Index Number

Anglo-Chinese School
(Independent)

END-OF-YEAR EXAMINATION 2019
YEAR 3 INTEGRATED PROGRAMME

PHYSICS **PAPER 2**
Mark Scheme

Monday **7 October 2019** **1 hour 45 minutes**

Marks Awarded	
Section	**Marks**
A	
B	
Penalty	
Sig. Fig.	
Units	
TOTAL SCORE	

INSTRUCTIONS TO STUDENTS

Write your index number in the box provided on the top right corner of this page.

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

Section A
Answer **all** questions in the spaces provided in the paper.

Section B
Answer **all** questions in the spaces provided in the paper.

INFORMATION FOR STUDENTS
Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show their answers 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.
Calculators are allowed for this paper.
Take g = 10 N/kg. There are 18 pages.

Section A [50 Marks]

A1 A 6.0 kg parcel is dropped off vertically from a helicopter 800 m above the ground. Its parachute is activated some time after the fall. The speed-time graph for the first 25 seconds of its journey is shown in **Fig. A1.1**.

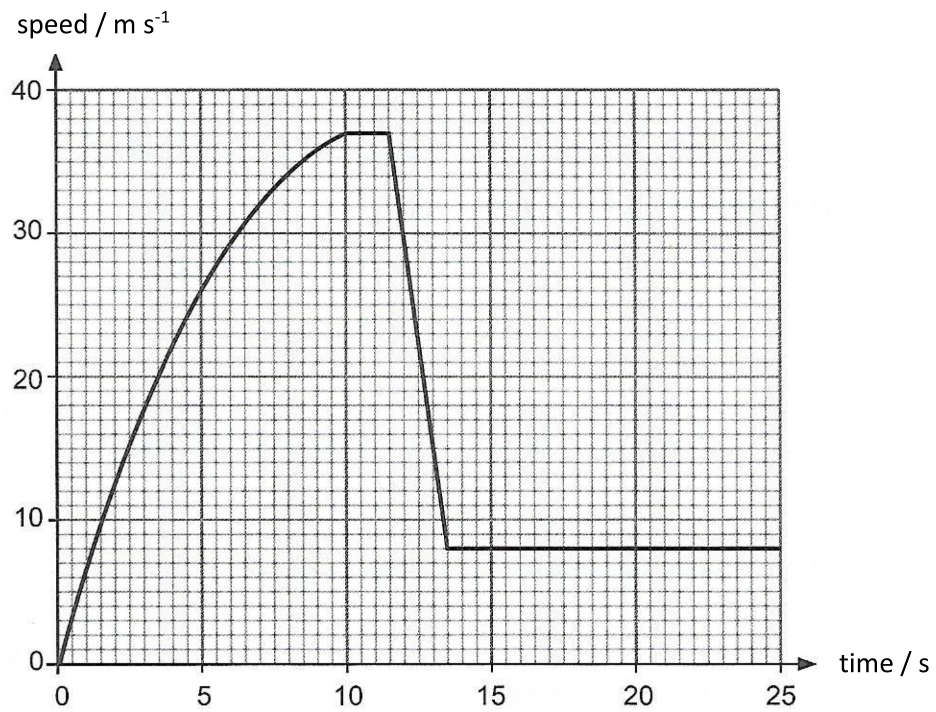


Fig. A1.1

(a) Explain what is meant by "The Earth's gravitational field strength has a magnitude of 10 N kg^{-1}". [1]

There is a force of 10 N acting on per unit mass of 1 kg.

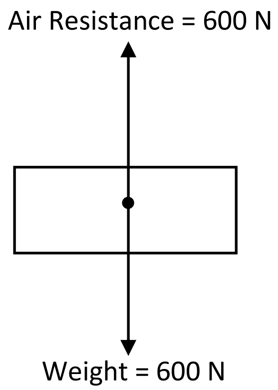
(b) Explain, in terms of forces, why the parcel's velocity increased immediately after being dropped. [2]

The weight of the parcel is larger than the air resistance acting on it. There is a net force in the downwards direction and hence the parcel's velocity increases immediately.

(c) State the time at which the parcel first achieves terminal velocity. [1]

10 s

(d) Draw a labelled diagram to show all the forces that act on the parcel at t = 15 s. Indicate the values of these forces on your diagram. [2]



Correct direction of arrows, correct values indicated. eeoo

(e) As the parcel falls, the Earth exerts a downward force on the parcel. Name the reaction force. [1]

(upwards) Force by parcel on Earth.

