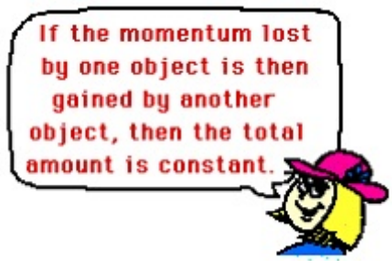
Physics 2204
Unit 2: Dynamics
Worksheet 13: Conservation of Momentum

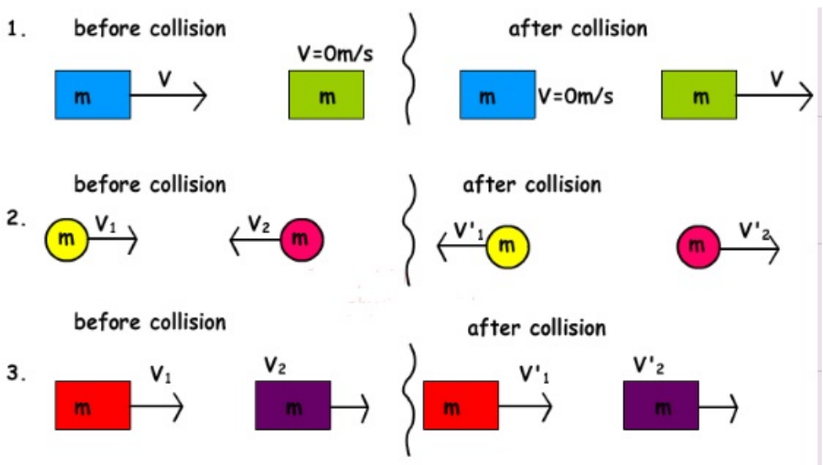
Student Name:_____

The Law of conversation *states that the total momentum of all parts of a system before an interaction equals the total momentum after, if no external unbalanced force acts on the system.*

$$p_T = p_T'$$
$$p_1 + p_2 = p_1' + p_2'$$
$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$



Elastic Collision is one in which the objects rebound after the collision



Example 1:

Your small bumper car (m = 100 kg) has a velocity of 6 m/s and collides head-on with a large stationary bumper car (m = 500 kg). It turns out that, after the collision, the large bumper car moves back with a velocity of v = 2 m/s.

A) What is the total momentum of the two-car-system before the collision?

B) What is it after the collision?

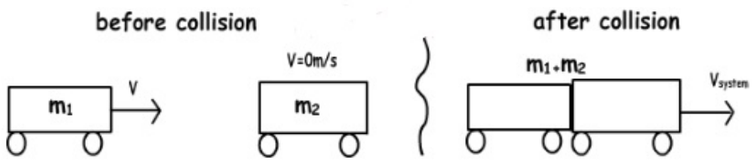
C) What is the large car's momentum after the collision?

D) With what velocity do you move after the collision?

Example 2:

A 1.0 kg ball, moving to the right at 10.0 m/s collides with a 1.5 kg ball moving to the left at 8.0 m/s. The 1.0 kg ball rebounds to the left at 11.0 m/s. What is the velocity of the 1.5 kg ball after the collision?

Inelastic Collision is one in which the objects stick together after the collision



Example 3:

A dynamics cart A with a mass of 1.0 kg is moving to the right at 3.0 m/s. It collides with and sticks to, stationary dynamics cart B with a mass of 2.0 kg. After the collision the two carts move off to the right at 1.0 m/s.

A) What is the momentum of cart A before the collision?

B) What is the momentum of cart B before the collision?

C) What is the total momentum before the collision?

D) After the collision the carts can be considered as ONE cart with a combined mass of 3.0 kg. What is the momentum after the collision?

Example 4:

Ball 1, with a mass of 1.5 kg is moving right at 3.0 m/s. It collides with ball 2, which is moving left at 2.0 m/s and has a mass of 1.8 kg. If the two balls stick together after impact, what will be the velocity of the combined masses after impact?

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Which of the following would be used to decribe a gun recoiling when it is fired?

