# Science for Technology -Year End Examination – 2024 A/L

## 1.0

(a) (i) A potential difference $V$ is supplied across an electrical equipment and a current $I$ flows through it. Write down an expression for the rate of energy dissipation of the equipment.

(ii) A current $I$ flows through a resistor $R$. Write down an expression for the rate of heat dissipation $P$ across the resistor $R$.

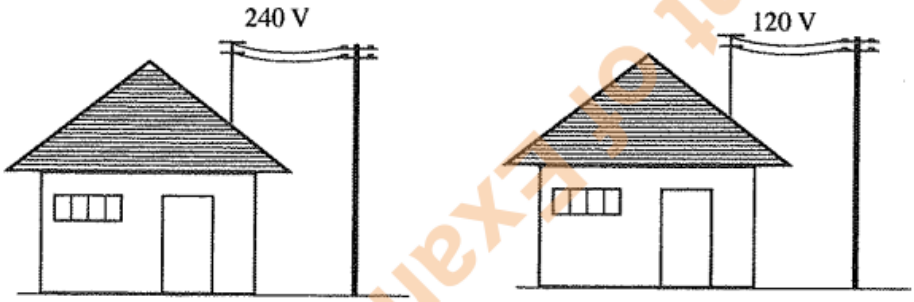
(b) The voltages of national electric supply of two countries are 240 V and 120 V.

(i) Two electric kettles rated 240 V, 1 kW and 120 V, 1 kW are connected to 240 V and 120 V supply voltages, respectively. Find the current flowing through each kettle.

(ii) If conducting wires with same resistance are used to connect the kettles to the main supply, explain which circuit generates more heat.

(iii) Suggest a method to reduce energy loss of the circuit mentioned in above part (b)(ii). Consider that the supply voltage cannot be changed.

(c) Two houses situated at a distance of 1 km from two electricity distributing centers of 120 V and 240 V voltages are shown below. Copper (Cu) and aluminium (Al) wires of cross sectional area $8 \times 10^{-6}$ m$^2$ can be used for the transmission of electricity. The resistivity of copper is $1.7 \times 10^{-8}$ Ω m and its density is 8900 kg m$^{-3}$, and these values for aluminium are $2.5 \times 10^{-8}$ Ω m and 2800 kg m$^{-3}$ respectively.




(i) Using the given data, calculate the resistance and the mass of copper and aluminium wires used.

(ii) State an advantage and a disadvantage of using each type of wire.

(iii) The following table shows the power of electrical equipment, number of equipment use and the number of hours use daily in a house. If the cost for one unit of electric power (1 kW h) is Rs. 20/= calculate the electricity bill for a month of 30 days.

| Electric equipment | Power of each equipment (W) | Number of equipment use | Number of hours use daily (h) |
|---|---|---|---|
| Bulb | 11 | 8 | 5 |
| Fan | 50 | 5 | 12 |
| Refrigerator | 70 | 1 | 24 |
| Kettle | 1500 | 1 | 1 |
| Iron | 750 | 1 | ½ |

2.0

The following questions are based on various geometrical shapes. Information that can be required for the calculations is provided at the end of the question. Give answers for calculations to the first decimal point.

(a) A sketch of a logo designed for a society is given in Figure (1). It consists of a regular hexagon and six semi-circles.

(i) What is the value of $A\hat{O}B$ ?

(ii) Calculate the area of the logo showing the relevant steps.

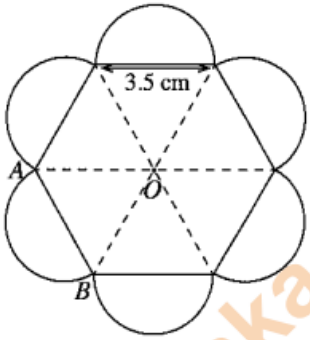



Figure (1)

(b) The data obtained to determine the height of a mountain are given in Figure (2). Calculate the height, $CD$ of the mountain.

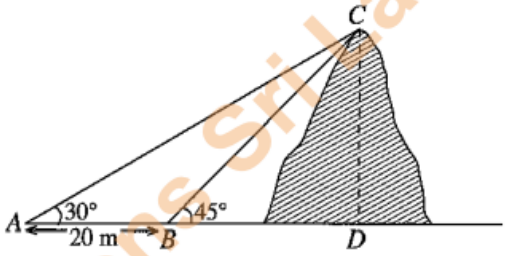



Figure (2)

(c) Calculate the area of the land $OABCD$ shown in Figure (3).

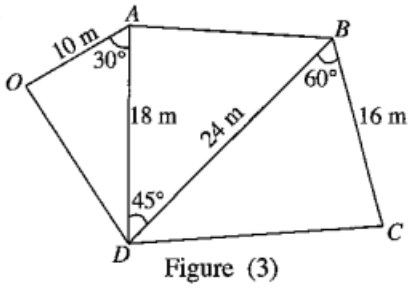



Figure (3)

(d) The length, the width and the height of a pencil box which has a cuboid shape are 16 cm, 4 cm and 3 cm respectively. What is the length of the longest pencil that can be kept inside this pencil box?