A2 A ball of weight **W** is suspended by two ropes as shown in **Fig. A2.1** (not drawn to scale). The tension in the ropes are 870 N and 500 N.

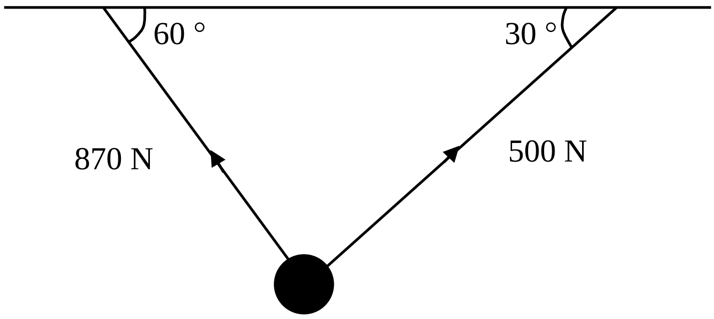


Fig. A2.1

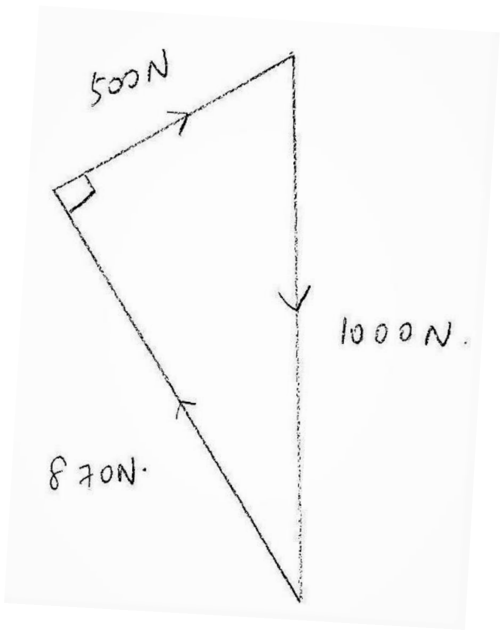
(a) What is the resultant force acting on the weight **W**? [1]

0 N

(b) By means of a scaled diagram, determine the weight **W**.
State the scale used. [4]

Scale :

scale: 1.0 cm rep 10 N [A1]



Correct diagram with arrows
W = 1000 N (accept from 950 N to 1050 N)

(c) State the effect on the tension of each rope when the ropes are placed closer to each other. The weight **W** remains unchanged. [1]

The tension decreases.

A3 Jonathan applies a vertical force **F** on a pedal of his bicycle, as shown in **Fig. A3.1**.

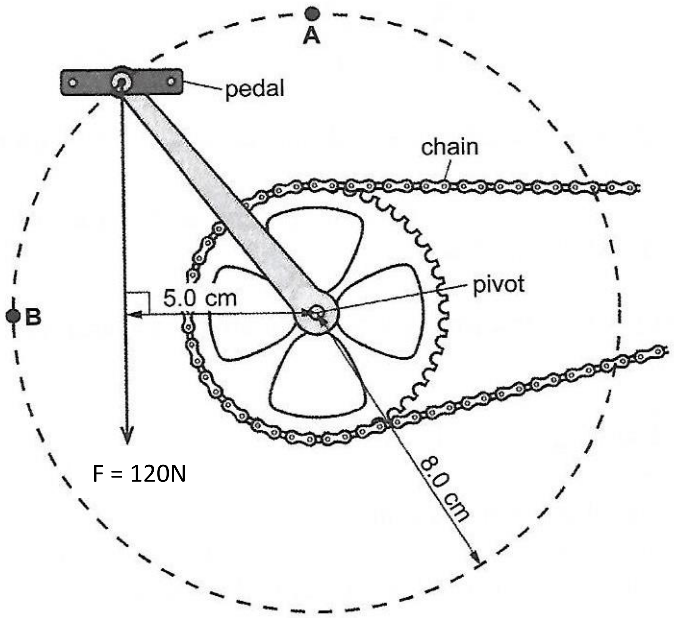


Fig. A3.1

(a) As he travels along, the pedal moves through a circle of radius 8.0 cm. For the pedal in the position as shown in **Fig. A3.1**, the line of action of the force, F is 5.0 cm from the pivot. Calculate the moment of force, **F**, about the pivot when **F** = 120 N. [2]

Moment of force F = 120 x 5.0

= 600 N cm or 6.0 Nm

(b) Subsequently, the pedal now moves from position **A** to position **B** as shown in **Fig. A3.1**. Explain why the same force of 120 N applied at **A** will have a different effect from the same force applied at **B**. Justify your answer with calculations. [3]

The perpendicular distance of the line of action of the vertical downward force F from the pivot changes (from 0.0 cm at A to a maximum of 8.0 cm at B). The moment produced will change from 0 N cm to 120 x 8.0 = 960 N cm.

