Conservation of Momentum Name_____ Period_____

WS8

1. What's the difference between a Ping-Pong ball moving at 30 mi./hr and a semi-trailer truck moving at the same speed?
Truck has more momentum

2. What characterizes an elastic collision?
objects bounce off each other

3. Why is it better to hold a rifle tightly against your arm while firing it rather than holding it loosely away from your body?
mass of whole torso > mass of arm, so smaller recoil velocity

4. ~~What is center of mass and how does it relate to momentum conservation?~~
Total linear momentum = product of total mass Mt Vcm

5. If you were floating freely outside a Space Shuttle and tossed a huge tool to another astronaut, what would happen to you? Why?
You move backward: conservation of momentum

6. Which of Newton's laws of motion is related to the idea of momentum?
1st: inertia (mass) similar to momentum (mv)
3rd: equal & opposite forces is similar to equal & opposite momentum (rocket liftoff, balloon from #16)

7. Which of Newton's laws of motions is related to the idea of impulse?
2nd: $F=ma \rightarrow F=m\frac{\Delta v}{\Delta t} \rightarrow \underbrace{F\Delta t}_{J} = \underbrace{m\Delta v}_{\Delta p}$

8. What happens to the center of mass if a ball explodes?
Same spot

9. What is meant by the term conservation of momentum?
total momentum of a system is the same if no external forces act on an object
(i.e. if a crash brings a car to rest, the crash is an external force on the car, so its momentum isn't conserved. But for 2 cars that hit each other, the forces are between them so total p is conserved.)

10. ~~In billiards, how is hitting a ball straight on different from hitting it at an angle? Describe what happens to the cue ball and the ball being hit.~~

11. How do high-jumpers and pole-vaulters use center of mass?
keep CM below the bar, so they can jump higher w/ same amount of F

12. A watermelon is dropped and strikes the ground without bouncing. What becomes of its momentum?
goes into / transferred to the ground

13. On a cold day a person is at rest in the middle of a frictionless ice pond. How can the person get to shore?
throw something!

14. While driving, a bug splatters on your car windshield. Compared to the change in momentum of the bug, how much does your car's momentum change?
Smaller Δp for car: very little change in speed. Bug accelerates more, so greater Δv
Sum of p for bug + car is the same before + after collision. force of bug on car = Force of car on bug

15. ~~A certain object is at rest. It suddenly explodes. Two particles are detected shooting off at right angles to each other. Are these the only two particles given off? Explain.~~

16. Release an inflated balloon. Explain the motion.
Downward momentum of air = upward momentum of balloon

Sample problem

A 5.0 kg projectile launcher shoots a 0.209 kg projectile at 350 m/s. Wha tis the recoil velocity of the projectile launcher?

$0 = 5\,kg(v_1') + (0.209\,kg)(350\,m/s)$

$v_1' = 14.6\,m/s$

Collisions

Definition:

What is conserved in all collisions?

Collision types

Describe a perfectly elastic collision

Describe a perfectly inelastic collision

What is conserved in both elastic and inelastic collisions? p

What is conserved in an elastic collision but not conserved in an inelastic collision?

KE

Sample Problem (I will give you v_1 on this test)

An 80-kg roller skating grandma collides inelastically with a 40-kg kid. What is their velocity after the collision? What is the change in kinetic energy? $80\,kg\,v_1 = (80kg+40kg)v'$

$v' = \frac{2}{3}v_1$

$KE_f = \frac{1}{2}(80kg+40kg)(v')^2 = \frac{1}{2}(120kg)(\frac{2}{3}v_1)^2$

$KE_i = \frac{1}{2}(80kg)v_1^2$

$\Delta KE = KE_f - KE_i = 26\frac{2}{3}v_1^2 - 40v_1^2$

$= -13\frac{1}{3}v_1^2$

Sample Problem

A 9 kg fish moving at 2 m/s swallows a 3 kg stationary fish. What is the velocity of the big fish after dinner?

$(9kg)(2m/s) = (9kg+3kg)(v')$

$v' = 1.5\,m/s$

Sample Problem:

A 0.5-kg cart moving at 2.0 m/s on an air track inelastically collides with a 1-kg cart at rest. What is the resulting velocity of the two carts?

$(0.5kg)(2) = (0.5+1)v'$

$1kgm/s = 1.5v'$

$v' = 0.67\,m/s$

Sample Problem:

Suppose three equally strong, equally massive astronauts decide to play a game as follows: The first astronaut throws the second astronaut towards the third astronaut. Describe the motion of the astronauts as the game proceeds. Assume each toss results from the same- sized "push". How long will the game last? keep moving farther + farther back

CM (center of mass) between the astronauts remains the same

...key concept do you need to remember when you

Sample Problem

Suppose a 1.5-kg brick is dropped on a glass table top from a height of 20 cm.

a. What is the magnitude and direction of the impulse necessary to stop the brick?

don't worry about this problem. use 3 Ns as impulse for part b)

b. If the table top doesn't shatter, and stops the brick in 0.01 seconds, what is the average force it exerts on the brick?

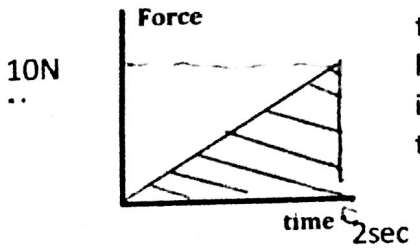
$3\,Ns = F(0.01\,s)$

$F = 300\,N$

c. What is the average force that the brick exerts on the table top during this period?

300 N

Sample problem:



The variable force to the left acts on a 1.2 kg object at rest. What is the new velocity of the object?

$J = \frac{1}{2}(10\,N)(2\,sec) = 10\,Ns = m\Delta v$

$\Delta v = \frac{10\,Ns}{1.2\,kg} = 8.3\,m/s$

Law of Conservation of Momentum

Definition:

Equation:

Sample Problem

A 75-kg man sits on the back of a 120-kg canoe that is at rest in a still pond. If the man jumps out of the canoe at 0.50 m/s, what happens to the canoe?

$0 = (75\,kg)(0.5\,m/s) + (120\,kg)v_2'$

$v_2' = 0.31\,m/s$

Explosions/recoil

What is recoil?

What is conserved in an explosion?

p

What is not conserved in an explosion?

KE

Which of Newton's 3 Laws is most applicable to recoil?

...the ... particles collide ... the same ... work ... concept do ...

Center of Mass

Define center of mass

Define center of gravity

How can you find an object's center of mass?

What determines whether an object will balance or topple? if CM or CG is over the "support base"

Fill in the blank: Applying a force outside of an object's center of mass causes it to _____ around its _____