



Department of Examinations - Sri Lanka
G.C.E. (A/L) Examination - 2018

117

67 - Science for Techonology

Marking Scheme

This document has been prepared for the use of Marking Examiners. Some changes would be made according to the views presented at the Chief Examiners' meeting.

Amendments to be included

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව

ජාතික ඇගයීම් හා ජර්නලයන් කොටුව

இலங்கைப் பரீட்சைத் திணைக்களம்
தேசிய மதிப்பீட்டிற்கும் பரீட்சித்தலுக்குமான சேவை

රහස්‍යයි
செறிவாகப் பாதுகாக்கப்பட்டது

අ.පො.ස.(උ.පෙළ) විභාග - 2018

க.பொ.த (உயர் தர)ப் பரீட்சை - 2018

විෂය අංකය } 67
பாட. இலக்கம் }

විෂය } Science for Technology
பாடம் }

ලකුණු දීමේ පටිපාටිය/புள்ளி வழங்கும் திட்டம் - I පත්‍රය/பத்திரம் I

ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.
01.	3	11.	5	21.	4	31.	1	41.	5
02.	5	12.	2	22.	3	32.	2	42.	4
03.	4	13.	1	23.	2	33.	2	43.	1
04.	4	14.	3	24.	1	34.	3	44.	4
05.	4	15.	2	25.	1	35.	1	45.	5
06.	3	16.	4	26.	5	36.	5	46.	2
07.	4	17.	4	27.	3	37.	2	47.	1
08.	3	18.	2	28.	4	38.	5	48.	3
09.	4	19.	4	29.	5	39.	4	49.	3
10.	1	20.	2	30.	2	40.	5	50.	2

විශේෂ උපදෙස්
விசேட அறிவுறுத்தல்

එක් පිළිතුරකට
ஒரு சரியான விடைக்கு

ලකුණු

01

වැරදිත් 50
புள்ளி வீதம்

මුළු ලකුණු
மொத்தப் புள்ளிகள்

1×50 = 50

G.C.E. (A/L) Examination - 2018

67 - Science for Technology- II

Marking Scheme

Part A - Structured Essay

Part A – Structured Essay

Answer all questions on this paper itself.

1. Microorganisms are found in almost everywhere on the earth. Few of those microorganisms are listed in the box below. Answer the following questions, using the microorganisms given in the box.

(A) <i>Acetobacter</i>	(B) <i>Clostridium</i>	(C) <i>Lactobacillus</i>
(D) <i>Saccharomyces</i>	(E) <i>Penicillium</i>	(F) <i>Methanococcus</i>

- (a) (i) What is the group, that the above D and E microorganisms belong to?

Fungi

(10 marks)

- (ii) What is the major component of the cell wall of both microorganisms, D and E?

Chitin

(05 marks)

- (iii) Which antibiotic can be produced by using the microorganism E?

Penicillin

(05 marks)

- (iv) Name the microorganism that can be used in more than one industry.

Saccharomyces OR "D" / *Lactobacillus* OR "C"

(10 marks)

- (v) Name the microorganism that is involved in biogas production.

Methanococcus OR "F"

(05 marks)

- (vi) Which microorganism grows only under the compulsory anaerobic condition?

Clostridium OR "B"

(05 marks)

- (vii) What is the shape of a *Lactobacillus* cell?

Bacillus/ rod/ cylindrical

(10 marks)

(Total marks 50)

- (b) Industrial vinegar production is done by the microbial fermentation. The two main steps in the vinegar production can be given as follows:

Step 1

Step 2

Raw material (X) \longrightarrow Intermediate product (Y) \longrightarrow Vinegar

- (i) What is the most widely used raw material in the vinegar production in Sri Lanka?

Coconut inflorescence sap /sap

(05 marks)

- (ii) Name the disachcharide in 'X'.

Sucrose

(05 marks)

- (iii) What is the experiment used for the identification of 'X'?

Testing with benedict reagent in the presence of diluted HCl (acidic medium/H⁺).

(05 + 05 marks)

(iv) Out of step 1 and step 2, which step is based on the microbial fermentation?

Step 1

(05 marks)

(v) What is the step in the vinegar production process that *Acetobacter* is involved?

Step 2

(05 marks)

(vi) If the production process is terminated at step 1, what is the product that can be obtained?

Ethanol/ C_2H_5OH / CH_3CH_2OH / Ethyl alcohol / toddy

(10 marks)

(vii) Write the chemical name of vinegar.

Acetic acid/ Ethanoic acid

(10 marks)

(No marks for formula).

(Total marks 50)

2. Calorific value (amount of heat produced on complete burning of 1 g of fuel) of wood is less than LP gas. Technologically advanced Gliricidia wood pellets have a greater calorific value compared to typical wood based fuel. Gliricidia (*Gliricidia sepium*) is commonly used in wood pellet production industries in Sri Lanka.

Chemical reaction of the combustion of the Gliricidia pellets can be given as follows.

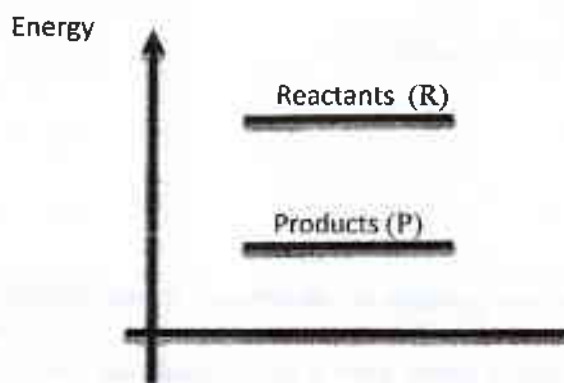


(a) (i) Is the combustion of wood fuel an endothermic or exothermic?

Exothermic

(10 marks)

(ii) For the above combustion, mark the energy positions of the reactants (R) and the products (P) on the relevant energy levels in the given diagram below.



(If the student considered the reaction, all reactants and products should be written).

