Formulas & Definitions: Section 13-4

Definition: Velocity vector $v(t)$ at time t is

$$v(t) = \lim_{h \to 0} \frac{r(t+h) - r(t)}{h} = r'(t).$$

Definition:

- The **speed** of the particle at time t is $|v(t)|$ and

$$|v(t)| = |r'(t)| = \frac{ds}{dt}.$$

- The **acceleration** of the particle is

$$a(t) = v'(t) = r''(t).$$

Newton's Second Law of Motion: at any time t, a force $F(t)$ acts on an object of mass m producing an acceleration $a(t)$:

$$F(t) = ma(t).$$

Definition: The parametric equations of the trajectory are

$$\boxed{\text{x=(v}_0 \cos\theta)t, \quad y = (v_0 \sin\theta)t - (gt^2)/2}$$

Definition: Tangential and Normal components of acceleration are

$$\boxed{\text{a=a}_T T + a_N N}$$

where

$$\boxed{\text{a}_T = v', \quad a_N = \kappa v^2}$$

or

$$a_T = \frac{r'(t) \cdot r''(t)}{|r'(t)|}, \quad a_N = \frac{|r'(t) \times r''(t)|}{|r'(t)|}.$$

Kepler's Laws:

- A planet revolves around the sun in an elliptical orbit with the sun at one focus.
- The line joining the sun to a planet sweeps out equal areas in equal times.
- The square of the period of revolution of a planet is proportional to the cube of the length of the major axis of its orbit.