Equation Sheet for PHY2053C – Final Exam
(see back of page for CONSTANTS)

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$

$$v_x = v_{x0} + a_x t$$

$$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$$

$$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$$

$$v_y = v_{y0} + a_y t$$

$$v_y^2 = v_{y0}^2 + 2a_y(y - y_0)$$

$$\sum F_x = ma_x; \sum F_y = ma_y$$

$$\sin\theta = opp/hyp$$

$$\cos\theta = adj/hyp$$

$$\tan\theta = opp/adj$$

$$V_x = V\cos\theta; \quad V_y = V\sin\theta$$

$$V = \sqrt{V_x^2 + V_y^2}; \theta = \tan^{-1}\left(\frac{V_y}{V_x}\right)$$

$$Weight = W = F_G = mg$$

$$Kinetic\ Friction = F_{fr} = \mu_k F_N$$

$$Static\ Friction = F_{fr(\max)} = \mu_s F_N$$

$$F_G = G\frac{m_1 m_2}{R^2}$$

$$g = G\frac{M_E}{R_E^2}$$

$$a_R = a_c = \frac{v^2}{R}$$

$$\sum F_R = ma_R$$

$$f = \frac{1}{T}; \quad v = \frac{2\pi R}{T}$$

$$W = Fd\cos\theta$$

$$KE = \frac{1}{2}mv^2$$

$$PE = mgh; \quad PE_{spring} = \frac{1}{2}kx^2$$

$$W_{net} = \Delta KE = KE_f - KE_i$$

$$W_{NC} = \Delta KE + \Delta PE$$

$$KE_1 + PE_1 = KE_2 + PE_2 \ (no\ fric.)$$

$$Power(P) = \frac{Energy}{Time}$$

$$I = \sum F\Delta t = \Delta p$$

$$p = mv$$

$$p_{before} = p_{after}$$

$$KE_{before} = KE_{after} \ (elastic)$$

$$v_1 + v_1' = v_2 + v_2' \ (elastic)$$

$$v = r\omega$$

$$a_T = r\alpha$$

$$a_R = \frac{v^2}{r} = \omega^2 r$$

$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$

$$I = \sum mr^2$$

$$L = I\omega$$

$$I_i\omega_i = I_f\omega_f$$

$$\tau = r_\perp F$$

$$\tau = I\alpha$$

$$KE_{rot} = \frac{1}{2}I\omega^2$$

$$KE_{total} = \frac{1}{2}I_{CM}\omega^2 + \frac{1}{2}mv_{CM}{}^2$$

$$\sum F_x = 0 \ (equil.)$$

$$\sum F_y = 0 \ (equil.)$$

$$\sum \tau = 0 \ (equil.)$$

$$stress = \frac{F}{A}$$

$$strain = \frac{\Delta L}{L_0}$$

$$E = \frac{stress}{strain} = \frac{F/A}{\Delta L/L_0}$$

$$\rho = M/V$$

$$S.G. = \frac{\rho}{\rho_{water}}$$

$$P = F/A$$

$$P = \rho gh$$

$$P_{in} = P_{out}$$

$$F_{bouyant} = \rho_F gV_{disp.}$$

$$P + \frac{1}{2}\rho v^2 + \rho gy = const.$$

$$Av = const.$$

$$P_{abs} = P_{gauge} + P_{atm}$$

$$T_F = \frac{9}{5}T_C + 32$$

$$T_K = T_C + 273$$

$$\Delta L = \alpha L_0 \Delta T$$

$$\overline{KE}_{molecule} = \frac{3}{2}kT$$

$$v_{rms} = \sqrt{\frac{3kT}{m}}$$

$$PV = nRT = NkT$$

$$Q = cm\Delta T$$

$$Q = mL_f; \quad Q = mL_v$$

$$Q_{gain} = Q_{lost}$$

$$\frac{\Delta Q}{\Delta t} = \kappa A \frac{T_H - T_L}{l}$$

$$\frac{\Delta Q}{\Delta t} = e\sigma A T^4$$

$$W = P\Delta V$$

$$U = \frac{3}{2} nRT$$

$$\Delta U = \frac{3}{2} nRT_f - \frac{3}{2} nRT_i$$

$$\Delta U = Q - W$$

$$Q_H = W + Q_L$$

$$e = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$$

$$e_{ideal} = 1 - \frac{T_L}{T_H}$$

$$refrigerator\ CP = \frac{Q_L}{W} = \frac{Q_L}{Q_H - Q_L}$$

$$refrigerator\ CP_{ideal} = \frac{T_L}{T_H - T_L}$$

$$heat\ pump\ CP = \frac{Q_H}{W} = \frac{Q_H}{Q_H - Q_L}$$

$$heat\ pump\ CP_{ideal} = \frac{T_H}{T_H - T_L}$$

$$\Delta S = \frac{Q}{T}$$

$$F_{spring} = -kx$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T_{pendulum} = 2\pi\sqrt{\frac{l}{g}}$$

$$\omega = 2\pi f$$

$$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$$

$$E = \frac{1}{2}kA^2 = \frac{1}{2}mv_0^2$$

$$v = \pm v_0\sqrt{1 - \frac{x^2}{A^2}}$$

$$x = A\sin(2\pi ft); \quad x = A\cos(2\pi ft)$$

$$v_{wave} = f\lambda = \lambda / T$$

$$v_{wave-on-string} = \sqrt{\frac{F_T}{m/l}}$$

$$f_n = nf_1 = n(v/2L) \quad n = 1,2,3,\ldots$$

$$f_n = nf_1 = n(v/4L) \quad n = 1,3,5,\ldots$$

$$f' = \frac{f}{1 \pm \frac{v_s}{v}}$$

$$f' = f(1 \pm \frac{v_o}{v})$$

$$volume = LWH \quad (box)$$

$$volume = \pi r^2 h \quad (cylinder)$$

$$volume = \frac{4}{3}\pi r^3 \quad (sphere)$$

$$A = 4\pi r^2 \quad (sphere)$$

$$g = 9.80\, m/s^2$$

$$1\, mile = 1.6\, km = 1600\, m$$

$$G = 6.67 \times 10^{-11}\, N \cdot m^2 / kg^2$$

$$M_E = 5.97 \times 10^{24}\, kg$$

$$R_E = 6.38 \times 10^6\, m$$

$$1\, atm = 1.013 \times 10^5\, Pa$$

$$k = 1.38 \times 10^{-23}\, J/K$$

$$N_A = 6.02 \times 10^{23}\, mole^{-1}$$

$$R = N_A k = 8.31\, J / mole \cdot K$$

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

$$c_{water} = 4186\, J / kg \cdot {}^0C$$

$$c_{ice} = 2100\, J / kg \cdot {}^0C$$

$$L_f\, (H_2O) = 3.33 \times 10^5\, J/kg$$

$$L_v\, (H_2O) = 22.6 \times 10^5\, J/kg$$

$$1\, kcal = 1000\, cal = 4186\, J$$

$$1\, liter = 0.001\, m^3$$

$$1\, u = 1.66 \times 10^{-27}\, kg$$

$$\sigma = 5.67 \times 10^{-8}\, \frac{W}{m^2 \cdot K^4}$$

$$v_{sound} = 343\, m/s$$