(If both correct, 10 marks)

(iii) State two environmental advantages of using Gliricidia wood pellets over LP gas to produce energy

Gliricidia is a renewable energy source

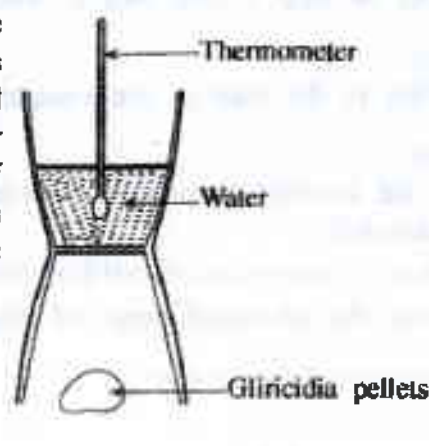
Gliricidia do not add additional CO_2 to the environment / No contribution to change CO_2 percentage in the atmosphere

Use of Gliricidia can save the other fuels with higher energy density such as LP gas.

(Any two answers, $10 \times 2 = 20$ marks)

(Total marks 40)

- (b) A sketch of the experimental setup to determine the calorific values of Gliricidia wood and Gliricidia wood pellets is given in the figure. A mass of 500 g of water is used for the experiment. The specific heat capacity of water is $4.2 \text{ J } ^\circ\text{C}^{-1} \text{ g}^{-1}$. The water at the initial temperature of 32°C has warmed up to final temperature of 62°C when a mass of 15 g of Gliricidia pellets combusted for the experiment.



- (i) Calculate the amount of heat absorbed by water.

$$\begin{aligned}\Delta E &= mc\Delta\theta / mc\theta \text{ or } ms\Delta\theta / ms\theta \\ &= 500 \text{ g} \times 4.2 \text{ J } ^\circ\text{C}^{-1} \text{ g}^{-1} \times 30^\circ\text{C} \\ &= 63000 \text{ J or } 63 \text{ kJ}\end{aligned}$$

(05 marks)

(05 marks)

(04 + 01 marks)

- (ii) The time taken for the combustion of 15 g of Gliricidia wood pellets is 20 minutes. Calculate the rate of combustion in g min^{-1} .

$$\begin{aligned}\text{Rate} &= - (\text{weight difference}) / \text{time difference OR } -(\Delta m / \Delta t) \\ &= - (-15 \text{ g}) / 20 \text{ min} \\ &= 0.75 \text{ g min}^{-1}\end{aligned}$$

(05 marks)

(05 marks)

(05 marks)

- (iii) Calculate the calorific value of Gliricidia wood pellets used for the experiment.

$$\begin{aligned}\text{Calorific value} &= 63000 \text{ J} / 15 \text{ g or } 63 \text{ kJ} / 15 \text{ g} \\ &= 4200 \text{ J/g or } 4.2 \text{ kJ/g}\end{aligned}$$

(10 marks)

(04 + 01 marks)

- (iv) Standard calorific value reported in literature is greater than the calorific value of Gliricidia wood pellets obtained from this experiment. State one possible reason for this observation.

Loss of heat to the environment (partial combustion) OR

Heat gained by the vessel OR

Gliricidia wood pellets are not dried.

(15 marks)

(Total marks 60)

3. (a) You have been asked to design and perform an experiment in the laboratory to determine the specific latent heat of fusion of ice using the method of mixtures. A thermally insulated copper calorimeter with water and a stirrer with a mesh, small ice pieces, blotting papers, a triple beam balance, a thermometer and a Bunsen burner are provided.

- (i) State one advantage of using a thermally insulated calorimeter.

Heat loss (to the surroundings) can be neglected.

Heat loss (to the surroundings) is minimized or prevented.

No heat exchange with the surrounding.

(Any reason 05 marks)

- (ii) What are the three measurements obtained before adding ice to the calorimeter?

X₁: Mass of empty calorimeter (+ stirrer)

X₂: Mass of water and calorimeter (+ stirrer)

X₃: (Initial) Temperature of water

(05 x 3 = 15 marks)

(Irrespective of the order)

- (iii) State two precautionary steps that you should follow when ice is added into the calorimeter.

Use small ice pieces

Add one ice piece at a time

Before adding ice pieces wipe out water on them (dry the ice pieces)

Avoid splashing of water

Use a stirrer with a mesh to stop floating ice on water.

Any two (05 x 2 = 10 marks)

- (iv) What are the two measurements obtained after finishing the process of adding ice

X_4 : Minimum temperature of the mixture

X_5 : Final mass of the mixture

(05 x 2 = 10 marks)

- (v) If L is the specific latent heat of fusion of ice, C_w is the specific heat capacity of water and C is the specific heat capacity of copper,

(1) write an expression for the heat gained in terms of the measurements you obtained when melting ice.

$$\text{Heat received when melting ice} = (X_5 - X_2)L + (X_5 - X_2)C_w(X_4 - 0)$$

(05 marks)

(2) write an expression for the heat emitted by water and the calorimeter in terms of the measurements you obtained.

$$\text{Heat released from water and calorimeter} = (X_2 - X_1)C_w(X_3 - X_4) + X_1C(X_3 - X_4)$$

(05 marks)

(3) write an equation to determine the specific latent heat of fusion of ice using the above expressions.

$$(X_2 - X_1)C_w(X_3 - X_4) + X_1C(X_3 - X_4) = (X_5 - X_2)L + (X_5 - X_2)C_wX_4$$

(10 marks)

(Only to equalize above (1) and (2) expressions, award 05 marks)

- (vi) Write a reason for not using powdered ice instead of small ice pieces in this experiment.

Powdered ice becomes liquid water easily and involve in heat exchange.

During the transfer of the powdered ice to the calorimeter, amount of heat lost from the powder is high because of its high surface area.

Temperature of the powdered ice will be higher than 0°C when it is transferred to the calorimeter because of higher melting rate (due to large surface area).

Water stays around powdered ice. They cannot blot.

(Any reason 05 marks)

(Total marks 65)

- (b) (i) Explain why ice is transported as large pieces.

Smaller specific surface area reduces the melting rate OR

To control melting of ice.

(05 marks)

- (ii) Fishes are stored in synthetic polymer boxes with ice pieces for preservation. What is the scientific reason to use synthetic polymer boxes?

Reduce heat conductivity / Boxes are heat insulators / boxes are lagged

(05 marks)

- (iii) In transportation, ice pieces are embedded in wooden flakes. Give the scientific reason for this.

Wooden flakes act as an insulator / act as an lagging material.

(05 marks)

- (iv) What is the biological reason for preserving fishes at low temperature?

Population/density of microorganisms controls/reduces OR

The growth rate of the microorganism population reduces.

(05 marks)

- (v) There are 10kg of fish in a heat insulated box at 30°C temperature. Calculate the mass of ice that is needed to decrease the temperature of fish to 15°C.