(c) Johnathan and Tony are cycling at the same speed. The combined mass of Johnathan and his bicycle is 100 kg while the combined mass of Tony and his bicycle is 120 kg. Both decided to stop for a break. Who do you think will be more difficult to stop? Why? [2]

Tony will be more difficult to stop as he has a larger inertia.

A4 **Fig. A4.1** shows a slide in a playground. A boy of mass 35.0 kg climbs up from the side **AB** in 10.0 seconds and slides down from **B** to **C**. Then he decelerates uniformly in the horizontal section **CD** to a complete stop. The vertical height of the slide is 5.000 m. The horizontal section **CD** is 0.500 m above ground level.

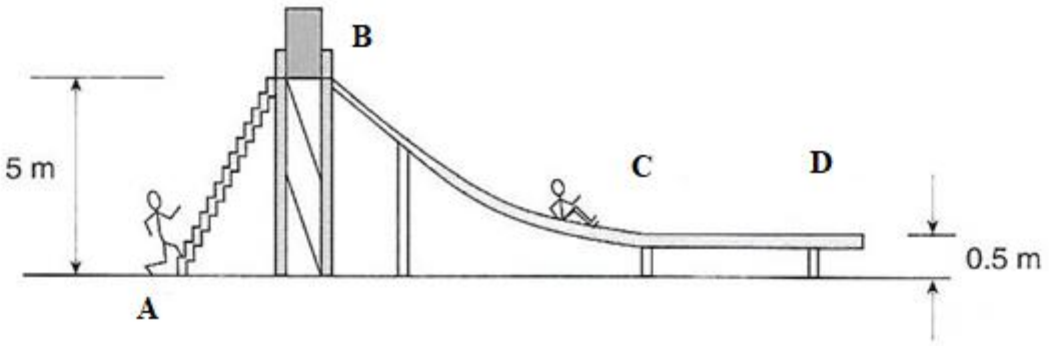


Fig. A4.1

(a) Find the average power developed by the boy when he climbs up the slide. [2]

Gain in gravitational potential energy = mgh = 35.0 x 10 x 5.000 = 1750 J
Average power = 1750 / 10.0 = 175 W

(b) What is the loss in gravitational potential energy of the boy when he moves from point **B** to point **C**? [1]

Loss in gravitational potential energy

= mgh = 35.0 x 10 x (5.000 – 0.500) = 1575 J or 1580 J

(c) If the work done against friction when he moves from **B** to **C** is 1000 J, what is the kinetic energy possessed by the boy at point **C**? [2]

Along BC,

By conservation of energy,

Gravitational energy at B = gravitational potential energy at C + kinetic energy at C

+ work done to overcome friction

Loss in gravitational potential energy = KE at C + 1000

1580 = KE at C +1000

KE at C = 580 J

(d) State the energy transformation in the horizontal section **CD**. [1]

Energy is converted to work done against friction.

(e) The length of the horizontal section **CD** is 5.000 m. Find the magnitude of friction, assuming that friction is constant. [2]

Work done against friction = 580 J

f x 5.000 = 580

f =116 N

A5 **Fig. A5.1** shows two vessels, **X** and **Y**, connected by a narrow tube and kept in water baths of temperatures 323 K and 363 K respectively. Compared to vessel **Y**, vessel **X** has a larger volume. The vessels contain the same type of gas.

