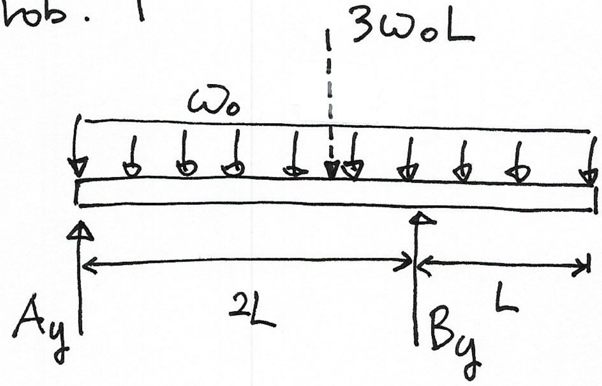
Prob. 1



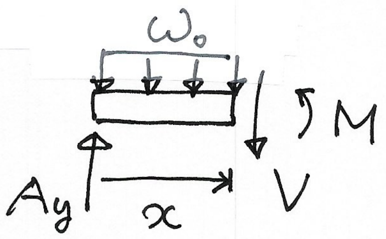
$$\Sigma M_A = 2LB_y - \frac{3}{2}L \times (3\omega_o L) = 0$$

$$\therefore B_y = \frac{9}{4}\omega_o L \quad 2$$

$$\Sigma F_y = A_y + B_y - 3\omega_o L = 0$$

$$\therefore A_y = \frac{3}{4}\omega_o L \quad 2$$

(1) $0 < x < 2L$



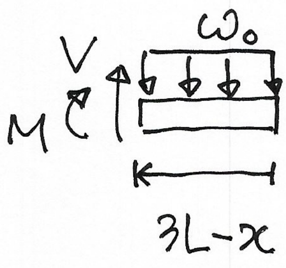
$$\Sigma F_y = A_y - \omega_o x - V = 0$$

