14.3

All the weight is exerted on a single heel.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{\sim mg}{\pi r^2} = \frac{50(9.8)}{\pi(0.005)^2}$$

$$= 6.24 \times 10^6 \text{ Pa}$$

$$\approx 906 \text{ psi}$$

14.8

The pressure is the same throughout the fluid as long as we are comparing the same heights.

$$P_A = P_B$$

$$\frac{\text{Force } A}{\text{Area } A} = \frac{\text{Force } B}{\text{Area } B}$$

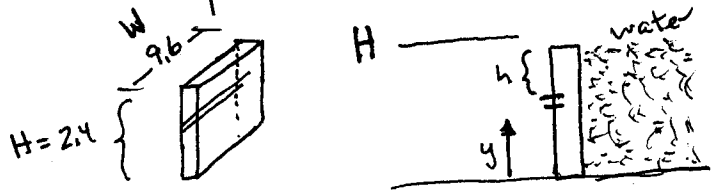
Area $A = 3 \text{ cm}^2$ Area $B = 200 \text{ cm}^2$

we can mix units here,

$$\frac{\text{Force } A}{3} = \frac{15{,}000}{200}$$

Force $A = 225$ Newtons

14.9 This is the same as Book Example 14.4 It sure would have been nice to have a picture to go with this




The pressure is difference at every height along the wall.

$$P = \rho g h = \rho g (H-y)$$

$$dF = P\,dA = \rho g (H-y)\, w\, dy$$

$$F_{TOT} = \int_{bot}^{top} dF = \int P\,dA = \int_0^H \rho g (H-y) w\, dy$$

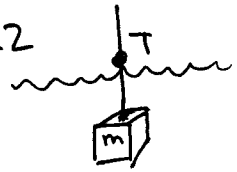
$$= \tfrac{1}{2} \rho g w H^2$$

$$= \tfrac{1}{2} 10^3 \; 9.8 \; 9.6 \; (2.4)^2$$

$$= 2.71 \times 10^5 \text{ Newtons}$$

$$= 6.09 \times 10^4 \text{ lb}$$

14.22




$mg = 5$ Newtons

$T = 3.5$ N when submerged

$$m\cancel{a_y}^{\,0} = T + B - mg$$

$$B = mg - T = 5 - 3.5$$
$$= 1.5 \text{ Newtons}$$

Bouyant Force = weight of fluid displaced

$$1.5 = \rho_{water}\, g \text{ Volume}$$

$$1.5 = 10^3 \; 9.8 \text{ Vol}$$

$$\text{Vol} = 1.53 \times 10^{-4} \text{ m}^3$$

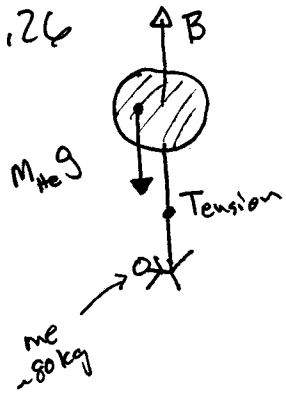
$mg = 5$ Newtons

$m(9.8) = 5$

$m = 0.51$ kg

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{0.51}{1.53 \times 10^{-4}} = 3.33 \times 10^{3} \text{ kg/m}^3$$
$$= 3.33 \text{ gm/cm}^3$$

14.26




the Tension in the rope will be the same value as the weight of me.

$$T = mg = (80\text{kg})(9.8)$$
$$= 784 \text{ Newtons}$$

$$m_{He}\cancel{a}^{\,0} = B - T - m_{He}g$$

B: weight of displaced ~~fluid~~ air

$m_{He}g$: (density of He)(vol)

$$0 = \rho_{air}\, g V - 784 - \rho_{He}\, g V$$

$$0 = (\rho_{air} - \rho_{He})\, g V - 784$$

$$0 = (1.29 - 0.179)\, 9.8\, V - 784$$

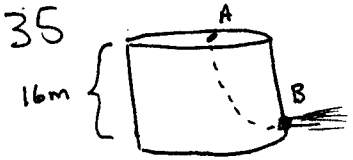
$$V = 72 \text{ m}^3$$

That's alot of ballons

$\sqrt[3]{72} = 4.2$ m on a side,

$\approx 13$ ft on a side.

