

Question 1.

a. Area = Width $\times$ Length

$$W(W + 20) = 2400 \quad (2)$$

$$W^2 + 20W = 2400 \quad (1)$$

$$W^2 + 20W - 2400 = 0 \quad (1)$$

$$W = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$W = \frac{-20 \pm \sqrt{20^2 - 4 \times 1 \times -2400}}{2 \times 1}$$

$$W = \frac{-20 \pm \sqrt{400 - 4 \times 1 \times -2400}}{2 \times 1}$$

$$W = \frac{-20 \pm \sqrt{400 - -9600}}{2}$$

$$W = \frac{-20 \pm \sqrt{10000}}{2}$$

$$W = \frac{-20 \pm 100}{2} \quad (6)$$

$$W = \frac{-20 + 100}{2} = \underline{\underline{40m}} \quad \text{CORRECT ANSWER} \quad (2)$$

$$W = \frac{-20 - 100}{2} = -60m \quad \text{IMPOSSIBLE}$$

b. Length = $W + 20 = 40 + 20 = \underline{\underline{60m}} \quad (1)$

c. Total Area = Width $\times$ Length

$$= (40 + 5 + 5) \times (60 + 5 + 5)$$

$$c. \text{ Total Area} = \text{Width} \times \text{Length}$$

$$= (40 + 5 + 5) \times (60 + 5 + 5) \\ = 50 \times 70 = 3500 \text{ m}^2 \quad (2)$$

$$\text{Area of Concrete} = \text{Total Area} - \text{Area enclosed by path} \\ = 3500 - 2400 = 1100 \text{ m}^2 \quad (2)$$

$$\text{Volume of Concrete} = \text{Area of Concrete} \times \text{Depth} \\ = 1100 \times 0.2 = \underline{\underline{220 \text{ m}^3}} \quad (1)$$

$$d. \text{ Perimeter} = 2 \times \text{Total Length} + 2 \times \text{Total Width} \\ = (2 \times 70) + (2 \times 50) \\ = 140 + 100 = \underline{\underline{240 \text{ m}}} \quad (2)$$

Question 2.

$$a. \text{ If } h = 25t - 4.9t^2 \text{ then } \frac{dh}{dt} = \text{velocity} \text{ \& } \frac{d^2h}{dt^2} = \text{acceleration}$$

$$v = \frac{dh}{dt} = (25 \times 1)t^{(1-1)} - (4.9 \times 2)t^{(2-1)} \\ = \underline{\underline{25 - 9.8t}} \quad (5)$$

$$a = \frac{d^2h}{dt} = (25 \times 0) - (9.8 \times 1)t^{(1-1)} \\ = \underline{\underline{-9.8}} \quad (5)$$

$$b. \text{ The maximum height is reached when velocity} = 0 \quad (2)$$

$$25 - 9.8t = 0$$

$$-9.8t = 0 - 25$$

$$-9.8t = -25$$

$$t = \frac{-25}{-9.8} = 2.55 \text{ s}$$

$$\text{Maximum Height reached at } 2.55 \text{ s} \quad (4)$$

$$h = (25 \times 2.55) - (4.9 \times 2.55^2) \quad (4)$$

$$= 12.78 - 2.10 = 10.68$$

$$n = (25 \times 2.55) - (4.9 \times 2.55) \quad (4)$$

$$= 63.78 - 31.86 = \underline{\underline{31.9 \text{ m}}}$$

Question 3.

