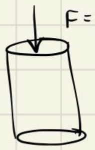
HW 1.1 : Ch 1; 48, 58, 63, 76, 92, 107

48) A coining press is used to produce commemorative coins with the likenesses of all the U.S. presidents. The coining process requires a force of 18 000 lb. The hydraulic cylinder has a diameter of 2.50 in. Compute the required oil pressure.

$F = 18{,}000^{\#}$



$d = \frac{2.5\text{ in}}{2}$

$r = 1.25\text{ in}$

$\text{Area}_{\text{circle}} = \pi r^2$

$= \pi(1.25\text{ in})^2$

$= 4.908\text{ in}^2$

$P = \frac{F}{A}$

$= \frac{18{,}000^{\#}}{4.908\text{ in}^2} = 3667.5\text{ Psi}$

$= 3.6675\text{ Ksi}$

58) Compute the pressure change required to cause a decrease in the volume of mercury by 1.00 percent. Express the result in both psi and MPa.

$E_{merc} = 3{,}590{,}000\text{ Psi} \approx 24{,}750\text{ mPa}$

$E = \frac{-P}{\left(\frac{\Delta V}{V}\right)}$

$E\left(\frac{\Delta V}{V}\right) = -P$

$-E\left(\frac{\Delta V}{V}\right) = P$

$-24{,}750\text{ mPa}\,(-0.01) = P$

$247.5\text{ mPa} = \Delta P$

$-3{,}590{,}000\text{ Psi}\,(-0.01) = P$

$35{,}900\text{ Psi} = \Delta P$

76) In the United States, hamburger and the other meats are sold by the pound. Assuming that this is 1.00# force, compute the mass in slugs, the mass in kg, and the weight in Newton's.

$$1\ lb_f = 4.44\ N$$

$$1\ lb_f \approx 1\ \cancel{lb_m} \cdot \frac{1\ slug}{32.174\ \cancel{lb_m}} = 0.0311\ slug$$

$$1\ lb_f \approx 1\ \cancel{lb_m} \cdot \frac{1\ kg}{2.204\ \cancel{lb_m}} = .454\ kg$$

92) A cylindrical container is 150 mm in diameter and weighs 2.25 N when Empty. When filled to a depth of 200 mm w/ a certain oil, it weighs 35.4 N. Calculate the specific gravity of the oil.

$d = 150^{mm}$

$r = 75^{mm} \cdot \frac{1m}{1000mm} = 0.075\ m$

$A_{circ} = \pi r^2$

$= \pi (0.075\ m)^2$

$= 0.0176\ m^2$

$W_{total} = W_{oil} + W_{container}$

$W_{total} - W_{container} = W_{container}$

$V_{cyl} = (0.0176\ m^2)(200\ \cancel{mm} \cdot \frac{1m}{1000\ \cancel{mm}})$

$V_{cyl} = .00352\ m^3$

$35.4\ N - 2.25\ N = 33.15\ N$

$W_{oil} = \frac{33.15\ \cancel{N}\ \frac{kg \cdot m}{s^2}}{9.81\ \frac{m}{s^2}}$

$W = mg$

$\frac{W}{g} = \frac{mg}{g}$

$\frac{W}{g} = m$

$\rho = \frac{m}{V}$

$m_{oil} = 3.3792\ kg$

$\rho_{oil} = \frac{3.372^{kg}}{.00352\ m^3}$

$\rho_{oil} = 957.95\ \frac{kg}{m^3}$

$\frac{\rho_{oil}}{\rho_{water}} = \frac{957.95\ \frac{kg}{m^3}}{1000\ \frac{kg}{m^3}} = .957 = S.G._{oil}$

$\gamma = \frac{W}{V}$

$\gamma = \frac{33.15\ N}{.00352\ m^3}$

$\gamma = 9417.61\ \frac{N}{m^3}$

$\gamma_{oil} = 9417.61\ \frac{N}{m^3}$ $\quad \gamma_{water} = 9810\ \frac{N}{m^3}$

$sg. = \frac{9417.61\ \frac{N}{m^3}}{9810\ \frac{N}{m^3}}$

$sg._{oil} = .96$

107 | Alcohol has a specific gravity of 0.79, Calculate its density both in slugs/ft³ and g/cm³.

$$S.G_{Alco.} = 0.79 = \frac{\gamma_{Alco}}{\gamma_{H_2O}} = \frac{\rho_{Alco}}{\rho_{H_2O}}$$

$$(S.G_{Alco})(\rho_{H_2O}) = \rho_{Alco.}$$

$$(0.79)(1000 \tfrac{kg}{m^3}) = \rho_{Alco.}$$

$$790 \tfrac{kg}{m^3} = \rho_{Alco}$$

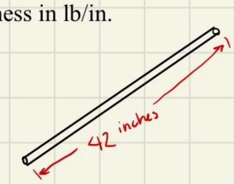
$$\left(790 \frac{\cancel{kg}}{\cancel{m^3}}\right)\left(\frac{1000 g}{1 \cancel{kg}}\right)\left(\frac{1 \cancel{m}}{100 cm}\right)^3 = .79 \frac{g}{cm^3}$$

$$\rho_{Alco} = \left(790 \frac{\cancel{kg}}{\cancel{m^3}}\right)\left(\frac{1 slug}{14.5939 \cancel{kg}}\right)\left(\frac{1 \cancel{m}}{3.2808 ft}\right)^3 = 1.533 \frac{slug}{ft^3}$$

63) A measure of the stiffness of a linear actuator system is the amount of force required to cause a certain linear deflection. For an actuator that has an inside diameter of 0.50 in and a length of 42.0 in and that is filled with machine oil, compute the stiffness in lb/in.

$$S = \frac{F}{A \Delta L}$$

$$E = \frac{-\Delta P}{\left(\frac{\Delta V}{V}\right)}$$



$X_0 = 42''$

$X_1 = 40''$

$l_0 = 42 \text{ in} \quad l_1 = 40 \text{ in}$

$\Delta L = 2^{in}$

$$A_{circle} = \pi r^2$$
$$= \pi (.25^{in})^2$$
$$= .1963 \text{ in}^2 \cdot 42^{in}$$

$$V_0 = 8.2446 \text{ in}^3$$

$$V_1 = .1963 \text{ in}^2 \cdot 40^{in}$$
$$= 7.852 \text{ in}^3$$

$$\Delta V = V_0 - V_1$$
$$= 8.2446 - 7.852$$
$$= .3926 \text{ in}^3$$

$$\frac{\Delta V}{V} = \frac{.3926 \text{ in}^3}{8.2446 \text{ in}^3}$$

$$\frac{\Delta V}{V} = 0.0476$$

$$E_{machine\ oil} = 189{,}000 \text{ Psi}, 1{,}303 \text{ MPa}$$

$$-E\left(\frac{\Delta V}{V}\right) = \Delta P$$

$$189{,}000 \frac{lb}{in^2}(0.0476) = \Delta P$$

$$-8996.4 \frac{\#}{in^2} = \Delta P$$

$$P = \frac{F}{A}$$

$$F = P \cdot A$$

$$\left(8996.4 \frac{\#}{in^2}\right)\left(.1963 \text{ in}^2\right) = F$$

$$1765.99 \ \# = F$$

$$S = \frac{F}{L}$$

$$S = \frac{1765.99 \frac{\#}{in^2}}{(2^{in})}$$

$$\boxed{S = 882.995 \frac{\#}{in}}$$