Chapter N3: Newton's Laws

N3.2: Newton's First Law

For an isolated system, $\vec{v_{\rm CM}}$ is constant.

N3.3: Newton's Third Law

An interaction between two objects A and B exerts forces on them that are opposite but equal in magnitude: $\vec{F_A} = -\vec{F_B}$.

N3.4: Newton's Second law

$$\vec{F}_{\rm net} = m\vec{a} \tag{1}$$

and, for a system of objects

$$\vec{F}_{\rm net,ext} = m\vec{a}_{\rm CM} \tag{2}$$

The second law is implied by conservation of energy.

Examples:

1. A 1500 kg car accelerates from 0 to 30 m/s in 10 seconds. What is the average force exerted on the car during this time interval?

2. You sit in a chair. Draw a free body diagram for yourself.

3. A 50 kg skydiver jumps out of an airplane and after accelerating for a while reaches a constant velocity of 120 m/s.
   (a) Draw a free-body diagram for the skydiver one she's reached 120 m/s.
   (b) What is the net force acting on the skydiver?
   (c) What is the force due to gravity acting on the skydiver (magnitude and direction)?
   (d) What is the force due to friction acting on the skydiver (magnitude and direction)?

4. I throw a .5 kg ball at 3 m/s against a wall. The ball bounces back to me at essentially the same speed. The ball is in contact with the wall for .05 seconds. What is the average force exerted by the wall on the ball?

5. A 50 kg person sits in the passenger seat of a car. The car travels at 20 m/s in a circular path of radius 20 m.

   (a) Draw a free body diagram for the passenger.

   (b) What is the acceleration of the passenger?

   (c) What is the net force acting on the passenger?

6. A 50 kg person exerts a horizontal force on a 10 kg box, holding it against a wall so it doesn't slide down. Draw a free body diagram for the box.