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 First

Instructor: Mr. Adel Dweik

Summer Semester 2011/2012

**1<sup>st</sup> Hour Exam**

**Problem #1: (15 %)**

- ✓ A solid cylinder having a mass of 1 kg, 60mm diameter and a length of 100 mm slides down a 62 mm diameter pipe as shown in figure 1. An oil having viscosity of  $0.08 \text{ N}\cdot\text{s}/\text{m}^2$  keeps the cylinder concentric in the pipe. Determine the terminal velocity of the falling cylinder.

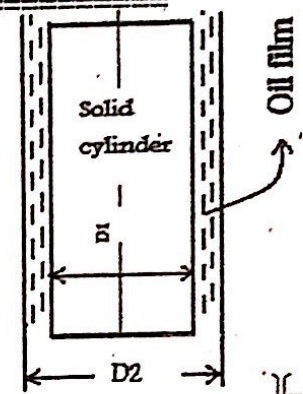


Fig.1

**Problem #2: (20 %)**

- ✓ a) In Fig.2a; an open tube is connected to a tank. The water rises to a height of 900 mm in the tube. A tube used in this way is called Piezometer. What are the pressures  $P_A$  and  $P_B$  of the air above the water? ( $\gamma_{\text{water}} = 9790 \text{ N}/\text{m}^3$ )

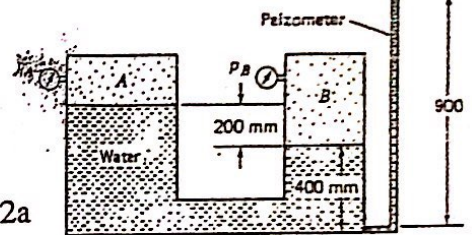


Fig.2a

- X b) A block of wood having a volume of  $0.034 \text{ m}^3$  and weighing  $300 \text{ N}$  is suspended in water as shown in Fig.2b. A wooden rod of length 3.4 m and cross section of  $2000 \text{ mm}^2$  is attached to the weight and also to the wall. If the rod weighs  $16 \text{ N}$ , what will the angle  $\theta$  be for equilibrium?

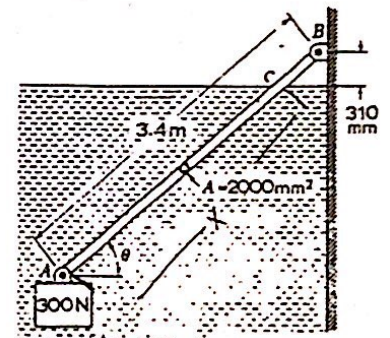


Fig.2b

**Problem #3: (15 %)**

*Depth = 6 ft*

- The gate AB in Fig.3 weighs  $2000 \text{ lb}_f$  when submerged. It is hinged at B and rests against a smooth wall at A. Determine the water level (h) which will just cause the gate to open.

$\gamma_{\text{water}} = 62.4 \text{ lbf}/\text{ft}^3$

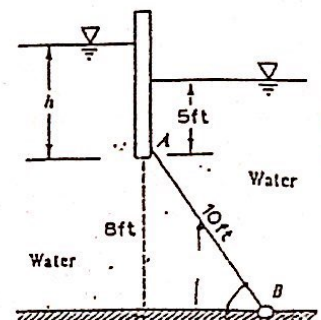


Fig.3

Q1)  $\sum f_y = 0$

$$\sum f_y = 0 = \cancel{w} - \tau A$$

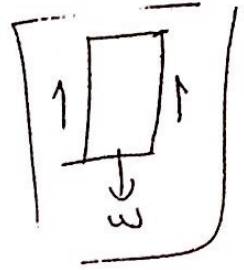
$$0 = mg - \left(\frac{\mu V}{h}\right)(A)$$

$$mg = \left(\frac{\mu V}{R_2 - R_1}\right) (2\pi R_1 L)$$

$$mg = \frac{\mu V}{R_2 - R_1} 2\pi R_1 L \rightarrow V = \frac{mg(R_2 - R_1)}{\mu 2\pi R_1 L}$$

$$V = \frac{(1)(9.81)(0.062 - 0.06)}{(0.08)(2\pi)(0.06)(0.1)} = \frac{0.01962}{3.0154289 \times 10^{-3}}$$

$$V = 6.50546 \text{ m/s}$$



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Q2) A: -

$$P_A + \gamma_w h_1 = P_B + \gamma_w h_2 = P_C + \gamma_w h_3$$

$$P_A + (9790)(0.6) = P_{atm} + (9790)(0.9)$$

$$P_A = P_{atm} + (9790)(0.9) - (9790)(0.6)$$

$$P_A = P_{atm} + (8811) - (5874) = P_{atm} + 2937$$

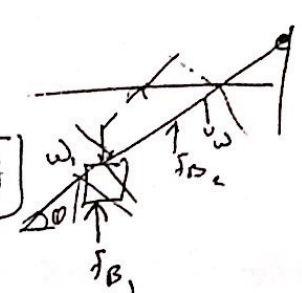
$$P_A = (P_{atm} + 2937) P_a \rightarrow P_A = 2937 P_a \text{ gage}$$

$$P_B + \gamma_w h_2 = P_{atm} + \gamma_w h_3 \rightarrow P_B = P_{atm} + \gamma_w h_3 - \gamma_w h_2$$

$$P_B = P_{atm} + (9790)(0.9) - (9790)(0.4) = P_{atm} + 3916 - 3916 - 8811$$

$$= P_{atm} + 8811 - 3916 = (P_{atm} + 4895) \rightarrow P_B = 4895 P_a \text{ gage}$$

