(38) $P = \rho_f g d$

the fluids are identical so $\rho_{f_1} = \rho_{f_2}$

X + Y are at the same depth so

the pressure is the same

(39) (a) if no water was removed from the beaker when the block was added then the second beaker has a greater mass.

(b) the pressure at the bottom of the beaker with the block will be greater as the depth of the water is greater.

(40) (a) the mass of the beakers is the same, the displaced water has the same mass as the block

(b) the pressure at the bottom is the same since the depth is the same.

(41) $P = P_0 + \rho_f g d$

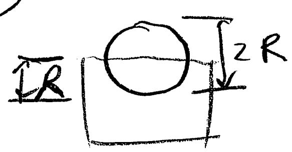
$= 101.3\ kPa + (1 \times 10^3\ kg\ m^{-3})(9.81 m s^{-2})(1 - .45\ m)$

$= 1.1 \times 10^5\ kPa$

(42) The mass of water displaced by the ice is equal to the mass of the ice. The density of the ice is less than the water, but once it melts it will have the same density.

(43) The pressure increases by an amount WA for each block added.

(44)



$B = F_g$ $\qquad \rho = \frac{m}{V}$ $\qquad$ R = outside radius
r = inside radius

$$\rho_f V_f g = mg$$

$$\rho_f \left(\tfrac{\cancel{4}}{\cancel{3}}\cancel{\pi} R^3\right)\tfrac{1}{2}\cancel{g} = \rho_s\left[\left(\tfrac{\cancel{4}}{\cancel{3}}\cancel{\pi} R^3\right) - \left(\tfrac{\cancel{4}}{\cancel{3}}\cancel{\pi} r^3\right)\right]\cancel{g}$$

$$\rho_s = \frac{\left(\rho_f R^3\right)\frac{1}{2}}{R^3 - r^3} = \frac{\left(1\times10^3\ kg\,m^{-3}\right)\left(.15m\right)^3 \frac{1}{2}}{.15m^3 - .14m^3}$$

$$= \underline{2.7\times10^3\ kg\,m^{-3}}$$

(45) $P_1 = P_2$

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

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

$$\frac{\cancel{\pi} d_1^2}{\cancel{4}} = \frac{(800\,N)\cancel{\pi}(1.8m)^2}{\cancel{4}(1400kg)(9.81ms^{-2})}$$

$$d = \underline{0.4m}$$

(46) $A_1 v_1 = A_2 v_2$

$\frac{1}{2} m v_2^2 = mgh + \frac{1}{2} m v_1^2$

$v_2 = \sqrt{(.05g)2 + v_1^2}$

$A_1^2 v_1^2 = A_2^2\left[(2)(.05g) + v_1^2\right]$

$A_1^2 v_1^2 = .1 A_2^2 g + A_2^2 v_1^2$

$(A_1^2 - A_2^2) v_1^2 = .1 A_2^2 g$

$v_1 = \sqrt{\frac{.1 A_2^2 g}{A_1^2 - A_2^2}} = \sqrt{\frac{.1(.6 \times 10^{-4} m^2)(9.81 ms^{-2})}{(1.4 \times 10^{-4})^2 - (.6 \times 10^{-4})^2}}$

$= .47 ms^{-1}$

$A_1 V_1 = (1.4 \times 10^{-4} m^2)(.47 ms^{-1}) = \underline{6.6 \; m^3 s^{-1}}$

(47) $A_1 V_1 = A_2 V_2$

$\frac{\pi d_1^2}{4} v_1 = 30\left(\frac{\pi d_2^2}{4}\right) V_2$

$V_2 = \frac{d_1^2 v_1}{30 d_2^2} = \frac{(.012 m)^2 (1.1 ms^{-1})}{30(.002 m)^2} = \underline{1.3 ms^{-1}}$

(48) $P = \frac{W}{t} = \frac{1}{2}\frac{m}{t}v^2 + \frac{m}{t}gh$

$= \frac{1}{2}(\rho A v)v^2 + (\rho A v)gh$

$= \rho A v\left(\frac{v^2}{2} + gh\right)$

$= (1 \times 10^3 kg m^{-3}) \pi (1.2 \times 10^{-2} m)^2 (3.8 ms^{-1})\left(\frac{(3.8 ms^{-1})^2}{2} + 9.81 ms^{-1}(4 m)\right)$