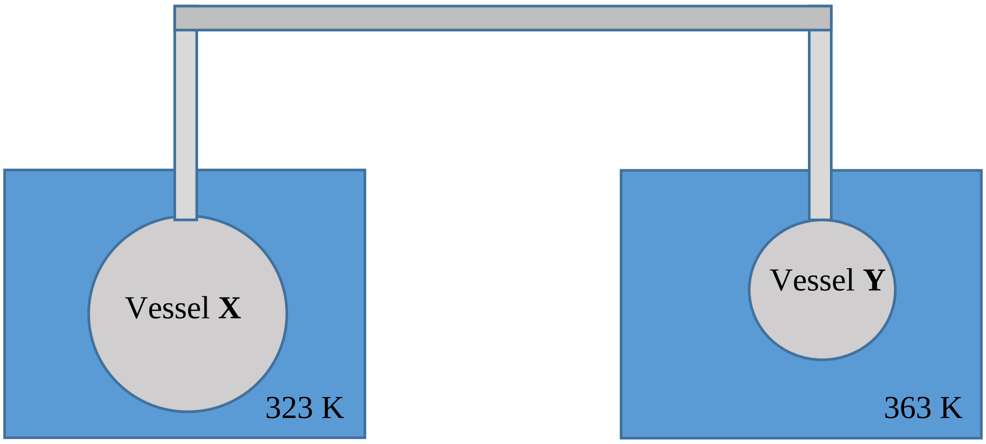


Fig. A5.1

(a) Discuss whether the following statements are true or false.

(i) After some time, the gases in both vessels **X** and **Y** would reach the same equilibrium temperature. [2]

False. The gases contained inside the respective vessels will be in thermal equilibrium with the water baths that they are immersed in and not with each other.

(ii) After a long time, the gas pressure in vessel **X** is smaller than the gas pressure in vessel **Y**. [2]

False. Gas particles will move from a region of high pressure to a region of low pressure until the gas pressures in both vessels are the same.

(Note: Pressure Y will be greater than X actually for line 1 substantiation.)

(b) Vessel **Y** is removed from the water bath and is then connected to a U-tube manometer as shown in **Fig. A5.2** below.

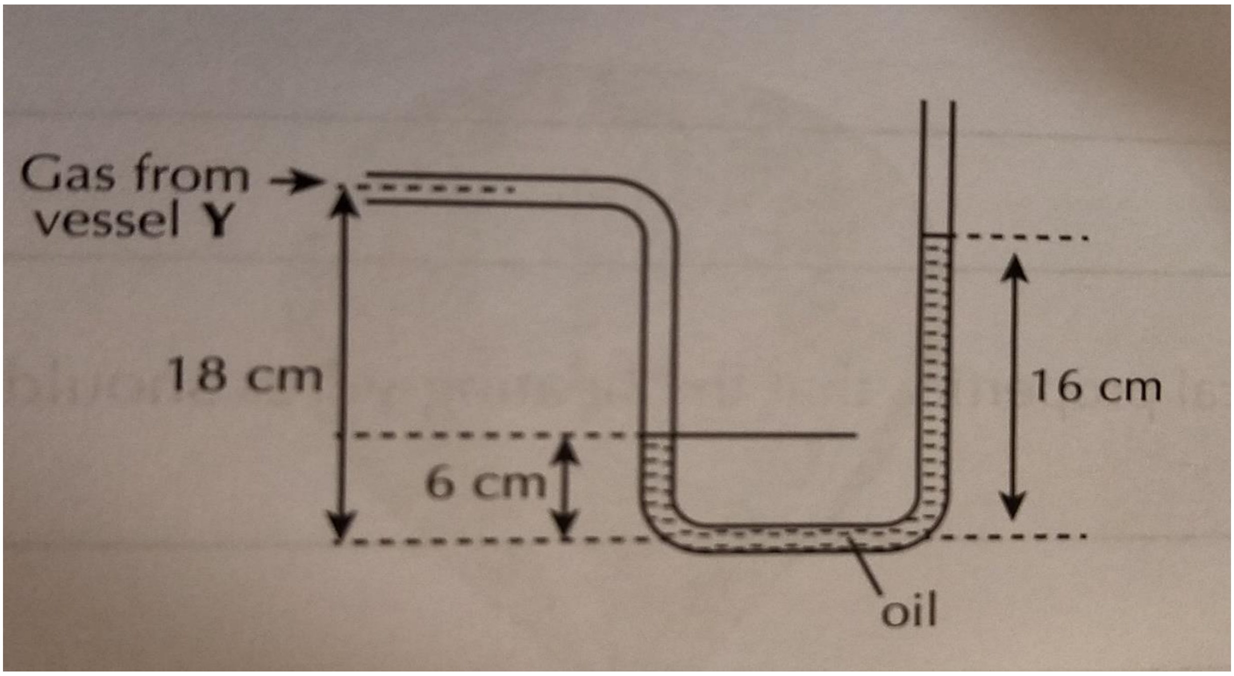


Fig. A5.2

(i) Given that the density of oil is 850 kg m^{-3} and atmospheric pressure is 1.0×10^5 Pa, calculate how much greater than atmospheric pressure is the pressure of the gas in vessel **Y**? [2]

Py = P atm + hpg

Py – P atm = hpg
= (0.16-0.06)(850)(10)
= 850 Pa

(ii) If the oil inside the manometer is replaced by water, would the level of water in the vertical arm of the manometer which is exposed to atmospheric pressure increase or decrease in height? Explain your answer. [2]

The density of water is more than density of oil. Since the other end of the manometer is connected to the same gas supply, if water replaces oil, the level of water in the vertical arm that is exposed to atmospheric pressure will decrease.

