Grade 12 Physics

SPH4U

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Chapter 3

Unit 2: Energy and Momentum

3.1 Conservation of Momentum

Definition 3.1.1. *Two or more objects interact and* ***exert forces from each other****. The forces in the interaction are a Newton's Third Law pair of forces (ie* $\vec{F_{A/B}} = -\vec{F_{B/A}}$*)*

3.1.1 Equation

Consider a person standing on any icy surface throws a heavy object horizontally:

FBD for the person (Left) and the object (Right)

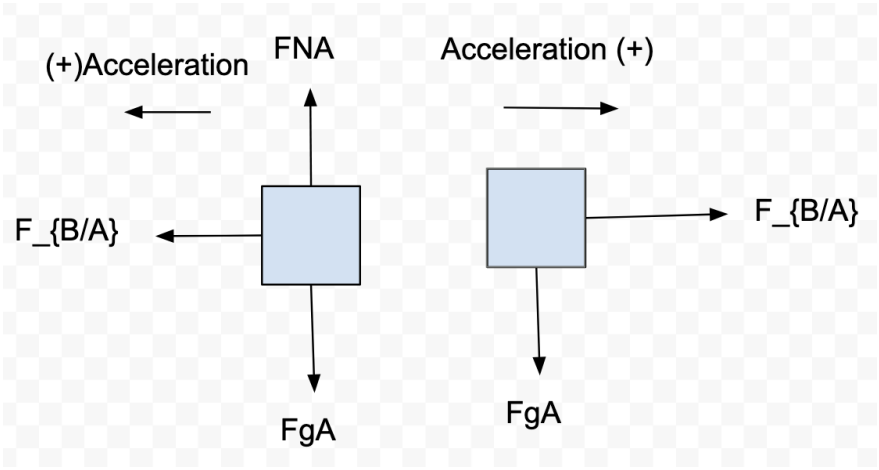

Figure 3.1: We will assume that the interaction forces are essentially the net force acting on the object

Equation for the object A:

$$\begin{aligned} \sum \vec{F_A} &= m_A * \vec{a_A} \\ \vec{F_{B/A}} &= m_A \vec{a_A} \\ \vec{F_{B/A}} &= m_A \frac{\vec{v_{fA}} - \vec{v_{iA}}}{\Delta t_A} \end{aligned} \tag{3.1}$$

Equation for the object B:

$$\sum \vec{F_B} = m_B * \vec{a_B}$$
$$\vec{F_{A/B}} = m_B \vec{a_B}$$
$$\vec{F_{A/B}} = m_B \frac{\vec{v_{fB}} - \vec{v_{iB}}}{\Delta t_B} \tag{3.2}$$

Lemma 3.1.2. *From Newton's third law, we know* $\vec{F_{A/B}} + \vec{F_{B/A}} = 0$

We add 3.1 and 3.2 together:

$$m_A \frac{\vec{v_{fA}} - \vec{v_{iA}}}{\Delta t_A} + m_B \frac{\vec{v_{fB}} - \vec{v_{iB}}}{\Delta t_B} = 0$$

We know the time for both object should be the same.

$$m_A * \vec{v_{fA}} + m_B * \vec{v_{fB}} = m_A * \vec{v_{iA}} + m_B * \vec{v_{iB}}$$
$$\vec{P_{A2}} + \vec{P_{B2}} = \vec{P_{A1}} + \vec{P_{B1}} \tag{3.3}$$

3.3 is the law of **Conservation of Momentum**
Always write this line at the beginning of your analysis

Definition 3.1.3. *(The Law of Conservation of Momentum): The total momentum of a system of objects after an interaction is* ***equal*** *to the total momentum of the system before the interaction.*

According to the 3.1.3, we can understand the total momentum of the system is **constant through out** the interaction.

The law assume that any other force that could **accelerate** any objects in the system during the interaction is **negligible**