Calculate the time taken for Car A to travel from X to Y.

time = …… [2]

2 In Fig. 2.1, a giant balloon of weight 400 N is filled with helium. It is being secured to the ground by two identical ropes. Each rope experiences a tension of 500 N and the angle between them is 100°.

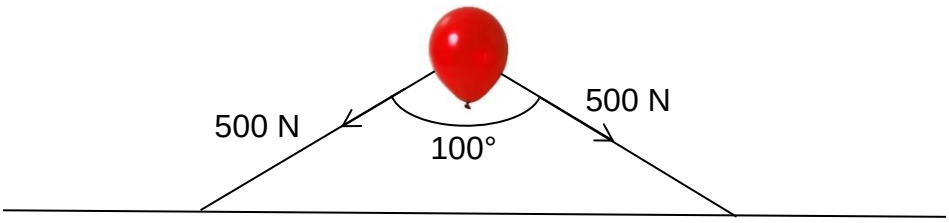


Fig. 2.1

(a) By drawing a labelled vector diagram, determine the magnitude of the resultant of the two tensions.

magnitude = …….. [3]

(b) State the action-reaction pair to the weight of the balloon.

……..……...[1]

3 Fig. 3.1 shows a uniform block of wood of weight 1.8 N being tilted about the edge P by a horizontal force *F* applied at a position 0.1 m vertically above the table. G is the centre of gravity of the block.

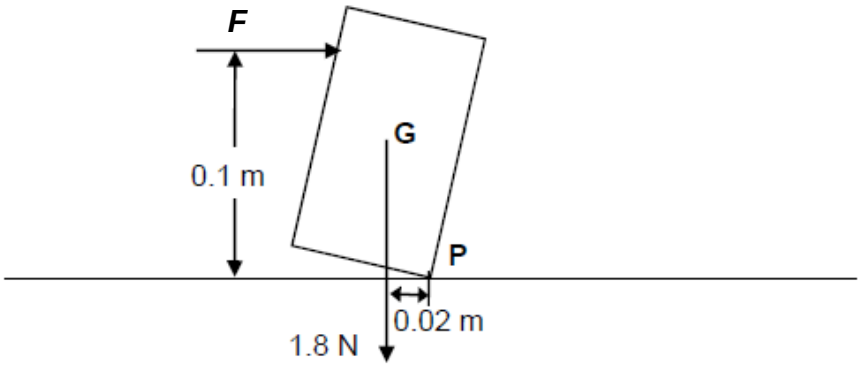


Fig. 3.1

(a) State the *principle of moments*.

……...

……...

……...[1]

(b) Calculate the horizontal force *F* in Fig. 3.1.

F = …….. [2]

4 Fig. 4.1 shows a hydraulic device that is used to compress paper in a waste disposal site. A force is exerted on piston A, which causes a force to be exerted on the paper. The hydraulic fluid used is an incompressible liquid.

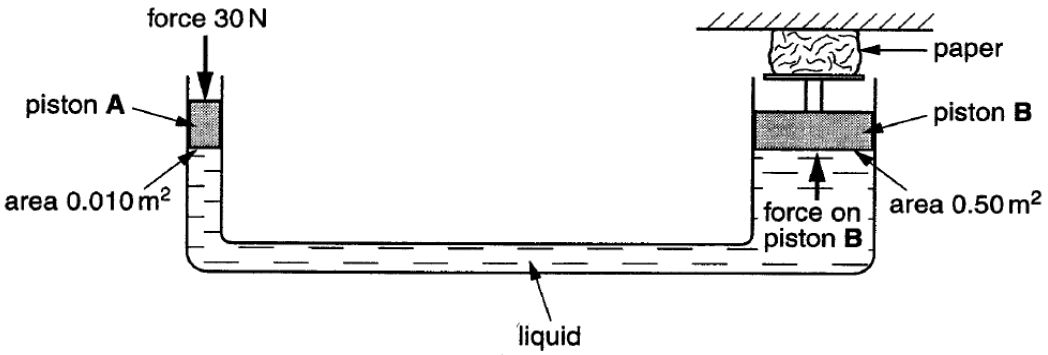


Fig. 4.1

(a) By referring to kinetic particle model of matter, explain why liquids are incompressible.

……...

……...

……...