A6 **Fig. A6.1** shows a column of gas trapped in an air-tight container. A tight-fitting piston prevents the gas from escaping. The piston can move up and down the container smoothly.

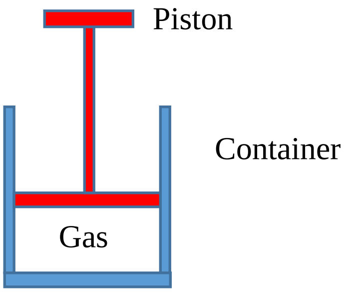


Fig. A6.1

The piston is slowly being pulled upwards, thereby allowing the gas to expand at constant temperature, discuss whether each of the following statements is true or false?

(a) The average distance between the gas particles increases. [2]

True. Expansion leads to a greater volume, therefore the distance between the gas particles should consequently increase.

(b) The average kinetic energy of the gas particles becomes larger. [2]

False. Since the temperature of the gas remains constant, the average speed of the gas particles should remain the same. Therefore, the average kinetic energy of the gas particles should also remain the same.

(c) The pressure exerted by the gas on the inner walls of the container and on the underside of the piston increases. [2]

False. Since the pressure of a fixed mass of gas is inversely proportional to its volume at constant temperature, the pressure of the gas decreases as the volume increases.

A7 An experimental set-up shown in **Fig. A7.1** below is used to measure the specific latent heat of vaporisation of water. Water in a beaker is kept boiling by an immersion heater which is connected to the main supply through a kilowatt-hour meter. The following data are obtained from the experiment:

Energy consumed by the heater = 0.128 kWh = (Give in Power and Time)

Initial reading of the electronic balance = 0.864 kg

Final reading of the electronic balance = 0.712 kg

Heat capacity of the beaker and the heater = 240 J $^{\circ}C^{-1}$

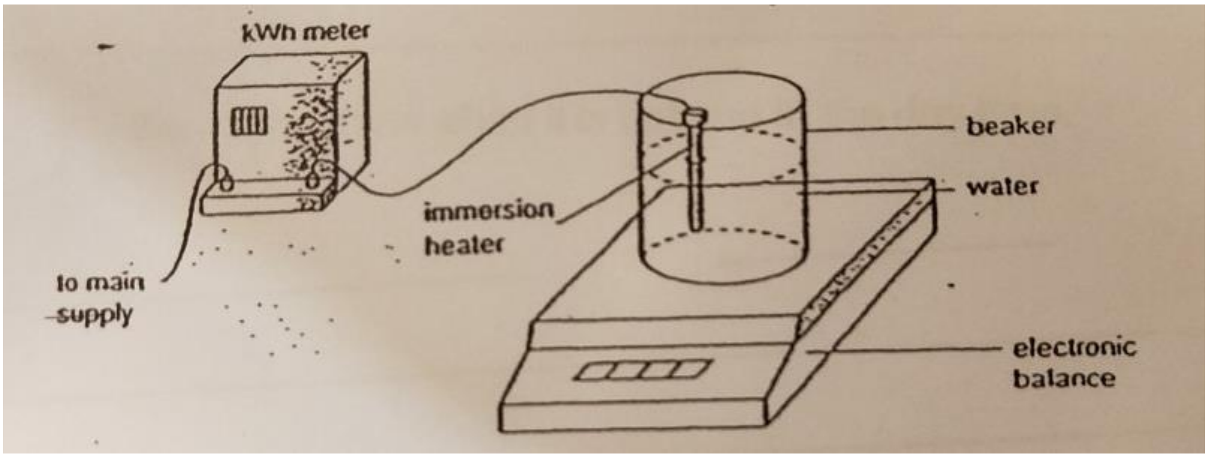


Fig. A7.1

(a) Before water starts to boil, the reading of the electronic balance decreases slowly with time. Calculate the specific latent heat of vaporization of water from the data obtained above. [2]

Q = E = Pt = 0.128 x 1000 x 3600 = 460 800 J
Mass of water vapourised = 0.864 – 0.712 = 0.152 kg.

