

In showing work, these formulas may be used without derivation.

FLUIDS

$$\Delta p = -\rho g \Delta y$$

$$F = \rho V g$$

$$Av = \text{const}$$

$$p + \frac{1}{2}\rho v^2 + \rho g y = \text{const}$$

CIRCUITS

$$E = \frac{q}{\kappa \epsilon_0 A} \quad E = \frac{\Delta V}{d}$$

$$C = \kappa \epsilon_0 \frac{A}{d} \quad i = \frac{dq}{dt}$$

ELECTROMAGNETISM

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B} \quad \vec{F} = i\vec{L} \times \vec{B}$$

$$\Delta V = - \int_i^f \vec{E} \cdot d\vec{s}$$

$$\vec{E} = - \left(\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}, \frac{\partial V}{\partial z} \right) \equiv -\vec{\nabla} V$$

$$d\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{dq}{r^3} \vec{r} \quad d\vec{B} = \frac{\mu_0}{4\pi} i \frac{d\vec{s} \times \vec{r}}{r^3}$$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{enc}}}{\epsilon_0} \quad \oint \vec{B} \cdot d\vec{A} = 0$$

$$\oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt} \quad \oint \vec{B} \cdot d\vec{s} = \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{\text{enc}}$$

$$u_E = \frac{\epsilon_0}{2} E^2 \quad u_B = \frac{1}{2\mu_0} B^2$$

ELECTROMAGNETIC WAVES

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \quad \vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

$$I = \frac{P}{4\pi r^2}$$

$$\Delta p = \frac{\Delta U}{c} \quad p_r = (1 \text{ to } 2) \frac{I}{c}$$

$$I = I_0 \cos^2 \theta$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

INTERFERENCE AND DIFFRACTION

$$d \sin \theta = n\lambda \quad d \sin \theta = \left(n - \frac{1}{2}\right) \lambda$$

$$I = 4I_0 \cos^2 \left(\frac{1}{2} \Delta \phi\right) \quad \Delta \phi = \frac{2\pi}{\lambda} d \sin \theta$$

$$a \sin \theta = m\lambda$$

$$a \sin \theta = 1.430297\lambda \quad \text{or} \quad 2.459024\lambda$$

$$I_0 = I_m \left(\frac{\sin \alpha}{\alpha} \right)^2 \quad \alpha = \frac{1}{2} \phi = \frac{\pi}{\lambda} a \sin \theta$$

THERMODYNAMICS

$$\Delta L = L\alpha \Delta T \quad \Delta V = V\beta \Delta T$$

$$\Delta E = C \Delta T = cm \Delta T = c_m n \Delta T$$

$$\Delta E = mLf$$

$$P = \frac{A}{R} (T_H - T_C) = kA \frac{T_H - T_C}{L}$$

$$P = \epsilon \sigma AT^4$$

$$pV = nRT = NkT$$

$$c_V = \frac{f}{2} R \quad E_{\text{avg}} = \frac{f}{2} kT$$

$$p \propto \frac{1}{V^\gamma} \quad T \propto V^{1-\gamma} \quad p^{1-\gamma} \propto \frac{1}{T^\gamma}$$

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

CONSTANTS

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$$

$$\rho_{\text{air}} \approx 1.21 \text{ kg/m}^3$$

$$T_3 = 273.16 \text{ K}$$

$$\sigma = 5.6703 \times 10^{-8} \text{ W/m}^2\text{K}^4$$

$$R = 8.314 \text{ J/mol} \cdot \text{K} \quad k = 1.381 \times 10^{-23} \text{ J/K}$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

FLUIDS

$$p = \frac{F}{A} \quad p_g = p_a - p_{\text{atm}}$$

$$\Delta p = \text{const (Pascal's principle)}$$

MECHANICS

$$\sum \vec{F} = m\vec{a}$$

$$\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2$$

$$\vec{v} = \vec{v}_0 + \vec{a} t$$

WAVES

$$v = \lambda f$$

$$k = \frac{2\pi}{\lambda} \quad f = \frac{\omega}{2\pi}$$

(Think of 2π as having units rad/cycle.)

ELECTROMAGNETISM, WITH WAVES

$$\Phi_E = \int \vec{E} \cdot d\vec{A} \quad \Phi_B = \int \vec{B} \cdot d\vec{A}$$

$$\vec{E} = \vec{E}_m \sin(kx - \omega t)$$

$$\vec{B} = \vec{B}_m \sin(kx - \omega t)$$

$$E = Bc$$

$$I = \frac{P}{A} \quad I = \left| \vec{S}_{\text{avg}} \right| = \frac{1}{2} \left| \vec{S}_{\text{max}} \right|$$

THERMODYNAMICS

$$T[^\circ\text{C}] = T[\text{K}] - 273.15 \text{ K}$$

Expansion coefficients: $\beta = 3\alpha$

$$dW = p dV \quad \Delta E = Q - W$$

$$R_T = \sum R_i \text{ (in series)}$$

$$M = N_A m \quad R = N_A k \quad N = N_A n$$

$$K_{\text{avg}} = \frac{3}{2} kT \quad E_{\text{int}} = N E_{\text{avg}}$$

$$c_p = c_V + R \quad \text{or} \quad c_p = c_V + k$$

$$\gamma = \frac{c_p}{c_V} = \frac{f+2}{f} = 1 + \frac{2}{f}$$

MATH

circle: $C = 2\pi R \quad A = \pi R^2$

sphere: $A = 4\pi R^2 \quad V = \frac{4}{3}\pi R^3$

cylinder: $A = 2\pi(RL + R^2) \quad V = \pi R^2 L$

$$\frac{d}{dx} (x^n) = nx^{n-1}$$

$$\frac{d}{dx} \sin(kx) = k \cos(kx)$$

$$\frac{d}{dx} \cos(kx) = -k \sin(kx)$$

... and the corresponding integrals

$$ds = r d\theta$$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_z B_z + A_y B_y = AB \cos(\theta)$$

$$|\vec{A} \times \vec{B}| = AB \sin(\theta)$$

Right Hand Rule

CONSTANTS

$$c \approx 3.00 \times 10^8 \text{ m/s}$$

$$p_{\text{atm}} \approx 100 \text{ kPa}$$

$$\rho_{\text{water}} = 1000 \text{ kg/m}^3$$