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Chapter 12 In-Class Problems.

Ex. 5

A uniform lead sphere and a uniform aluminum sphere have the same mass. $R_{Al} / R_{Pb} = ?$

$$\rho = \frac{M}{\frac{4}{3}\pi R^3}$$

$$\frac{\rho_{Pb} = \dfrac{M}{\frac{4}{3}\pi R_{Pb}^3}}{\rho_{Al} = \dfrac{M}{\frac{4}{3}\pi R_{Al}^3}} \Rightarrow \frac{\rho_{Pb}}{\rho_{Al}} = \left(\frac{R_{Al}}{R_{Pb}}\right)^3 \qquad \frac{R_{Al}}{R_{Pb}} = \left(\frac{\rho_{Pb}}{\rho_{Al}}\right)^{1/3}$$

$$\frac{R_{Al}}{R_{Pb}} = \left(\frac{11.3 \times 10^3}{2.7 \times 10^3}\right)^{1/3} = 1.6$$

Ex. 10

A barrel contains a 0.120 m layer of oil floating on water that is 0.250 m deep.

a.) $P - P_o = \text{gauge pressure} = \rho_{oil}\, g\, h_{oil} = 600 \frac{kg}{m^3} (9.8 \, m/s^2)(0.120 m)$

$$\boxed{P - P_o = 705.6 \text{ Pa}}$$

b.) Gauge Pressure at the bottom of barrel

$(P - P_o)_{\text{water only}} = \rho_w g h_w = 1{,}000 \frac{kg}{m^3} \left(9.8 \frac{m}{s^2}\right)(0.250 m)$

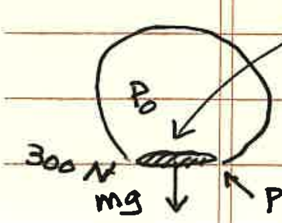
$(P - P_o)_{water} = 2450 \text{ Pa} \qquad (P - P_o)_{TOTAL} = (705.6 + 2450) \text{ Pa}$

$$\boxed{(P - P_o)_{TOTAL} = 3156 \text{ Pa}}$$

Ex. 17

An electrical short cuts of power to a submersible diving vehicle.

Area $= 0.75 m^2$



Net force $= (P - P_o)A - mg = (3.028 \times 10^5 \text{ Pa})(0.75 m^2) - 300 \text{ N}$

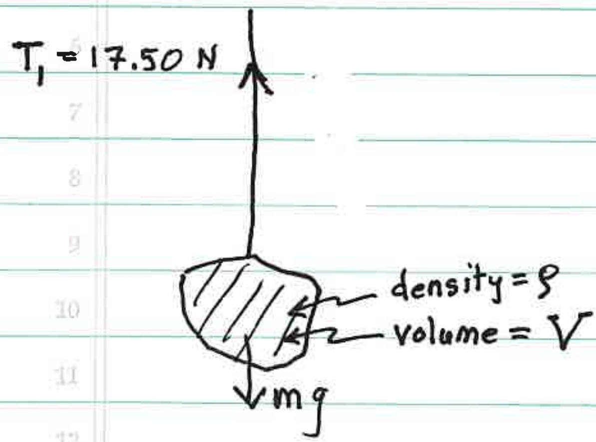
Net force $= 2.27 \times 10^5$ N

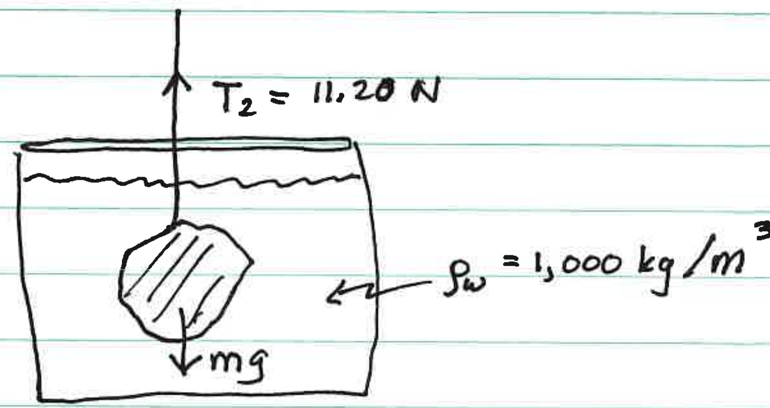
$P - P_o = \rho_{sw}\, g\, h = (1.03 \times 10^3)(9.8)(30 m) = 3.028 \times 10^5$ Pa

Chapter 12 In-Class Homework

Ex.29 An ore sample weighs 17.50 N in air.
In water, completely submerged, its weight is 11.20 N.

