Physic 1201
FINAL EXAM FORMULA SHEET

Vectors

$$magnitude A = A = |\vec{A}|$$
$$\vec{A}+\vec{B}=\vec{B}+\vec{A}$$
$$(\vec{A}+\vec{B})+\vec{C}=\vec{A}+(\vec{B}+\vec{C})$$
$$\vec{A}=\vec{A}_x+\vec{A}_y$$
$$A_x = A\cos q$$
$$A_y = A\sin q$$
$$\tan q = A_y / A_x$$
$$A=\sqrt{A_x^2+A_y^2}$$
$$R_x = A_x + B_x$$
$$R_y = A_y + B_y$$
$$\vec{A}\cdot\vec{B} = AB\cos q_{AB}$$

Kinematics – 1 dimension

$$v_{ave} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$
$$v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t}$$
$$a_{ave} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$
$$a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t}$$
$$v = v_0 + at$$
$$x = x_0 + v_0 t + \frac{1}{2}at^2$$
$$v^2 = v_0^2 + 2a(x - x_0)$$
$$x - x_0 = \frac{v_0 + v}{2}t$$

Kinematics – 2 dimensions

$$v_{ave} = \frac{\Delta\vec{r}}{\Delta t}$$
$$\vec{v} = \lim_{\Delta t\to 0}\frac{\Delta\vec{r}}{\Delta t}$$
$$v_x = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t}$$
$$v_y = \lim_{\Delta t\to 0}\frac{\Delta y}{\Delta t}$$
$$\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t}$$
$$\vec{a} = \lim_{\Delta t\to 0}\frac{\Delta\vec{v}}{\Delta t}$$
$$\vec{a}_x = \lim_{\Delta t\to 0}\frac{\Delta v_x}{\Delta t}$$
$$\vec{a}_y = \lim_{\Delta t\to 0}\frac{\Delta v_y}{\Delta t}$$
$$a_\perp = v^2 / R$$
$$v = \frac{2pR}{t}$$

Newton's Laws

1st: $\sum \vec{F} = 0$

2nd: $\sum \vec{F} = m\vec{a}$

3rd: $\vec{F}_{12} = -\vec{F}_{21}$

$$\sum F_x = ma_x$$
$$\sum F_y = ma_y$$
$$\sum F_\perp = ma_\perp = m\frac{v^2}{R}$$
$$\vec{w} = m\vec{g}$$

Constants and Math

$$g = 9.8(m/s^2)$$
$$G = 6.67\times 10^{-11}(Nm^2/kg^2)$$
$$R = 8.314(J\cdot mol^{-1}\cdot K^{-1})$$
$$s = 5.7\times 10^{-8}(W\cdot m^{-2}\cdot K^{-4})$$
$$ax^2 + bx + c = 0$$
$$\Rightarrow x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$\sin^2 q + \cos^2 q = 1$$
$$\sin = opp/hyp$$
$$\cos = adj/hyp$$
$$\tan q = \frac{\sin q}{\cos q}$$

Forces

$$F_k = m_k N$$
$$F_s \le m_s N$$
$$F_{spring} = -kx$$
$$w = mg$$
$$F_g = G\frac{m_1 m_2}{r^2}$$
$$g = \frac{Gm_E}{R_E^2}$$

Work, Energy and Power

$$K = \frac{1}{2}mv^2$$
$$W = \vec{F}\cdot\vec{s} = Fs\cos q_{Fs}$$
$$W = \Gamma(q_2 - q_1)$$
$$W_{tot} = \Delta K = K_2 - K_1$$
$$U_{grav} = mgh$$
$$U_{grav} = -\frac{GMm}{r}$$
$$U_{spring} = \frac{1}{2}kx^2$$
$$W_{grav} = -\Delta U_{grav}$$
$$W_{spring} = -\Delta U_{spring}$$
$$E_{mech} = K + U$$
$$W_{other} = \Delta U + \Delta K$$
$$P = \frac{\Delta W}{\Delta t} = F_{\|}v$$
$$P = \Gamma w$$

Rotational Impulse and Momentum, Torque

$$L = Iw$$
$$L = pr_{\perp} = mvr_{\perp} = mwr_{\perp}^2$$
$$L = \sum mwr_{\perp}^2$$
$$J_q = \Gamma(t_2 - t_1) = \Gamma\Delta t$$
$$J_q = \Delta L$$
$$\sum\Gamma = Ia = I\frac{\Delta w}{\Delta t} = \frac{\Delta L}{\Delta t}$$
$$\Gamma = Fl = Fr\sin q$$
$$a_{\perp} = v^2/R$$
$$v = \frac{2pR}{t}$$

Rotational Kinematics

$$w_{ave} = \frac{q_2 - q_1}{t_2 - t_1} = \frac{\Delta q}{\Delta t}$$
$$w = \lim_{\Delta t\to 0}\frac{\Delta q}{\Delta t}$$
$$a_{ave} = \frac{w_2 - w_1}{t_2 - t_1} = \frac{\Delta w}{\Delta t}$$
$$a = \lim_{\Delta t\to 0}\frac{\Delta q}{\Delta t}$$
$$w = w_0 + at$$
$$q = q_0 + w_0 t + \frac{1}{2}at^2$$
$$w^2 = w_0^2 + 2a(q - q_0)$$
$$q - q_0 = \frac{w_0 + w}{2}t$$

