93/100

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Fluid Mechanics – First Exam (Makeup) November 17th, 2011

Answer All Questions

Question 1:

Choose the right answer by circling one of the multiple choices for each statement:

1. The mass of an object is ***10 kg***. The gravitational acceleration at a location is ***5 m/s²***. The specific weight is:
   (a) 2 N
   (b) 15 N
   (c) 5 N
   (d) 50 N

2. In a circular cylinder of ***0.2 m*** diameter and ***0.4 m*** height a fluid of specific weight ***1200 × 9.81 N/m³*** is filled to the brim and rotated about its axis at a speed when half the liquid spills out. The pressure at the centre is:
   (a) $0.2 \times 1200 \times 9.81$ N/m²
   (b) Zero
   (c) $0.4 \times 1200 \times 9.81$ N/m²
   (d) $0.1 \times 1200 \times 9.81$ N/m²

3. In a static fluid, with *y* as the vertical direction, the pressure variation is given by:
   (a) $dp/dy = \rho$
   (b) $dp/dy = -\rho$
   (c) $dp/dy = \gamma$
   (d) $dp/dy = -\gamma$

4. In a differential manometer a head of ***0.6 m*** of fluid ***A*** in limb ***1*** is found to balance a head of ***0.3m*** of fluid ***B*** in limb 2. The ratio of specific gravities of ***A*** to ***B*** is
   (a) A constant rate of strain
   (b) A constant kinematic viscosity
   (c) A constant normal stress
   (d) A constant shear stress

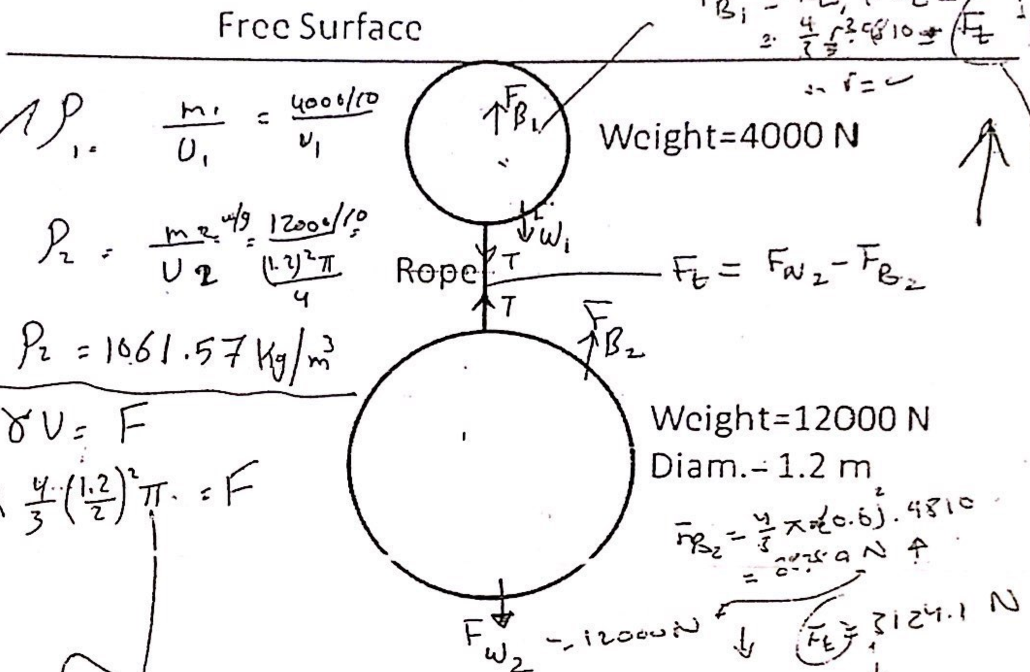
Question 2:

Two spheres, one heavier and weighing ***12000 N*** and of diameter ***1.2 m*** and the other lighter and weighing ***4000 N***, are tied with a rope and placed in water. It was found that the spheres floated vertically with the lighter sphere just submerging.
Determine the diameter of the lighter sphere and the tension in the rope.

$F_{B_1} = F_{w_1} + F_t =$

$\frac{4}{3} r^3 \cdot 9810 = F_t + 4000$

$\therefore r =$



$\rho_1 = \frac{m_1}{V_1} = \frac{4000/10}{V_1}$

$\rho_2 = \frac{m_2}{V_2} = \frac{12000/10}{\frac{(1.2)^2 \pi}{4}}$

$\rho_2 = 1061.57\ Kg/m^3$

$F_t = F_{w_2} - F_{B_2}$

As $\gamma V = F$

$\gamma \frac{4}{3}\left(\frac{1.2}{2}\right)^3 \pi = F$

$F_{B_2} = \frac{4}{3} \pi (0.6)^3 \cdot 9810$

$F_{w_2} = 12000 N$

$F_t = 3124.1 N$

$\Sigma F_z = 0$

$-W - T + B_1 = 0$

$-4000 - T + B_1 = 0 \Rightarrow B_1 - T = 4000$ — (1)