   (A) Conservation of momentum
   (B) Conservation of angular momentum
   (C) Conservation of energy
   (D) None of the above

2. A 4.00 kg ball is moving at 4.0 m/s to the right and a 6.00 kg ball is moving at 3.00 m/s to the left. The total momentum of the system is

   (A) 16 kg m/s to the right
   (B) 2.0 kg m/s to the right
   (C) 2.0 kg m/s to the left
   (D) 18 kg m/s to the left

3. Which of the following statements about the conservation of momentum is not correct?

   (A) Momentum is conserved for a system of objects pushing away from each other.
   (B) Momentum is not conserved for a system of objects in a head-on collision.
   (C) Momentum is conserved when two or more interacting objects push away from each other.
   (D) The total momentum of a system of interacting objects remains constant regardless of forces between the objects.

4. A rubber ball moving at a speed of 5 m/s hit a flat wall and returned to the thrower at 5 m/s. Which of the following describes the magnitude of the momentum of the rubber ball?

   (A) Increased
   (B) Decreased
   (C) Remained the same
   (D) Was not conserved

5. A 75 kg person walking around a corner bumped into an 80 kg person who was running around the same corner. Which of the following decribes the momentum of the 80 kg person?

   (A) Increased
   (B) Decreased
   (C) Remained the same
   (D) Was not conserved

6. Two objects with different masses collide and bounce back after an elastic collision. Before the collision, the two objects were moving at velocities equal in magnitude but opposite in direction. Which of the following is true for after the collision?

   (A) The less massive object had gained momentum
   (B) The more massive object had gained momentum
   (C) Both objects had the same momentum
   (D) Both objects lost momentum

7. Two swimmers relax close together on air mattresses in a pool. One swimmer's mass is 48 kg, and the other's mass is 55 kg. Which of the following describes their momentum if the swimmers push away from each other?

   (A) Their total momentum triples
   (B) Their momenta are equal but opposite
   (C) Their total momentum doubles
   (D) Their total momentum decreases

8. Two objects move separately after colliding, the total momentum remains constant. What type of collision occurred.

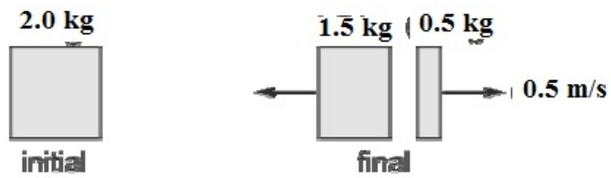
(A) Elastic
(B) Inelastic
(C) Nearly elastic
(D) Perfectly inelastic

9. A 100.0 kg canon fires a 20.0 kg ball at a velocity of 45 m/s (E). What is the recoil velocity of the canon?

(A) 0.11 m/s (E)
(B) 0.11 m/s (W)
(C) 9.0 m/s (E)
(D) 9.0 m/s (W)

10. A 2.0 kg stationary block explodes and breaks into two parts as shown in the figure. What is the final speed of the heavier mass?

(A) 0.560 m/s
(B) 0.167 m/s
(C) 0.615 m/s
(D) 0.205 m/s



11. In a car accident, car A of 1 000 kg is hit by car B of 1 580 kg. Car A is initially at rest. From the marking of the tyre on the road, police found that the speed of car A and B after the collision is 10 m/s and 8 m/s respectively. What is the speed of car B before the collision?

(A) 16.97 m/s
(B) 20.58 m/s
(C) 14.32 m/s
(D) 26.44 m/s

12. Car A of mass 500 kg is moving with uniform velocity of 10 m/s and having a head on collision with a car B of 500 kg moving with velocity -5 m/s. Given that the collision is elastic, what is the velocity of car B after the collision?

(A) 10 m/s
(B) 0 m/s
(C) -5 m/s
(D) -7 m/s

13. An astronaut in a space suit is motionless in outer space. The propulsion unit strapped to her back ejects some gas with a velocity of 50 m/s. The astronaut recoils with a velocity of 1.0 m/s. If the mass of the astronaut and space suit after the gas is ejected is 120 kg, What is the mass of the gas ejected?

(A) 1.0 kg
(B) 1.9 kg
(C) 2.4 kg
(D) 3.00 kg

14. Two objects stick together and move with a common velocity after colliding. Identify the type of collision.

(A) Elastic
(B) Inelastic
(C) Nearly elastic
(D) Perfectly inelastic

15. A blue ball of mass 0.350 kg traveling at 2.60 m/s to the left collides with a red ball of mass 0.350 kg that is initially at rest. After the collision, the blue ball is at rest. What is the new velocity of the red ball?