$$\therefore V(x) = A_y - \omega_o x = \frac{3}{4}\omega_o L - \omega_o x$$

$$\Sigma M_A = -\frac{1}{2}\omega_o x^2 - Vx + M = 0$$

$$\therefore M(x) = \frac{3}{4}\omega_o L x - \frac{1}{2}\omega_o x^2$$

(2) $2L < x < 3L$

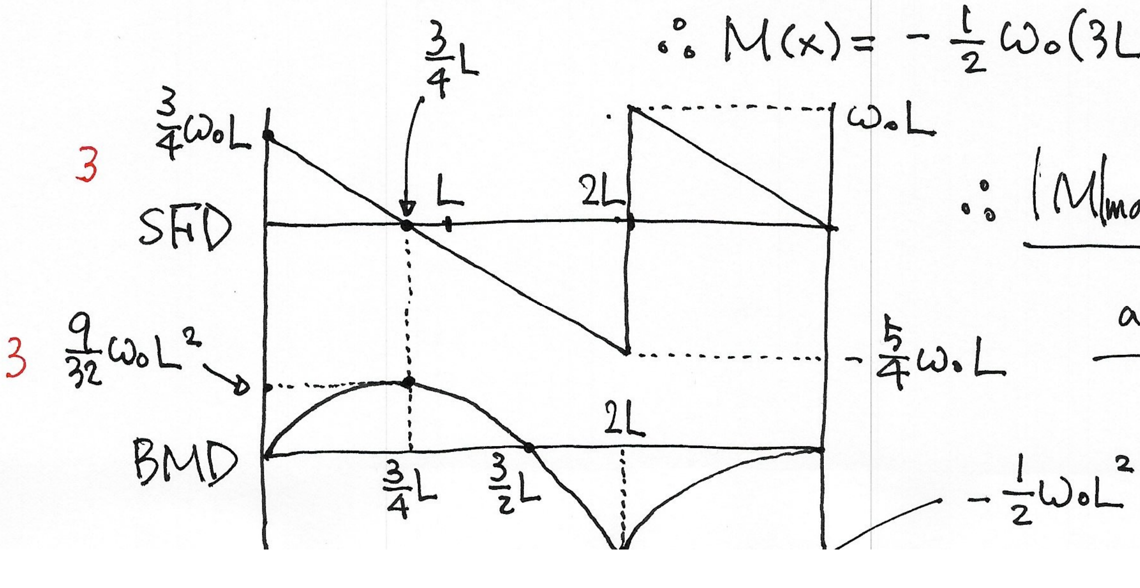


$$\Sigma F_y = V - \omega_o(3L - x) = 0$$

$$\therefore V(x) = \omega_o(3L - x)$$

$$\Sigma M_{(3L-x)} = -M - \frac{1}{2}\omega_o(3L-x)^2 = 0$$

$$\therefore M(x) = -\frac{1}{2}\omega_o(3L-x)^2$$



$$\therefore |M|_{max} = \frac{1}{2}\omega_o L^2 \quad 3$$

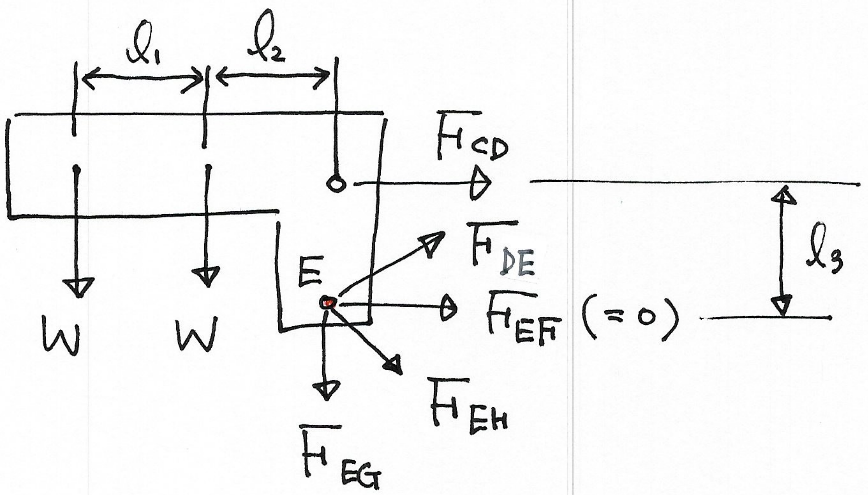
at $x = 2L$ 2

Prob. 2.

4 (1) Zero-force member : EF & GH

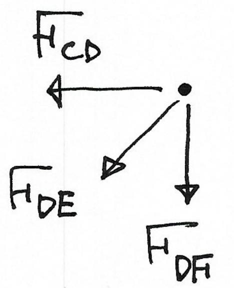
7 (2)

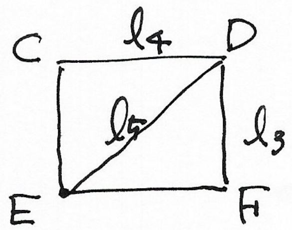
2



$$\Sigma M_E = l_2 W + (l_1 + l_2) W - l_3 F_{CD} = 0$$

2 $$\therefore F_{CD} = \frac{1}{l_3}(l_1 + 2 l_2) W$$

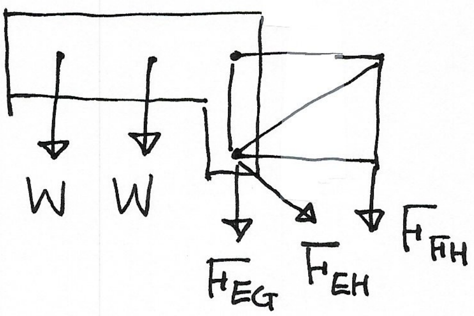




$$\Sigma F_x = -F_{CD} - \frac{l_4}{l_5} F_{DE} = 0$$

3 $$\therefore F_{DE} = -\frac{l_5(l_1 + 2 l_2)}{l_4 l_3} W$$

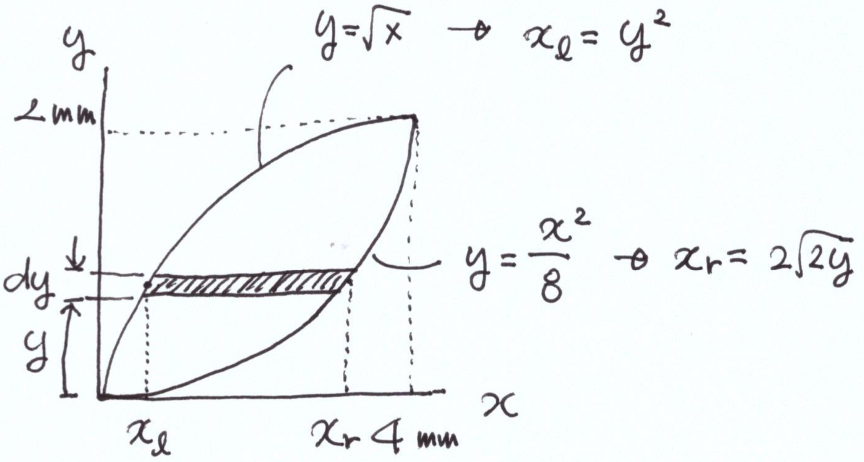
4 (3)



