Fluids Worksheet

MCQ

(1) B Fluid pressure depends on depth and both containers have the same depth

(2) C $P = \rho g h$

$= (1\times10^3)(9.8)(1-.45)$

$= 5390$

(3) D

$\Sigma F = ma$

$F_B - W = 0$

$F_B = W$

$\rho_{water} \frac{V_{sphere}}{2} g = m_{sphere} g$

$\rho_{water} \frac{V_{sphere}}{2} = \rho_{material} V_{material}$

$\rho_{water} \left(\frac{\frac{4}{3}\pi r_o^3}{2}\right) = \rho_{material}\left(\frac{4}{3}\pi (r_o^3 - r_i^3)\right)$

$\rho_m = \frac{\rho_w r_o^3}{2(r_o^3 - r_i^3)} = \frac{1\times10^3 (.15)^3}{2(.15^3 - .14^3)}$

$\rho_m = 2674 \ kg/m^3$

(4) B — Both beakers contain the same amount of water. Beaker B also has a block of wood.

(5) A — Y is deeper than X

(6) C — The water displaced in B is the same mass as the block. Therefore, since the water levels are the same, the weights are the same.

(7) B — Same depth at X and Y

(8) A — $P = \frac{F}{A}$ Force of W is added to B, so pressure of $\frac{W}{A}$ is added. Similarly 2W is added to C

(9) B

$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{F_1}{\frac{\pi d_1^2}{4}} = \frac{mg}{\frac{\pi d_2^2}{4}}$$

$$d_1 = \sqrt{\frac{F_1 d_2^2}{mg}} = \sqrt{\frac{800(1.8)^2}{1400(9.8)}}$$

$$d_1 = 0.43 \text{ m}$$

(10) D

$$A_1 v_1 = A_2 v_2$$

$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

$$v_2 = \sqrt{2gy_1 + v_1^2}$$

$$A_1 v_1 = A_2\left(\sqrt{2gy + v_1^2}\right)$$

$$A_1^2 v_1^2 = A_2^2 (2gy + v_1^2)$$

$$A_1^2 v_1^2 = A_2^2 2gy + A_2^2 v_1^2$$

$$A_1^2 v_1^2 - A_2^2 v_1^2 = A_2^2 2gy$$

$$v_1^2(A_1^2 - A_2^2) = A_2^2 2gy$$

$$v_1^2 = \frac{A_2^2 2gy}{(A_1^2 - A_2^2)}$$

$$= \frac{(.6\times10^{-4})^2\, 2(9.8)(.05)}{(1.4\times10^{-4})^2 - (.6\times10^{-4})^2}$$

$$\sqrt{v_1^2} = \sqrt{0.2205}$$

$$v_1 = 0.4696$$

Volumetric flow rate $= Av$

$$A_1 v_1 = (1.4\times10^{-4})(0.4696)$$

$$= 6.6\times10^{-5}\ m^3/s$$

(11) B

$$A_1 v_1 = A_2 v_2$$

$$v_2 = \frac{A_1 v_1}{A_2} = \frac{\frac{\pi d_1^2}{4} v_1}{\left(\frac{\pi d_2^2}{4}\right) \times 30}$$

$$= \frac{(0.012)^2 (1.1)}{(0.002)^2 (30)} = 1.32 \text{ m/s}$$

(12) C

$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

P_1 - outside

P_2 - inside.

$$v_1 = \sqrt{(P_{inside} - P_{outside})\frac{2}{\rho_{air}}}$$

$$= \sqrt{\frac{(12000)2}{.35}} = 261.9$$

(13) D

$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

$$v_2 = \sqrt{2 g y_1}$$

$$v_2 = \sqrt{2(9.8)(3)} = 7.67 \text{ m/s}$$

x	y
$v_x = 7.67$	$v_y = 0$
$x = ?$	$a = -9.8$
$t = __$	$y = -(15-3) = -12$
	$t = __$