$\Sigma F_z = 0$

$-W + T + B_2 = 0$

$-12000 + T + B_2 = 0 \Rightarrow B_2 + T = 12000$ — (2)

$B_1 + B_2 = 16000$

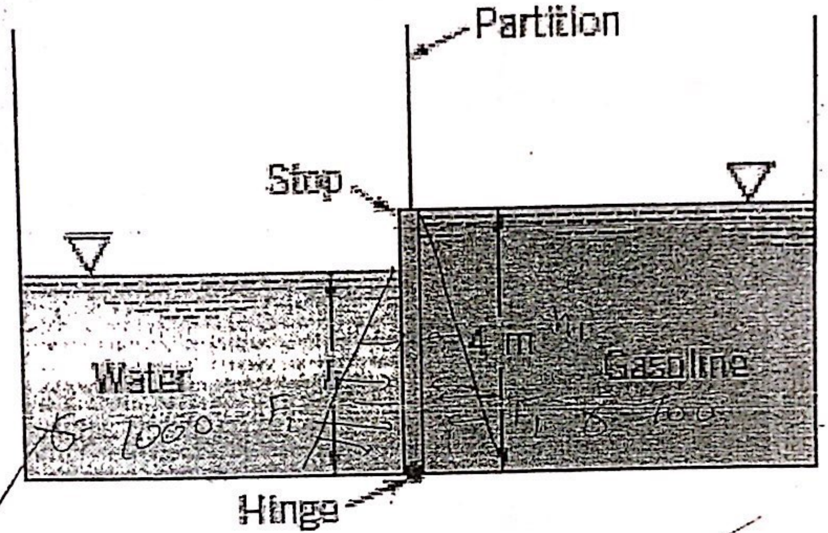
As a one particle B = Weight of two objects

$B_1 + B_2 = 16000$

Question 3:

An open tank has a vertical partition and on one side contains gasoline with a density of $700\ kg/m^3$ at a depth of *4 m*, as shown in Figure below. A rectangular gate that is *4 m* high and *2 m* wide and hinged at one end is located in the partition. Water is slowly added to the empty side of the tank.

At what depth, *h*, will the gate start to open?



$$F_1 = \frac{\gamma_G h_1^2 \cdot b}{2} = \frac{700 \times 4^2}{2} = 5600 \cdot b$$

$$F_2 = \frac{\gamma_w h^2 \cdot b}{2} = \frac{1000 \times h^2 \cdot b}{2} = 500 h^2 b$$

$$\Sigma M_o = 0 \Rightarrow F_1 \times \frac{h_1}{3} - 500 h^2 b \times \frac{h}{3} = 0$$

$$\Rightarrow 5600 \times \frac{4}{3} \times b = 500 \times \frac{h^2}{3} \times h\, b$$

$$22400 = 500 h^3$$

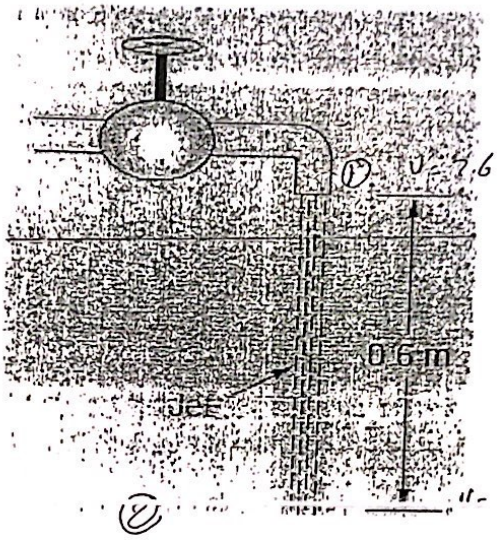
$$h^3 = 44.8 \Rightarrow h = 3.55\ m$$

Question 4:

A tap discharges water evenly in a jet at a velocity of ***2.6 m/s*** at the tap outlet, the diameter of the jet at this point being ***15 mm***. The jet flows down vertically in a smooth stream.

Determine the velocity and the diameter of the jet at ***0.6 m*** below the tap outlet.

25/25



① $v = 2.6$ m/s $d = 15$ mm.

② $v = ??$ $d = ??$

bernoli ⇒ $h_1 + \frac{v_1^2}{2g} + \frac{P_1}{\gamma} = h_2 + \frac{V_2^2}{2g} + \frac{P_2}{\gamma}$

assume $P_1 \approx P_2$

$$0.6 + \frac{2.6^2}{2 \times 10} + \frac{P_1}{\gamma} = 0 + \frac{U_2^2}{2 \times 10} + \frac{P_2}{\gamma}$$

$$18.76 = U_2^2$$

$$4.33 \text{ m/s} = U_2$$

⇒ As it a constant mass flow rate

$$\dot{m}_1 = \dot{m}_2$$

$\rho_1 Q_1 = \rho_2 Q_2$ ⇒ as $\rho_1 = \rho_2$

so ⇒ $Q_1 = Q_2$ ⇒ $V_1 A_1 = V_2 A_2$ ⇒ $2.6 \times \frac{\pi (15)^2}{4} = 4.33 \frac{\pi d^2}{4}$ ⇒ $d =$