$$\overset{A}{\begin{bmatrix} 1 & 1 & 0 \\ -3 & 0 & 1 \\ 0 & -2 & 1 \end{bmatrix}} \begin{bmatrix} x_1 \\ x_2 \\ T \end{bmatrix} = \begin{bmatrix} 0 \\ 3g \\ 2g \end{bmatrix} \quad (3)$$

$$|A| = 1(0 \times 1 - -2 \times 1) - 1(-3 \times 1 - 1 \times 0) + 0(-3 \times -2 - 0 \times 0)$$

$$= 1(0 + 2) - 1(-3 - 0) + 0(6 - 0)$$

$$= 1(2) - 1(-3)$$

$$= 2 + 3 = 5 \quad (2)$$

$$\overset{A_{x_1}}{\begin{bmatrix} 0 & 1 & 0 \\ 3g & 0 & 1 \\ 2g & -2 & 1 \end{bmatrix}} \quad (1)$$

$$|A_{x_1}| = 0(0 \times 1 - -2 \times 1) - 1(3g \times 1 - 1 \times 2g) + 0(3g \times -2 - 0 \times 2g)$$

$$= 0(0 + 2) - 1(3g - 2g) + 0(-6g - 0)$$

$$= -1(3g - 2g)$$

$$= -g \quad (2)$$

$$x_1 = \frac{|A_{x_1}|}{|A|} = \frac{-g}{5} \quad (2)$$

$$\underline{\underline{\quad \quad \quad}}$$

$$\overset{A_{x_2}}{\begin{bmatrix} 1 & 0 & 0 \\ -3 & 3g & 1 \\ 0 & 2g & 1 \end{bmatrix}} \quad (1)$$

$$\begin{aligned}
 |A_{x_2}| &= 1(3g \times 1 - 2g \times 1) - 0(-3 \times 1 - 1 \times 0) + 0(-3 \times 2g - 3g \times 0) \\
 &= 1(3g - 2g) - 0(-3 - 0) + 0(-6g - 0) \\
 &= 1(3g - 2g) \\
 &= g \quad (2)
 \end{aligned}$$

$$x_2 = \frac{|A_{x_2}|}{|A|} = \frac{g}{5} \quad (2)$$

$$A_T = \begin{bmatrix} 1 & 1 & 0 \\ -3 & 0 & 3g \\ 0 & -2 & 2g \end{bmatrix} \quad (1)$$

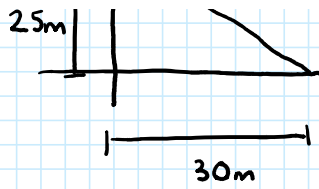
$$\begin{aligned}
 |A_T| &= 1(0 \times 2g - 3g \times -2) - 1(-3 \times 2g - 3g \times 0) + 0(-3 \times -2 - 0 \times 0) \\
 &= 1(0 + 6g) - 1(-6g - 0) + 0(6 - 0) \\
 &= 1(6g) - 1(-6g) \\
 &= 6g + 6g \\
 &= 12g \quad (2)
 \end{aligned}$$

$$T = \frac{|A_T|}{|A|} = \frac{12g}{5} \quad (2)$$

Question 4.



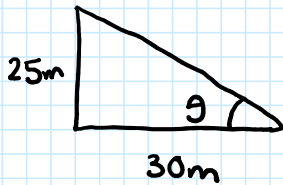
The longest cable must span half the distance between towers & reaches top of the tower. (2)



the distance between towers & reaches top of the tower. (2)

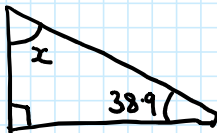
$$\begin{aligned} \text{Length} &= \sqrt{25^2 + 30^2} \\ &= \sqrt{625 + 900} \\ &= \sqrt{1525} = \underline{\underline{39.05\text{m}}} \end{aligned} \quad (3)$$

b. Top Cable



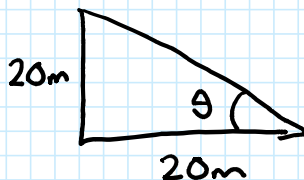
$$\tan \theta = \frac{25}{30}$$

$$\theta = \tan^{-1} \left(\frac{25}{30} \right) = \underline{\underline{39.8^\circ}} \quad (2)$$



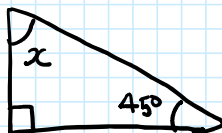
$$x = 180 - 90 - 39.8 = \underline{\underline{50.2^\circ}} \quad (1)$$

