## Conversion Factors

Mass & Force:

$$\frac{14.59\ \text{kg}}{\text{slug}} \quad \frac{32.174\ \text{lb}_\text{m}}{\text{slug}} \quad \frac{2.205\ \text{lb}_\text{m}}{\text{kg}} \quad \frac{2000\ \text{lb}_\text{m}}{\text{ton}_\text{m}} \quad \frac{1000\ \text{kg}}{\text{metric ton}_\text{m}} \quad \frac{4.448\ \text{N}}{\text{lb}_\text{f}} \quad \frac{10^5\ \text{dynes}}{\text{N}}$$

Length:

$$\frac{3.281\ \text{ft}}{\text{m}} \quad \frac{39.37\ \text{in}}{\text{m}} \quad \frac{12\ \text{in}}{\text{ft}} \quad \frac{1.609\ \text{km}}{\text{mi}} \quad \frac{5280\ \text{ft}}{\text{mi}}$$

Volume:

$$\frac{7.48\ \text{gal}}{\text{ft}^3} \quad \frac{3.785\ \text{L}}{\text{gal}} \quad \frac{1000\ \text{L}}{\text{m}^3} \quad \frac{1.201\ \text{U.S. gal}}{\text{Imperial gallon}}$$

Volume Flow Rate:

$$\frac{449\ \text{gal/min}}{\text{ft}^3/\text{s}} \quad \frac{3.785\ \text{L/min}}{\text{gal/min}} \quad \frac{60{,}000\ \text{L/min}}{\text{m}^3/\text{s}} \quad \frac{2119\ \text{ft}^3/\text{min}}{\text{m}^3/\text{s}}$$

Energy & Power:

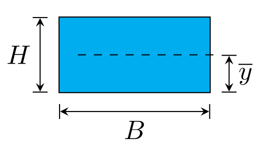
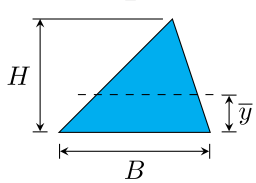
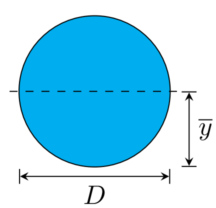
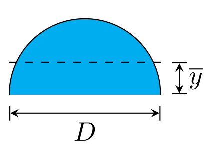
$$\frac{1.356\ \text{J}}{\text{lb}\cdot\text{ft}} \quad \frac{1.0\ \text{J}}{\text{N}\cdot\text{m}} \quad \frac{1.055\ \text{kJ}}{\text{Btu}} \quad \frac{745.7\ \text{W}}{\text{hp}} \quad \frac{550\ \text{lb}\cdot\text{ft/s}}{\text{hp}} \quad \frac{3.412\ \text{Btu/hr}}{\text{W}}$$

## Properties of water at 15°C / 59°F

$$\gamma = 9.81\ \text{kN/m}^3 = 62.4\ \text{lb/ft}^3 \qquad \rho = 1000\ \text{kg/m}^3 = 1.94\ \text{slugs/ft}^3$$

$$\eta = 1.15\times10^{-3}\ \text{Pa}\cdot\text{s} = 2.40\times10^{-5}\text{lb}\cdot\text{s/ft}^2 \qquad \nu = 1.15\times10^{-6}\ \text{m}^2/\text{s} = 1.24\times10^{-5}\ \text{ft}^2/\text{s}$$

## Properties of Areas

| | Area | Distance to Centroidal axis ($\overline{y}$) | Moment of Inertia about Centroidal Axis ($I_c$) |
|---|---|---|---|
|  | $BH$ | $H/2$ | $BH^3/12$ |
|  | $BH/2$ | $H/3$ | $BH^3/36$ |
|  | $\pi D^2/4$ | $D/2$ | $\pi D^4/64$ |
|  | $\pi D^2/8$ | $2D/(3\pi)$ | $\left(\frac{\pi}{128} - \frac{1}{18\pi}\right) D^4$ |