14.35




flow rate

$2.5\times10^{-3}\ \frac{m^3}{min} = 2.5\times10^{-3}\ \frac{m^3}{60\,s}$

$= 4.17\times10^{-5}\ m^3/s$

$$\overset{atm}{P_A} + \frac{1}{2}\rho v_A^2 + \rho g y_A = \overset{atm}{P_B} + \frac{1}{2}\rho v_B^2 + \rho g \cancel{y_B}^{\,0}$$

very slow

$$\cancel{\rho} g y_A = \frac{1}{2}\cancel{\rho} v_B^2$$

$$9.8(16) = \frac{1}{2} v_B^2$$

$$v_B = 17.7\ m/s$$

Flow Rate = $Av$

$$4.17\times10^{-5}\ \frac{m^3}{s} = A(17.7)$$

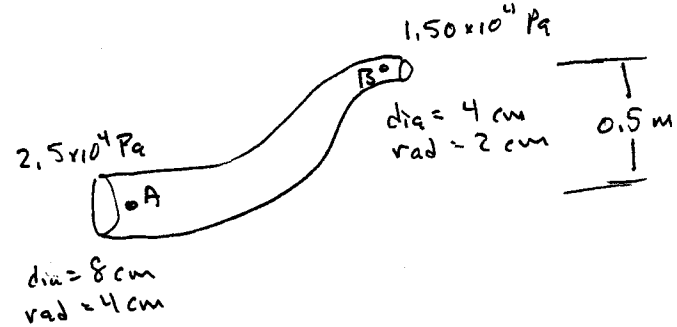
$$A = 2.36\times10^{-6}\ m^2$$

$$\pi r^2 = 2.36\times10^{-6}$$

$$r = 8.66\times10^{-4}\ m$$

$$= 8.66\times10^{-2}\ cm$$

14.38




$$P_A + \frac{1}{2}\rho v_A^2 + \rho g \cancel{y_A}^{\,0} = P_B + \frac{1}{2}\rho v_B^2 + \rho g y_B$$

$$(P_A - P_B) = \frac{1}{2}\rho\left(v_B^2 - v_A^2\right) + \rho g y_B$$

Also must have

$$A_A v_A = A_B v_B$$

$$v_A = \frac{A_B}{A_A} v_B = \frac{\pi r_B^2}{\pi r_A^2} v_B = \frac{r_B^2}{r_A^2} v_B$$

Then

$$(P_A - P_B) = \frac{1}{2}\rho\left[v_B^2 - \left(\frac{r_B}{r_A}\right)^4 v_B^2\right] + \rho g y_B$$

$$(P_A - P_B) = \frac{1}{2}\rho v_B^2\left[1 - \left(\frac{r_B}{r_A}\right)^4\right] + \rho g y_B$$

10.2

$$1\times10^4 = \frac{1}{2}\,10^3\, v_B^2\left[1 - \left(\frac{2}{4}\right)^4\right] + 10^3(9.8)(0.5)$$

$$v_B = 3.3\ m/s$$

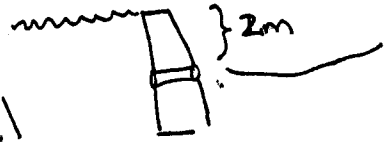
And then

$$v_A = \left(\frac{r_B}{r_A}\right)^2 v_B = \left(\frac{2}{4}\right)^2(3.3) = 0.82\ m/s$$

Volume Flow Rate

$$A_B v_B = \pi(0.02)^2\, 3.3 = 4.1\times10^{-3}\ m^3/s$$

14.41




dia = 1.20 cm  radius = 0.60 cm

$A = \pi r^2 = 1.13 \times 10^{-4}\ m^2$

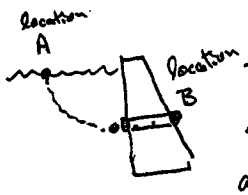
a) $\Delta P = \rho g \Delta h = (1030\ \frac{kg}{m^3})\ 9.8\ (2)$

