Name: _____

Period: _____

Momentum and Conservation of Momentum

Momentum

$$p = mv$$

Momentum (in kgm/sec) → Mass (in kg)

→ Velocity (in m/sec)

Momentum equals mass times velocity.

A house that is not moving has no momentum.

Something has to be moving to have momentum.

A fast baseball: a lot of momentum; light, but fast.

Slow bowling ball: little momentum; heavy, but slow.

Something with more momentum would hurt worse if it hit you.

Ex. How much momentum does a 30 kg object going 4 m/s have?		*Ex. An object going 3 m/s has 36 kgm/s of momentum. Find mass.*		*Ex. How fast is a 15 kg object going if it has 45 kgm/s.*	

Variables:
30 kg = m
4 m/s = v
p = ?
 	
Equation:
p = mv
	Solve:
	p = mv
	  = (30kg)(4m/s)
	  = 120 kgm/s
	
	Just put together the units for m and v.
		Variables:
		3 m/s = v
		36 kgm/s = p
		m = ?
		
		Equation:
		p = mv
			Solve:
			If p = mv
			
			Then m = p/v
			  = (36kgm/s)/(3m/s)
			  = 12 kg
				Variables:
				45 kgm/s = p
				15 kg = m
				v = ?
				
				Equation:
				p = mv
					Solve:
					If p = mv
					
					Then v = p/m
					  = (45kgm/s)/(15kg)
					  = 3 m/s

Newton's Third Law says that when you throw a ball, the ball pushes on you, too. Using momentum, you can describe what happens between pairs of forces.

Law of Conservation of Momentum

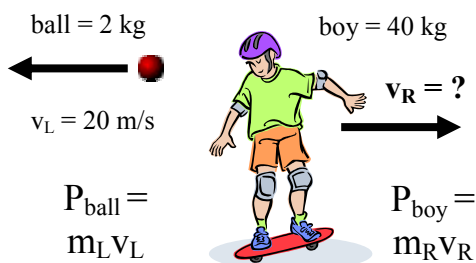**"Momentum is conserved in a closed system" OR "The total amount of momentum does not change."**

Law of Conservation of Momentum:

$$p_{change} = 0$$

$$p_{left} = p_{right}$$

$$m_L v_L = m_R v_R$$

Ex. A 40 kg boy on a skateboard throws a 2 kg, 20 m/s to the left. Find how fast the boy is going afterward.

ball = 2 kg

boy = 40 kg

v_L = 20 m/s

v_R = ?

$P_{ball} = m_L v_L$

$P_{boy} = m_R v_R$

Use The Law of Conservation of Momentum

Solution:

$$P_{change} = 0 = P_R - P_L$$
$$P_L = P_R$$
$$P_{ball} = P_{boy}$$
$$m_L v_L = m_R v_R$$

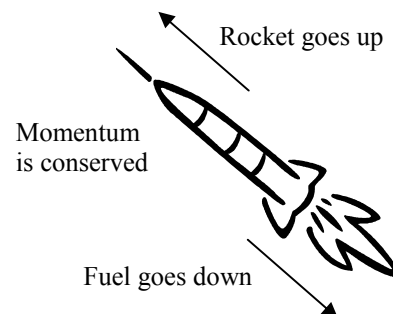$$\frac{m_L v_L}{m_R} = v_R$$

$$\frac{(2kg)(20m/s)}{40kg} =$$

$$\frac{40 \text{ m/s}}{40} = \boxed{1 \text{ m/s}}$$

The boy ends up going 1 m/s to the right.

Conservation of momentum is also how rockets fly. A rocket expels gases at very fast velocity and the rocket goes the opposite direction.

Rocket goes up

Momentum is conserved

Fuel goes down

$$p_{rocket} = p_{fuel}$$

1. Momentum	A. Momentum does not change in a closed system OR $m_L v_L = m_R v_R$	Which of Newton's Three Laws Applies?
2. kgm/sec	B. Units for momentum	___ A rocket moves forward because gases are pushed out the back.
3. Law of Conservation of momentum	C. Measure of the product of an object's mass and velocity.	___ More force creates more acceleration.
4. Weight	D. Changes when gravity changes.	___ A magician pulls out the tablecloth from under the plates on a table and the plates stay put.
5. Inertia	E. Doesn't change with gravity.	___ You pull back on the paddle and the canoe goes forward.

1. Newton's First Law	____ For every action there is an equal an opposite reaction.	___ A larger car takes a bigger engine to move it.
2. Newton's Second Law	____ Objects at rest stay at rest and objects in motion stay at motion unless acted on by a net force.	___ Once the engines stop, a rocket coasts through space.
3. Newton's Third Law	____ Force equals mass times acceleration.	

Find the momentum of a 25 kg object going 4 m/s.

_____

An object is going 22 m/s and is 3 kg.
Find momentum.

_____

A pingpong ball has 2 kgm/s of momentum when thrown 8 m/s.   Find the mass of the ball.

_____

A 25 kg cart has 125 kgm/s of momentum. How fast is the cart going?

A 50 kg boy on ice skates throws a 5 kg ball to the left. If the ball ends up going 20 m/s. How fast is the boy going?

_____

Two astronauts push off of each other in space. The 80 kg astronaut ends up going 10 m/s. The other one ends up going 8 m/s. What is the mass of the other astronaut?

_____

Find the weight of a 25 kg table. (Use g = 10 m/s^2)

_____

A 20 N force pulls to the right and friction pulls 5 N. If the mass is 5 kg, find acceleration.