## Key Equations

| | | | |
|---|---|---|---|
| PRESSURE | $p = \dfrac{F}{A}$ | BULK MODULUS | $E = \dfrac{-\Delta p}{(\Delta V)/V}$ |
| DENSITY | $\rho = m/V$ | SPECIFIC WEIGHT | $\gamma = mg/V$ |
| DYNAMIC VISCOSITY | $\eta = \tau\left(\dfrac{\Delta y}{\Delta v}\right)$ | KINEMATIC VISCOSITY | $\nu = \eta/\rho$ |

ABSOLUTE AND GAUGE PRESSURE: $p_{\text{abs}} = p_{\text{gauge}} + p_{\text{atm}}$

PRESSURE-ELEVATION RELATIONSHIP: $\Delta p = \gamma h$

FORCE ON A SUBMERGED PLANE AREA: $F_R = \gamma h_c A$

LOCATION OF CENTER OF PRESSURE: $L_p = L_c + \dfrac{I_c}{L_c A}, \qquad h_p = h_c + \dfrac{I_c \sin^2\theta}{h_c A}$

PIEZOMETRIC HEAD: $h_a = p_a/\gamma$ — BUOYANT FORCE: $F_b = \gamma_f\, V_d$

VOLUME, WEIGHT AND MASS FLOW RATE: $Q = Av, \qquad W = \gamma Q, \qquad M = \rho Q$

CONTINUITY EQUATION: $\rho_1 A_1 v_1 = \rho_2 A_2 v_2\,, \qquad A_1 v_1 = A_2 v_2$ (LIQUIDS)

GENERAL ENERGY EQ. (FLOW: $1 \to 2$): $\dfrac{p_1}{\gamma} + z_1 + \dfrac{v_1^2}{2g} + h_A - h_R - h_L = \dfrac{p_2}{\gamma} + z_2 + \dfrac{v_2^2}{2g}$

POWER ADDED TO FLUID BY A PUMP: $P_A = h_A W = h_A \gamma Q$

PUMP EFFICIENCY: $e_M = \dfrac{\text{Power delivered to fluid}}{\text{Power consumed by pump}} = \dfrac{P_A}{P_I}$

POWER REMOVED FROM FLUID BY A MOTOR: $P_R = h_R W = h_R \gamma Q$

MOTOR EFFICIENCY: $e_M = \dfrac{\text{Power output from motor}}{\text{Power delivered by fluid}} = \dfrac{P_O}{P_R}$

REYNOLDS NUMBER – CIRCULAR SECTIONS: $N_R = \dfrac{vD\rho}{\eta} = \dfrac{vD}{\nu}$

DARCY'S EQUATION FOR ENERGY LOSS: $h_L = f \times \dfrac{L}{D} \times \dfrac{v^2}{2g}$

MINOR LOSSES: $h_L = K\left(v^2/2g\right) \qquad (K = \text{Resistance coefficient})$

$K$ FOR VALVES AND FITTINGS: $K = (L_e/D)\, f_T$

$K$ FOR SUDDEN ENLARGEMENT: $K \approx [1 - (A_1/A_2)]^2$

$K$ FOR SUDDEN CONTRACTION: $K \approx 0.5\,[1 - (A_2/A_1)]$

FORCE EQUATION IN X-DIRECTION: $F_x = \rho Q \Delta v_x = \rho Q\left(v_{2_x} - v_{1_x}\right)$

| | | | |
|---|---|---|---|
| DRAG FORCE | $F_D = C_D\left(\rho v^2/2\right) A$ | LIFT FORCE | $F_L = C_L\left(\rho v^2/2\right) A$ |
| STOKE'S LAW | $F_D = 3\pi\eta v D$ | IDEAL GAS LAW | $\dfrac{p}{\gamma T} = \text{constant} = R$ |