……...[2]

(b) Calculate the force exerted on piston B, given the values of force and areas in Fig. 4.1.

force = …….. [2]

(c) Calculate the vertical distance moved by piston B when piston A is pushed downward through a distance of 200 mm.

distance = ……mm [1]

5 In Fig. 5.1, two mercury-in-glass barometers, M and N, are set-up side by side at sea level using identical glass tubes. There is a vacuum in the space above the mercury column in barometer M whereas barometer N contains trapped air. Take density of mercury to be 13 600 kg/m^3 and gravitational field strength g is taken to be 10 N/kg.

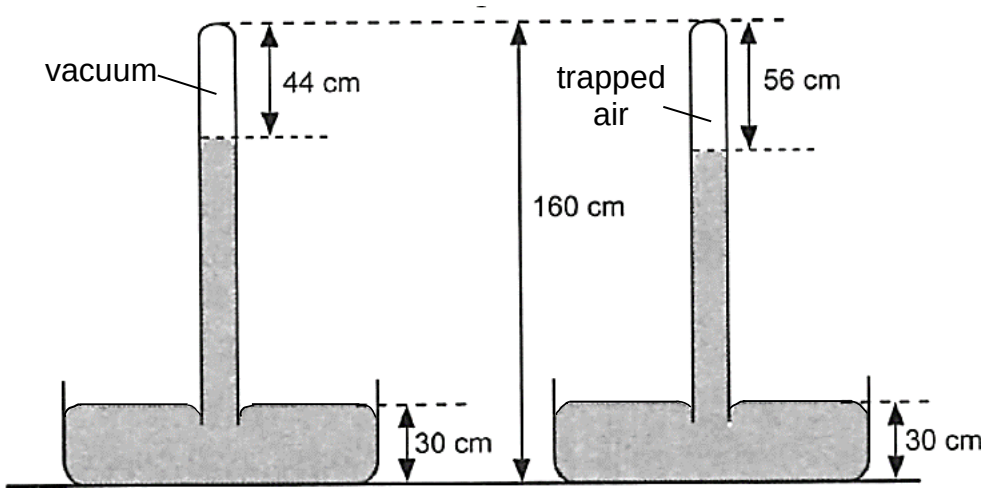


Fig. 5.1

(a) State the atmospheric pressure measured by barometer M in cmHg.

pressure = …….cmHg [1]

(b) Calculate the atmospheric pressure measured by barometer M in Pascals.

pressure = …….Pa [2]

(c) State how your answer to part **(b)** would change if it was brought to the top of Mount Everest.

……...[1]

(d) Using ideas about molecules, explain how the trapped air in barometer N causes a decrease in the height of the mercury column in N.

……...

……...

……...

……...

……...[2]

6 Fig. 6.1 shows a hot water storage tank. Water enters from water inlet X and leaves from water outlet Y.

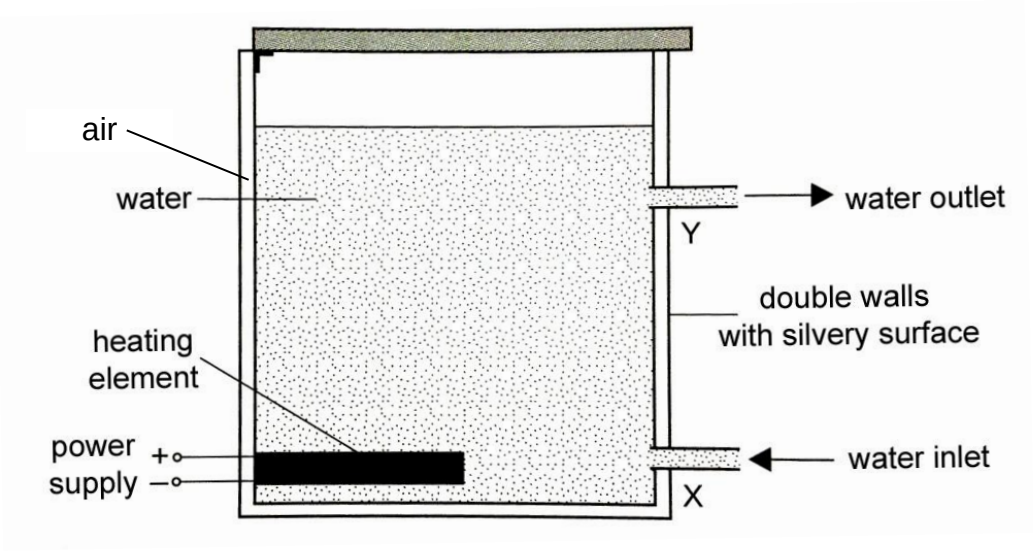


Fig. 6.1

(a) Explain how the heating element is able to heat up the entire water tank.