$$\Sigma F_x = \frac{l_4}{l_5} F_{EH} = 0$$

$$\therefore F_{EH} = 0$$

Prob. 3



$$A = \int dA = \int_0^{2\,mm} (x_r - x_\ell)\,dy = \int_0^2 (2\sqrt{2y} - y^2)\,dy$$

$$= \left[\frac{4}{3}\sqrt{2}\,y^{\frac{3}{2}} - \frac{1}{3}y^3\right]_0^2 = \frac{16}{3} - \frac{8}{3} = \frac{8}{3}$$ 6

$$A\bar{x} = \int x_c\,dA = \int_0^{2\,mm} \frac{1}{2}(x_r + x_\ell)(x_r - x_\ell)\,dy$$

2 $$= \frac{1}{2}\int_0^2 (x_r^2 - x_\ell^2)\,dy = \frac{1}{2}\int_0^2 (8y - y^4)\,dy$$

$$= \frac{1}{2}\left(4y^2 - \frac{1}{5}y^5\right)\Big|_0^2 = \frac{1}{2}\left(16 - \frac{32}{5}\right) = 8\left(1 - \frac{2}{5}\right)$$

$$= \frac{24}{5}$$

$$\therefore \bar{x} = \frac{9}{5}\ \text{mm}$$ 5

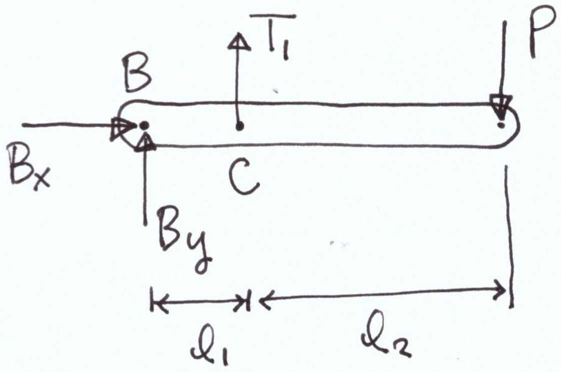
$$A\bar{y} = \int y_c\,dA = \int_0^{2\,mm} y\,(x_r - x_\ell)\,dy$$

2 $$= \int_0^2 y\,(2\sqrt{2y} - y^2)\,dy = \int_0^2 (2\sqrt{2}\,y^{\frac{3}{2}} - y^3)\,dy$$

$$= \left[\frac{4\sqrt{2}}{5}y^{\frac{5}{2}} - \frac{1}{4}y^4\right]_0^2 = \frac{32}{5} - 4 = \frac{12}{5}$$

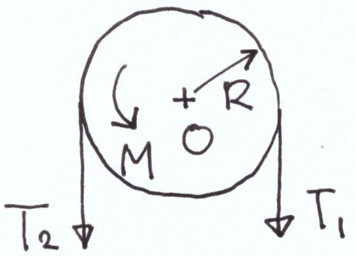
$$\therefore \bar{y} = \frac{9}{10}\ \text{mm}$$ 5

Prob. 4



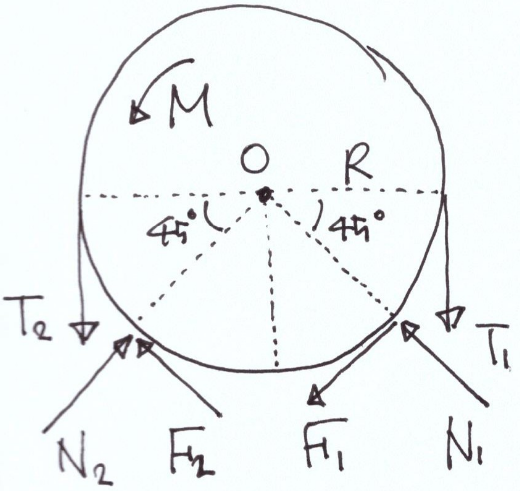
$$\Sigma M_B = l_1 T_1 - (l_1 + l_2) P = 0$$

$$\therefore T_1 = \left(1 + \frac{l_2}{l_1}\right) P$$ 4



$T_1 > T_2$.