L = Q/ M = (460 800/ 0.152)
= 3.03 x 10 6 J kg^{-1}

(b) If the experiment was repeated with a lid covering the beaker, would you expect the boiling point to be higher, equal or lower than the present set-up? Explain briefly. [2]

Scenario 1

If the experiment is repeated with a lid, there will be an increase in the pressure inside the beaker, this will cause the boiling point to be raised.

Scenario 2

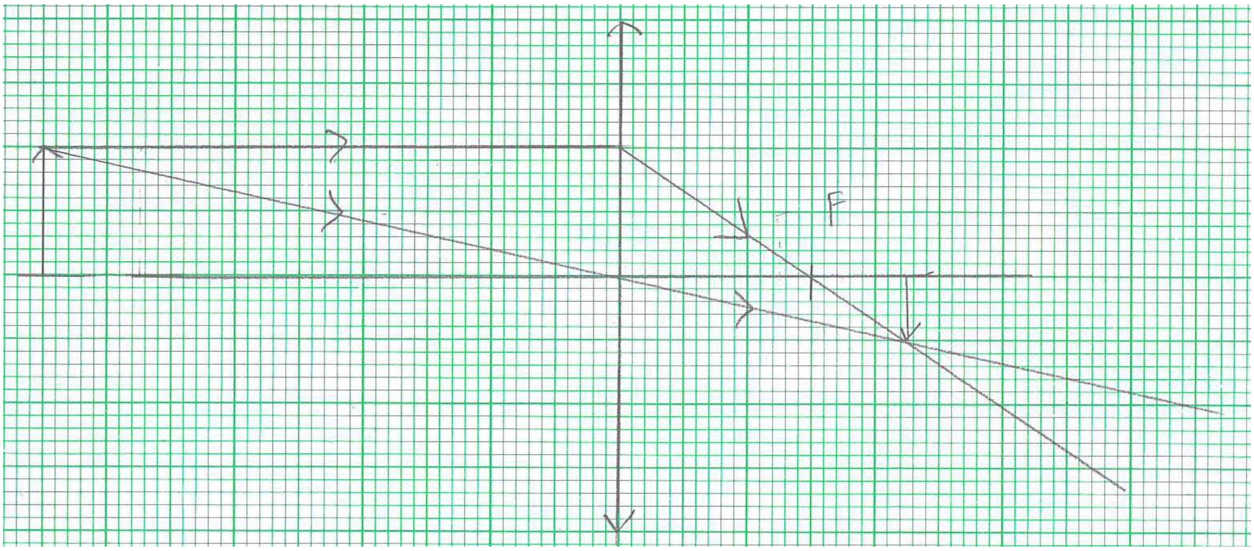
If the lid opens up during the middle of the experiment, then pressure will be equalised to atmospheric pressure. If that happens, boiling point is the same as before.

A8 An object with a height of 2.0 cm is placed 9.0 cm in front of a converging lens. The lens has a focal length of 3.0 cm. A sharp image is captured on a screen.

(a) By means of a scale diagram, find the image distance. [3]

Solution

(a) Scale: 1.0 cm rep 1.0 cm



Diagram

Image distance = 4.5 cm (accept 4.0 cm to 5.0 cm)

(b) Where should the object be placed if the image required is to be the identical to that of the object? [1]

Place the object at twice the focal length, away from centre of lens.

Section B [30 marks]

B9 When a traffic accident occurs, a proper investigation requires close inspection of the road and the surrounding area to find physical evidence in the forms of marks on the surface of the road. In a traffic accident, a driver knocked down a pedestrian on a rainy day, leaving a braking mark of length 30.0 m on the road. The police did a series of test on a rainy day and the results were as shown in **Fig. B8.1**. Assume that the car decelerated uniformly.

u / m s^{-1}	**s** / m	$\mathbf{u^2}$ / m^2 s^{-2}
10.0	25.0	
12.0	36.5	
14.0	49.3	
16.0	65.0	
18.0	81.0	
20.0	100.8	