……

……

……

……

……

……

……

……[3]

(b) Describe how the design of the storage tank reduces energy transfer to the surroundings through conduction and radiation.

……

……

……

……

……[2]

7 Fig. 7.1 shows a gold leaf electroscope which consists of a metal ball connected to a metal stem with a gold leaf attached. The gold leaf hangs straight down when the electroscope is uncharged.

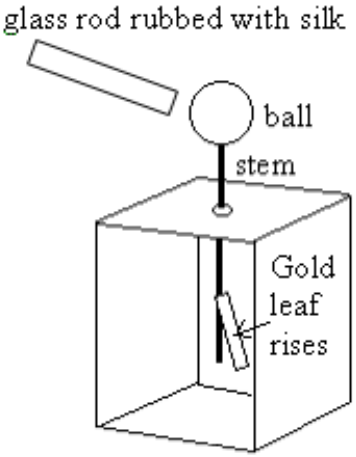


Fig. 7.1

When a charged glass rod is brought close to (but not touching) the ball of the electroscope, the leaf is observed to rise.

(a) The glass rod becomes positively charged when rubbed with silk. Explain how the rod becomes positively charged.

……...

……...

……...[1]

(b) Explain why the gold leaf rises when the rod is brought near to the metal ball.

……...

……...

……...

……...

……...[2]

8 Fig. 8.1 shows a circuit diagram for an electrical household appliance with a 5 A fuse.

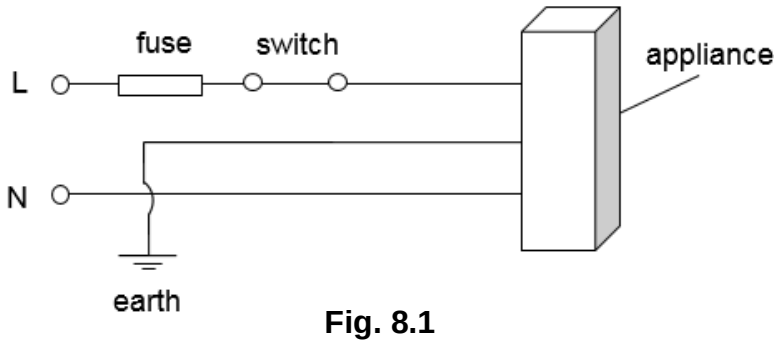


Fig. 8.1

(a) Explain why the switch must be placed on the live wire of the circuit.

……...

……...[1]

(b) State the function of the 5 A fuse.

……...

……...[1]

(c) The appliance is rated 1500 W 240 V. Suggest and explain if the 5 A fuse is suitable for this circuit. Support your answer with necessary working.

……...

……...[2]

9 The circuit in Fig. 9.1 is used to investigate the relationship between potential difference and current for a filament lamp.

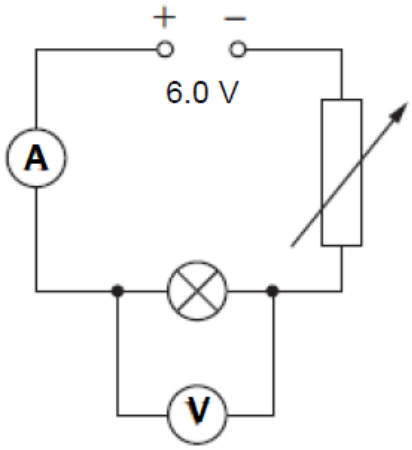


Fig. 9.1

The resistance of the variable resistor is altered causing changes to the voltmeter and ammeter reading. The readings are plotted in Fig. 9.2.