Find V, and ρ.





$\Sigma F_y = 0$

$T_1 - mg = 0$

$T_1 = mg = \rho V g$

$\Sigma F_y = 0$

$T_2 + F_B - mg = 0$

$T_2 = mg - F_B = \rho V g - \rho_w g V$

$$\left.\begin{aligned} T_2 &= gV(\rho - \rho_w) \\ T_1 &= gV\rho \end{aligned}\right\} \quad \frac{T_2}{T_1} = \frac{\rho - \rho_w}{\rho} = 1 - \frac{\rho_w}{\rho}$$

$$\frac{\rho_w}{\rho} = 1 - \frac{T_2}{T_1} \qquad \rho = \frac{\rho_w}{1 - T_2/T_1} = \frac{1{,}000\ kg/m^3}{1 - 11.20/17.50}$$

$$\boxed{\rho = 2778\ kg/m^3}$$

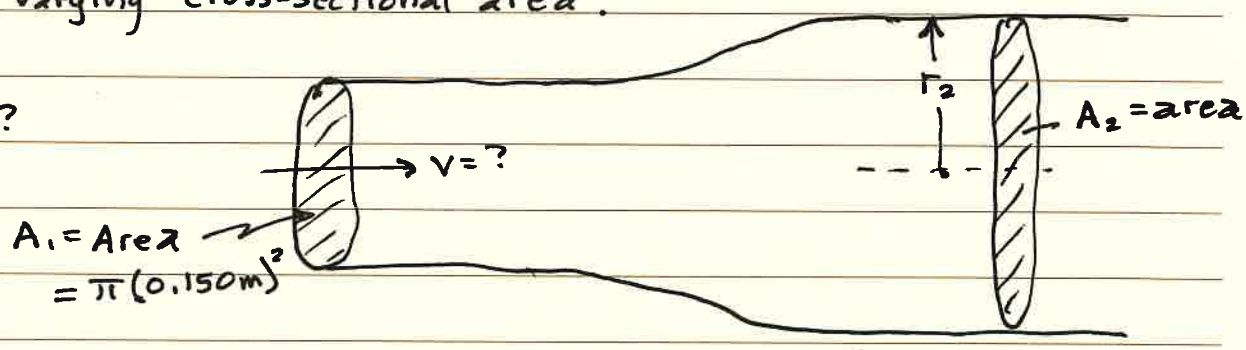
V = ? $\rho = \frac{m}{V}$ $V = \frac{mg}{\rho g} = \frac{17.50\ N}{2778\ \frac{kg}{m^3}(9.8\ m/s^2)}$

$$\boxed{V = 6.43 \times 10^{-4}\ m^3} = 0.643 \times \underbrace{10^{-3}\ m^3}_{1\ liter}$$

In class problems Chapter 12

Ex. 41 Water is flowing in a pipe with a circular cross section with varying cross-sectional area.

a.) $v = ?$



Volume Rate $= R = A_1 v_1$ $\quad v_1 = \dfrac{R}{A_1} = \dfrac{1.20\ m^3/s}{\pi(0.150 m)^2} = \underline{\underline{16.98\ m/s}}$

