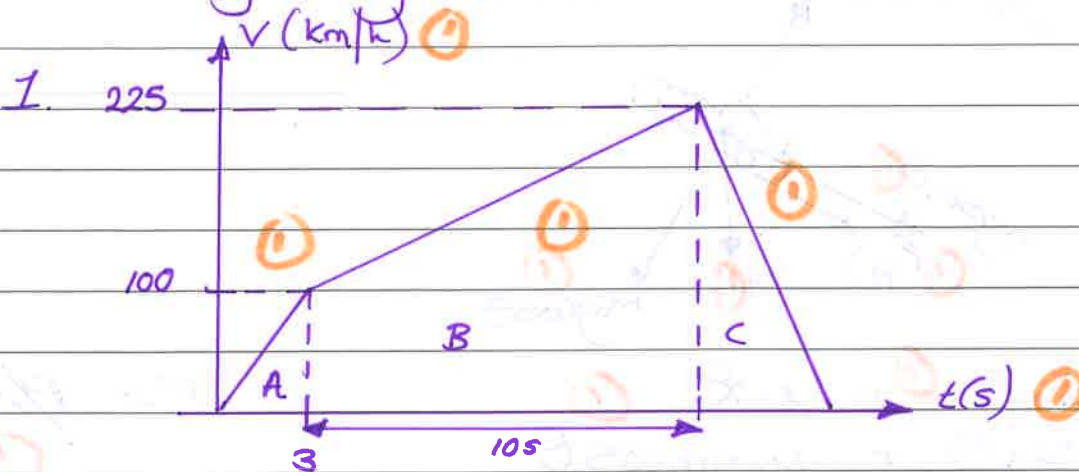


Engineering Science I M4x00385 2018-2019



a) $u = 0$

$$v = \frac{100 \times 1000}{3600} = 27.78 \text{ m/s}$$

$$t = 3 \text{ s}$$

$$a = ?$$

$$v = u + at$$

$$a = \frac{v - u}{t}$$

$$a = \frac{27.78}{3} = 9.26 \text{ m/s}^2$$

b) $u = 27.78 \text{ m/s}$

$$v = \frac{225 \times 1000}{3600} = 62.5 \text{ m/s}$$

$$t = 10 \text{ s}$$

$$a = ?$$

$$a = \frac{v - u}{t}$$

$$a = \frac{62.5 - 27.78}{10} = 3.47 \text{ m/s}^2$$

c) $u = 62.5 \text{ m/s}$

$$v = 0$$

$$t = ?$$

$$s = 65 \text{ m}$$

$$s = \frac{(u + v)t}{2}$$

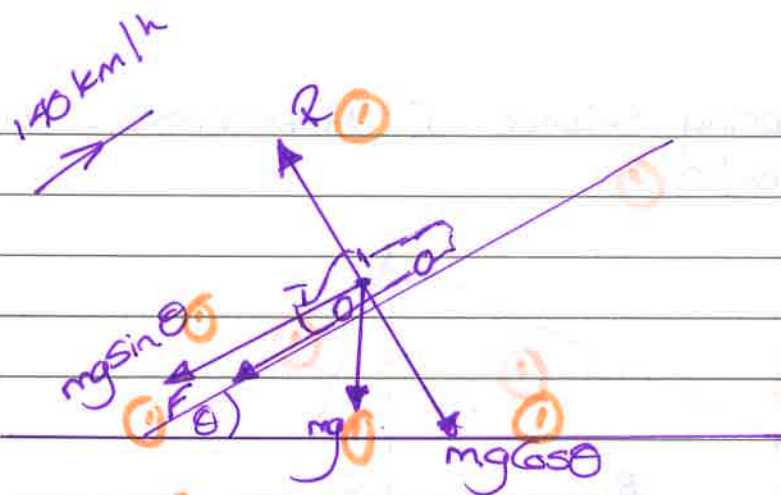
$$t = \frac{2s}{u + v} = \frac{2 \times 65}{62.5} = 2.08 \text{ s}$$

d) $s = \frac{1}{2} \text{ base} \times \text{height} = \frac{1}{2} \times 3 \times 27.78 = 41.67 \text{ m}$

$$s = \frac{(a + b)t}{2} = \frac{(27.78 + 62.5)10}{2} = 451.4 \text{ m}$$

$$\therefore 41.67 + 451.4 + 65 = 558.07 \text{ m}$$

2.



