Homework 1

1.48 Coining press requiring 18,000 lbs. has a cylinder diameter of 2.5 in. Calculate Pressure

Pressure $= F/A$ $\quad \frac{18{,}000 \text{ lbs}}{\left(\pi\left(\frac{2.5}{2}\right)^2\right) \text{in}} = \underline{3666.93 \text{ pounds}/\text{in}^2}$

1.58 Pressure change required to cause a decrease in volume of mercury by 1%, in MPA and psi

$$E = \frac{-\Delta P}{\frac{\Delta V}{V}}$$

$\Delta V = 0.01$, $V = 1$, $\Delta P =$ unknown

Bulk modulus of Mercury in:
Psi = 3590000, MPA = 24750

In Psi

$3590000 \cdot \left(\frac{0.01}{1}\right) = -\Delta P$
$= \underline{-35900 \text{ psi}}$

In MPa

$24750 \cdot \left(\frac{0.01}{1}\right) = -\Delta P$
$\underline{-247.5 \text{ MPa}}$

$$E = \frac{-P}{\Delta V / V}$$

1.63 Find stiffness in lb/in

$D = 0.5$ in , $L = 42.0$ in
w/ machine oil

Stiffness = Force for certain linear deflection

$$E = \frac{-PV}{\Delta V} \qquad P = \frac{F}{A}$$

$A = \pi r^2$
$\pi \cdot .5^2$
$= \cancel{0.7854}\ in^2$
0.196

$V = A \cdot L$

$$\downarrow$$

$$\frac{\left(\frac{F}{A}\right) \cdot (A \cdot L)}{\Delta V} \rightarrow \frac{F \cdot L}{\Delta V} = E$$

$$\text{Stiffness} = \frac{lb}{in} \qquad E = 189\,000 \text{ psi}$$

$$189\,000 \text{ psi} = \frac{F(lb) \cdot 42 \text{ in}}{\Delta V} \rightarrow \frac{F \cdot L}{-A \cdot \Delta L} = \frac{\cdot A \, E}{L}$$

$$\downarrow$$

$\Delta V = -A \cdot \Delta L$
$- \cancel{0.7854} \cdot \Delta L$
0.196

$$\frac{F}{\Delta L} = \frac{A \cdot E}{L}$$

in^2 psi

$$\frac{0.196 \cdot 189 \times 10^3}{42 \text{ in}}$$

$$\frac{F}{\Delta L} = \boxed{883.6 \ lb/in}$$

1.76

I lb-force Find
mass in
- slugs
- kg
- Weight in N

1 pound force $\cdot$ 0.031 = 0.031 slug

1 lbf $\cdot$ 0.4536 = 0.4536 kg

1 lbf $\cdot$ 4.448 = 4.448 N

1.92:- A cylinder container is 150 mm in diameter and weighs 2.25 N when empty. When filled to a depth of 200 mm with a certain oil, it weighs 35.4 N. Calculate the specific gravity of the oil.

$$Weight_{oil} = 35.4 - 2.25 = \underline{33.15\,N}$$

$$= (33.15)\left(1\,kN/1000\,N\right) = \underline{0.03315\ kN}$$

$$Volume_{cylinder} = \pi \times 0.075^2 \times 0.02 = 0.000353429$$
$$= \underline{3.534 \times 10^{-3}\ m^3}$$

$$\gamma = \frac{W}{V} = \frac{33.15}{3.534\times10^{-3}} = 9380.3 = \underline{9.38\ kN/m^3}$$

$$sg = \frac{\gamma_s}{\gamma_w\ @\ 4^\circ C} = \frac{\rho_s}{\rho_w\ @\ 4^\circ C}$$

$$\boxed{sg = \frac{9.38}{9.81} = \underline{0.9561}}$$

1.107:- Alcohol has a specific gravity of 0.79. Calculate its density both in slugs/ft^3 and g/cm^3.

$\rho = (0.79)(1.94) = \underline{1.5326 \text{ slugs/ft}^3}$

$\rho = (1.5326)(0.515/1) = 0.789 \simeq \underline{0.79 \text{ g/cm}^3}$

2.17) non-Newtonion fluids: Electrorheological fluid
Pseudo plastic fluids - syrups, adhesives
Dilatant fluid - starch in water.
Binghom fluid - tooth paste

2.18) Dynamic viscosity: η
water @ 40°C : 6.50×10^{-4} Pa·s

2.27) Hydrogen @ 40°F : 1.9×10^{-7} Pa·s

2.35) SAE 30 oil @ 210°F : 2.25×10^{-4} Pas

2.61) In a falling-ball viscometer, a steel ball 1.6mm in diamiter falls freely in a heavy oil with a specific gravity of 0.94 steel weighs 77 kN/m³. If ball falls 250mm in 10.4s. What is the viscosity of oil?

$sg_f = 0.94$ $\quad D = 1.6\,mm$ $\quad V = 2.14\,mm^3$

$sg = \frac{\gamma_f}{\gamma_w @ 4°c} = \frac{\gamma_f}{9.81\,\frac{kN}{m^3}} = 0.94$ $\quad \gamma_f = 9.22\,kN/m^3$

$\gamma_B = 77\,kN/m^3$ $\quad v = d/t = \frac{0.25\,m}{10.4\,s} = 0.024\,m/s$

$$\eta = \frac{(\gamma_B - \gamma_f) D^2}{18\,v}$$

$$\eta = \frac{(77\,\frac{kN}{m^3} - 9.22\,kN/m^3)(0.0016\,m)^2}{18 \cdot 0.024\,m/s} = 0.000401\,\frac{kN \cdot s}{m^2}$$

$$\eta = 0.000401\,\frac{kN \cdot s}{m^2} = 0.401\,\frac{N \cdot s}{m^2} = \boxed{0.401\ Pa\text{-}s}$$