Momentum and Impulse

Momentum

- Momentum
  - Inertia that
  - Making
  - Momentum =
  -
  - Vector
  - Same direction as the
  - Units =

Impulse

- Newton's
  - No change in
  - No change in
  - No change in
- Newton's
  -
  -
  -
-

- Impulse
  - Force applied to an object over a
  - Reduces the
  - Produces a change in an
  - Impulse =
  - Units =
- The greatest change in momentum occurs

- To stop an object ($v_f = 0$), the force must be in the
  - $m(0 - v_i) = -\Delta p$, so

- Changing direction also results in a
  - $m(-v_f - v_i) = -\Delta p$, so

1. A deer with a mass of 146 kg is running head on toward you with a speed of 17 m/s. You are going north. Find the momentum of the deer.

2. What velocity must a 1,210 kg car have in order to have the same momentum as the deer in the previous problem?

3. Fred strikes a 0.058 kg golf ball with a force of 272 N and gives it a velocity of 62.0 m/s. How long was the club in contact with the ball?

4. In running a ballistics test, Officer Sam fires a 6.00 g bullet at 360 m/s into a container that stops it in 0.30 m. what average force stops the bullet?

5. A 0.24 kg volley ball approaches Sally with a velocity of 3.8 m/s. Sally bumps the ball giving it a velocity of 2.4 m/s in the opposite direction. What average force did she apply if the interaction time between her hands and the ball is 0.025 s?

6. A 0.145 kg baseball is pitched at 42 m/s. The batter hits it horizontally to the pitcher at 58 m/s.
   a. What is the change in momentum of the ball?
   b. If the ball and bat were in contact for 4.6×10^{-4} s, what would be the average force while they touched?

Conservation of Momentum

Systems

- **System** : a specific
- **Closed System**
  - Does not gain or lose mass;
  - Closed system has **Internal Forces**, but these do not

- **Isolated System**
  - The net external forces on a
  - No forces from the surroundings

Law of Conservation of Momentum

- Newton's 3rd Law
  - For every *action force* there is an equal
- $-F_{action}$ =
- $-(ma)_{action}$ =
-
- $-m_1$
- v_f =
- $-m_1$
-
-
-
-
-
- Σ Momenta Before =

- Law of Conservation of Momentum
  - The momentum of a closed, isolated system does not change;

  - The momentum of all the objects before a collision ***is equal to*** the momentum of all the

Collisions

- **Elastic**
  - Two objects bounce after the collision and
  - Conservation of Momentum
    -
  - Conservation of Kinetic Energy
- **Explosion**
  - Type of
  - Two objects push away from each other
  - Conservation of Momentum
    -
  - Conservation of Kinetic Energy

- **Inelastic**
  - Objects collide, then leave, but are
  - Conservation of Momentum
    -
  - Kinetic Energy is transformed into other

- **Perfectly Inelastic**
  - Two objects collide and
  - The final velocity is the same for
  - Conservation of Momentum
    -
  - Kinetic Energy is transformed into

7. Big Bird, mass 42.00 kg is riding a skate board, mass 2.00 kg, traveling at 1.20 m/s. Big Bird jumps off and the skateboard stops dead in its tracks. In what direction and with what velocity did Big Bird jump?

8. A truck weighs four times as much as a car. If the truck coasts into the car at 12.0 km/hr and they stick together, what is the final velocity of the truck/car combination?

9. A 50.0 g projectile is launched with a horizontal velocity of 647 m/s from a 4.65 kg launcher moving in the same direction at 2.0 m/s. What is the velocity of the launcher after the projectile is launched?

10. Two lab carts are pushed together with a spring mechanism compressed between them (we will do this in lab). Upon release, the 5.0 kg cart repels one way with a velocity of 0.12 m/s while the 2.0 kg cart goes in the opposite direction. What is the velocity of the 2.0 kg cart?

11. A 12.0 g rubber bullet travels at a velocity of 150 m/s, hits a stationary 8.5 kg concrete block resting on a frictionless surface, and ricochets in the opposite direction with a velocity of 100 m/s. How fast will the concrete block be moving?

12. A 6,500 kg freight car traveling at 2.5 m/s collides with a 8,100 kg stationary freight car. If they interlock upon collision, find their velocity.

16. A 15.0 g bullet is fired horizontally into a 3.000 kg block of wood suspended by a long cord. The bullet sticks in the block. Compute the velocity of the bullet if the impact causes the block to swing 10.0 cm above its initial level.

17. A golf ball with a mass 0.046 kg rests on a tee. It is struck by a golf club with an effective mass of 0.220 kg and a speed of 44 m/s. Assuming that the collision is elastic, find the speed of the ball when it leaves the tee.

18. A 25 g ball is fired with an initial velocity toward a 125 g ball that is hanging motionless from a 1.25 m sting. The balls have a perfectly elastic collision. At a result the 125 g ball swings out until the string makes an angle of 37° with the vertical. What was the initial velocity of the 25 g ball?

Conservation of Momentum
In 2 Dimensions

- Momentum is conserved in an
- Objects can hit and go off in different angles, but momentum

- ΣHorizontal Momenta Before =
- ΣVertical Momenta Before =
- !!!NOT
- !!!NOT
- !!!NOT
- !!!NOT
- !!!NOT
- !!!NOT

14. Two opposing hockey players, one of mass 82.0 kg skating north at 6.00 m/s and the other of mass 70.0 kg skating east at 3.00 m/s, collide and become entangled. What is the velocity (magnitude and direction) of the hockey players?

13. A cue ball, mass 0.16 kg, rolling at 4.0 m/s hits a stationary eight ball of similar mass. If the cue ball travels 50° above its original path, and the eight ball at 40° below, what is the velocity of each after colliding?

15. A compact car, mass 875 kg, moving south at 15.0 m/s, is struck by a full sized car, mass 1,584 kg, moving east at 12.0 m/s. The two cars stick together, and the momentum is conserved in the collision.
    a. Find the velocity of the wreck immediately after the collision, remembering that momentum is a vector quantity.
    b. The wreck skids along the ground and comes to a stop. The coefficient of kinetic friction while the wreck is skidding is 0.55. Assume that the acceleration is constant. How far does the wreck slide?