Equations for Midterm 2

1D Kinematics:

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1} \quad \textbf{E1}; \qquad v = \frac{dx}{dt} \quad \textbf{E2}; \qquad s_{avg} = \frac{total\ distance}{total\ time} \quad \textbf{E3}$$

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1} \quad \textbf{E4}; \qquad a = \frac{dv}{dt} \quad \textbf{E5}$$

$$v = v_0 + at \quad \textbf{E6}; \qquad x = x_0 + v_0 t + \frac{1}{2}at^2 \quad \textbf{E7}; \qquad v^2 = v_0^2 + 2a(x - x_0) \quad \textbf{E8}$$

2D Kinematics:

$$\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\vec{r}_2 - \vec{r}_1}{t_2 - t_1} = \frac{x_2 - x_1}{t_2 - t_1}\hat{\imath} + \frac{y_2 - y_1}{t_2 - t_1}\hat{\jmath} + \frac{z_2 - z_1}{t_2 - t_1}\hat{k} = v_{avg,x}\hat{\imath} + v_{avg,y}\hat{\jmath} + v_{avg,z}\hat{k} \quad \textbf{E9};$$

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{\imath} + \frac{dy}{dt}\hat{\jmath} + \frac{dz}{dt}\hat{k} = v_x\hat{\imath} + v_y\hat{\jmath} + v_z\hat{k} \qquad \textbf{E10}$$

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} = \frac{v_{2x} - v_{1x}}{t_2 - t_1}\hat{\imath} + \frac{v_{2y} - v_{1y}}{t_2 - t_1}\hat{\jmath} + \frac{v_{2z} - v_{1z}}{t_2 - t_1}\hat{k} = a_{avg,x}\hat{\imath} + a_{avg,y}\hat{\jmath} + a_{avg,z}\hat{k} \quad \textbf{E11}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{dv_x}{dt}\hat{\imath} + \frac{dv_y}{dt}\hat{\jmath} + \frac{dv_z}{dt}\hat{k} = a_x\hat{\imath} + a_y\hat{\jmath} + a_z\hat{k} \qquad \textbf{E12}$$

Projectile Motion

Horizontal:

$v_{0x} = v_0 \cos\theta_0$ **E13**; $x = x_0 + v_{0x}t$ **E14**

Vertical:

$v_{0y} = v_0 \sin\theta_0$ **E15**; $v_y = v_{0y} - gt$ **E16**; $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$ **E17**

$v_y^2 = v_{0y}^2 - 2g(y - y_0)$ **E18**

Newton's Law

Newton's first Law states that if there is no applied force on an object will move in a straight line at constant speed. **Constant Velocity**

Newton's Second Law: An object acted on by a force, $\vec{F}$, accelerates according to $\vec{F} = m\vec{a}$
When there is more than one force acting on an object, the net effect is found using the **Principle** of **Superposition** of **Forces to** calculate the $\boldsymbol{net\ force}$:

$$\vec{F}_{net} = \sum_i \vec{F}_i = M\vec{a}$$

Newton's Third Law: When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction

Friction: $f_{s,max} = \mu_s F_N > f_s$, $f_k = \mu_k F_N$

Work and Energy

$K = \frac{1}{2}mv^2$ **E19**; Work $W = \vec{F} \cdot \vec{d}$ **E20**;

Work-Energy Theorem $W = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ **E21**