$= \underline{80. \; W}$

49

$$\frac{1}{2}\rho v_1^2 + \cancel{\rho g z_1} + P_1 = \frac{1}{2}\rho v_2^2 + \rho g z_2 + P_2$$

$$P_2 = \frac{1}{2}\rho v_1^2 + P_1 - \frac{1}{2}\rho v_2^2 + \rho g z_2$$

$$= \frac{1}{2}(850\,kgm^{-3})(2ms^{-1})^2 + 220\times10^3\,Pa - \frac{1}{2}(850\,kgm^{-3})(4ms^{-1})^2 + (850\,kgm^{-3})(4.81)(8m)$$

$$= \underline{2.8\times10^5\,Pa} = 280\,kPa$$

50

(a) $\cancel{\frac{1}{2}\rho v_1^2} + \rho g z_1 + \cancel{P_1} = \frac{1}{2}\rho v^2 + \cancel{\rho g z_2} + \cancel{P_2}$

$$v_2 = \sqrt{\frac{\cancel{\rho} g z_1}{\frac{1}{2}\cancel{\rho}}} = \sqrt{2gz_1}$$

$$v_2 = \sqrt{2(9.81ms^{-2})(3.0m)} = \underline{7.7\,ms^{-1}}$$

(b)

x	y
$u = v$	$u = 0$
$s_x = R$	$a = -g$
$t =$	$s_y = -y$
	$t =$

$t = \frac{s}{u} = \frac{R}{v}$

$s_y = \cancel{ut} + \frac{1}{2}at^2$

$t^2 = \frac{2y}{g}$

$R = v\sqrt{\frac{2y}{g}}$ $\quad v = \sqrt{2gz_1}$

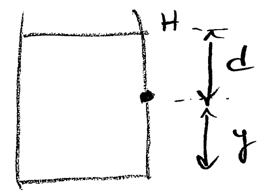
$$R = \sqrt{\frac{2\cancel{g}z_1 2y}{\cancel{g}}} = 2\sqrt{z_1 y_1} \qquad z + y = 9$$

$$R = 2\sqrt{z(9-z)}$$

$$\frac{R_1}{R_2} = \frac{\cancel{2}\sqrt{3(9-3)}}{\cancel{2}\sqrt{6(9-6)}} = \underline{1}$$

(51)

x	y
$u = v$	$u = 0$
$s_x = R$	$a = -g$
$t = \frac{R}{v}$	$s_y = (H-d)$
	$t =$



$$s_y = \cancel{ut} + \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s_y}{a}} = \sqrt{\frac{2(H-d)}{g}}$$

$$R = v\sqrt{\frac{2(H-d)}{g}}$$

$$\cancel{\frac{1}{2}\rho v_1^2} + \rho g z_1 + \cancel{P_1} = \frac{1}{2}\rho v_2^2 + \cancel{\rho g z_2} + \cancel{P_2}$$

$$v_2 = \sqrt{2gz_1} = \sqrt{2gd}$$

$$R = \sqrt{\frac{2\cancel{g}d\,2(H-d)}{\cancel{g}}} = 2\sqrt{dH - d^2}$$

$$R^2 = 4(dH - d^2)$$

$$\frac{R^2}{4} = -d^2 + dH$$

$$= -\left(d - \frac{H}{2}\right)^2 + \frac{H^2}{4}$$

or $\frac{d}{d(d)}\left(-d^2 + dH\right) = 0$

$$-2d + H = 0$$

$$d = \frac{H}{2}$$

$\therefore$ for maximum range $\underline{d = \frac{H}{2}}$

52 (a) $P = P_0 + \rho_f g d$

at x $d = 125m$ $P = 101.3 kPa + (1\times10^3 \ kg m^{-3})(9.81 ms^{-2})(125 m)$

$= \underline{1.3\times10^6 \ Pa}$

at y $d = 220m$ $P = 101.3 kPa + (1\times10^3 \ kg m^{-3})(9.81 ms^{-2})(220 m)$

$= \underline{2.3\times10^6 \ Pa}$

(b) (i) $\cancel{\frac{1}{2}\rho v_1^2} + \rho g z_1 + \cancel{P_1} = \frac{1}{2}\rho v_2^2 + \cancel{\rho g z_2} + \cancel{P_2}$

$v = \sqrt{2gz} = \sqrt{2(9.81 ms^{-2})(220m)} = \underline{66 \ ms^{-1}}$

(ii) $A_1 V_1 = A_2 V_2$

$\frac{\cancel{\pi} d_x^2}{\cancel{4}} V_x = \frac{\cancel{\pi} d_y^2}{\cancel{4}} V_y$

$V_x = \frac{d_y^2}{d_x^2} V_y = \frac{(.24m)^2}{(.8m)^2} 66 ms^{-1} = 5.94 \ ms^{-1}$

at y $P = \underline{101.3 \ kPa}$

at x

$\frac{1}{2}\rho v_x^2 + \rho g z_x + P_x = \frac{1}{2}\rho v_y^2 + \cancel{\rho g z_y} + P_y$

$P_x = \frac{1}{2}\rho v_y^2 + P_y - \frac{1}{2}\rho v_x^2 - \rho g z_x$

$= \frac{1}{2}(1\times10^3 kg m^{-3})(66 ms^{-1})^2 + 101.3 kPa - \frac{1}{2}(1\times10^3 kg m^{-3})(5.94 ms^{-1})^2 - (1\times10^3)(9.81)(95)$

