MET 330
HOMEWORK 1.1

AL McCLENNEY

1-48.) $\text{PRESSURE} = \frac{\text{FORCE}}{\text{AREA}} \rightarrow P = \frac{F}{A}$

$$\frac{18{,}000\ \text{lb}}{\pi (2.5\ \text{in})^2/4} = \boxed{3667\ \text{psi}}$$

1-58.) BULK MODULUS OF MERCURY: 3.59×10^6 psi
24750 MPa

TABLE 1.3
PAGE 10

$$\text{BULK MODULUS } E = \frac{-\Delta p}{(\Delta V)/V}$$

$$\Delta p = -E(\Delta V/V) = -3.59 \times 10^6\ \text{psi}(-0.01) = \boxed{35900\ \text{psi}}$$

$$\Delta p = -E(\Delta V/V) = -24750\ \text{MPa}\ (-0.01) = \boxed{247.5\ \text{MPa}}$$

1-63.) $\text{STIFFNESS} = \frac{\text{FORCE}}{\text{CHANGE IN LINEAR DEFLECTION}} \rightarrow k = \frac{F}{\Delta L}$

BULK MODULUS OF MACHINE OIL = 189000 Psi = E

AXIAL STIFFNESS IS EXPRESSED AS: $k = \frac{AE}{L}$ $\quad A = \pi r^2$

$$k = \frac{AE}{L} = \frac{\pi r^2 (E)}{L} = \frac{\pi (0.25\ \text{in})^2 (189000\ \text{lb})}{42\ \text{in}} = \boxed{883.57\ \text{lb/in}}$$

1-76.) GIVEN; HAMBURGER = 1.00-lb FORCE

$$\text{MASS} = \frac{\text{WEIGHT}}{\text{GRAVITY}} \rightarrow m = \frac{w}{g} = \frac{1.00\ \text{lb}}{32.2\ \text{ft/s}^2} = \boxed{0.0311\ \text{SLUGS}} = m$$

$1\ \text{lbf} = 4.448\ \text{N} = w$

$$\therefore\ m = \frac{4.448\ \text{N}}{9.81\ \text{m/s}^2} = \boxed{0.453\ \text{kg}} = m$$

$$w = 1.00\ \text{lb} \times 4.448\ \text{N/lb} = \boxed{4.448\ \text{N}} = w$$

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1-92.) GIVEN: DIAMETER (CONTAINER) = 150 mm

EMPTY WEIGHT (CONTAINER) = 2.25 N

WHEN FILLED W/CERTAIN OIL = 200 mm DEEP = 0.2 m

WHEN FILLED W/CERTAIN OIL = 35.4 N

WEIGHT OF OIL = $W_{OIL} = 35.4\ N - 2.25\ N = 33.15\ N$

VOLUME OF CYLINDER = $V = \pi r^2 h$

RADIUS OF CONTAINER = $r = \frac{D}{2} = \frac{150\ mm}{2} = 75\ mm = 0.075\ m$

$V = \pi r^2 h = \pi (0.075\ m)^2 (0.2\ m) = 3.534 \times 10^{-3}\ m^3$

SPECIFIC WEIGHT OF OIL = $\gamma_{OIL} = \frac{W_{OIL}}{V} = \frac{33.15\ N}{3.534 \times 10^{-3}\ m^3}$

$\frac{33.15\ N}{3.534 \times 10^{-3}\ m^3} = 9.38 \times 10^3\ N/m^3 = 9.38\ kN/m^3$

SPECIFIC GRAVITY OF OIL = $Sg = \frac{\gamma_{OIL}}{\gamma_{WATER\ @\ 4^\circ C}} = \frac{9.38\ kN/m^3}{9.81\ kN/m^3}$

$Sg = 0.956$

1-107.) ALCOHOL SPECIFIC GRAVITY = $Sg = 0.79$

(TABLE A-2, APPENDIX A)

$\rho_{WATER} = 1.94\ slugs/ft^3$

DENSITY = $\rho = Sg \times \rho_{WATER\ @\ 4^\circ C}$

$\rho = (0.79)(1.94\ slugs/ft^3) = 1.53\ slugs/ft^3$

$1\ slug/ft^3 = 0.515\ g/cm^3$

$\therefore \rho = (1.53\ slugs/ft^3)\left(\frac{0.515\ g/cm^3}{1\ slug/ft^3}\right) = 0.788\ g/cm^3$

$\rho \approx 0.79\ g/cm^3$

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2-17.) PSEUDOPLASTIC: SYRUPS, MOLASSES, INKS

DILATANT FLUIDS: STARCH IN WATER, TITANIUM DIOXIDE

BINGHAM FLUIDS: CHOCOLATE, MUSTARD, TOOTHPASTE, ASPHALT

FROM APPENDIX D, FIGURE D.1 →

2-18.) WATER AT 40°C → $\eta = 6,5 \times 10^{-4}\ Pa \cdot s$

FROM APPENDIX D, FIGURE D.2 →

2-27.) HYDROGEN AT 40°F → $\eta = 1,9 \times 10^{-7}\ lb \cdot s/ft^2$

FROM APPENDIX D, FIGURE D.2 →

2-35.) SAE 30 OIL AT 210°F → $\eta = 2.2 \times 10^{-4}\ lb \cdot s/ft^2$

2-61.) GIVEN: DIAMETER OF STEEL BALL = $D = 1.6\ mm = 1.6 \times 10^{-3}\ m$

SPECIFIC GRAVITY OF HEAVY OIL = 0.94

WEIGHT OF STEEL = $\gamma_s = 77\ kN/m^3$

BALL TRAVEL = 250 mm IN 10,4 s

VISCOSITY = $\eta = \dfrac{(\gamma_s - \gamma_f)D^2}{18v}$ ← EQUATION 2-10 (PAGE 30)

SPECIFIC WEIGHT OF OIL = (SPECIFIC GRAVITY OF OIL)(SPECIFIC WEIGHT OF WATER)

$\gamma_f = (0,94)(9.81\ kN/m^3) = 9,22\ kN/m^3$

$$\eta = \frac{(\gamma_s - \gamma_f)D^2}{18v} = \frac{(77\ kN/m^3 - 9,22\ kN/m^3)(1.6 \times 10^{-3}\ m)^2}{18\ m^3(2.40 \times 10^{-2}\ m/s)} = \frac{1.735 \times 10^{-4}}{0,432}$$

$$\eta = 4,016 \times 10^{-4}\ kN \cdot s/m^2 = 0,4016\ N \cdot s/m^2 = 0,4015\ Pa \cdot s$$

VISCOSITY OF OIL = $\eta = 0,4015\ Pa \cdot s$