$$F = mg \sin \theta + \mu R$$

$$F = mg \sin \theta + \mu mg \cos \theta$$

$$F = (888 \times 9.81 \times \sin 20) + (\mu \times 888 \times 9.81 \times \cos 20)$$

$$\frac{P}{v} = (888 \times 9.81 \times \sin 20) + (\mu \times 888 \times 9.81 \times \cos 20)$$

$$\mu = \frac{P - (888 \times 9.81 \times \sin 20)}{(888 \times 9.81 \times \cos 20)}$$

$$\mu = \left[\frac{\left(\frac{150000}{38.89} \right) - (888 \times 9.81 \times \sin 20)}{(888 \times 9.81 \times \cos 20)} \right]$$

$$\mu = 0.14$$

3. $\omega_1 = 0$

a) $\omega_2 = 20000 \text{ rpm} \times \frac{2\pi}{60}$
 $= 2094.4 \text{ rad/s}$

$t = 0.5 \text{ s}$

$\alpha = ?$

$\omega_2 = \omega_1 + \alpha t$

$\alpha = \frac{\omega_2 - \omega_1}{t}$

$\alpha = \frac{2094.4}{0.5} = 4188.79 \text{ rad/s}^2$

$T = I\alpha$

$I = \frac{T}{\alpha} = \frac{145}{4188.79} = 0.035 \text{ kg m}^2$

b) $I = mk^2$

$I = m \frac{d^2}{8} \therefore m = \frac{I}{d^2/8} = \frac{0.035}{(0.26^2/8)} = 4.14 \text{ kg}$

c) $P = T\omega = 145 \times 2094.4 = 303688 \text{ W}$
 $= 303.69 \text{ kW}$

d) $KE = \frac{1}{2} I \omega^2 = \frac{1}{2} \times 0.035 \times 2094.4^2 = 76.76 \text{ kJ}$

4.

$P_1 = 200 \times 10^5 \text{ Pa}$

$T_1 = (35 + 273) \text{ K}$

$T_2 = (15 + 273) \text{ K}$

$P_2 = ?$

$V_1 = V_2$

$V_2 = 0.8 V_1$

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

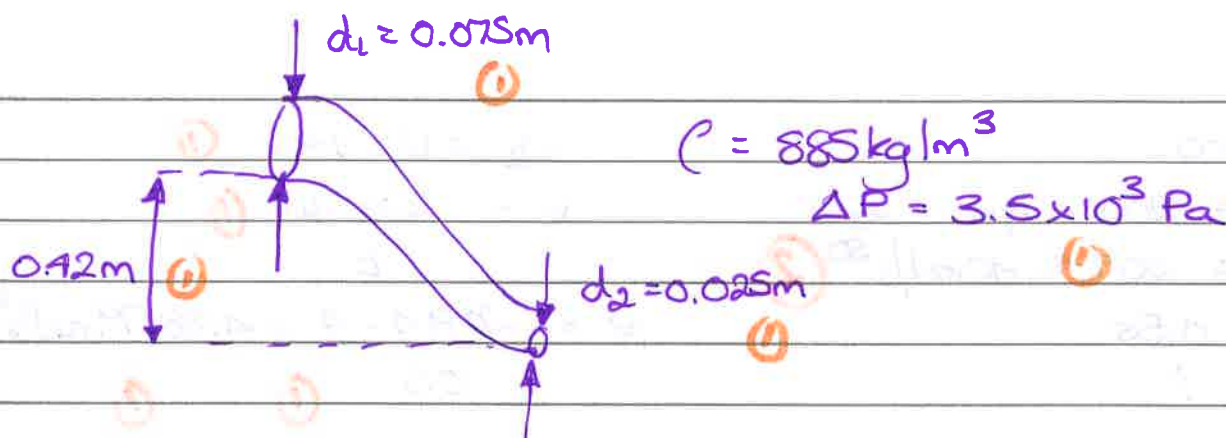
$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2}$

$P_2 = \frac{200 \times 10^5 \times V_1 \times (15 + 273)}{(35 + 273) \times 0.8 V_1}$

$P_2 = 233.77 \times 10^5 \text{ Pa}$

Q 5.