$$T_2 = T_1 e^{-\mu_{BP} \theta}$$
$$= T_1 e^{-\frac{\ln 2}{\pi} \cdot \pi}$$
$$= \frac{T_1}{2}$$
$$= \frac{1}{2}\left(1 + \frac{l_2}{l_1}\right) P$$ 4



1 $$\Sigma F_x = \frac{1}{\sqrt{2}}\left(-N_1 - F_1 + N_2 - F_2\right) = 0$$

$$\therefore N_1 + F_1 - N_2 + F_2 = 0$$

1 $$\Sigma F_y = \frac{1}{\sqrt{2}}\left(N_1 - F_1 + N_2 + F_2\right) - T_1 - T_2 = 0$$

$$\therefore N_1 - F_1 + N_2 + F_2 = \frac{3}{2}\sqrt{2}\left(1 + \frac{l_2}{l_1}\right) P$$

1 $$\Sigma M_O = R\left(-T_1 + T_2 - F_1 - F_2\right) + M = 0$$

$$\therefore M = R\left(T_1 - T_2 + F_1 + F_2\right)$$

1 Impending motion : $F_1 = \mu_{PV} N_1$ & $F_2 = \mu_{PV} N_2$

$$(1+\mu_{pv})N_1 = (1-\mu_{pv})N_2$$

$$\therefore\ N_1 = \frac{1-\mu_{pv}}{1+\mu_{pv}} N_2$$

$$(1-\mu_{pv})N_1 + (1+\mu_{pv})N_2 = \frac{3}{2}\sqrt{2}\left(1+\frac{l_2}{l_1}\right)P$$

$$\frac{(1-\mu_{pv})^2}{1+\mu_{pv}} N_2 + (1+\mu_{pv})N_2 = \frac{3}{2}\sqrt{2}\left(1+\frac{l_2}{l_1}\right)P$$

$$2\left(\frac{1+\mu_{pv}^2}{1+\mu_{pv}}\right)N_2 = \frac{3}{2}\sqrt{2}\left(1+\frac{l_2}{l_1}\right)P$$

2 $$\therefore\ N_2 = \frac{3}{4}\sqrt{2}\left(\frac{1+\mu_{pv}}{1+\mu_{pv}^2}\right)\left(1+\frac{l_2}{l_1}\right)P$$

2 $$\therefore\ N_1 = \frac{3}{4}\sqrt{2}\left(\frac{1-\mu_{pv}}{1+\mu_{pv}^2}\right)\left(1+\frac{l_2}{l_1}\right)P$$

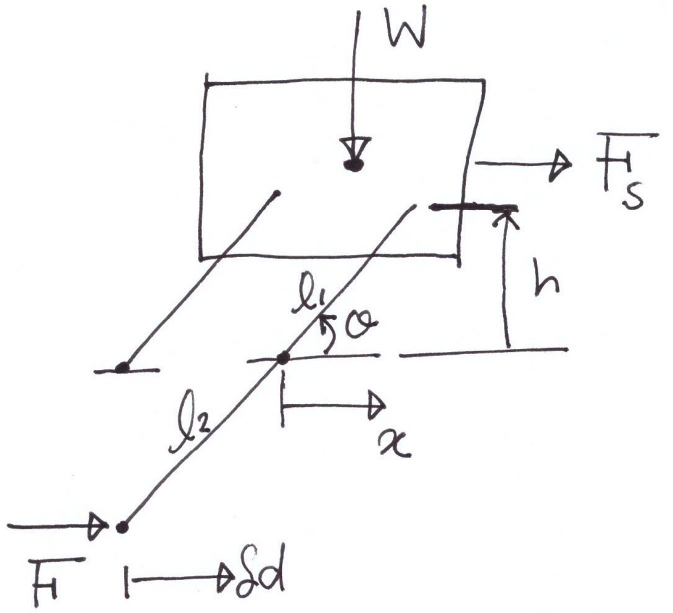
4 $$\therefore\ M = R\left(\frac{1}{2}T_1 + \mu_{pv}N_1 + \mu_{pv}N_2\right)$$