$x = v_0 t$

$= 7.67(1.56)$

$= 12$

$y = v_0 t + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2(-12)}{-9.8}} = 1.56$

(14) A

$$P = P_0 + \rho g h$$

$$P_x = 101.3 \times 10^3 + 1 \times 10^3 (9.8)(220 - 95)$$
$$= 1.3 \times 10^6 \text{ Pa}$$

$$P_y = 101.3 \times 10^3 + 1 \times 10^3 (9.8)(220)$$
$$= 2.3 \times 10^6 \text{ Pa}$$

(15) A

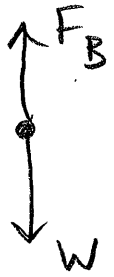
Assuming the tank is large and velocity at top of tank is zero, depth does not change.
Therefore $P_x = 1.3 \times 10^6$ Pa

Y is open to the atmosphere and therefor $P_y = 1.0 \times 10^5$ Pa

FRQ

(1) The mass of water displaced is equal to the mass of the ice. The density of the ice is less than the density of water, but once it melts the density is the same. The same density and mass gives the same volume.

(2) (a) $789 \ kg/m^3$

(b) 

$$\Sigma F = ma$$

$$F_B - W = 0$$

$$F_B = W$$

$$\rho_{ethanol} V_{sphere} g = m_{water} g$$

$$\rho_{ethanol} V_{sphere} = \rho_{water} V_{water}$$

$$V_{water} = \frac{\rho_e}{\rho_w}\left(\frac{4}{3}\pi r_s^3\right)$$

$$= \frac{789}{1\times10^3}\left(\frac{4}{3}\pi(.03)^3\right)$$

$$\boxed{V_{water} = 8.9\times10^{-5} \ m^3}$$

(3) $$P_1 + \cancel{\rho g y_1} + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

lower upper

$$P_2 = P_1 + \frac{1}{2}\rho v_1^2 - \rho g y_2 - \frac{1}{2}\rho v_2^2$$

$$= 220\times10^3 + \frac{1}{2}(850)(2)^2 - 850(9.8)(8) - \frac{1}{2}(850)(4)^2$$

$$= 148260$$

$$\boxed{P_2 = 1.5\times10^5 \ Pa}$$

(4) $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

$$v = \sqrt{2gy} = \sqrt{2gd}$$

x	y
$v = \sqrt{2gd}$	$v = 0$
$x = ?$	$a = -g$
$t =$ ———	$y = -H$
	$t =$ ———

$x = vt$

$= \sqrt{2gd}\sqrt{\frac{2H}{g}}$

$= \sqrt{4dH}$

$y = v_0 t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2(H)}{g}}$

$$\boxed{x = 2\sqrt{Hd}}$$

(5) tube with mercury.

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

$$\frac{P_1 - P_2}{\rho_{Hg}\, g} = h$$

tube with air

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$$

Combining the equations

$$h = \frac{\frac{1}{2}\rho_{air}\left(v_2^2 - v_1^2\right)}{\rho_{Hg}\, g}$$

Velocity from flow rate. AV

$A_1 v_1 = 1.8\times10^{-3}$

$\frac{\pi d_1^2}{4} v_1 = 1.8\times10^{-3}$

$v_1 = \frac{4(1.8\times10^{-3})}{\pi(4\times10^{-2})^2}$

$v_1 = 1.43$ m/s

$A_2 v_2 = 1.8\times10^{-3}$

$\frac{\pi d_2^2}{4} v_2 = 1.8\times10^{-3}$

$v_2 = \frac{4(1.8\times10^{-3})}{\pi(8\times10^{-3})^2}$

$v_2 = 35.81$ m/s

$$h = \frac{\frac{1}{2}(1.2)(35.81^2 - 1.43^2)}{1.36\times10^4(9.8)} = 5.76\times10^{-3}$$

$\boxed{h = 5.8\times10^{3}\ m}$ or $h = 5.8$ mm