4.



$$d_1^2 v_1 = d_2^2 v_2$$

$$v_1 = \frac{d_2^2 v_2}{d_1^2} = \frac{0.025^2 v_2}{0.075^2}$$

$$v_1 = 0.11 v_2 \quad \text{--- ①}$$

$$gh_1 + \frac{P_1}{\rho} + \frac{v_1^2}{2} = \text{Datum} \quad gh_2 + \frac{P_2}{\rho} + \frac{v_2^2}{2}$$

$$\frac{P_1}{\rho} - \frac{P_2}{\rho} = \frac{v_2^2}{2} - \frac{v_1^2}{2} - gh_1$$

$$2 \left(\frac{P_1 - P_2}{\rho} + gh_1 \right) = v_2^2 - v_1^2$$

$$2 \left[\frac{P_1 - P_2}{\rho} + gh_1 \right] = v_2^2 - (0.11 v_2)^2$$

$$2 \left[\left(\frac{3.5 \times 10^3}{885} \right) + (9.81 \times 0.45) \right] = v_2^2 - 0.012 v_2^2$$

$$6991.76 = 0.988 v_2^2$$

$$v_2 = \sqrt{\frac{6991.76}{0.988}} = 84.12 \text{ m/s}$$

$$Q = A_2 v_2 = \frac{\pi d_2^2}{4} v_2 = \frac{\pi \times 0.025^2}{4} \times 84.12 = 0.04 \text{ m}^3/\text{s}$$

Circle answer

6.

$$u = \frac{k}{x} \quad (1)$$

$$\frac{1}{u} = \frac{1}{u_a} + \frac{1}{u_b} + \frac{1}{u_c}$$

$$\frac{1}{u} = \frac{x_a}{k_a} + \frac{x_b}{k_b} + \frac{x_c}{k_c} \quad (2)$$

$$\frac{1}{u} = \frac{1.5 \times 10^{-3}}{280} + \frac{3 \times 10^{-3}}{0.05} + \frac{1.5 \times 10^{-3}}{280} \quad (1)$$

$$\frac{1}{u} = 0.06 \quad (1)$$

$$u = 1/0.06 = 16.67 \text{ W/m}^2\text{K} \quad (1)$$

$$Q = uA(T_1 - T_2) \quad (1)$$

$$Q = 16.67(0.8 \times 0.45)(62 - 22) \quad (1)$$

$$Q = 240.05 \text{ N} \quad (1)$$

Answer a).

$$7. \quad \tau = \frac{F}{A} = \frac{250}{(0.025 \times 0.4)} = 25 \text{ kN/m}^2 \quad (1)$$

$$\gamma = \frac{\tau}{\delta} \quad \delta = \frac{\tau}{\gamma} = \frac{25 \times 10^3}{44 \times 10^9} = 5.68 \times 10^{-7} \text{ (no units)} \quad (1)$$

$$\delta = \frac{x}{l} \quad x = \delta \times l = 5.68 \times 10^{-7} \times 0.1$$

$$x = 5.68 \times 10^{-8} \text{ m} \quad (1)$$

$$8. \quad \frac{I}{J} = \frac{r}{r}$$

$$J = \frac{I r}{J} = \frac{1200 \times 0.5}{65 \times 10^6} = 2.77 \times 10^{-6} \text{ m}^4$$

$$J = \frac{\pi}{32} (D^4 - d^4)$$

$$\frac{32J}{\pi} = D^4 - d^4$$

$$d^4 = D^4 - \frac{32J}{\pi}$$

$$d = \sqrt[4]{D^4 - \frac{32J}{\pi}} = \sqrt[4]{0.15^4 - \left(\frac{32 \times 2.77 \times 10^{-6}}{\pi} \right)}$$

$$d = 0.148 \text{ m}$$