~~(2) (3)~~



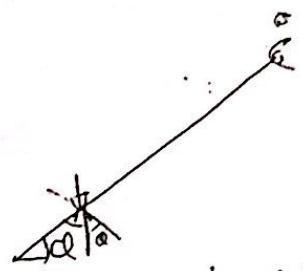
$$F_{B1} = \mu_w (N_{\text{block}}) = (0.34)(9790) = 332.86 \text{ N}$$

$$w_{\text{block}} = 300 \text{ N}$$

$$w_{\text{rod}} = 16 \text{ N}$$

$$F_{B2} = \mu_w (A)(x) = (0.34)(2 \times 10^3)(x)$$

$$F_{B2} = (680x) \text{ N} \quad x = (3.4 - \frac{0.31}{\sin \theta})$$



$$\sum M_B = 0 = (F_{B1})(\cos \theta)(3.4) + (300)(\cos \theta)(3.4) - (F_{B2})(\cos \theta)(3.4 - \frac{x}{2}) + \frac{(w_{\text{rod}})(3.4)}{2}$$

$$0 = -(F_{B1})(3.4) + (300)(3.4) - (F_{B2})(3.4 - \frac{x}{2}) + \frac{(w_{\text{rod}})(3.4)}{2}$$

$$0 = -(332.86)(3.4) + (300)(3.4) - (680x)(3.4 - \frac{x}{2}) + (16)(\frac{3.4}{2})$$

$$0 = -111.724 + 27.2 - (680x)(3.4) + \frac{(680x^2)}{2} \quad 7.5$$

$$84.52 = -66.572x + 340x^2$$

$$\rightarrow 340x^2 - 66.572x - 84.52 = 0$$

$$\frac{(66.572) \pm \sqrt{(66.572)^2 - 4(340)(-84.52)}}{2(340)} = \frac{66.572 \pm 87.986}{680}$$

~~x = 7.892 m~~  
~~x = 1.09366 m~~

$x = 1.09366 \text{ m}$

$\theta = ?$

~~$\theta = \sin^{-1}(\frac{0.31}{3.4 - 1.09366})$~~

$\rightarrow ?$   
 where to?

Q3)

to calculate the force from the Right side:-

$$h_{CG} = 5 + \left( 8 - 5 \left( \frac{8}{10} \right) \right) = 9.74 \text{ ft}$$

$$A = (6 \text{ ft})(10) \text{ ft} = 60 \text{ ft}^2$$

$$F_P = \gamma_w h_{CG} \cdot A = (62.4)(9)(60) = 33696 \text{ lbf}$$

$$y_{CP} = \frac{\left( \frac{1}{12} \right) (6)(10)^3 \left( \frac{8}{10} \right)}{(9)(60)} = 0.74 \text{ ft}$$

$$F_1 = 33696 \text{ lbf} \text{ act on } 9 + 0.74 = 9.74 \text{ ft from the surface}$$

to calculate the force from the left side:-

$$h_{CG} = h + \left( 8 - 5 \left( \frac{8}{10} \right) \right) = h + 4 \text{ ft}$$

$$A = (6)(10) = 60 \text{ ft}^2$$

$$F_2 = \gamma_w h_{CG} \cdot A = (62.4)(h+4)(60) = 3744(h+4) \text{ lbf}$$

$$y_{CP2} = \frac{-I_{xx} \sin \phi}{h_{CG} \cdot D} = \frac{-\left( \frac{1}{12} \right) (6)(10)^3 \left( \frac{8}{10} \right)}{(h+4)(60)} = \frac{-6.667}{(h+4)}$$

$$F_2 \text{ act on } (h+4) + \frac{6.667}{(h+4)} \text{ from the surface.}$$

$$\sum M_B = 0 = (w) \cos \alpha (5) - (F_1)(13 - 9.74) + (F_2) \left( 13 - (h+4) - \frac{6.667}{(h+4)} \right)$$

$$0 = (2000) \left( \frac{6}{10} \right) (5) - (33696)(3.26) + 3744(h+4) \left( 13 - (h+4) - \frac{6.667}{(h+4)} \right)$$

$$103848.96 = (3744)(13)(h+4) - (3744)(h+4)^2 - 6.667(3744)$$