(e) A water tank consists of two cylindrical parts ($A$ and $C$) and a part of a cone ($B$) as shown in Figure (4). Calculate the volume of the water tank, in terms of $\pi$.

**Note :**

$\sqrt{3} = 1.73$, $\sqrt{2} = 1.41$ and $\pi = \frac{22}{7}$

| | 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 | $\sqrt{3}$ |

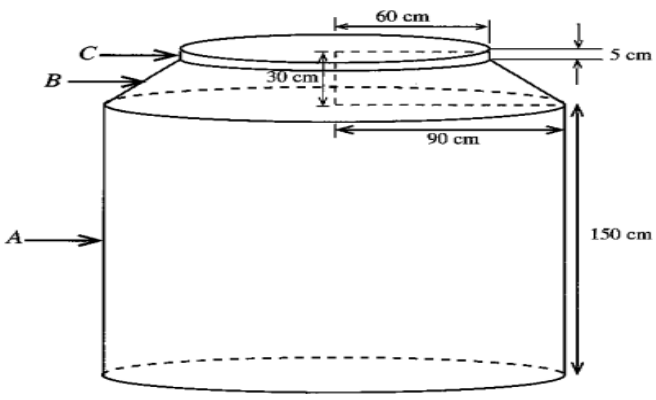
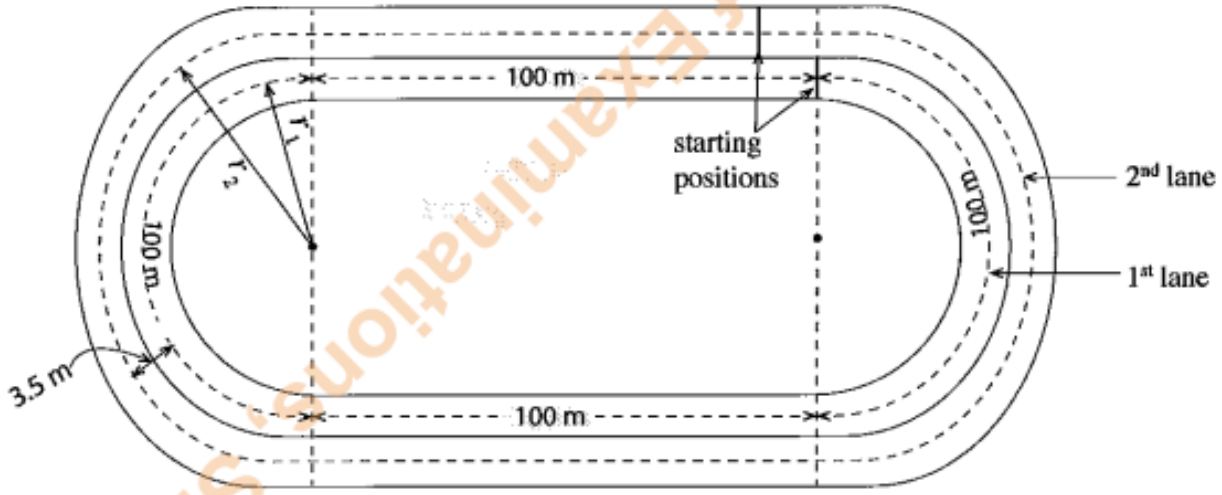



Figure (4)

3.0

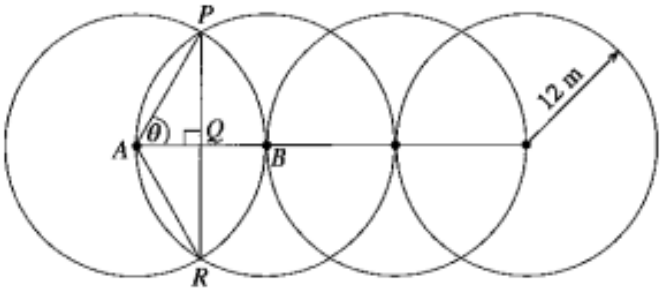
A design of a 400 m race track with 3.5 m gap between two dashed lines of any two consecutive lanes in a playground is given in the diagram. The diagram is not drawn to the scale. All athletes should run 400 m distance on the dashed line in the middle of their respective lanes.




(a) Write down the radii $r_1$ and $r_2$ of the semi-circular sections of the lanes shown in the diagram in terms of $\pi$.

(b) What should be the gap between the starting positions of the first and the second lanes?

(c) As shown in the following diagram, four circles with radii 12 m were drawn on the above playground for a drill such that the centres of the circles are fallen onto a horizontal line. The distance between two centres of consecutive circles is 12 m.




| | 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 | $\sqrt{3}$ |

(i) Find the length of $PQ$.

(ii) Find the angle $\theta$ in radian.

(iii) Find the area of the triangle $APR$.

(iv) Find the area of the sector $APBR$, in terms of $\pi$.

