I. SIMPLE HARMONIC MOTION

$$x(t) = A\cos(\omega_o t + \phi) \tag{1}$$

$$v(t) = \frac{dx}{dt} = -A\omega_o \sin(\omega_o t + \phi) \tag{2}$$

$$a(t) = \frac{d^2x}{dt^2} = -A\omega_o^2 \cos(\omega_o t + \phi) \tag{3}$$

$$\omega_o = \sqrt{\frac{k}{m}} \tag{4}$$

$$T = \frac{2\pi}{\omega_o} \tag{5}$$

$$f = 1/T \tag{6}$$

$$\frac{d^2x}{dt^2} = -\omega_o^2 x(t) \tag{7}$$

$$PE_{\max} = \frac{1}{2}kA^2 \tag{8}$$

$$KE_{\max} = \frac{1}{2}mv_{\max}^2 = \frac{1}{2}kA^2 \tag{9}$$

$$\omega_o = \sqrt{\frac{mgd}{I}} \qquad \text{physical pendulum} \tag{10}$$

$$\omega_o = \sqrt{\frac{g}{l}} \qquad \text{simple pendulum} \tag{11}$$

II. UNITS IN THERMO

$$T_F = \frac{9}{5}T_C + {}^o32 \tag{12}$$

$$T_K = T_C + {}^o273.15 \tag{13}$$

$$N_A = 6.022 \times 10^{23} \tag{14}$$

$$1N_A \times \underbrace{1u}_{\text{Atomic mass unit } 1.66\times10^{-27}\text{kg}} = 1g \tag{15}$$

$$1Pa = \frac{N}{m^2} \tag{16}$$

$$1 \underbrace{\text{atm}}_{\text{atmosphere}} \approx 1\text{bar} = 10^5 Pa \tag{17}$$

$$1L = 10^{-3}m^3 \tag{18}$$

$$N_A k_B = R = 8.314\frac{J}{mol\ {}^oK} \tag{19}$$

$$Nk_B = nR \tag{20}$$

III. THERMO

$$PV = nRT \tag{21}$$

$$E = \frac{3}{2}nRT \qquad (\text{mono} - \text{atomic}) \tag{22}$$

$$E = \frac{5}{2}nRT \qquad (\text{di} - \text{atomic}) \tag{23}$$

$$Q = mc\Delta T \tag{24}$$

$$Q = \pm mL \tag{25}$$

$$W = \int_{V_i}^{V_f} PdV \tag{26}$$

$$W = P\Delta V \qquad \text{const} - \text{pressure} \tag{27}$$

$$W = nRT\ln\left(\frac{V_f}{V_i}\right) \qquad \text{const} - \text{temperature} \tag{28}$$

$$\Delta E = Q - W \tag{29}$$

$$\Delta E = 0 \text{for a closed cycle} \tag{30}$$

$$\epsilon = \frac{W}{Q_{\text{in}}} \tag{31}$$