The specific latent heat of fusion of ice is $3.33 \times 10^5 \text{ J kg}^{-1}$ and the specific heat capacity of water is $4200 \text{ J } ^\circ\text{C}^{-1} \text{ kg}^{-1}$. Assume that the average specific heat capacity of the body materials of fish is $2640 \text{ J } ^\circ\text{C}^{-1} \text{ kg}^{-1}$.

$$m_f s_f (30^\circ\text{C} - 15^\circ\text{C}) = m_i L + m_i s_w (15^\circ\text{C} - 0^\circ\text{C}) \quad \text{OR}$$

$$10 \times 2640 \times 15 = m_i (333 \times 10^3 + [4200 \times 15])$$

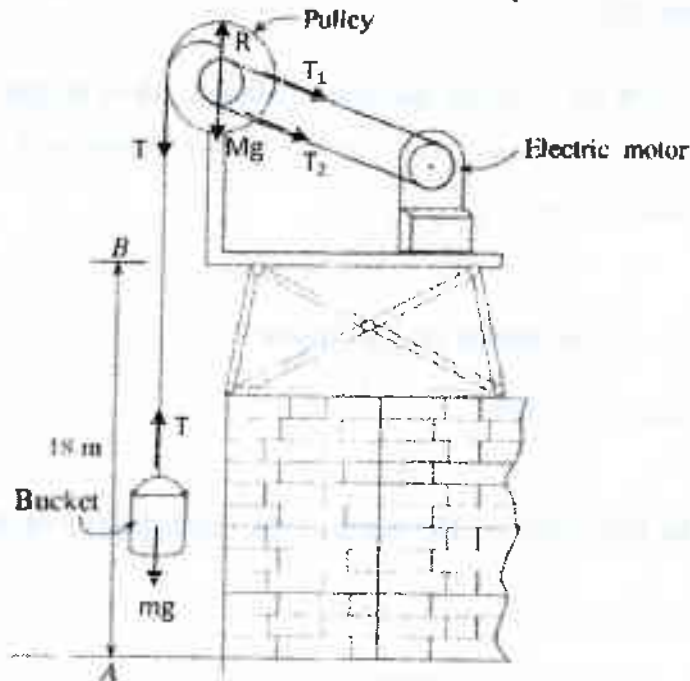
(Left side + Right side = 05 + 05 marks)

$$m_i = 1 \text{ kg}$$

(04 + 01 marks)

(Total marks 35)

4. The given diagram shows a setup used to lift a mixture of concrete at a building construction site. A light cable has been wound around the pulley. One end of the cable has been attached to the pulley and the other end to the bucket. When the pulley is rotated by the electric motor, the bucket is lifted by winding the cable around the pulley. Consider the gravitational acceleration as 10 m s^{-2} and the ground as the level of zero potential.



- (a) (i) The bucket with concrete mixture is performing motion.

Linear / vertical

(05 marks)

- (ii) Pulley is performing motion.

Rotational

(05 marks)

- (iii) Mark the forces acting on the bucket in the diagram.

(For marking T, 05 marks)

(For marking $1000 \text{ N} / W / mg / 100 \text{ g}$, 05 marks)

- (iv) Mark the forces acting on the pulley in the diagram, if the pulley with the axle is rotated around a smooth axis.

(For marking T, 05 marks)

(For marking unequal T_1 and T_2 , 10 marks)

(Total marks 35)

- (b) (i) Calculate the tension of the cable when it is lifting at an acceleration of 2 m s^{-2} and if the mass of the bucket with the concrete mixture is 100 kg .

$$T - 1000 = 100 \times 2$$

$$T = 1200 \text{ N}$$

(04 + 01 marks)

- (ii) What is the angular acceleration of the pulley if the radius of it is 25 cm ?

$$a = R\alpha$$

$$\alpha = \frac{a}{R} = \frac{2}{0.25} =$$

$$8 \text{ rad s}^{-2}$$

(05 marks)

(04 + 01 marks)

- (iii) What is the effective torque acting on the pulley if the moment of inertia of the pulley with the axle is 25 kg m^2 ?

$$\tau = I\alpha = 25 \times 8 =$$

$$200 \text{ N m}$$

(04 + 01 marks)

(Total marks 20)

- (c) The bucket with the concrete mixture is lifted at 18 m height at 6 seconds and stopped.

- (i) What is the potential energy gained by the bucket with the mixture?

$$\text{Potential energy} = 100 \times 10 \times 18$$

$$= 18 \text{ kJ}$$

(04 + 01 marks)

- (ii) What is the output power of the motor?

$$\text{Output power} = \frac{100 \times 10 \times 18}{6}$$

$$= 3 \text{ kJ}$$

(05 marks)

(04 + 01 marks)

- (iii) What is the efficiency of the setup if the input power of the motor is 5 kW?

$$\text{Efficiency of the setup} = \frac{3}{5} \times 100\%$$

(05 marks)

$$= 60 \%$$

(04 + 01 marks)

(Total marks 25)

- (d) Will the change of radius of the pulley affect the efficiency of the setup?

No

(02 marks)

Justify your answer scientifically.

Power transmission belt is connected to the axle. So there is the same speed of rotation of the pulley.

(08 marks)

- (e) If the rotating axle of the pulley in the setup is rough, is the efficiency of the setup decreasing or increasing or not changing?

Decrease.

(02 marks)

Briefly write the scientific reason for your answer.

Energy loss due to frictional torque.