Rotational Inertia and Energy

$$I = \sum_{i=1}^{n} m_i r_i^2$$
$$I_{solid\_cylinder} = \frac{1}{2}MR^2$$
$$I_{thin\_walled\_cyl} = MR^2$$
$$I_{sphere} = \frac{2}{5}MR^2$$
$$K = \frac{1}{2}Iw^2$$

Rotational and Linear Motion

$$s = qR$$
$$v_{\|} = wR$$
$$a_{\|} = aR$$
$$a_{\perp} = \frac{v_{\|}^2}{R} = w^2 R$$
$$t = 2p/w$$

Impulse, Momentum and CM

$$\vec{p} = m\vec{v}$$
$$\vec{J} = \vec{F}(t_2 - t_1) = \vec{F}\Delta t$$
$$\vec{J} = \Delta\vec{p}$$
$$\vec{P} = \vec{p}_1 + \vec{p}_2$$
$$\vec{F} = m\vec{a} = m\frac{\Delta\vec{v}}{\Delta t} = \frac{\Delta\vec{p}}{\Delta t}$$
$$X = \frac{m_1x_1 + m_2x_2 + \ldots}{m_1 + m_2 + \ldots}$$
$$Y = \frac{m_1y_1 + m_2y_2 + \ldots}{m_1 + m_2 + \ldots}$$
$$V_x = \frac{m_1v_{1x} + m_2v_{2x} + \ldots}{m_1 + m_2 + \ldots}$$
$$V_y = \frac{m_1v_{1y} + m_2v_{2y} + \ldots}{m_1 + m_2 + \ldots}$$
$$A_x = \frac{m_1a_{1x} + m_2a_{2x} + \ldots}{m_1 + m_2 + \ldots}$$
$$A_y = \frac{m_1a_{1y} + m_2a_{2y} + \ldots}{m_1 + m_2 + \ldots}$$
$$\sum\vec{F}_{ext} = M\vec{A}$$

Equilibrium

$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum_{any\_axis}\Gamma = 0$$
$$X_{cog} = \frac{w_1x_1 + w_2x_2 + \ldots}{w_1 + w_2 + \ldots}$$
$$Y_{cog} = \frac{w_1y_1 + w_2y_2 + \ldots}{w_1 + w_2 + \ldots}$$

Simple Harmonic Motion

$$F_{spring} = ma = -kx$$

$$w = 2pf = \frac{2p}{t}$$

$$w_{spring} = \sqrt{\frac{k}{m}}$$

$$x(t) = A\cos(wt + f)$$

$$v(t) = -Aw\sin(wt + f) = \pm w\sqrt{A^2 - x^2}$$

$$a(t) = -Aw^2\cos(wt + f) = -w^2 x(t)$$

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

$$F_{pend} = ma \approx -mgq\,(forq << 1) = -mg\frac{x}{L}$$

$$w_{pendulum} = \sqrt{\frac{g}{L}}$$

Fluid Mechanics

$$r = \frac{m}{V}$$

$$p = \frac{\Delta F}{\Delta A}$$

$$p = p_0 + rgh$$

$$A_1 v_1 = A_2 v_2$$

$$p + rgy + \frac{1}{2}rv^2 = const$$

Temperature & Heat

$$1cal = 4.186J$$

$$T_K = T_C + 273$$

$$\Delta L = aL_0\Delta T$$

$$\Delta V = bV_0\Delta T$$

$$\Delta Q = mc\Delta T = nC\Delta T$$

$$Q = mL_F$$

$$Q = mL_V$$

Elasticity

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

$$Strain = \frac{\Delta\ell}{\ell_0}$$

$$Y = \frac{Stress}{Strain} = \frac{\ell_0 F}{A\Delta\ell}$$

$$\frac{\Delta w}{w_0} = -s\frac{\Delta\ell}{\ell_0}$$

$$Vol\_strain = \frac{\Delta V}{V_0}$$

$$B = -\frac{p}{\Delta V/V_0} = \frac{1}{k}$$

$$shear\_strain = f$$

$$S = \frac{F/A}{f}$$

Heat Transfer & Thermo

$$\frac{\Delta Q}{\Delta t} = H = kA\frac{T_2 - T_1}{L}$$

$$H = hA(\Delta T)^{5/4}$$

$$H = Ae\,sT^4$$

$$H_{net} = Ae\,s\,(T_1^4 - T_2^4)$$

$$V = V_0[1 + b(T - T_0) - k(p - p$$

$$m = nM$$

$$pV = nRT$$

$$\Delta W = p\Delta V$$

$$Q = \Delta U + W$$

$$\Delta Q = nC_v\Delta T\,(const\_V)$$

$$\Delta Q = nC_p\Delta T\,(const\_p)$$

$$C_p = C_v + R$$

$$g = \frac{C_p}{C_v}$$

$$g_{monatomic} = 1.67$$

$$\Delta U = nC_v\Delta T\,(ideal\_gas)$$

$$pV^g = const$$

$$e = \frac{W}{Q_H} = \frac{Q_H + Q_C}{Q_H} = 1 + \frac{Q_C}{Q_H}$$

$$K = -\frac{Q_C}{W} = -\frac{Q_C}{Q_H + Q_C}$$

$$e_{carnot} = 1 - \frac{T_C}{T_H}$$