Chapter 4

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- If a particle undergoes a displacement $\Delta\vec{r}$ in time interval Δt, its average velocity is given as $\vec{v_{avg}} = \frac{\Delta\vec{r}}{\Delta r}$
- The instantaneous velocity $\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k}$.
- Projectile motion for an object in flight:
  - $1x - x_0 = (v_0 \cos\theta_0)t$
  - $y - y_0 = (v_0 \sin\theta_0)t - \frac{1}{2}gt^2$
  - $v_y = v_0 \sin\theta_0 = -gt$
  - $v_y^2 = (v_0 \sin\theta_0^2) - 2g(y - y_0)$

  The trajectory (path) of a particle in projectile motion is parabolic and is given by $y = (tan\theta_0)x - \frac{gx^2}{2(v_0 \cos\theta_0)^2}$ if x_0 and y_0 are 0.
- The particle's horizontal range R (distance from launch to landing assuming both points are at the same height) is given as $R = \frac{v_0^2}{g}\sin 2\theta_0$
- The horizontal range R is maximum for a launch angle of $45°$
- A particle is in uniform circular motion if it travels around a circle or a circular arc at constant (uniform) speed.
- The magnitude of the centripetal acceleration is given as $a = \frac{v^2}{r}$
- A particle in uniform circular motion will the circumference of the circle in time $T = \frac{2\pi r}{v}$.
- When two frames of reference A and B are moving relateive to each other at constant velocity, the velocity of a particle P as measured by an observer in frame A usually differs from that measured from frame B. The two measured velocities are related by $\vec{V}_{PA} = \vec{V}_{PB} + \vec{V}_{BA}$ where $\vec{V}_{BA}$ is the velocity of B with respect to A.