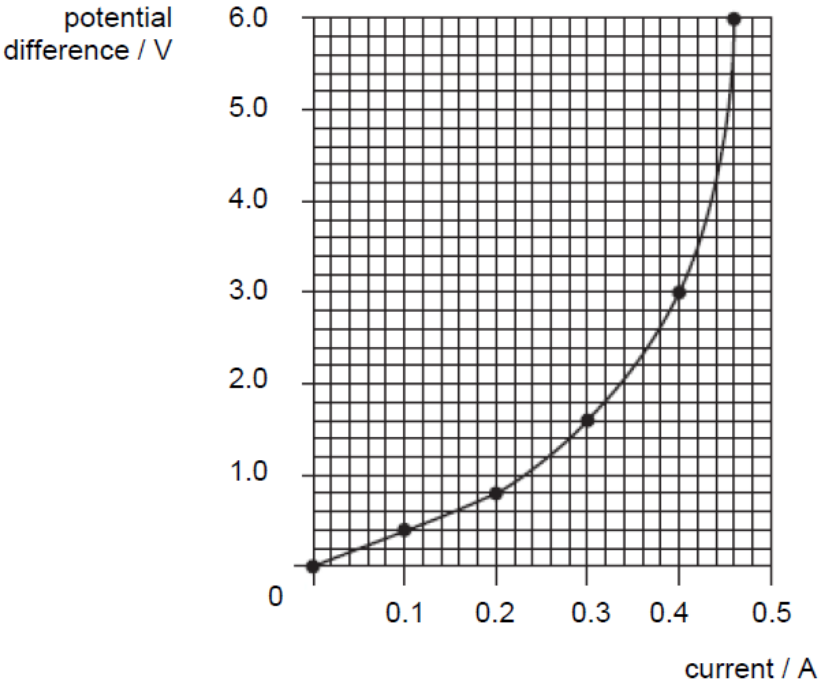


Fig. 9.2

(a) Using Fig. 9.2,

(i) Calculate the resistance of the filament lamp when the current is 0.40 A.

resistance = ... [1]

(ii) State how the resistance of the filament lamp changes as the potential difference across it increases.

……..[1]

(b) Explain briefly why filament lamps are not very energy efficient.

……

……...[1]

10 Fig. 10.1 shows a simple transformer with a soft iron core. The secondary coil is connected to a lamp.

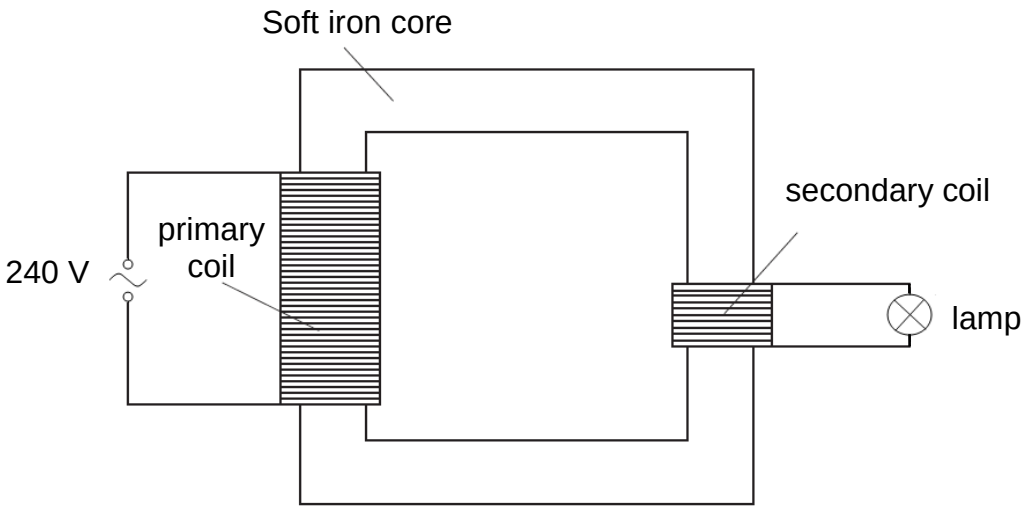


Fig. 10.1

(a) Explain how a voltage is obtained at the secondary coil.

……...

……...

……...

……...

……...

……...

……...

……...[3]

(b) Given that the lamp requires a potential difference of 40 V to work efficiently, what is the turns ratio (ratio of number of turns in the primary coil to the number of turns in the secondary coil) required in the transformer?

turns ratio = ……. [1]

11 Fig. 11.1 shows a bar magnet and two nails.

Fig. 11.1

(a) On Fig. 11.1, draw the magnetic field lines inside the bar magnet. [1]

(b) The magnet causes the nails to become magnetised by induction. Both ends of each nail becomes magnetic poles.

