

Collisions

<u>TYPE</u>	<u>Kinetic Energy</u>	<u>Momentum</u>
Elastic: Objects bounce off each other undamaged	Conserved	Conserved
Inelastic: Objects impact and separate, but there has been damage done to each	NOT conserved	Conserved
Perfectly Inelastic: Objects impact and STICK TOGETHER as one larger mass with the same, slower velocity	NOT conserved	Conserved

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<u>TYPE</u>	<u>Kinetic Energy</u>	<u>Momentum</u>
Elastic: $(m_1v_1 + m_2v_2)_{initial} = (m_1v_1 + m_2v_2)_{final}$	Conserved	Conserved
Inelastic: $(m_1v_1 + m_2v_2)_{initial} = (m_1v_1 + m_2v_2)_{final}$	NOT conserved	Conserved
Perfectly Inelastic: $(m_1v_1 + m_2v_2)_{initial} = (m_1 + m_2) \cdot v_{final}$	NOT conserved	Conserved

Example problem:

- A freight train is being assembled in a switching yard. Boxcar #1 has a mass of 6.5×10^4 kg, and Boxcar #2 has a mass of 9.2×10^4 kg. If car 1 is moving with a velocity of $+0.80 \text{ m}\cdot\text{s}^{-1}$, and car 2 hits it from behind with a velocity of $+1.2 \text{ m}\cdot\text{s}^{-1}$, with what velocity will the two cars move with together after coupling?

Example problem: solution

$$\begin{aligned} \Sigma p_{before} &= \Sigma p_{after} \\ (m_1v_1 + m_2v_2)_{before} &= (m_1 + m_2) \cdot v_{after} \\ (6.5 \times 10^4 \text{ kg}) \cdot (0.80 \text{ m}\cdot\text{s}^{-1}) + (9.2 \times 10^4 \text{ kg}) \cdot (1.2 \text{ m}\cdot\text{s}^{-1}) &= (6.5 \times 10^4 \text{ kg} + 9.2 \times 10^4 \text{ kg}) \cdot v_{after} \\ 52000 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} + 110400 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} &= (157000 \text{ kg}) \cdot v_{after} \\ \frac{162400 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}}{(157000 \text{ kg})} &= v_{after} = 1.0 \text{ m}\cdot\text{s}^{-1} \end{aligned}$$

Problem 2:

- Starting from rest, two ice skaters push off against each other on smooth, level ice. Skater 1 has a mass of 54 kg and moves away from her friend (mass = 88 kg) with a velocity of 2.5 m/s. Find the “recoil” velocity of the second skater.

Problem 2: Solution

$$\begin{aligned}\Sigma p_{before} &= \Sigma p_{after} \\ (m_1 v_1 + m_2 v_2)_{before} &= (m_1 v_1 + m_2 v_2)_{after} \\ 0 &= (54\text{kg})(2.5\text{m}\cdot\text{s}^{-1}) + (88\text{kg})v_2 \\ \frac{-135\text{kg}\cdot\text{m}\cdot\text{s}^{-1}}{88\text{kg}} &= v_2 = 1.5\text{m}\cdot\text{s}^{-1}\end{aligned}$$