Fig. B8.1

u : initial velocity

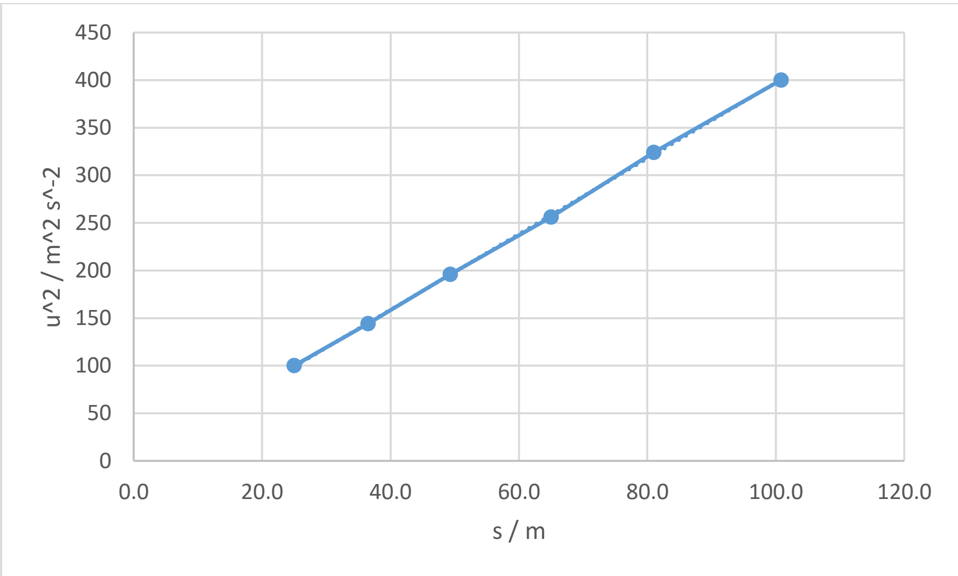
s : displacement

The final velocity, initial velocity and displacement of the vehicle are related by the equation **"$v^2 = u^2 + 2as$"**, whereby **v** and **a** are the final velocity and acceleration of the car respectively.

(a) Complete the table by calculating the values of $\mathbf{u^2}$. [1]

u / m s^{-1}	s / m	u^2 / m^2 s^{-2}
10.0	25.0	100
12.0	36.5	144
14.0	49.3	196
16.0	65.0	256
18.0	81.0	324
20.0	100.8	400

(b) Plot a graph of u^2 against **s**. The gradient of the graph corresponds to the deceleration of the car. [4]



A, S, P, L [B4]

(c) (i) The speed limit is 50 km h^{-1}. Convert 50 km h^{-1} into m s^{-1}. [1]

50 km h^{-1} = 50 x1000 / 3600 = 13.9 m s^{-1}

(ii) With reference to **(c) (i)**, deduce the corresponding braking distance. [1]

13.9 x 13.9 = 193 m s^{-1}
From graph, braking distance is 48.7 m

(iii) With reference to your answer in **(c) (ii)**, determine if the driver was speeding before braking. [1]

Since 48.7 m is more than the 30 m, he is not speeding.

(iv) How will the gradient of the graph change if the test is carried out on a dry day? Explain your answer. Assume that the reaction time of the driver remains unchanged. [2]

Gradient is larger. Larger friction between the tyres and road.

B10 A heat sink is a device to help remove heat from electronic parts. **Fig. B10.1** shows a heat sink typically placed above the computer chips. **Fig. B10.2** shows a thin layer of thermal paste being applied to the surfaces between the computer chips and the heat sink. This pasting is done as the surfaces may not be perfectly flat.