(08 marks)

(Total marks 20)

Part B - Essay

5. The floor plan of an equilateral hexagonal shaped old fort is shown in figure 01. The centre of the fort is O and the side length is 60 m. The main entrance of the fort is at the AB wall and shape of it is depicted in figure 02. There are 6 similar towers in A, B, C, D, E and F corners and the shape of a tower is shown in figure 03 (Consider $\pi = 3.14$, $\sqrt{26} = 5.01$ and $\sqrt{3} = 1.73$ in calculations)

	30°	45°	60°
sin	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$
cos	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$
tan	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$

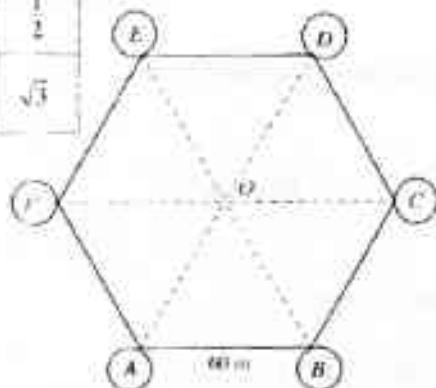


Figure 01

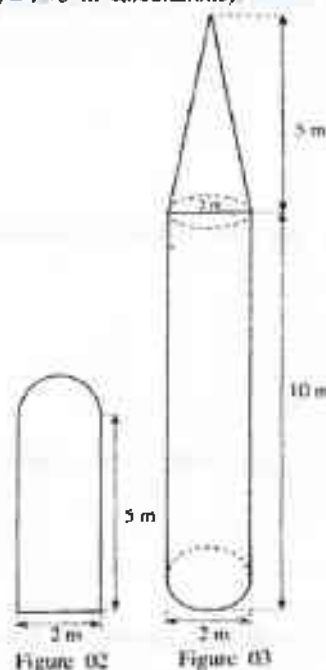


Figure 02

Figure 03

- (a) Using the data in the given figures, calculate the following.

- Length of FO
- Area of the base of a tower
- Floor area of section $ABCF$
- Area of the inner floor of the fort

(i) Consider $\triangle AFO$.

According to the given data, $\angle FOA = \angle FAO = 60^\circ$

(05 marks)

Therefore, $\triangle AFO$ is an equilateral triangle.

(05 marks)

Therefore, length of $FO = 60$ m

(04 + 01 marks)

- (ii) Radius of the tower base = $\frac{2}{2} = 1$ m

(05 marks)

Area of the tower base = $\pi \times 1^2$

(05 marks)

$$= 3.14 \text{ m}^2$$

(04 + 01 marks)

- (iii) $\triangle OCB$ is also an equilateral triangle. So the length of OC also is 60 m

(05 marks)

Therefore, length of $FC = 60 \text{ m} + 60 \text{ m}$

$$= 120 \text{ m.}$$

(05 marks)

Considering $\triangle AEF$ triangle, height of trapezium $ABCF = 60 \cos 30^\circ = 60 \times \frac{\sqrt{3}}{2}$

(05 marks)

$$= 30 \times 1.73 = 51.9 \text{ m}$$

(05 marks)

$$\begin{aligned} \text{Area of trapezium } ABCF &= \frac{1}{2} (60 + 120) \times 51.9 \\ &= 4671 \text{ m}^2 \end{aligned}$$

(05 marks)

(04 + 01 marks)

Alternative method

Consider AFO equilateral triangle .The side length of it is 60 m.

$$\text{Hence the height of AFO equilateral triangle} = 60 \cos 30^\circ = 60 \times \frac{\sqrt{3}}{2}$$

(05 marks)

$$= 30 \times 1.73 = 51.9 \text{ m}$$

(05 marks)

$$\text{Therefore the area of AFO equilateral triangle} = \frac{1}{2} \times 60 \times 51.9$$

(05 marks)

$$= 1557 \text{ m}^2$$

(05 marks)

$$\text{Area of trapezium ABCF} = 3 \times \text{area of AFO triangle}$$

(05 marks)

$$= 3 \times 1557 = 4671 \text{ m}^2$$

(04 + 01 marks)

$$\text{(iv) According to the figure, Area of trapezium FCDE} = 4671 \text{ m}^2$$

(05 marks)

$$\text{Inner floor area of the fort} = 4671 + 4671$$

(05 marks)

$$= 9342 \text{ m}^2$$

(04 + 01 marks)

(Total marks 75)

(b) The door at the main entrance is made of 0.3 m thick wood. The shape of the upper part of the door is semi-circular as shown in figure 02.

(i) Calculate the area of the front surface of the door.

(ii) The mass of a cubic metre of wood used to make the door is 100 kg. Calculate the mass of the door.

$$\text{(i) Area of the rectangular part of the door} = 2 \times 5 = 10 \text{ m}^2$$

(05 marks)

$$\text{Radius of the semi-circular part of the door} = \frac{2}{2} = 1 \text{ m}$$

(05 marks)

$$\text{Area of the semi-circular part} = \frac{1}{2} \times \pi \times 1^2 = \frac{\pi}{2} \text{ m}^2$$

(05 marks)

$$= 1.57 \text{ m}^2$$

(05 marks)

$$\text{Front surface area of the door} = 10 + 1.57 = 11.57 \text{ m}^2$$

(04 + 01 marks)

$$\text{(ii) Thickness of the door} = 0.3 \text{ m}$$

$$\text{Volume of the wood of the door} = 11.57 \times 0.3 = 3.471 \text{ m}^3$$

(05 marks)

$$\therefore \text{Mass of the door} = 3.471 \times 100 = 347.1 \text{ kg}$$

(04 + 01 marks)

(Total marks 35)

(c) If the tower given in figure 03 consists of a cylindrical part and a right circular cone, calculate the surface area of a tower. (excluding the base).

$$\text{Radius of the tower} = \frac{2}{2} = 1 \text{ m}$$

$$\text{Surface area of the cylindrical shaped part of the tower} = 2 \times \pi \times 1 \times 10 = 20\pi \text{ m}^2$$

(05 marks)

$$= 62.8 \text{ m}^2$$

(05 marks)

$$\text{Surface area of the conical shaped part of the tower} = \pi \times 1 \times 5.01 = 5.01\pi \text{ m}^2$$

(05 marks)

$$= 15.73 \text{ m}^2 \quad (05 \text{ marks})$$

$$\text{Surface area of the tower} = 62.8 + 15.73 = 78.53 \text{ m}^2 \quad (04 + 01 \text{ marks})$$

(Total marks 25)

- (d) Obtain the tangent value of the angle of elevation to the top of the tower located at the position F as seen by a child at the position O whose eye level is 1 m above the ground.

$$\text{Height of the tower from the eye level} = 5 + 10 - 1 = 14 \text{ m} \quad (05 \text{ marks})$$

$$\begin{aligned} \text{Distance from } O \text{ to centre of the tower} &= OA + \text{radius of the cylindrical part of the tower} \\ &= 60 + 1 = 61 \text{ m} \end{aligned} \quad (05 \text{ marks})$$

$$\text{If } \theta \text{ is the angle of elevation to the top of the tower, } \tan \theta = \frac{14}{61} = 0.229 \text{ or } 0.23 \quad (05 \text{ marks})$$

(Total marks 15)

6. (a) Amount of carbon monoxide emission is measured at the vehicle emission test. Amounts of carbon monoxide obtained by testing 50 petrol cars are given in the following grouped frequency distribution.

