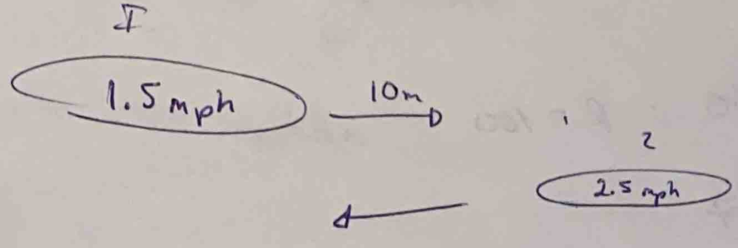
1



Using Newtons laws of motion

$$\Delta X = X_0 + V_0 \Delta t + \frac{1}{2} a \Delta t^2$$

1 $$X_m - \cancel{X_0}^{0} = V_1 \Delta t + \frac{1}{2} \cancel{a_1 \Delta t^2}$$

$a_1 = a_2 = 0$

2 $$X_m - X_{0_2} = V_2 \Delta t + \frac{1}{2} \cancel{a_2 \Delta t^2}$$

$$X_m = V_1 \Delta t \qquad (3)$$

$$X_m - X_0 = V_2 \Delta t \qquad (4)$$

$$(-1)\; V_1 \Delta t + X_0 = V_2 \Delta t$$

$$X_0 = V_1 \Delta t - V_2 \Delta t$$

$$X_0 = \Delta t (V_1 - V_2) \Rightarrow \Delta t = X_0 / (V_1 - V_2)$$ ← sub into equation (3)

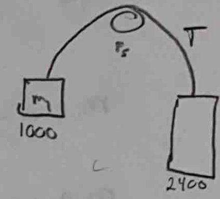
$$X_m = \frac{V_1 X_0}{V_1 - V_2} = \frac{1.5\ \text{mph} \cdot 10\ \text{mi}}{1.5 - (-2.5)\ \text{mph}}$$

$$= \frac{1.5 \cdot 10}{4.} \frac{\text{mi} \cdot \text{mph}}{\text{mph}}$$

$$\boxed{X_m = 3.8\ \text{mi}}$$

-②

ⓐ Determining the Tension in the string



$F = m_1 a$ ~~$- m_1 g$~~

$F = m_1 g - T$

$m_1 a = m_1 g - T$

1000 lb → kg & 2400 lb → kg = 1088.62 kg

= 453.59 kg

$-m_1(a-g) = -T$

$-m_1(a-g) = T$

$a = g/4$

$+m_1(g-a) = T \Rightarrow 453.59\left(9.81 - \left(\frac{9.81}{4}\right)\right) = T$

$\Rightarrow \boxed{T = 3337.29N}$

Thus to determine the force the shaft exherts.

$F = m_2 a \quad , F = T - m_2 g - F_s$

$m_1 a = T - m_2 g - F_s$

$F_s = T - m_2 g - m_2 a$

$= 3337.29N - 1088.62kg\left(9.81 m/s^2 - \left(\frac{9.81}{4} m/s^2\right)\right)$

$\boxed{F_s = -10011.91N}$ *The elevator moves upwards.

(b) What force does the wall of the elevator shaft exhert on the motor if the elevator starts from rest & goes down

$F = m_1 a$ $\quad F = -m_1 g + T$

$m_1 = 453.56\,kg$

$m_2 = 1088.62\,kg$

$m_1 a = -m_1 g + T$

$m_1 a + m_1 g = T$

$m_1 (a + g) = T$

$453.56\,kg \left(\frac{9.81}{4} + 9.81\right) = T$

$\Rightarrow T = 5562.15\,N$

Finding the force on the shaft.

$F = m_2 a$; $F = -T + m_2 g - F_s$

$m_2 a = -T + m_2 g - F_s$

$F_s = -m_2 a - T + m_2 g$

$F_s = -T + m_2 (g - a)$

$F_s = -5562.15\,N + 1088.62\,kg \left(9.81 - \left(\frac{9.81}{4}\right)\right)$

$\boxed{F_s = 2447.37}$

③

$a_c = \omega^2 R$

$D = 200 \therefore R = 100$

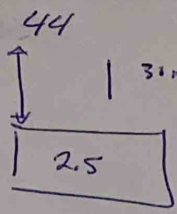
$a_c = 0.7$

$\omega^2 = \frac{a_c g}{R}$

$\omega = \sqrt{a_c g / R} = \sqrt{\frac{(0.7 \cdot 9.81)\ m/s \cdot rad}{100\ m}} = 0.262\ rad/s$

$\boxed{\omega = 0.262\ rad/s}$

4



70kg

$E_g = E_s$

$mgh = \frac{1}{2} k x^2$

Solve for k

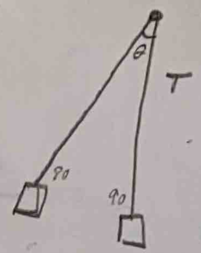
$\frac{2mgh}{x^2} = k$

$\frac{2 \cdot 70 \cdot 9.81 \cdot 42}{(12)^2} = \boxed{400.575 \text{ N/m} = k}$

5

SOH CAH TOA

$\theta = 10°$



Vertical Tension in the string

$T\sin\theta = mg$

where $mg = (120 \times 10^{-3})(9.81) = 1.176\ N$

$T = \frac{mg}{\sin\theta} = \frac{1.176\ N}{\sin 80} = \boxed{1.1941 N = T}$

$X = X_0 \cos 80$

$X = 30 \cos 80 = 5.21\ cm$

$= 0.0521 m$

$\boxed{X = 0.0521 m}$

$F \cancel{= \frac{q}{x}} 10$

$F = \frac{k q_1 q_2}{r^2} = T$

$\frac{\cancel{k q_1} = (9 \times 10^9) q^2}{(0.0521)^2} = 1.1941$

$q^2 = \sqrt{\frac{1.1941 (0.0521)^2}{(9 \times 10^9)} (\cos 80)}$

$\boxed{q = 0.2501\ \mu C}$

6

$$F_c = \frac{k q_1 q_2}{r^2} \qquad F_g = \frac{2 G m_n m_p}{r^2}$$

same

$$\frac{k q_1 q_2}{r^2} = \frac{2 G m_n m_p}{r^2}$$

mass of proton = neut

$\cancel{k q_1 q_2}$

$$\frac{k q^2}{\cancel{r^2}} = \frac{2 G m^2}{\cancel{r^2}}$$

$$m^2 = \frac{k q^2}{2G}$$

$$m = \sqrt{\frac{9 \times 10^9 \, (1.6 \times 10^{-19})^2}{2\,G}}$$

, where $G = 6.67 \times 10^{-11}$

$$m = \sqrt{\frac{9 \times 10^9 (1.6 \times 10^{-19})^2}{2 (6.67 \cdot 10^{-11})}}$$

m 1.31