Momentum and Impulse

Momentum

- Momentum can be defined as "mass in motion." All objects have mass; so if an object is moving, then it has momentum
- Momentum depends upon the variables mass and velocity
- **Momentum = mass * velocity**
- **p = m * v**
- where m = mass and v=velocity

Momentum is a vector quantity

- To fully describe the momentum of a 5-kg bowling ball moving westward at 2 m/s, you must include information about both the magnitude and the direction of the bowling ball
- **p = m * v**
- **p =** 5 kg * 2 m/s west
- **p** = 10 kg * m / s west

Elastic and inelastic Collisions

- When a Ball hits the ground and sticks, the collision would be totally inelastic
- When a Ball hits the ground and bounces to the same height, the collision is elastic
- All other collisions are partially elastic collision

Check Your Understanding

- Determine the momentum of a ...
- 60-kg halfback moving eastward at 9 m/s.
  - p = mv = 60 kg (9 m/s)
  - 540 kg *m /s east
- 1000-kg car moving northward at 20 m/s.
  - p = mv = 1000 kg (20 m/s)
  - 20,000 kg *m /s north

Given: m = 60Kg

v= 9 m/s

Find :

momentum (p)

Given: m = 1000Kg

v= 20 m/s

Momentum and Impulse Connection

- To stop such an object, it is necessary to apply a force against its motion for a given period of time

$$J = F\,(t) = m\,\Delta\,v$$

Impulse = Change in momentum

Check Your Understanding

- If the halfback experienced a force of 800 N for 0.9 seconds to the north, determine the impulse
- $J = F (t) = m \Delta v$
- 800N (0.9s) = 720 N*s
- the impulse was 720 N*s or
- a momentum change of 720 kg*m/s

Given: F = 800 N

t = 0.9 s

Find :

Impulse (J)

Impulse Question #2

- A 0.10 Kg model rocket's engine is designed to deliver an impulse of 6.0 N*s. If the rocket engine burns for 0.75 s, what is the average force does the engine produce?
- J = F (t) = m D v
- 6.0 N*s = F (0.75s)
- 6.0 N*s/ 0.75s = F
- 8.0 N = F

Given: F = 800 N

t = 0.9 s

Find :

Average Force

Impulse Question # 3

- A Bullet traveling at 500 m/s is brought to rest by an impulse of 50 N*s. What is the mass of the bullet?
- $J = F (t) = m \Delta v$
- $50 \text{ N*s} = m (500 \text{ m/s} - 0 \text{ m/s})$
- $50 \text{ kg-m/s}^2 \text{*s} / 500 \text{ m/s} = m$
- $.1 \text{ kg} = m$

Given: v = 500 m/s

J = 50 N*s

Find :

m = ?

Summary

- the impulse experienced by an object is the force*time
- the momentum change of an object is the mass*velocity change
- the impulse equals the momentum change