(A) 0.350 m/s to the right
(B) 2.60 m/s to the left
(C) 5.20 m/s to the left
(D) 5.20 m/s to the right

16. In an inelastic collision between two objects with unequal masses. Which of the following is true?

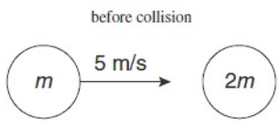
(A) The total momentum of the system will increase.
(B) The total momentum of the system will decrease.
(C) The kinetic energy of one object will increase by the amount that the kinetic energy of the other object decreases.
(D) The momentum of one object will increase by the amount that the momentum of the other object decreases.

17. A 1500 kg truck traveling at 80 km/h collides with another car of mass 1000 kg traveling at 30 km/h in the same direction. The two cars stick together after the collision. What is their speed immediately after the collision?

(A) 40 km/h
(B) 60 km/h
(C) 110 km/h
(D) 55 km/h

18. Two balls, of mass m and 2m, collide and stick together. The combined balls are at rest after the collision. If the ball of mass m was moving 5 m/s to the right before the collision, what was the velocity of the ball of mass 2m before the collision?

(A) 2.5 m/s to the right
(B) 2.5 m/s to the left
(C) 10 m/s to the right
(D) 10 m/s to the left



19. A 2.50×10^5 kg tugboat is traveling north at 3.40 m/s and attaches itself to a stationary 5.25×10^5 kg barge. Find the new velocity of the tug–barge system after the coupling.

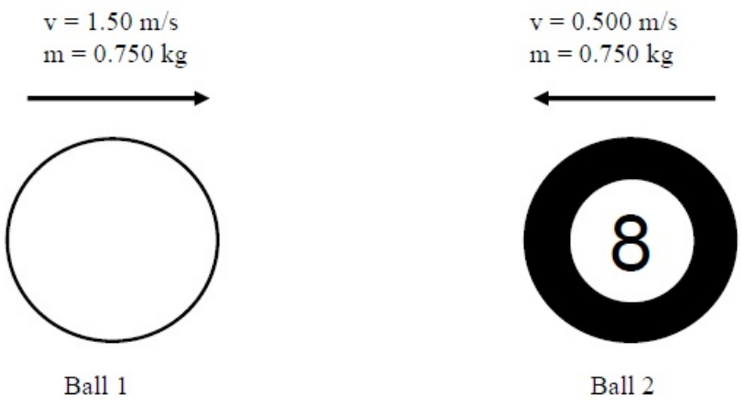
(A) 1.10 m/s north
(B) 2.30 m/s north
(C) 3.50 m/s north
(D) 7.5 m/s south

20. When is momentum is conserved?

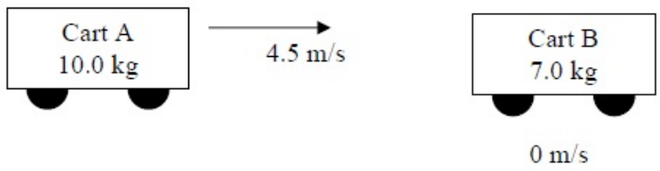
(A) In an elastic collision of two balls
(B) In an inelastic collision of two balls
(C) In the absence of an external force
(D) In all of the preceding cases

PART B: WRITTEN RESPONSE

1. Two pool balls each having a mass of 0.750 kg are approaching each other as shown. Ball 1 is initially traveling at 1.50 m/s to the right while ball 2 is traveling at 0.500 m/s to the left. After the collision, ball 1 is traveling to the right at a speed of 0.35 m/s. Calculate the velocity of ball 2 after the collision



2. Cart B of mass 7.0 kg is initially at rest. Cart A of mass 10.0 kg approaches cart B with a velocity of 4.5 m/s (E) as shown. The carts do not stick together on collision. If cart A moves at 2.3 m/s (E) after the collision, calculate the velocity of cart B after the collision.



3. A 65 kg hockey player is standing on the ice wearing her skates and holding her 15 kg hockey bag. She then throws the hockey bag to the right at 5.0 m/s. Assuming there is no friction, calculate the hockey player's velocity immediately after throwing the bag.

4. A 65 kg athlete is running at a constant velocity of 3.50 m/s [E] when he jumps on a stationary 12 kg sled. If friction is ignored, with what velocity does the athlete and sled move?

5. A 120 kg ATV moving at 15 m/s collides with a stationary 35 kg barbeque. If they stick together on impact, what is their common final velocity?

6. A swimmer with a mass of 75 kg dives off a raft with a mass of 500 kg. If the swimmer's speed is 4.0 m/s immediately after leaving the raft, what is the speed of the raft?