There are 4 forces that we have to consider in this experiment.

(1). Whenever a mass m is near the surface of the Earth, the **gravitational force** on it is

$$\vec{\boldsymbol{F}} = -\boldsymbol{mg}\hat{\boldsymbol{y}}$$

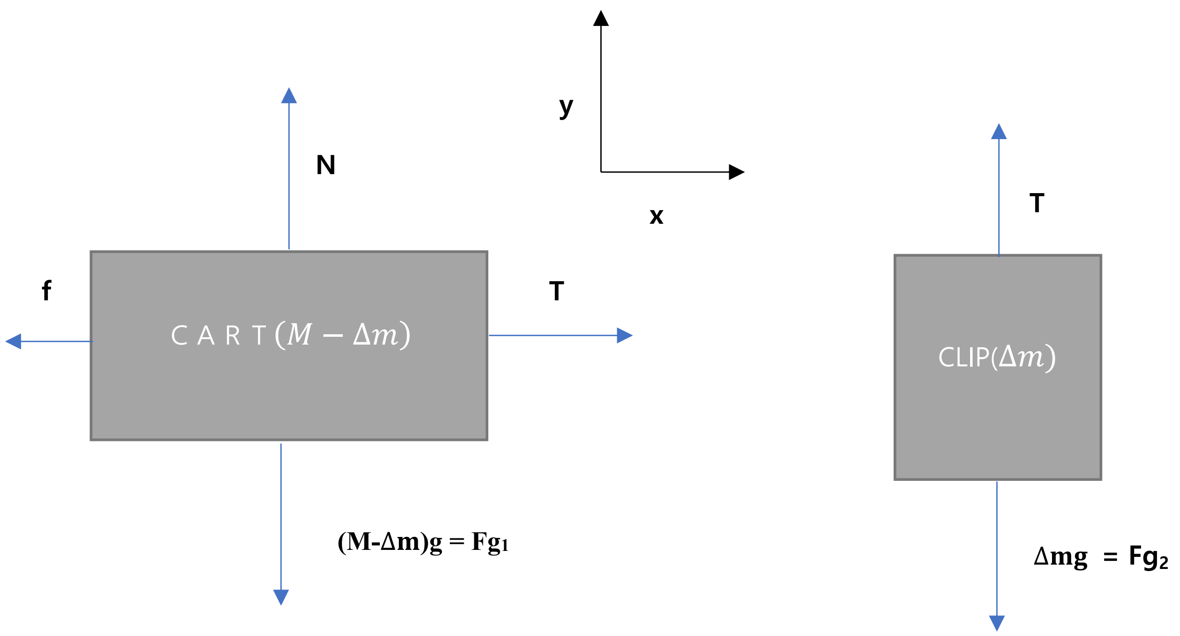
(2). When an object is in contact with a surface, the component of the force perpendicular to the surface exerted on the object is called the **normal force.**

(3). When rope or string is pulled, there is a **tension force.**

(4). When two surfaces attempt to slide against each other, there is a force called **friction.** Friction depends on the materials of the surface.

$$f_k = \mu_k N$$

By FBD(Free Body Diagram), find all of the forces acting on the object.



After finding all of the forces acting on the object by drawing FBD(Free Body Diagram), We find the net force in each direction depends on the chosen coordinate system.

CART net force

$$\sum F_x = T - f = (M - \Delta m)a_x \qquad (1)$$

$$\sum F_y = N - Fg_1 = (M - \Delta m)a_y = 0 \qquad (2)$$

CLIP net force

$$\sum F_y = T - Fg_2 = (\Delta m)a_y \qquad (3)$$

Since the two objects are connected by the string, Tension and acceleration of the two objects have same magnitude. According to chosen coordinate system above, Tension force has same sign and acceleration has opposite sign. Using Eq (1), (2)

$$a_x = -a_y = a$$

$$(M - \Delta m)a + f = -(\Delta m)a + \Delta mg \quad (4)$$

When we rewrite to solve acceleration of the object

$$a = \left(\frac{g}{M}\right)\Delta m - \frac{f}{M}$$

Where slope of the acceleration vs. hanging mass(Δm) is g/M, and when we multiply M we can get approximately g = 9.8 m/s^2. We can know that there is another factor that influences the acceleration which is y-intercept(f/M).