Chapter N1: Newton's Laws

Physics I

College of the Atlantic

N1.1: The Newtonian Synthesis

This is a nice historical summary.

N1.2: Newton's First Law

For an isolated system, $\vec{v_{\mathrm{CM}}}$ is constant. This is equivalent to the principle of conservation of momentum. Another way this is often stated is: Objects at rest stay at rest and objects in motion remain in motion, unless acted upon by an external force.

N1.3: Newton's Third Law

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

N1.4: Newton's Second law

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

and, for a system of objects

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

Example: A 150g baseball is thrown at 30 m/s. The act of throwing takes around 0.2 seconds. What is the average force exerted on the ball?

N1.5: Classification of Forces

- Normal force $\vec{F_{\mathrm{N}}}$: The part of the contact force acting perpendicular to an interface between solids
- Static friction $\vec{F_{\mathrm{SF}}}$: contact force that prevents surfaces from moving relative to each other. "Sticking force."
- Kinetic friction: $\vec{F_{\mathrm{KF}}}$: contact force that oppose motion of surfaces relative to each other.
- Drag forces $\vec{F_{\mathrm{D}}}$: oppose motion of object relative to a fluid
- Lift forces $\vec{F_{\mathrm{L}}}$: perpendicular to object's motion relative to a fluid
- Thrust forces $\vec{F_{\mathrm{Th}}}$: exerted when propeller, jet engine, etc. forces fluid to move.

N1.6: Free-Body Diagrams

Learning to make accurate free-body diagrams is essential for applying Newton's laws. Page 13 contains helpful advice, some of which is excerpted below:

1. Start by imagining the object in its context. Think about things that might interact with the object.
2. Draw a sketch of the object alone. Free-body diagrams apply to a *single* object.
3. Draw an arrow for each force acting directly on the object. Label each arrow.
4. All arrows should correspond to a force. Remember, that a force always arises as the result of an interaction between two objects.

Examples: Draw a free-body diagram for the following situations:

1. A person sitting on a chair.
2. A box sliding down an inclined plane.