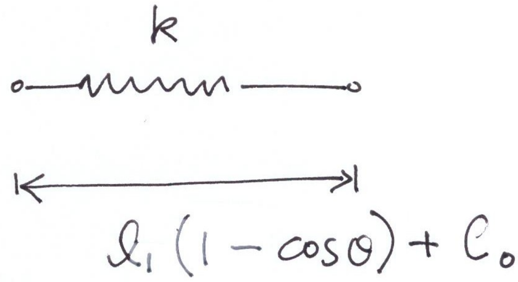
$$= \frac{1}{2}RT_1 + \mu_{pv}R(N_1+N_2)$$

$$= \frac{1}{2}\left(1+\frac{l_2}{l_1}\right)RP + \mu_{pv}R\,\frac{3}{2}\sqrt{2}\,\frac{1}{1+\mu_{pv}^2}\left(1+\frac{l_2}{l_1}\right)P$$

$$= \underline{\left(\frac{1}{2} + \frac{3}{2}\sqrt{2}\cdot\frac{\mu_{pv}}{1+\mu_{pv}^2}\right)\left(1+\frac{l_2}{l_1}\right)RP}$$

Prob. 5





Principle of Virtual Work.

$$\delta W' = F\,\delta d = F\,\delta\left(l_2 - l_2\cos\theta\right) = F\,l_2\sin\theta\,\delta\theta$$

$$V = Wh + \frac{1}{2}k\left(l_1 - l_1\cos\theta\right)^2$$

$$\delta V = W\,\delta(l_1\sin\theta) + k\,l_1^2(1-\cos\theta)\sin\theta\,\delta\theta$$

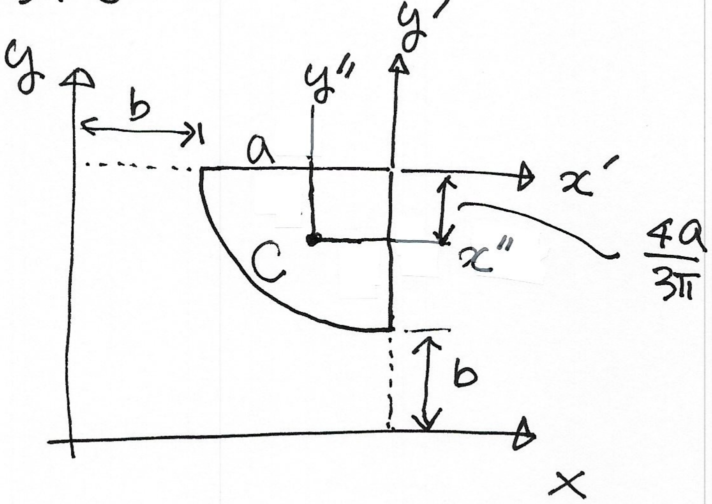
$$= W l_1\cos\theta\,\delta\theta + k\,l_1^2(1-\cos\theta)\sin\theta\,\delta\theta$$

$$\delta W' = \delta V$$

$$\therefore F\,l_2\sin\theta = W l_1\cos\theta + k\,l_1^2(1-\cos\theta)\sin\theta$$

$$\therefore F = \frac{l_1}{l_2}W\left(\frac{\cos\theta}{\sin\theta}\right) + k\frac{l_1^2}{l_2}(1-\cos\theta)$$

Prob. 6



4 1 2

$$I_{x'} = \frac{\pi}{16}a^4, \qquad A = \frac{\pi}{4}a^2, \quad d = \frac{4a}{3\pi}$$

4 $$\bar{I}_x = I_{x'} - Ad^2 = \frac{\pi}{16}a^4 - \left(\frac{\pi}{4}a^2\right)\left(\frac{4a}{3\pi}\right)^2$$

$$= \frac{\pi}{16}a^4 - \frac{4}{9\pi}a^4$$

4 $$I_x = \bar{I}_x + A\left(b + a - \frac{4a}{3\pi}\right)^2$$

$$= \left(\frac{\pi}{16} - \frac{4}{9\pi}\right)a^4 + \frac{\pi}{4}a^2\left(b + a - \frac{4a}{3\pi}\right)^2$$