

Impulse, Momentum and Conservation of Momentum Review

Concepts:

- 1) The amount of momentum an object has depends on two variables: _____ and _____
- 1) Is there a difference between \bar{p} and $\Delta\bar{p}$? If so, what's the difference?
- 2) What are the units of change in momentum and of impulse?
- 3) What is the Law of Conservation of Momentum?
- 4) In order for an object to have momentum, what must it be doing?

Practice:

1. Two train cars **approach each other**, one of mass 113,000 kg traveling at 1.20 m/s [E], the other of mass 75000 kg traveling at 2.30 m/s [W]. After the collision, the two cars lock together.
 - a) What is the momentum of the heavier car? 135,600 kg m/s [E]
 - b) What is the momentum of the lighter car? 172,500 kg m/s [W]
 - c) What is the total momentum of the cars before the collision? 36,900 kg m/s [W]
 - d) What is the total momentum of the cars after the collision? 36,900 kg m/s [W]
 - e) What is the velocity of the cars after the collision? 0.196 m/s [W]
2. Two billiard balls, each of mass 565 g, **approach each other**, one with a speed of 2.3 m [E] and the other with a speed of 4.5 m/s. After they collide, the one that was faster reverses its direction and travels at 2.3 m/s. What is the velocity of the other ball? 4.5 m/s [W]
3. A car of mass 1500 kg traveling at 15.6 m/s loses its brakes and collides with the rear end of the car in front of it, which has a mass of 1020 kg and is traveling in the **same direction** at 12.5 m/s. If the smaller car is given a speed of 15.3 m/s by the collision, what is the **speed of the larger car** after the collision? 13.7 m/s
4. A tennis ball may leave the racket of a top player on the serve with a speed of 65.0 m/s. The ball's mass is 0.060 kg and it is in contact with the racket for 0.030 s.
 - a) What is the **impulse** on the ball? 3.9 N s
 - b) What is the **force** on the ball? 130 N
5. A 0.145 kg baseball pitched at 39 m/s is hit on a horizontal line drive **straight back** toward the pitcher at 52 m/s. If the contact time between bat and ball is 0.00100 s, calculate the **impulse** on the ball and the **force** between the ball and bat during contact. -13.2 N s, -13,200 N
6. An object is pushed with a force of 6.0 N [S] for 0.50 s. What **impulse** is given to it? 3 N s [S]
7. What **impulse** produces a velocity change of 4.00 m/s [E] in a 12.5 kg mass? 50 N s [E]
8. A 15.0 kg wagon accelerated by a constant force of 60.0 N from 5.00 m/s [N] to 13.00 m/s [N].
 - a) What **impulse** does the wagon receive? 120 N s [N]
 - b) For **how long** was the force acting on the wagon? 2 s
9. What **force** will stop a hammer with an impulse of 48 N s [W] in 0.030 s? 1600 N [W]

10. A stone of mass 10.0 kg slides along the ice in a straight line with a constant velocity of 8.00 m/s [N]. A force then acts on the stone for 2.50 s, changing its velocity to 2.00 m/s [N].
- What is the **momentum** of the stone **before** and **after** the force acts? 80 kg m/s [N], 20 kg m/s [N]
 - Calculate the **impulse** acting on the stone. 60 N s [S]
 - What is the magnitude and direction of the force that is acting? 24 N [S]
11. A **stationary** flatcar of mass 40,000 kg is rammed by a locomotive with a mass of 60,000 kg and a velocity of 4.5 m/s [E]. If **they stick together**, with what velocity will they continue to move? 2.7 m/s [E]
12. Two 2.5 kg carts are **moving along together** with a velocity of 2.0 m/s when a spring compressed between them expands rapidly. The front cart continues with a velocity of 5.0 m/s, in the same direction.
- What was the **momentum** of the **two carts before** the explosion? 10 kg m/s
 - What was the **momentum** of the **front cart after** the explosion? 12.5 kg m/s
 - What was the **velocity** of the **second cart after** the explosion? -1 m/s
 - What **velocity** would the front cart need in order for the second cart to **be stationary** after the explosion? 4 m/s
13. A 1.5 kg brick is dropped vertically onto a 2.5 kg toy truck, which is moving across a level floor at 0.80 m/s. With what **velocity** do the truck and brick continue to move, after the brick has landed on the truck? 0.5 m/s
14. A child throws a 5.4 kg rock horizontally from a canoe with velocity of 10.0 m/s. This causes the canoe to **slip backwards** as the rock flies forward. Calculate the resulting **velocity** of the canoe, assuming it was **initially at rest**. The mass of the child is 25.0 kg and the mass of the canoe is 55.0 kg. -0.675 m/s
15. An open railroad car of mass 11,000 kg travels forward along on a level frictionless track with a constant velocity of 18.0 m/s. A 6500 kg load is dropped onto the car. What will the new **velocity** of the car and load be? 11.3 m/s
16. A golf ball of mass 0.0450 kg is hit off the tee at a velocity of 50.0 m/s [N]. The golf club was in contact with the ball for 0.00500 s.
- What is the **impulse** on the golf ball? 2.25 N s [N]
 - What is the **force** exerted on the ball by the club? 450 N [N]