Table 1: Grouped frequency distribution for petrol cars

Class limits	Number of vehicles (frequency)	Class boundary	Class mark	Cumulative frequency	Percentage cumulative frequency
0.1 - 1.0	02				
1.1 - 2.0	03				
2.1 - 3.0	10				
3.1 - 4.0	20				
4.1 - 5.0	08				
5.1 - 6.0	05				
6.1 - 7.0	02				

- (i) Complete class boundary, class mark, cumulative frequency and percentage cumulative frequency columns in the Table 1 above.

Class limit	Number of vehicles	Class boundary	Class mark	Cumulative frequency	Percentage cumulative frequency
0.1 - 1.0	02	0.05-1.05	0.55	02	04
1.1 - 2.0	03	1.05-2.05	1.55	05	10
2.1 - 3.0	10	2.05-3.05	2.55	15	30
3.1 - 4.0	20	3.05-4.05	3.55	35	70
4.1 - 5.0	08	4.05-5.05	4.55	43	86
5.1 - 6.0	05	5.05-6.05	5.55	48	96
6.1 - 7.0	02	6.05-7.05	6.55	50	100

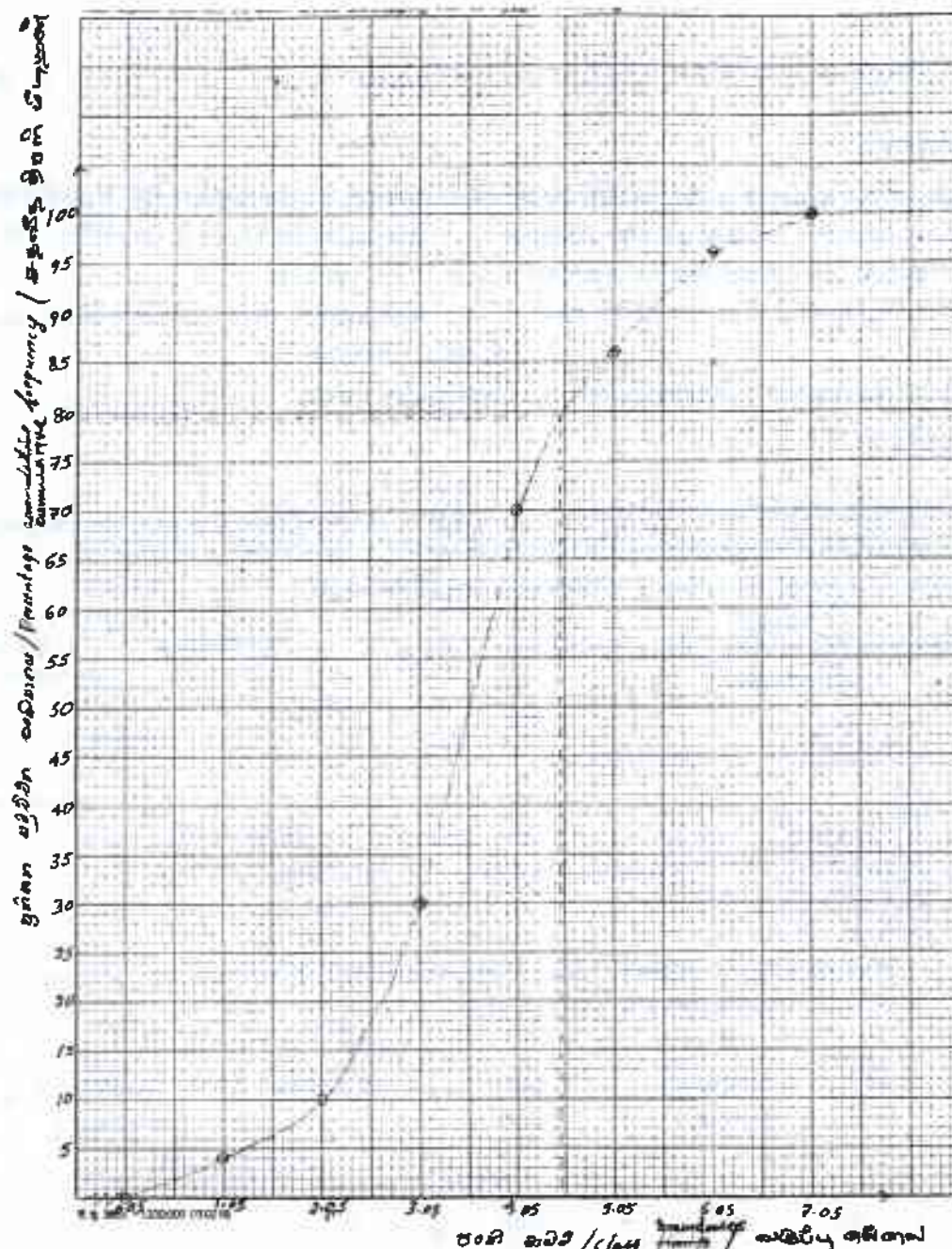
(10 marks) (10 marks) (10 marks) (10 marks)

- (ii) Using the grouped frequency distribution, calculate the mean of the amount of carbon monoxide emitted by petrol cars.

$$\text{Mean} = \frac{2 \times 0.55 + 3 \times 1.55 + 10 \times 2.55 + 20 \times 3.55 + 8 \times 4.55 + 5 \times 5.55 + 2 \times 6.55}{50} \quad (05 \text{ marks})$$

$$= 3.59 \quad (05 \text{ marks})$$

- (iii) Draw the percentage cumulative frequency curve for the above distribution on the graph paper provided.



(Labelled axes with rational scale, $04 \times 2 = 08$ marks)

Marking 7 points, $02 \times 7 = 14$ marks

Shape of the graph including point $(0.05, 0) = 03$ marks)

- (iv) According to the current law, the petrol cars with carbon monoxide emission greater than 4.5 are considered as not roadworthy. Find the percentage of unroadworthy petrol cars, using the percentage cumulative frequency curve.

Percentage of petrol cars with carbon monoxide emission less than 4.5%79.5 =

(05 marks)

Therefore, the percentage of petrol cars with carbon monoxide emission less than 4.5 =

79.5 - 100

(05 marks)

%20.5 = (%21.5 - %19.5)

(05 marks)

(Total marks 90)

(b) Amount of carbon monoxide obtained for 20 trishaws are tabulated as follows.

