Physics 1501: Things to know for Midterm I

Vectors

Addition and subtraction; components; magnitude and direction.

\[ \vec{A} = A_x \hat{i} + A_y \hat{j} = (A_x, A_y) \]

\[ \vec{A} \pm \vec{B} = (A_x \pm B_x, A_y \pm B_y) \]

\[ A \equiv |\vec{A}| = \sqrt{A_x^2 + A_y^2} \]

\[ \tan \theta = \frac{A_y}{A_x} \]

\[ A_x = A \cos \theta, \quad A_y = A \sin \theta \]

1-Dimensional motion with constant acceleration

Velocity, displacement

\[ v_x = v_{0x} + at, \]

\[ x = x_0 + v_{0x}t + \frac{1}{2}at^2 = x_0 + \frac{1}{2}(v_{0x} + v_x)t, \]

\[ v_x^2 - v_{0x}^2 = 2a(x - x_0) \]

Projectiles

\[ F_x = 0, \quad a_x = 0, \quad v_x = \text{const} \]

\[ F_y = -mg, \quad a_y = -g, \quad v_y = v_{y0} - gt \]

Horizontal range

\[ R = \frac{v_{0y}^2}{g} \sin(2\theta_0) \]

Maximal altitude

\[ H = \frac{1}{2} \frac{v_{y0}^2}{g} \sin^2(\theta_0) \]

Newton’s Laws

1. \( \vec{F}_{\text{Net}} = 0 \rightarrow \vec{v} = \text{const} \)

2. \( \vec{F}_{\text{Net}} = m \ddot{\vec{a}} \)

3. Reaction = - Action, \( \vec{F}_{a,b} = - \vec{F}_{b,a} \)
**Forces**

- **Gravity**
  \[ \vec{W} = m\vec{g} \]

- **Hook’s Law (springs)**
  \[ F = -kx \]

- **Friction: Kinetic friction**
  \[ F_k = \mu_k|\vec{N}| \]

  Direction — opposite to velocity

  **Static friction**
  \[ F_s \leq \mu_s|\vec{N}| \]

  Direction — opposite to applied force

**Uniform Circular Motion**

Frequency, period, angular velocity

\[ f = \frac{1}{T}, \quad \omega = 2\pi f = 2\pi \frac{1}{T} \]

Linear velocity, centripetal acceleration

\[ v = \omega r, \quad a_c = \frac{v^2}{r} = \omega^2 r \]