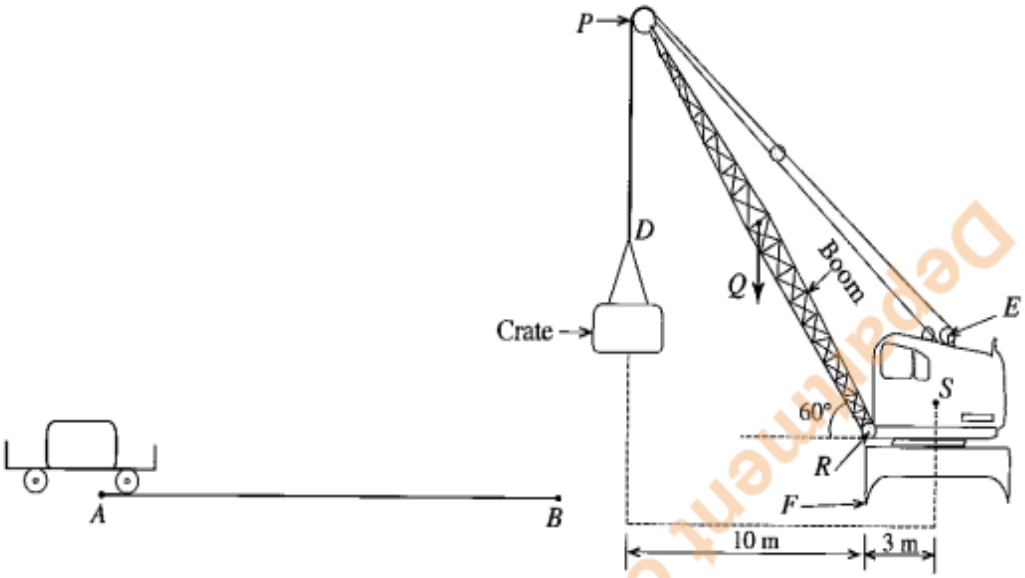
(v) Find the area enclosed by the arc $PBR$ and the chord $PR$, in terms of $\pi$.

(vi) Calculate the area of the compound diagram enclosed by these circles, in terms of $\pi$.

4.0

(a) Write the equation, which can be obtained from Newton's second law of motion and define each term.

(b) A crate with a mass of 400 kg is kept on a trolley with the mass of 100 kg located at the position $A$, in a warehouse. The trolley with the crate, which was initially at rest, is pushed using a uniform horizontal force to the location $B$, and then allowed to move freely closer to the lorry used for the transportation. Then only the crate will be loaded onto the lorry using a crane.




Consider the gravitational acceleration as 10 N $kg^{-1}$, and cos 60° = sin 30° = ½.

(i) Calculate the momentum at locations $A$ and $B$ if the velocity of the crate is 2 m $s^{-1}$ at $B$. (Assume that the energy loss during the movement between the positions $A$ and $B$ is zero.)

(ii) If the time taken to move the crate from $A$ to $B$ is 20 s, calculate the horizontal force.

(iii) If the distance between $A$ and $B$ is 20 m, calculate the work done in the above process.

(c) The crane with mass 20000 kg is used to lift the crate as shown in the figure. The mass of the boom $PR$ of the crane is 2000 kg. $S$ and $Q$ are the respective points where the masses of the crane and the boom are exerted. $Q$ is the mid-point of $PR$. A vertical cable section marked as $PD$ is holding the crate, and it is going through a smooth pulley connected at $P$. The other end of the cable is wrapped around a cylinder connected with a motor. The crate can be lifted by rotating the cylinder.

(i) What is the work done in lifting the crate to a height of 3 m?

(ii) Calculate the length of the crane boom.

(iii) The radius of the crane cylinder, used to wrap the cable, is 50 cm. What torque must be applied on the cylinder to lift the crate?

(iv) What is the tension of the vertical cable section ($PD$) carrying the crate?

(v) The crane will be toppled about the axis $F$, when the mass of the crate exceeds a certain limit. Calculate this limit.

5.0

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.

Reactants (R) Products (P)

$$\text{Gliricidia pellets} + O_2(g) \longrightarrow CO_2(g) + H_2O(l) + \text{Ash}$$

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

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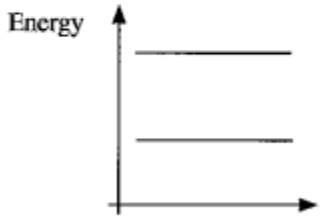
(ii) For the above combustion, mark the energy positions of the reactants (R) and the products (P) on the relevant energy levels in the given diagram below.

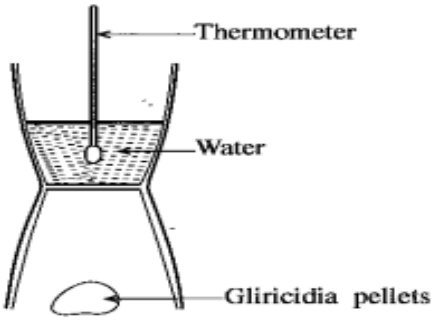



(iii) State **two** environmental advantages of using Gliricidia wood pellets over LP gas to produce energy.

(1) .....

(2) .....

(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 J °C$^{-1}$ g$^{-1}$. The water at the initial temperature of 32 °C has warmed upto 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.

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(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$^{-1}$.

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

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(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.

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