Table 2: Ungrouped frequency distribution for trishaws.

Amount of Carbon monoxide	Number of vehicles
3.5	02
4.1	02
4.8	01
5.2	01
5.7	03
6.0	05
6.3	01
6.5	02
7.4	03

(i) Calculate the range of the middle 50% of the amounts of carbon monoxide emitted by trishaws.

Inter quartile Range

Q1 – Middle value of the 5th and 6th data points (5.25th Data Point) (05 marks)

5.2 4.8 4.1 4.1 3.5 3.5

Q1 = 4.9 = 0.25 * (4.8 – 5.2) + 4.8 (05 marks)

Q3 – Middle value of the 15th and 16th data points (15.75th Data Point) (05 marks)

6.3 6.5 6.5 7.4 7.4 7.4

Q3 = 6.45 = 0.5 * (6.3 + 6.5) (05 marks)

Inter quartile Range = 6.45 – 4.9 = 1.55. (05 marks)

Therefore the range of the middle 50% of the data = 1.55 (05 marks)

(ii) Complete the following table using the data given in the Table 2.

Table 3 : Grouped frequency distribution for trishaws

Class limit	Number of vehicles
3.1 – 4.0	
4.1 – 5.0	
5.1 – 6.0	
6.1 – 7.0	
7.1 – 8.0	

Class limit	Number of vehicles
3.1-4.0	02
4.1- 5.0	03
5.1-6.0	09
6.1-7.0	03
7.1-8.0	03

(05 marks)

- (iii) Using the grouped frequency distributions given in Table 1 and Table 3, determine which type of vehicle has the higher dispersion in amounts of carbon monoxide. Justify your answer.

The maximum range for petrol cars $6.9 = 0.1 - 7.0 =$ (05 marks)

The maximum range for trishaws $4.9 = 3.1 - 8.0 =$ (05 marks)

Therefore, the dispersion is higher for petrol cars. (05 marks)

Alternative method

The minimum range for petrol cars $5.1 = 1.0 - 6.1 =$ (05 marks)

The minimum range for trishaws $3.1 = 4.0 - 7.1 =$ (05 marks)

Therefore, the dispersion is higher for petrol cars. (05 marks)

- (iv) Obtain a single grouped frequency distribution for two types of vehicles using Table 1 and Table 3. (It is enough to show the 'class limit' and the 'number of vehicles' in the new distribution).

Class limit	Number of vehicles
0.1 – 1.0	02
1.1 – 2.0	03
2.1 – 3.0	10
3.1 – 4.0	22 (20 + 2)
4.1 – 5.0	11 (8 + 3)
5.1 – 6.0	14 (5 + 9)
6.1 – 7.0	05 (2 + 3)
7.1 – 8.0	03

(05 x 2 = 10 marks)

(Total marks 60)

Part C - Essay

7. Based on current investigations, it has been reported that a larger amount of plastic dumped into the ocean has been collected on the Pacific Ocean surface. It has been estimated that the amount of plastic floating on the ocean surface is approximately 80,000 metric tons. The region with this plastic garbage collected is known as the 'Great Pacific Garbage Patch'.

- (a) (i) Is plastic a synthetic polymer or a natural polymer?

Synthetic

(10 marks)

- (ii) State one major advantage of plastics.

Easy to manufacture / low cost / can be used to many purposes / easily recycle / light / low weight

(Any one, 10 marks)

- (iii) State one major disadvantage of plastics.

Non-biodegradable / exist longer time in the environment.

(10 marks)

- (iv) State two actions that can be taken to minimize the environmental impact of plastics.

Recycle / reuse / reduce the use / use biodegradable alternatives

(Any two, 10 x 2 = 20 marks)

- (v) State one possible effect on human due to burning of plastics.

Production of poly aromatic compounds (dioxins) / production of toxic compounds (gases) / increasing the risk of cancers.

(Any one, 10 marks)

- (vi) What is the impact of the 'Great Pacific Garbage Patch' on the fish population in Pacific Ocean?

Reduce the population density (lower the number) OR Toxic and reduced.

(Any one, 10 marks)

(Total marks 70)

- (b) Drinking water is a limited natural renewable resource. National Water Supply and Drainage Board distributes water suitable to drink after processing.

(i) Water cycle is a natural cycle. Describe it.

Explain the way to show how water exchanged among the various parts/ phases of the nature.

(10 marks)

- (ii) What are the two cations responsible for the permanent hardness of water?

Ca^{2+} and Mg^{2+} / Ca ions and Mg ions / Ca and Mg

(Any answer, 10 marks)

- (iii) Name a chemical that is used by the National Water Supply and Drainage Board to remove mud particles during the water purification process.

Alum (Aluminum sulfate) OR Poly electrolyte

(10 marks)

- (iv) Water distributed by the National Water Supply and Drainage Board must not be used to wash vehicles and watering plants. Briefly explain the reason for this.

Drinking water is a limited resource OR Government spent money on production of drinking water.

(Any answer, 10 marks)

(Total marks 40)

- (c) An activity performed by a student using the waste plastic bottles is described below.

A used plastic bottle filled with water was tightly closed with a lid and dipped in the cistern of the toilet by the student. This reduced the volume of water required to fill the cistern by 1 litre. Due to this, the amount of water required to flush the toilet once can be reduced by 1 litre.

- (i) What is the amount of water that can be saved in a school, which uses the toilet 1000 times per day, for 30 days?

$$1\text{L} \times 1000 \times 30$$

$$= 30,000\text{ L}$$

(09 + 01 marks)

- (ii) If one unit of water is 1000 litre, what is the number of units that can be saved by this method for 30 days?

$$30,000\text{ (L)} / 1000\text{ (L)}$$

$$= 30\text{ units}$$

(10 marks)

- (iii) Use of liquid soap to wash hands after using toilet is a common practice. State one environmental issue that can occur as a result of the release of waste water containing liquid soap.

Release of dissolved organic compounds to the environment OR

Addition of organic (non-biodegradable) compounds to the environment OR

Water pollution OR

Soil pollution OR

Increase the salinity of soil

(Any answer, 10 marks)

- (iv) Suggest a method to reuse waste water containing hand washed liquid soap within the toilet to encourage the water management.