$= 2.019 \times 10^4$ Pa

Force $= \Delta P \cdot A = (2.019 \times 10^4)(1.13 \times 10^{-4})$

$= 2.28$ Newtons $\sim \frac{1}{2}$ lb.

b)




$$P_A + \frac{1}{2}\rho v_A^2 + \rho g \overset{2m}{y_A} = P_B + \frac{1}{2}\rho v_B^2 + \rho g \overset{=0}{y_B}$$

$P_A$ ↑ atm; $v_A$ ↑ the water level drops very slowly so $v_A \sim 0$; $P_B$ ↑ atm

$$\cancel{\rho} g y_A = \frac{1}{2}\cancel{\rho} v_B^2$$

$$9.8(2) = \frac{1}{2} v_B^2$$

$$v_B = 6.26\ m/s$$

c) Flow Rate

$$Av = (1.13 \times 10^{-4} m^2)(6.26) = 7.07 \times 10^{-4}\ m^3/s$$

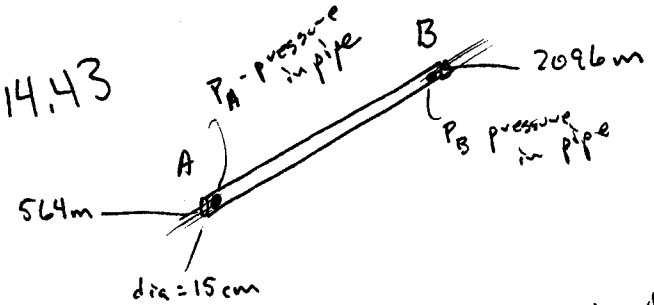
1 acre = 4047 $m^2$

time $\sim \frac{\text{volume}}{\text{flow rate}} = \frac{(4047)(0.30)}{7.07 \times 10^{-4}}$

$= 1.72 \times 10^6$ sec

$\sim 20$ days.

14.43




a) Assume the air pressure is the same on each end of the pipe.

$$P_A + \cancel{\frac{1}{2}\rho v_A^2} + \rho g y_A = P_B + \cancel{\frac{1}{2}\rho v_B^2} + \rho g y_B$$

$v_A = v_B$

$$P_A - P_B = \rho g (y_B - y_A)$$

$$\Delta P = 10^3\ 9.8\ (2096 - 564)$$

$$= 1.50 \times 10^7\ Pa$$

$$= 2179\ psig$$

this is the gauge pressure or press difference

b) Need 4500 $m^3$ water per day

Flow rate $= A v$

$$\frac{4500 m^3}{86400\ sec} = \pi (0.075\ cm)^2\ v$$

$$v = 2.95\ m/s$$

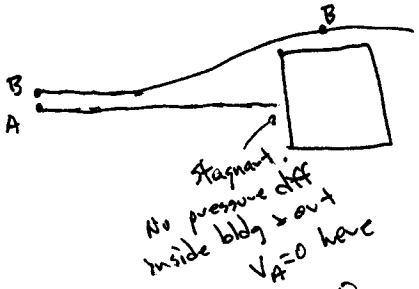
c) It's not terribly clear what they're asking here. But its that we are supposed to set $v_A = 0$ and $v_B = 2.95$ in part a)

Then $\Delta P$ from above would have been

$$\Delta P = 19.3 \times 10^7\ Pa$$

or about $4.3 \times 10^7$ Pa larger

14.50 This is like the pitot tube example




$$P_A + \frac{1}{2}\rho \cancel{V_A^2}^{\to 0} + \cancel{\rho g y_A} = P_B + \frac{1}{2}\rho V_B^2 + \cancel{\rho g y_B}$$

$$\Delta P = \frac{1}{2}\rho V_B^2$$

$$\text{Force} = \Delta P \cdot A = \frac{1}{2}\rho A V_B^2$$

$$= \frac{1}{2}\, 1.3\, [4 \times 1.5]\, (11.2)$$

$$= 489 \text{ Newtons}$$

$$= 111 \text{ lb.}$$

Double the wind speed to $V_B = 22.4$ m/s

the force will go up a factor of $2^2 = 4$

$$\text{Force} = 1956 \text{ Newtons}$$

$$= 444 \text{ lb}$$