Physics 101 Fall 2017 Equation Sheet

Motion:

$\Delta x = x_f - x_i$

$v_{av,x} = \frac{\Delta x}{\Delta t}$

$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$

$a_{av,x} = \frac{\Delta v_x}{\Delta t}$

$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t}$

Motion with constant acceleration:

$\Delta v_x = a_x \Delta t$

$\Delta x = \frac{1}{2}(v_{fx} + v_{ix})\Delta t$

$\Delta x = v_{ix}\Delta t + \frac{1}{2}a_x(\Delta t)^2$

$v_{fx}^2 - v_{ix}^2 = 2a_x \Delta x$

$\Delta v_y = a_y \Delta t$

$\Delta y = \frac{1}{2}(v_{fy} + v_{iy})\Delta t$

$\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$v_{fy}^2 - v_{iy}^2 = 2a_y \Delta y$

$R = \frac{v_i^2 \sin(2\theta_i)}{g}$ where θ_i is the initial angle defined from the horizontal

$v_{ix} = v_i \cos(\theta_i)$

$v_{iy} = v_i \sin(\theta_i)$

Forces:

$\sum F_x = ma_x$

$\sum F_y = ma_y$

$\mathbf{F}_{AB} = -\mathbf{F}_{BA}$

$F_g = G\frac{m_1 m_2}{r^2}$ with G =6.674×10^{-11} N m^2/kg^2 and $F_g = mg$ near the surface of the Earth with $g = 9.8\ m/s^2$

$F_{f_s} \leq \mu_s N$

$F_{f_k} = \mu_k N$

$F_{ad} = bv^2$

Work and energy:

$W = |F||\Delta x|\cos(\theta)$, where θ is the angle between the direction of the force and the direction of the displacement

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

$W_{total} = \Delta K$

$U_{grav} = -\frac{Gm_1 m_2}{r}$

$U_{grav} = mgh$ near the surface of the Earth

$\Delta U_{grav} = -W_{grav}$

$W_{nc} = \Delta U + \Delta K$

$F_{elas} = -kx$

$U_{elas} = \frac{1}{2}kx^2$

$\Delta U_{elas} = -W_{spring}$

$Power = \frac{\Delta Energy}{\Delta t}$

$Power = |F||v|\cos(\theta)$

Elasticity, oscillations, fluids:

$\frac{F}{A} = Y\frac{\Delta L}{L}$

$\frac{F}{A} = (Sh)\frac{\Delta x}{L}$

$\Delta P = -(Bu)\frac{\Delta V}{V}$

$f = \frac{1}{T}$

$\omega = 2\pi f$

$\omega = \sqrt{\frac{k}{m}}$ for spring w/ spring constant k

If $a_x(t) = -\omega^2 x(t)$, then $x(t) = (Amplitude)\cos(\omega t)$ if $x = Amplitude$ at $t = 0$.

$T = 2\pi\sqrt{\frac{l}{g}}$

$P = F/A$

Electric forces and fields:

$F_e = \frac{k_e|q_1||q_2|}{r^2}$ with $k_e = 8.988 \times 10^9\ N\,m^2/C^2$

and direction of F_e on one point charge due to the other is either directly toward the other charge (if opposite charges) and directly away (if same charges).

$F_e = qE$ and direction of E is determined by signs of charges involved

$E = k_e|q_1|/r^2$ for a point charge with charge q_1 and direction of E is determined by the sign of the point charge

$\epsilon_0 = \frac{1}{4\pi k_e} = 8.854 \times 10^{-12}\, C^2/(N\, m^2)$

$E = \frac{Q}{\epsilon_0 A}$ for E between two oppositely charged plates

Electric potential energy, electric potential, and capacitors:

$U_E = \frac{k_e q_1 q_2}{r}$

$V = \frac{U_E}{q}$, $\Delta U_E = q\Delta V$

$V = \frac{k_e Q}{r}$

$\Delta V = Ed$

$Q = C\Delta V$

$C = \frac{\epsilon_0 A}{d}$

$U = \frac{1}{2}Q\Delta V$

Electrical circuits:

$I = \frac{\Delta q}{\Delta t}$

$\Delta V = IR$

$R = \rho\frac{L}{A}$

$\sum_{junc} I_{i,in} - \sum_{junc} I_{i,out} = 0$

$\sum_{loop} \Delta V_i = 0$

$R_{eq} = \sum R_i$

$\frac{1}{R_{eq}} = \sum \frac{1}{R_i}$

$C_{eq} = \sum C_i$

$\frac{1}{C_{eq}} = \sum \frac{1}{C_i}$

$Power = \Delta V I$

Magnetic fields:

$B = \frac{\mu_0 I}{2\pi r}$ with $\mu_0 = 4\pi \times 10^{-7}$ T m/A

$B = \frac{\mu_0 N I}{L}$

Electromagnetic induction:

$\Phi_B = BA\cos(\theta)$

$\Delta V_{ind} = -N\frac{\Delta\Phi_B}{\Delta t}$

Temperature and thermodynamics:

$T_c = T_K - 273.15K$

$T_F = (1.8^oF/^oC)\; T_c + 32^oF$

$PV = Nk_BT$ with $k_B = 1.38 \times 10^{-23}$ J/K

$PV = nRT$ with $R = 8.31$ J/(mol-K)

$< K >= \frac{3}{2}k_BT$

$\Delta U = Q + W$

$Q = mc\Delta T$

$Q = mL$

$W = -P\Delta V$

$e = \frac{W_{net}}{Q_H} = 1 - \frac{T_c}{T_H}$

$\Delta S = Q/T$

$\Delta S_{tot} \geq 0$

General Math Stuff:
$V_{sphere} = \frac{4}{3}\pi r^3$

$V_{cylinder} = \pi r^2 h$

$\frac{\sin(\theta)}{\cos(\theta)} = \tan(\theta)$

$\sin(\theta)$ =opposite/hypotenuse

$\cos(\theta)$ =adjacent/hypotenuse

$\cos(0^o) = 1$, $\cos(90^o) = 0$, $\cos(180^o) = -1$, $\sin(0^o) = 0$, $\sin(90^o) = 1$, $\cos(60^o) = 0.5$, $\sin(60^o) = \frac{\sqrt{3}}{2}$, $\cos(30^o) = \frac{\sqrt{3}}{2}$, $\sin(30^o) = 0.5$

$ax^2 + bx + c = 0$, $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$