Middle Cable



$$\tan \theta = \frac{20}{20}$$

$$\theta = \tan^{-1} \left(\frac{20}{20} \right) = \underline{\underline{45^\circ}} \quad (2)$$



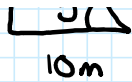
$$x = 180 - 90 - 45 = \underline{\underline{45^\circ}} \quad (1)$$

Bottom Cable



$$\tan \theta = \left(\frac{15}{10} \right)$$

$$\theta = \tan^{-1} \left(\frac{15}{10} \right) = \underline{\underline{56.3^\circ}} \quad (2)$$

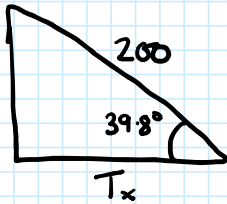


$$\theta = \tan^{-1} \left(\frac{15}{10} \right) = \underline{\underline{56.3^\circ}} \quad (2)$$



$$x = 180 - 90 - 56.3 = \underline{\underline{33.7^\circ}} \quad (1)$$

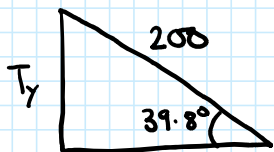
C. Horizontal Component



$$\cos 39.8 = \frac{T_x}{200}$$

$$T_x = 200 \times \cos 39.8 = \underline{\underline{153.7 \text{ kN}}} \quad (3)$$

Vertical Component



$$\sin 39.8 = \frac{T_y}{200}$$

$$T_y = 200 \times \sin 39.8 = \underline{\underline{128.0 \text{ kN}}} \quad (3)$$

Question 5.

a. Conical Section

$$A_{\text{cone}} = \pi r L = \pi \times 5 \times 10 = 157.1 \text{ m}^2 \quad (3)$$

Cylindrical Section

$$A_{\text{cyl}} = 2\pi r h = 2 \times \pi \times 5 \times 8 = 251.3 \text{ m}^2 \quad (2)$$

Hemispherical Section

$$A_{\text{hem}} = 2\pi r^2 = 2 \times \pi \times 5^2 = 157.1 \text{ m}^2 \quad (3)$$

$$\text{Total Area} = A_{\text{cone}} + A_{\text{cyl}} + A_{\text{hem}}$$

$$= 157.1 + 251.3 + 157.1 = \underline{\underline{565.5 \text{ m}^2}} \quad (1)$$

$$= 157.1 + 251.3 + 157.1 = \underline{\underline{565.5 \text{ m}^2}} \quad (1)$$

b. Conical Section

$$V_{\text{cone}} = \frac{1}{3} \pi r^2 h_{\text{cone}}$$

$$\begin{aligned} h_{\text{cone}} &= \sqrt{l^2 - r^2} = \sqrt{10^2 - 5^2} \\ &= \sqrt{100 - 25} \\ &= \sqrt{75} = 8.66 \quad (1) \end{aligned}$$

$$V_{\text{cone}} = \frac{1}{3} \times \pi \times 5^2 \times 8.66 = 226.7 \text{ m}^3 \quad (3)$$

Cylindrical Section

$$\begin{aligned} V_{\text{cyl}} &= \pi r^2 h = \pi \times 5^2 \times 8 \\ &= 628.3 \text{ m}^3 \quad (3) \end{aligned}$$

Hemiphenical Section

$$\begin{aligned} V_{\text{hem}} &= \frac{2}{3} \pi r^3 = \frac{2}{3} \times \pi \times 5^3 \\ &= 261.8 \text{ m}^3 \quad (3) \end{aligned}$$

$$\text{Total Volume} = V_{\text{cone}} + V_{\text{cyl}} + V_{\text{hem}}$$

$$\begin{aligned} &= 226.7 + 628.3 + 261.8 \\ &= \underline{\underline{1116.8 \text{ m}^3}} \quad (1) \end{aligned}$$