1 1D Kinematics

1.1 Constant Velocity

- x vs. t. Acceleration=0.

$$x(t) = x_0 + v\Delta t$$

1.2 Constant Acceleration

- v vs. t

$$v(t) = v_0 + a\Delta t$$

- x vs. t

$$x(t) = x_0 + v_0\Delta t + \frac{1}{2}a(\Delta t)^2$$

- v vs. x

$$v^2(x) = v_0^2 + 2a\Delta x$$

2 Vectors

A good knowledge of vectors is necessary but will not be reviewed here.

3 2D Motion

In two dimensions the equations of constant acceleration become vector equations

- x vs. t

$$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2 \tag{1}$$

  This vector equation means do it component-wise

$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \tag{2}$$

$$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2 \tag{3}$$

- v vs. t

$$\vec{v} = \vec{v}_0 + \vec{a}t \tag{4}$$

This vector equati0n means do it component-wise

$$v_x(t) = v_{0x} + a_x t \tag{5}$$
$$v_y(t) = v_{0y} + a_y t \tag{6}$$

- Remember the cardinal rule – x and y are totally separate. For any problem split it up into x and y problems

4 Forces

- Working problems
  - For each body draw all forces.
  - Remember that for every force you draw there is an equal and opposite force.
  - Once you have written all possible forces write we have the vectore equation

    $$\sum \vec{F} = m\vec{a}$$

    which can be written in components as

    $$\sum F_x = ma_x \tag{7}$$
    $$\sum F_y = ma_y \tag{8}$$

    Do this for each body separately. If you do not know a force give it a symbol. You will be able to solve for the forces and also determine the acceleration.

- Kinetic Friction. The magnitude of the friction force is

$$\left|\vec{F}_{\text{fr}}\right| = \mu_K \underbrace{N}_{\text{Normal Force}} \tag{9}$$

The direction of the friction opposes the motion.

- Static Friction. The magnitude of the static friction force is

$$\left|\vec{F}_{\text{sfr}}\right| \leq \mu_s \underbrace{N}_{\text{Normal Force}} \tag{10}$$

  The direction of the static friction is chosen so that the object remains stationary.

- Weight. The gravitational force on an objection is the weight.

$$F_g \equiv W = m \times \underbrace{g}_{\text{accel. due to gravity}} \tag{11}$$

  On the moon, the mass is the same but the weight and acceleration due to gravity are different, i.e.

$$g_{\text{earth}} = 9.8\,\text{m/s}^2 \neq g_{\text{moon}}$$