On Fig. 11.1, mark N or S on both ends of each nail to show the magnetic poles. [1]

(c) When the magnet is removed, the nails are still magnetised.

Explain why.

……...

……..[1]

12 In nuclide notation, iodine-131 is written as $^{131}_{53}I$.

When iodine-131 undergoes nuclear decay, it emits a beta-particle (β) and decays to an isotope of xenon (Xe).

(a) Describe what is meant by *nuclear decay*?

……...

……...

……...

……..[1]

(b) Complete the decay equation below for this decay.

$$^{131}_{53}I \rightarrow {}^{.....}_{.....}\text{Xe} + {}^{.....}_{.....}\beta$$

[2]

(c) Iodine-131 has a half-life of 8 days.

What fraction of a given sample of iodine-131 remains after 32 days?

……..[1]

13 3.0 kg of solid B was heated uniformly from a temperature of 30.0 ºC using a 150 W microwave oven. The temperature of B was taken in intervals of 5.0 minutes until it reaches the gaseous state. The results were recorded and tabulated as shown in Fig. 13.1.

Assume that the energy supplied was constant and no energy was transferred to the surroundings during the heating process.

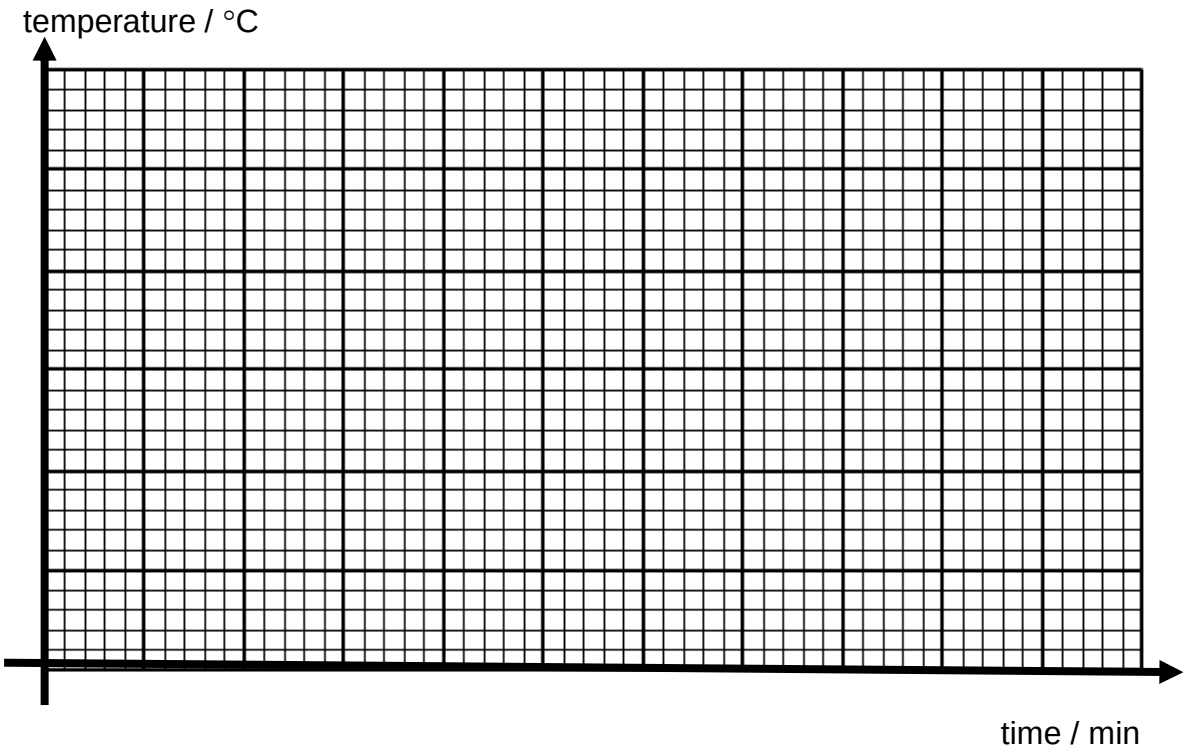
time / min	temperature / ºC
0.0	30.0
5.0	40.0
10.0	70.0
15.0	70.0
20.0	70.0
25.0	85.0

Fig. 13.1

Additional information:

Melting point of B = 40.0 ºC
Boiling point of B = 70.0 ºC
Time when B began melting = 2.5 minutes
Time taken for all of solid B to melt = 5.0 minutes
Time when B began boiling = 10.0 minutes
Time taken for all of liquid B to boil = 10.0 minutes
Specific latent heat of vaporization of B = 30.0 kJ/kg

(a) By analysing the data obtained and using the given information, plot the heating curve of solid B in the grid lines provided below. Indicate relevant values on the axes. [3]



(b) Calculate the specific heat capacity of solid B.

specific heat capacity = …… [3]

(c) Calculate the latent heat of vaporization of B.

latent heat of vaporization = …… [1]

(d) Describe what is meant by the *specific latent heat of vaporization* of B?

……...

……...[1]

(e) Does B have a higher specific latent heat of vaporization or a specific latent heat of fusion?

Explain your answer using the graph in part **(a)**.

……...

……...

……...

……...[2]

14 **(a)** Fig. 14.1 shows the path of a ray of blue light as it passes through a glass prism.

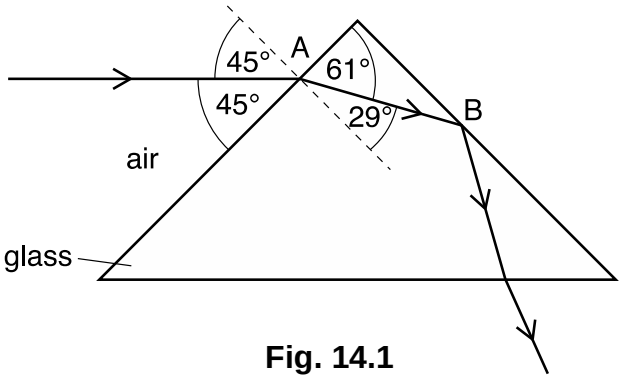


Fig. 14.1

(i) Using the angles shown in Fig. 14.1, calculate the refractive index of the glass.

refractive index = …… [2]

(ii) Explain why the ray does not emerge from the prism at B.

……

……

……

……

……

……[2]

(iii) In Fig. 14.2, a second ray of blue light strikes the glass prism at C. This ray is parallel to the ray that strikes the glass prism at A. It will also emerge from side XY of the glass prism.

In Fig. 14.2, complete the path of the second light ray through and out of the glass prism. [2]

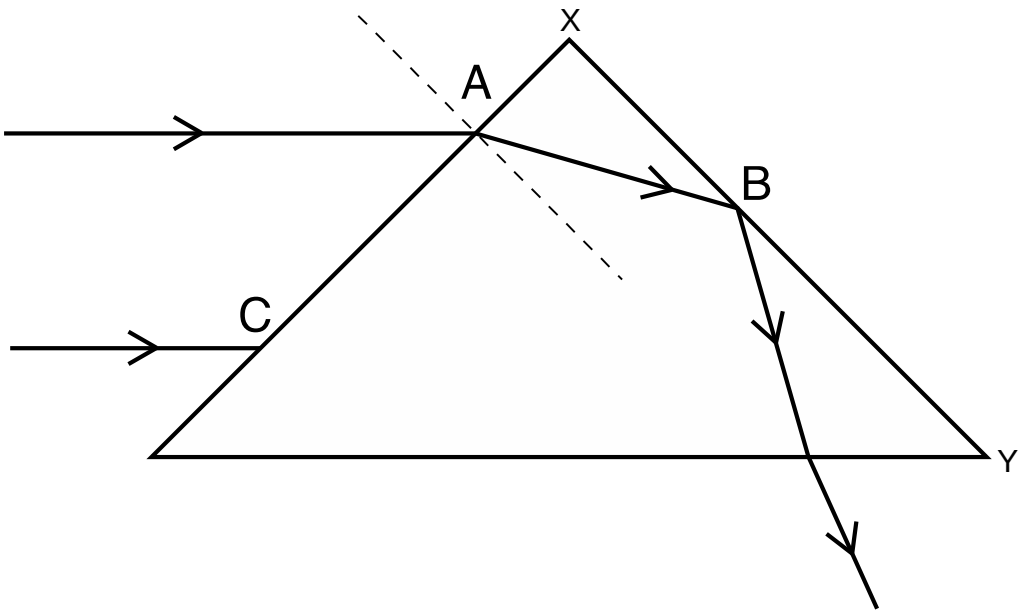


Fig. 14.2

(b) Fig. 14.3 shows an object placed in front of a converging lens. F represents the focal points.