$= \underline{1.3\times10^6 \ Pa}$

(53) $\frac{1}{2}\rho v_1^2 + \cancel{\rho g z_1} + P_1 = \frac{1}{2}\rho v_2^2 + \cancel{\rho g z_2} + P_2$

$$A_1 V_1 = A_2 V_2 = 1800\ cm^3 s^{-1} = 1.8\times10^{-3}\ m^3 s^{-1}$$

$$v_1 = \frac{1.8\times10^{-3}\ m^3 s^{-1}}{\frac{\pi(4\times10^{-2} m)^2}{4}} = 1.43\ ms^{-1}$$

$$v_2 = \frac{1.8\times10^{-3}\ m^3 s^{-1}}{\frac{\pi(8\times10^{-3} m)^2}{4}} = 35.8\ ms^{-1}$$

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

In the tube.

$$\cancel{\frac{1}{2}\rho_{Hg} V_1^2} + \cancel{\rho_{Hg} g z_1} + P_1 = \cancel{\frac{1}{2}\rho_{Hg} V_2^2} + \rho_{Hg} g z_2 + P_2$$

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

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

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

$$= \frac{1}{2}\frac{(1.2\,Kg\,m^{-3})}{(13600\ kg\,m^{-3})(9.81\,ms^{-2})}\left((35.8\,ms^{-1})^2 - (1.43\,ms^{-1})^2\right)$$

$$= \underline{5.7\times10^{-3}\ m} = 5.7\ mm$$

(54) $\frac{1}{2}\rho v_1^2 + \cancel{\rho g z_1} + P_1 = \cancel{\frac{1}{2}\rho v_2^2} + \cancel{\rho g z_2} + P_2$

$$v = \sqrt{\frac{P_{still} - P_{moving}}{\frac{1}{2}\rho_{air}}}$$

$$= \sqrt{\frac{12000 \text{ Pa}}{\frac{1}{2}(.35 \text{ kgm}^{-3})}} = \underline{260 \text{ ms}^{-1}}$$

(55) $R = \frac{v r \rho}{\eta} = \frac{(0.52 \text{ ms}^{-1})(.40 \text{ m})(850 \text{ kgm}^{-3})}{0.01 \text{ Pa s}} = 17680$

greater than 1000, so <u>turbulent flow</u>

(56) $\rho_{air} = 1.29 \text{ kgm}^{-3}$

$\eta_{air} = 0.018 \times 10^{-3} \text{ Pa s}$

on a windy day wind speed in Winnipeg could be

$50 \text{ km h}^{-1} = 13.9 \text{ ms}^{-1}$

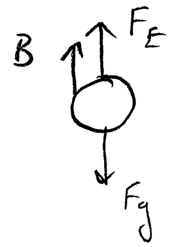
distances between tall buildings $5\text{m} \sim 20\text{m}$

$$R = \frac{v r \rho}{\eta} = \frac{(13.9 \text{ ms}^{-1})(2.5\text{m})(1.29 \text{ kgm}^{-3})}{(0.018 \times 10^{-3} \text{ Pa s})} = 2.5 \times 10^6$$

$$R = \frac{v r \rho}{\eta} = \frac{(13.9 \text{ ms}^{-1})(10\text{m})(1.29 \text{ kgm}^{-3})}{(.018 \times 10^{-3} \text{ Pa s})} = 1.0 \times 10^7$$

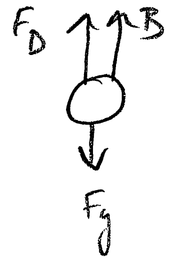
it is definitely <u>turbulent flow</u>.

(57) when stationary



$$F_E + B = F_g$$

when falling at terminal velocity.



$$F_D + B = F_g$$

ignoring Bouancy.

$$V = \frac{4}{3}\pi r^3$$

$$m = \rho_{oil}\frac{4}{3}\pi r^3$$

$$F_E = F_D = F_g$$

$$qE = 6\pi\eta r v = mg$$

$$6\cancel{\pi}\eta\cancel{r}v = \rho_{oil}\frac{4}{3}\cancel{\pi}r^{\cancel{3}\,2}g$$

$$r = \sqrt{\frac{18\eta v}{4\rho_{oil}g}}$$

$$q = \frac{6\pi\eta_{air}v}{E}\sqrt{\frac{9\eta_{air}v}{2\rho_{oil}g}}$$

$$= \frac{6\pi(1.82\times10^{-5}\,Pa\,s)(4.11\times10^{-4}\,ms^{-1})}{1.25\times10^{5}\,NC^{-1}}\sqrt{\frac{9(1.82\times10^{-5}\,Pa\,s)(4.11\times10^{-4}\,ms^{-1})}{2(870\,kgm^{-3})(9.81\,ms^{-2})}}$$

$$q = 2.24\times10^{-18}\,C = \underline{14e}$$