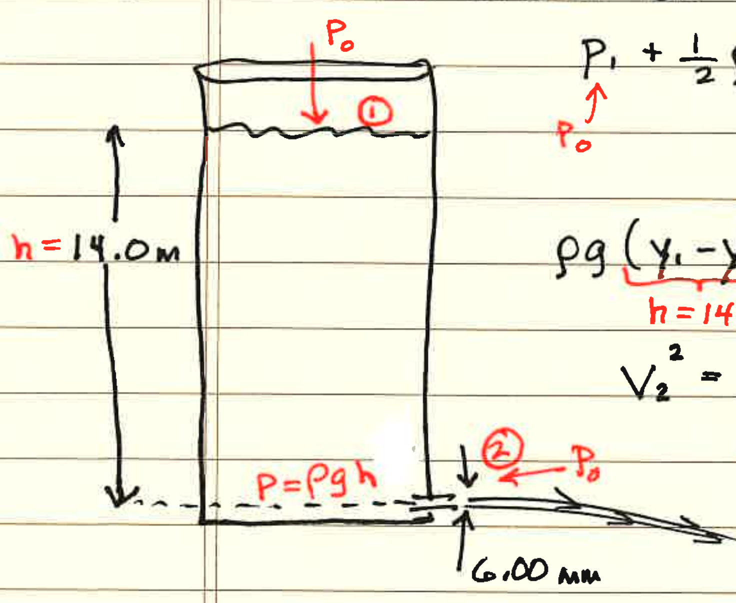
b.) $v_2 = 3.80 m/s$ Find r_2, the radius.

R = constant $\quad R = A_2 v_2 = (\pi r_2^2) v_2$

$$v_2 = \frac{R}{\pi r_2^2} = \frac{1.20\ m^3/s}{\pi(r_2^2)} \qquad r_2^2 = \frac{1.20\ m^3/s}{\pi\ (3.80 m/s)}$$

$r_2 = 0.32\ m$ $\quad \boxed{r_2 = 0.317 m}$

Ex. 48 A small circular hole



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

($P_1 = P_o$, $v_1 \approx 0$, $P_2 = P_o$)

$$\rho g \underbrace{(y_1 - y_2)}_{h = 14.0 m} = \tfrac{1}{2}\rho v_2^2$$

$v_2^2 = 2gh \quad v_2 = \sqrt{2(9.8 m/s^2)(14.0 m)}$

$\boxed{v_2 = 16.6\ m/s}$ $\quad \boxed{4.68 \times 10^{-4}\ \frac{m^3}{s}}$

$R = A v_2 = \frac{\pi}{4}(6.00 \times 10^{-3})^2\ 16.6\ m/s$

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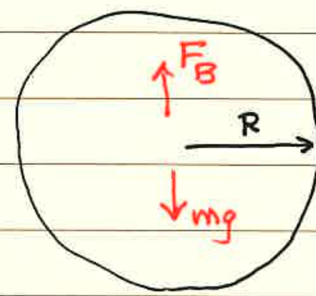
In class problems Chapter 12

Ex. 60 Ballooning on Mars:

$\rho_{atm} = 0.0154\ kg/m^3$

Plastic balloon $\sigma = 5.00\ g/m^2$ "surface mass density"

a.) Radius = ? such that $\sum F_y = 0$



$F_B - mg = 0$

$\rho_{atm}\, g\, V_b - \sigma(4\pi r^2) g = 0$

$\rho_{atm}\, g \left(\frac{4}{3}\pi r^3\right) = \underbrace{\sigma 4\pi r^2}_{m} g$

$r = \dfrac{3\sigma}{\rho_{atm}} = \dfrac{3\,(5\times10^{-3}\ kg/m^2)}{0.0154\ kg/m^3} = \underline{0.974\ m}$

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b.) Released on Earth, acceleration = ?

$\sum F = ma \qquad F_B - mg = ma \qquad a = \frac{F_B}{m} - g$

$a = \dfrac{\rho_{air}\, g\, V}{m = \sigma Area} - g = \dfrac{\rho_{air}\, g\, \frac{4}{3}\pi r^3}{\sigma\, 4\pi r^2} - g$

$a = \left[\dfrac{(\rho_{air})\, r}{3\sigma} - 1\right] g = \left[\ 76.92\ \right] g = \boxed{753.8\ m/s^2}$ up ⇑

c. How heavy an instrument package if $r \to 5r$ on Mars.

(mass of instrument)

$\sum F_y = 0 \qquad F_B - mg - Mg = 0 \qquad M = \frac{F_B}{g} - m$

$M = \dfrac{\rho_{atm}\, g\, \frac{4}{3}\pi (5r)^3}{g} - \sigma 4\pi (5r)^2 = \boxed{5.96\ kg}$