The diagram is drawn to scale.

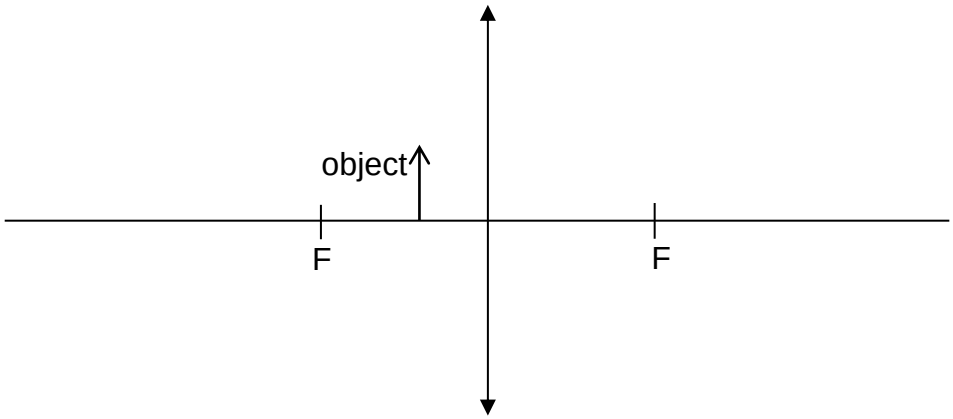


Fig. 14.3

(i) In Fig. 14.3, draw two rays from the top of the object to locate the position of the image and complete the drawing of the image. [2]

(ii) State three characteristics of the image formed in part **(b)(i)**.

……...[1]

(iii) State how the image height and image distance from lens would change when the object is brought closer towards the lens.

……[1]

Section B

Answer **one** question from this section**.**

15 Fig. 15.1 shows the technical specifications of an electric toy car powered by a battery.

Mass of toy car	1.0 kg
Input power	80 W

Fig. 15.1

The electric toy car travels up a slope at an incline of 30° as shown in Fig 15.2. The vertical height between points A and B is 6.0 m. Fig. 15.3 shows a graph of energy in the kinetic store of the toy car against displacement, *d*, as it travels from point A to point B.

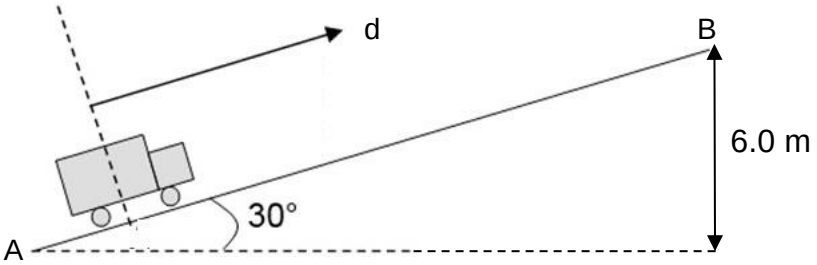


Fig. 15.2

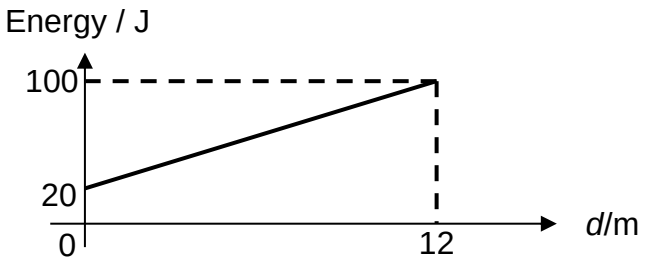


Fig. 15.3

The time taken to travel from point A to point B is 20 s. There is a constant resistive force acting against the toy car as it travels from point A to point B.

(a) State what is meant by the *principle of conservation of energy*.

……...

……...

……...

……..[1]

(b) Describe the energy transfers as the toy car travels from point A to B.

……...

……...

……...

