Lecture 20: Systems and Momentum

Project Final Drafts

- Include a reflection addressing all feedback (from me and your peers).
- **Cite your sources.**
  - I didn't give this much attention in my feedback (a significant oversight on my part), but it is extremely important to cite your sources.
  - Any information from outside of the course (numerical values for problems, concepts, models, equations) should be cited.
- Currently due on Friday, along with Homework 7.
  - Would you rather...
    (A) Turn them both in that day.
    (B) Postpone the homework due date to Sunday to focus on the project and get it done sooner.
    (C) Postpone the project due date to Sunday to get the homework out of the way sooner and have more time for the project.
  - Whatever you choose, I can still potentially negotiate small extensions with individual groups. However, we need things turned in early so we can give feedback and return them to you quickly before the end of the term.

Impulse and Momentum

Definitions:

- Impulse $\vec{J}_{net} = \int_{t_i}^{t_f} \vec{F}^{net} dt$
- Momentum $\vec{p} = m\vec{v}$
- Impulse-Momentum Theorem $\vec{J}_{net} = \Delta\vec{p}$

L20-1: Systems and Momentum Conservation

In each scenario below, if possible, identify a system for which momentum is conserved. If not possible, explain why not.

(1) Two cars crash into each other in an intersection.

(2) A baseball player catches a baseball while standing at second base.

(3) A block attached to a spring on a horizontal table oscillates back and forth.

(4) A firework bursts into pieces in the sky.

(5) A bird dives through the air, speeding up.

L20-2: Bumper Cars

- Two bumper cars collide with each other and get tangled together.
- Car 1 (m_1) moves north at v_1. Car 2 (m_2) moves south at v_2.

- Case 1
  - Car 1 (100 kg) moves north at 4 m/s.
  - Car 2 (200 kg) moves south at 3 m/s.
  - Find the final velocity of the cars.
  - Determine the initial and final kinetic energies of the cars.
  - Compare the total kinetic energy before and after the collision.

- Case 2
  - Car 1 (100 kg) moves north at 4 m/s.
  - Car 2 (200 kg) moves south.
  - Find the initial velocity of Car 2 assuming they both end at rest.
  - Determine the initial and final kinetic energies of the cars.
  - Compare the total kinetic energy before and after the collision.

L20-2: Bumper Cars

- Two bumper cars collide with each other and get tangled together.
- Car 1 (m_1) moves north at v_1. Car 2 (m_2) moves south at v_2.

- Case 1
  - Car 1 (100 kg) moves north at 4 m/s.
  - Car 2 (200 kg) moves south at 3 m/s.
  - Find the final velocity of the cars.
  - Determine the initial and final kinetic energies of the cars.
  - Compare the total kinetic energy before and after the collision.

- Case 2
  - Car 1 (100 kg) moves north at 4 m/s.
  - Car 2 (200 kg) moves south.
  - Find the initial velocity of Car 2 assuming they both end at rest.
  - Determine the initial and final kinetic energies of the cars.
  - Compare the total kinetic energy before and after the collision.

Main Ideas

- Momentum and impulse are useful quantities for solving dynamics problems.
- The impulse is always equal to the change in momentum for a system.
- When the impulse is zero (because the net force is zero), the momentum of the system is constant—it is *conserved*.