Collect and use the water with soap to flush/clean the toilet

(10 marks)

(Total marks, 40)

8. Resources required to start an industry can be divided into five groups according to the 5M concept.

(a) Two essential resource groups listed by this concept are Methods and Materials.

- (i) According to the 5M concept, what are the other three resource groups required to start an industry?

Money, Man, Power, Machines

(05 x 3 = 15 marks)

- (ii) State two factors that must be considered when selecting raw materials.

Easy to obtain (easy to access), available in large scale, high purity, long term affordable

(Any two, 05 x 2 = 10 marks)

- (iii) In the modern 5M concept, Methods and Materials are considered as one group and Marketing is included as a new group. Explain the importance of this group.

The produced goods must be sell in the market to make the industry commercially viable. Marketing provide the required publicity to sell the product.

(15 marks)

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(= x 3 05) 15 marks)

(Total marks 40)

- (b) The organic solvent in expired enamel paints can be recovered using distillation and can be used again for paint production.

- (i) What is the function of organic solvent present in enamel paint?

To control/reduce the viscosity

(10 marks)

- (ii) What is the solvent used in emulsion paint?

Water

(10 marks)

- (iii) Why is the use of emulsion paint is more environmental friendly compared to the enamel paint?

Do not release organic vapor to the environment

(10 marks)

- (iv) State two advantages that a producer can gain by using organic solvent recovered from expired paint for the production of enamel paints in Sri Lanka.

Reduce the cost to process the waste / Reduce the impact on the environment / Cost for the raw materials is less/ Time spent to import raw material is reduced.

(Any two 05 x 2 = 10 marks)

- (v) What is the main property of the solvent that must be considered when selecting a solvent for the production of a paint that dries quickly?

Low boiling point OR Evaporate quickly

(10 marks)

- (vi) State two physio-chemical changes that take place during the drying process of enamel paint after application.

Evaporation / drying of solvent,

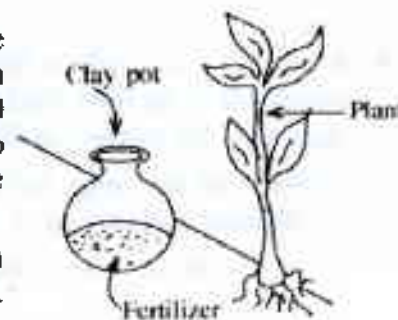
polymeric materials closely packed on the surface (produce cross links)

Forming dry paint film

(Any two 05 x 2 = 10 marks)

(Total marks 60)

- (c) A method suggested by a student to apply super phosphate fertilizer to a cultivation located on a steep mountain region with higher precipitation is shown in the diagram. Water is poured into clay pots with fertilizer buried in the ground parallel to the cultivation. Water with fertilizer is slowly dripped into the soil through the walls of clay pots.



- (i) State one economical and environmental disadvantage each of using larger amounts of fertilizers to obtain greater yields.

Economical disadvantage: Higher cost for fertilizers or Higher production cost

Environmental disadvantage : Release nutrients to the environment (Eutrophication) or describe any reason for Eutrophication.

(05 x 2 =10 marks)

- (ii) Name the city in which the largest phosphate deposit consisting phosphate in Sri Lanka.

Eppawala

(10 marks)

- (iii) What is the disadvantage of addition of super phosphate fertilizer to a cultivation located on a steep mountain region having a high precipitation?

Fertilizer can be washed away with the rain water.

(10 marks)

- (iv) How can the disadvantage stated in part (iii) be minimized by the method proposed by the student?

Fertilizer is trapped inside the clay pot OR fertilizer released slowly to the soil.

(Any reason, 10 marks)

- (v) State a possible disadvantage of the method proposed by the student.

Fertilizer is concentrated at a single location OR Fertilizer is not spread around the plant root system.

(10 marks)

(Total marks 50)

Part D - Essay

9. A stadium in Sri Lanka is fitted with 4 lighting poles at 4 corners to provide uniform lighting to the playground in the night. Each pole has 60 numbers of 2 kW Halide lamps. Spectator stands and other areas have 500 numbers of 100 W CFL lamps and 150 numbers of 200 W industrial fans.

(a) When all the lamps and fans are switched ON for 6 hours for a night match, calculate the electrical consumption of the following in kWh.

(i) by all the fans in the stadium

$$200 \text{ W} \times 150 \times 6 \text{ hrs}$$

(05 marks)

$$= 180 \text{ kWh}$$

[05 Marks]

(ii) by all the CFL lamps in the stadium

$$100 \text{ W} \times 500 \times 6 \text{ hrs}$$

(05 marks,

$$= 300 \text{ kWh}$$

[05 Marks]

(iii) by all the halide lamps in the stadium

$$2 \text{ kW} \times 240 \times 6 \text{ hrs}$$

(05 marks)

$$= 2,880 \text{ kWh}$$

[05 Marks]

(Total marks 30)

- (b) Every month, ten night matches are played in the stadium under floodlight. If the price for one unit of electric power is Rs. 45, calculate the amount of the monthly electricity bill for the stadium.

Total electrical power consumption per match is

$$= 180 \text{ kWh} + 300 \text{ kWh} + 2,880 \text{ kWh} = 3,360 \text{ kWh}$$

(05 marks)

$$= 3,360 \text{ units}$$

[05 Marks]

Total electrical power consumption for a month is,

$$= 3,360 \times 10 = 33,600 \text{ units}$$

[05 Marks]

The monthly electric bill will be,

$$= 33,600 \text{ units} \times \text{Rs. } 45.00$$

[05 Marks]

$$= \text{Rs. } 1,512,000/-$$

[04 + 01 Marks]

(Total marks 25)

- (c) (i) Name **three** sources, which are mainly used to produce electricity in Sri Lanka.

Under the government 'Soorya Bala Sangramaya' project, it is suggested to install solar panels on the roofs of the spectator stands. A solar panel of 1 kW with the surface area of 8 m² can generate 120 kWh electrical energy in a month.

Petroleum/diesel/burnt oil/fossil fuel, Hydro power (water), coal

(05 x 3 = 15 marks)

- (ii) Write **two** advantages and **two** disadvantages of using solar panels.