Fig. B10.1

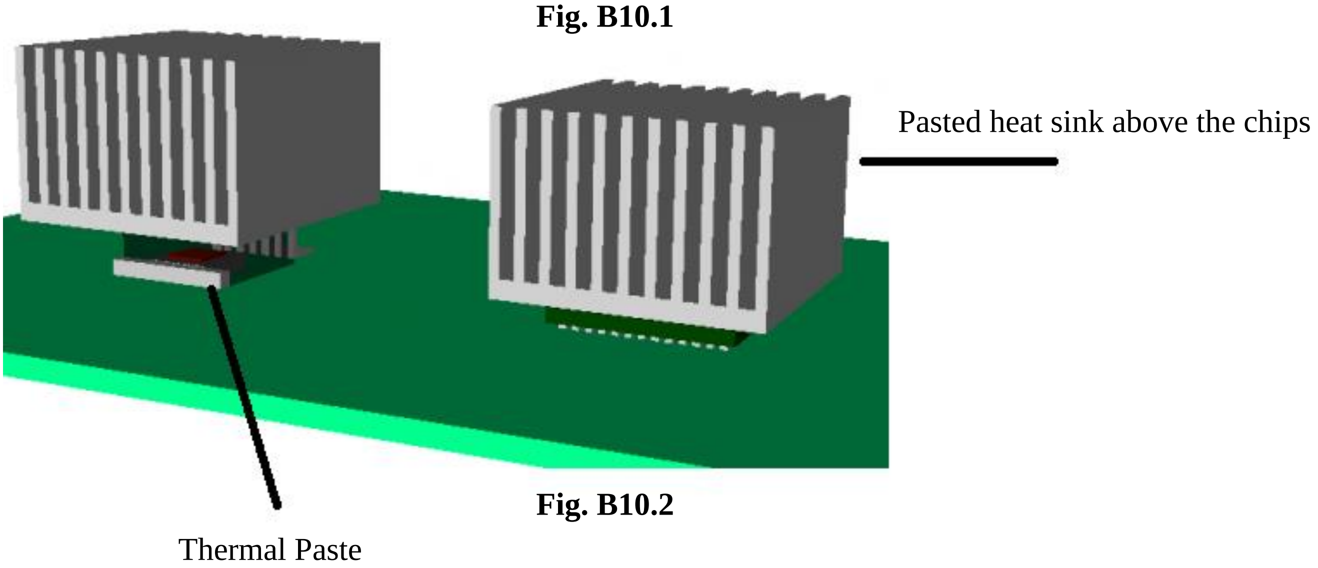


Fig. B10.2

(a) What is the purpose of the thermal paste and what property must it have? [2]

The purpose of the thermal paste is to ensure better contact for better heat conduction to take place from the computer chips to the heat sink. The paste must be able to conduct heat very well / exhibit high conductivity .

(b) Below are the features of the heat sink. [4]

1. Made of Aluminium
2. Black in colour.
3. Has many fins.
4. Air gaps between the fins.

Explain the purpose of each feature based on your knowledge of thermal heat transfer.

Aluminium is a good heat conductor and will conduct heat away from the computer chips quickly.
Black colour makes the heat sink a better heat emitter of radiant heat.
Many fins will increase the surface areas and makes the heat sink a better heat emitter of radiant heat.
The air gaps in the heat sink helps to increase heat loss by convection.

(c) Briefly describe the process of radiation and list three factors affecting it. [4]

Radiation is the process of the transmission of energy in the form of electro-magnetic radiation through space or through a material medium. It is affected by:

1. Surface Area
2. Colour
3. Texture
4. Temperature Difference (Any 3 of the 4 mentioned here)

B11 A monochromatic (single wavelength) light ray enters a semi-circular glass block at **Q** as shown in **Fig. B10.1** below.

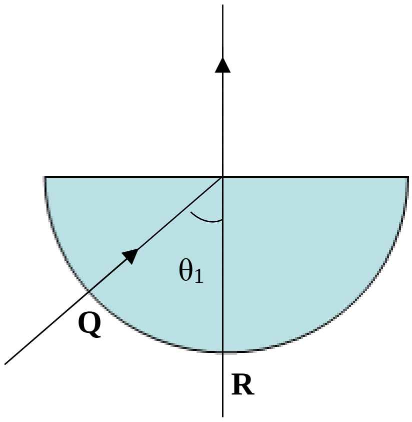


Fig. B10.1

Given that the refractive index of glass is 1.5.

(a) Explain why the light ray enters the block at **Q** without changing its direction. [2]

The incident light ray travels towards the glass along the normal, at the point of incidence. Hence the angle of incidence is 0˚.

(b) Calculate the speed of the light ray in the glass. [2]

$$n = \frac{c}{v} \qquad \frac{c}{v} = 1.5$$

$$v = \frac{3\times10^8}{1.5} = 2.0 \times 10^8 ms^{-1}$$

(c) Calculate the critical angle of the glass for the light. [2]

$$\theta c = sin^{-1}\frac{1}{nglass} = 41.8°$$

(d) Using your answer in (d), state and explain if refraction or total internal reflection occurs at $\theta_1 = 60˚$. [3]

For TIR, angle of incidence > critical angle and the light ray must pass from denser to less dense medium. Since $\theta_1 = 60˚ > 41.8˚$ (Critical angle), total internal reflection occurs.

(e) Ray **R** enters the semi-circular glass block as shown. Complete the ray diagram in **Fig. B11.1** above. [1]

END OF PAPER