UNIT 6: MOMENTUM

Upon completion of this unit, the student should be able to:

1. Define impulse and momentum and their metric units, describe their relationship, and calculate each from given data.

2. Explain Newton's second law of motion in terms of momentum.

3. Explain the Law of Conservation of Momentum and apply it in calculating initial and final momenta, velocities, and masses of colliding objects.

4. Describe the transfer of momentum during elastic, inelastic, and explosion collisions.

5. Define center of mass and why it is important in the study of collisions.

6. Describe the relationship between center of mass and stability and balance.

7. Calculate the center of mass of two objects given their masses and relative positions.

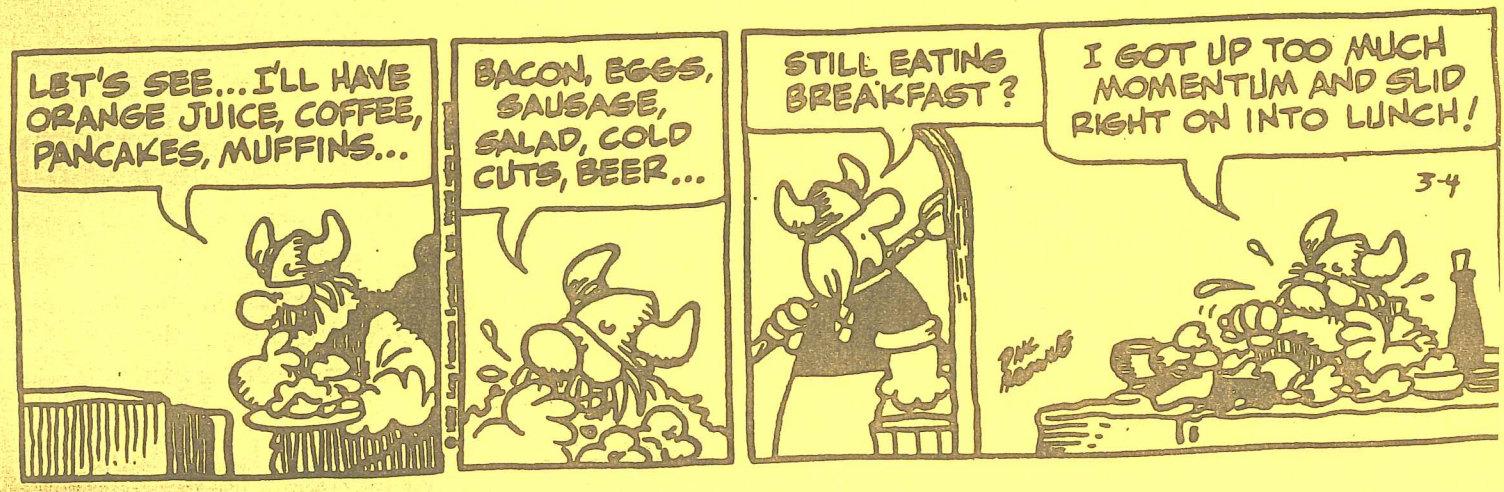
8. Describe the motion of the center of mass of a system of objects during a collision.

Reference: Holt Physics (Serway/Faughn), Chapter 6

Homework: Problem-solving handout (on back side)

Labs: All-American egg drop, Conservation of Momentum, hallway physics

HAGAR the Horrible **By Dik Browne**



$F = ma$; $a = \frac{\Delta v}{\Delta t}$ → $F = \frac{m\Delta v}{\Delta t}$

$F\Delta t = m\Delta v$

IMPULSE-MOMENTUM PROBLEMS

Pd 2

1. Before a collision, a 25 kg object is moving at +12 m/s. Find the impulse that acted on the object if, after the collision, it moves at: **a.** +8.0 m/s. **b.** –8.0 m/s. $-4\,m/s$

a. $F\Delta t = m\Delta v = \Delta p = (25kg)(8\,m/s - 12\,m/s) = -100\,N\cdot s$

Impulse = Change in momentum b.

2. According to Newton's Third Law of Motion, small thruster rockets can be used to make fine adjustments in satellite orbits. One such rocket has a thrust of 35 N. If it is fired to change the velocity of a 72,000 kg satellite by 63 cm/s, how long should it be fired?

$F\Delta t = m\Delta v$

$\Delta t = m\Delta v / F = \frac{(72{,}000kg)(.63\,m/s)}{35\,N\,kg\,m/s^2} =$ ( ) s

3. A car moving at 10 m/s crashes into a barrier and stops in 0.05 s. There is a 20 kg child in the car without any restraints or airbags.

a. What is the impulse acting on the child?

$F\Delta t = m\Delta v$

$F(.05s) = (20kg)(10\,m/s)$

Impulse = 200 N·s

b. What is the average force (in Newtons and pounds) acting on the child?

c. How many "g's" does this force (part b answer) exert on the child?

$F = ma$ $\quad a = \frac{g}{g}$

d. Would you be able to safely hold this child in your lap during the collision?

4. A 165 g hockey puck, moving at 35 m/s, strikes a 265 g octopus thrown on the ice by a Badger fan. If the puck and octopus slide off together, calculate their velocity. m_1 v_1 m_2 $v_2 = 0\,m/s$ $v' = ?$

$$v' = \frac{m_1v_1 + m_2v_2}{m_1 + m_2} =$$

5. A 50 kg woman is riding on a 10 kg cart moving east at 5.0 m/s. The woman jumps off the front of the cart and hits the ground at 7.0 m/s eastward, relative to the ground. Calculate the cart's velocity after the woman jumps off.

$\Sigma p = \Sigma p'$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

6. A 200 g plastic ball, moving with a speed of 0.30 m/s, collides with a 100 g plastic ball moving in the same direction with a speed of 0.10 m/s. After the collision, both balls continue moving in the same direction and the speed of the 100 g ball is 0.26 m/s. Calculate the velocity of the 200 g ball.