……...[3]

(c) Calculate the change in velocity as the toy car travels from point A to point B.

change in velocity = …….. [2]

(d) Calculate the gain in energy in the gravitational potential store of the toy car as it travels from point A to point B. The gravitational field strength is 10 N/kg.

energy = …….. [1]

(e) Calculate the energy provided by the battery for the electric toy car to travel from point A to point B.

energy = …….. [1]

(f) Determine the resistive force acting against the toy car as it travels from point A to point B.

force = …….. [2]

16 (a) A ship makes use of ultrasound waves to determine the depth of the sea. An ultrasound pulse is emitted from a ship and the echo is received by a receiver on the ship. The receiver then records the time, *t*, at which the echo returns to the ship.

Fig. 16.1 shows the duration taken for the ultrasound pulse to return to the receiver as the ship moves from point X to point Y.

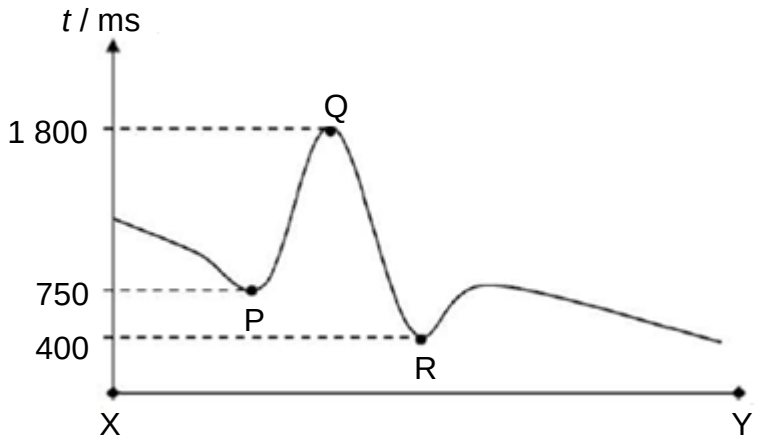


Fig. 16.1

(i) Describe what is meant by *ultrasound* waves.

……

……...[1]

(ii) At which point, P, Q or R, is the water the deepest? Explain your answer.

……

……...[1]

(iii) Describe how the ultrasound pulse passes through the water.

……

……

……

……

……[2]

(iv) Given that the speed of sound in water is 1 500 m/s, calculate the depth of the seabed at point P.

depth = ……..[2]

(b) The displacement-distance and displacement-time graphs of a sound wave are shown in Fig. 16.2 and Fig. 16.3 respectively.

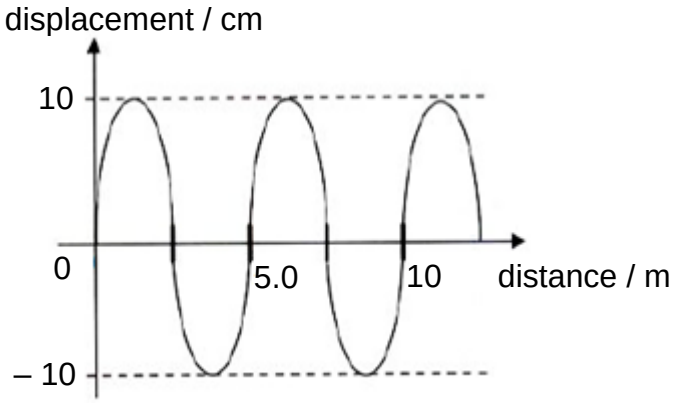


Fig. 16.2

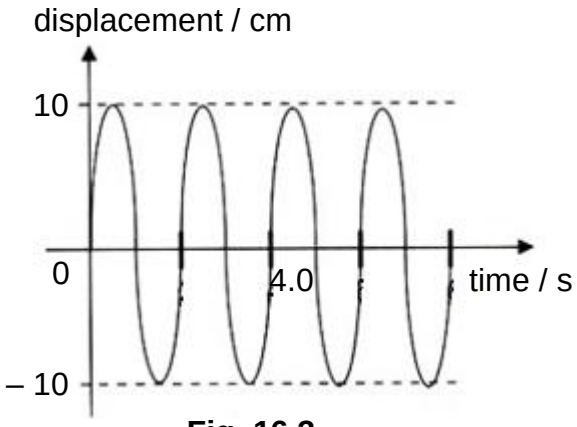


Fig. 16.3

(i) Determine the amplitude and frequency of the wave.

amplitude = …….. [1]

frequency = …….. [1]

(ii) Calculate the speed of the wave.

speed = …….. [2]

-------- END OF PAPER --------