Eco friendly / economical in the long run / energy source is freely available/ renewable energy/
reduces electricity bill/ low maintenance cost

(Any two 05 x 2 = 10

marks)

- (iii) Calculate the minimum number of solar panels required to be installed at the stadium to meet its monthly electrical consumption requirement.

$$\text{Minimum number of solar panels required} = 33,600 \text{ kWh} / 120 \text{ kWh}$$

(05 marks)

$$= 280 \text{ panels}$$

[05 marks]

- (iv) Assuming that all the solar panels are to be fixed only within the roof area of the stadium, calculate the minimum roof area needed to hold the required number of solar panels obtained in part (c)(iii) above.

$$\text{Roof area: } 280 \times 8 \text{ m}^2 \quad (05 \text{ marks})$$

$$= 2240 \text{ m}^2 \quad (04 + 01)$$

Marks]

- (v) If the cost of installing 1 kW solar panel with required components to connect to the national grid is Rs. 300 000,

- (1) what is the total cost for installing the minimum number of solar panels to meet the monthly requirement of the stadium?

$$\text{Rs. } 300,000 \times 280 \text{ panels} \quad (10 \text{ Marks})$$

$$= \text{Rs. } 84,000,000/- \quad (04 + 01)$$

Marks]

- (2) how long would it take in years to recover the investment on the installation of solar panels?

$$\text{Rs. } 84,000,000 / \text{Rs. } 1,512,000 \quad (10 \text{ Marks})$$

$$\approx 55 \text{ or } 56 \text{ months} \approx 4\frac{3}{4} \text{ years} \quad (05 \text{ Marks})$$

(Total marks 75)

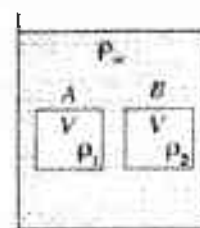
- (d) Net-Metering plan allows consumers to generate electricity through solar panels and set off the power generated against the power consumed from the national grid. Consumer pays only for the 'net' number of units (difference between import and export electrical energy) every month. What is the main advantage of using the net-metering arrangement at the stadium?

The excess electric power generated during the day time is readily exported to the national grid.

(2 0marks)

10. (a) Two cubes A and B each having volume V , are made of materials of densities ρ_1 and ρ_2 , respectively. These two cubes are kept closer to the middle of a tall vessel filled with water as shown in the figure and gently released them.

Consider that the density of water is ρ_w and $\rho_1 > \rho_w$ and $\rho_2 < \rho_w$. g is the gravitational acceleration



- (i) Write expressions for the weights of A and B using the given terms.

$$\text{Weight of A} = V \rho_1 g$$

$$\text{Weight of B} = V \rho_2 g$$

(05 x 2 = 10 marks)

- (ii) Write an expression for the upthrust acting on A and B.

$$U = V \rho_w g \quad (05 \text{ marks})$$

- (iii) Once A and B are released, what would be the directions of motion of them? Justify your answer by considering the expressions obtained in (a)(i) and (a)(ii).

$$\text{Since } \rho_1 > \rho_w, \text{ weight of A} > U < \quad (10 \text{ marks})$$

$$\text{So cube A vertically moves downward.} \quad (05 \text{ marks})$$

Since $\rho_2 < \rho_w$, weight of B < U

(10 marks)

So cube B vertically moves upward.

(05 marks)

(Total marks 45)

(b) When a hydrometer floats in water, 25 cm of its stem is dipped in water. When it floats in another liquid, 20 cm of its stem is dipped in the liquid. Find the relative density of the liquid.

$$1 \times \rho_w \times 25 = d \times \rho_w \times 20$$

(10 marks)

$$d = 1.25$$

(05 marks)

(Total marks 15)

(c) For what purpose the following apparatus are used?

(1) Lactometer

(2) Metrolac

(1) Lactometer :To compare /to obtain the densities of milk

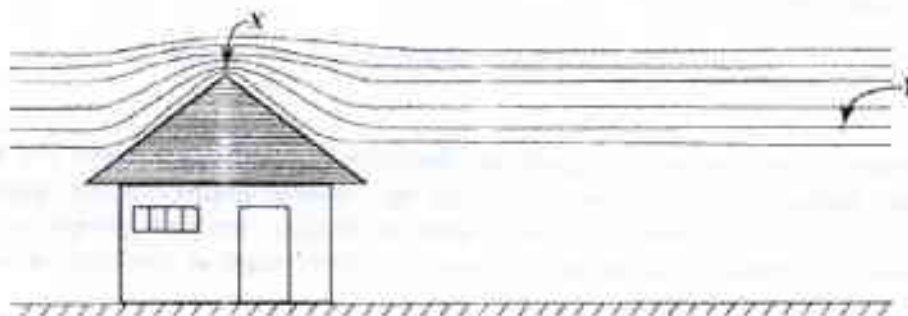
(10 marks)

(2) Metrolac :To compare/measure the densities of latex

(10 marks)

(Total marks 20)

(d) The figure shows the shape of a roof and the airflow over it during a cyclone.



Points X and Y are on a same streamline of the wind flow and they are far apart enough to neglect the difference in their heights.

(i) At which point the wind flow has higher velocity?

Point X

(05 marks)

(ii) At which point the wind flow has higher pressure?

Point Y

(05 marks)

(iii) If v_1 and v_2 are the velocities and P_1 and P_2 are the pressures of the wind flow at X and Y respectively, write the Bernoulli equation. Let ρ be the density of air.

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

(10 marks)

- (iv) If the effective area of the roof is 200 m^2 , the velocity of wind flow at point X is 360 km h^{-1} and the density of air is 1.3 kg m^{-3} , calculate the force acting on the roof due to the wind flow (Consider the velocity of wind inside the house as zero).

Consider the pressure in the house is P'

Bernoulli equation for X: $P_1 + \frac{1}{2} \times 1.3 \times 100^2$ (10 marks)

The pressure difference between inside and outside of the roof = $P' - P_1 = \frac{1}{2} \times 1.3 \times 100^2$ (10 marks)

Force = $(P' - P_1)A = \frac{1}{2} \times 1.3 \times 100^2 \times 200 = 1.3 \times 10^6 \text{ N}$ (10 marks)

- (v) A student says that the roof of a house is safe if the windows and doors are opened during a rapid wind flow. Do you agree with this statement? Explain your answer.

Yes (05 marks)

The pressure in the house is reduced when air flows through it. It reduces the pressure difference between inside and outside of the roof. Therefore, the additional force applying upward also reduces. So the roof is protective. (15 marks)

(Total marks 70)

* * *

