Aplusphysics momentum impulse worksheet answers

Conservation of Momentum

1. A 1.5 kg cart and a 2.0 kg cart are at rest next to each other. When the spring is released, the heavier cart goes 3.0 m/s to the right. What is the velocity of the lighter cart?
2. A 12 g bullet is shot from a 2.1 kg gun with a velocity of 370 m/s. What is the recoil velocity of the gun?
3. A 6 kg block sliding 4 m/s to the right collides inelastically with a 9 kg block sliding 3 m/s to the left. What is the velocity of the pair?
4. A 75 kg guy jumps off a 20 kg stationary canoe with a velocity of 2 m/s. What is the resulting velocity of the canoe?

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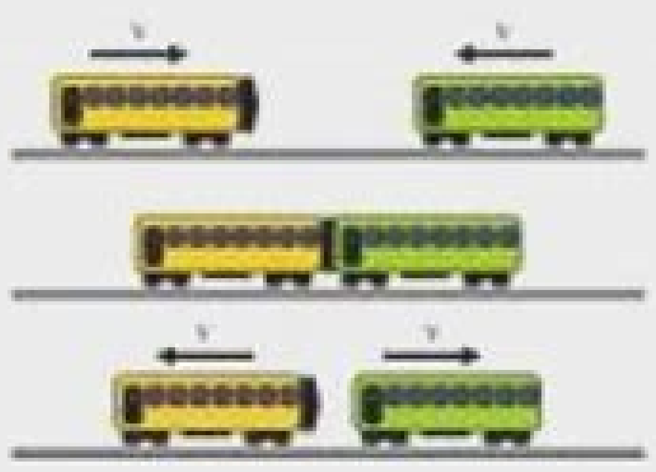
Name: ____________________ Date: ______

Period: ________

Collisions! (Momentum Worksheet #4)

Momentum	Elastic Collision	Inelastic Collision
$P = mv$	$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$	$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

1. Two train cars of identical mass (m = 10.0 kg) collide and move off as shown. The left car was initially traveling at 2.0 m/s right and the right car was initially traveling at a velocity of 3.0 m/s left. After the collision, the left car is traveling at a velocity of 2.5 m/s to the left.



a. What type of a collision is depicted here?

____

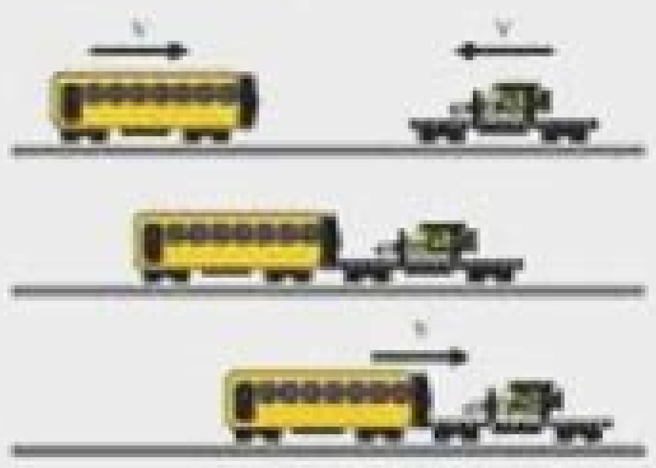
b. What was the initial momentum of the right car?

c. What was the initial momentum of the left car?

d. What was the final momentum of the left car?

e. What was the final momentum of the right car?

2. A Passenger car (m = 10.0 kg) and a flat car (m = 7.5 kg) collide and move off as shown. The left car was initially traveling at 3.5 m/s right and the right car was initially traveling at a velocity of 2.2 m/s left.



a. What type of a collision is depicted here?

____

b. What was the initial momentum of the right car?

Physics 10-20 Impulse and Momentum Formative Worksheet

Learning Target

1. **I can apply the concepts of Impulse and Momentum to the motion of objects in a system.**
   a. **I can define the terms impulse and momentum.**
   b. **I can state that the change in momentum is equal to the impulse applied to the object.**
   c. **I can apply the Impulse-Momentum Theorem to solve for a given unknown**
   d. **I can apply the Law of Conservation of Momentum to analyze**

Name: Key Period: ________

1. The momentum of an object depends upon the object's A, D. Pick two quantities.
   a. mass - how much stuff it has
   b. acceleration - the rate at which the stuff changes its velocity
   c. weight - the force by which gravity attracts the stuff to Earth
   d. velocity - how fast and in what direction it's stuff is moving
   e. position - where the stuff is at
2. The two quantities needed to calculate an object's momentum are mass and velocity.
3. Calculate the momentum value of .... (Include appropriate units on your answers.)
   a. ... a 2.0-kg brick moving through the air at 12 m/s.

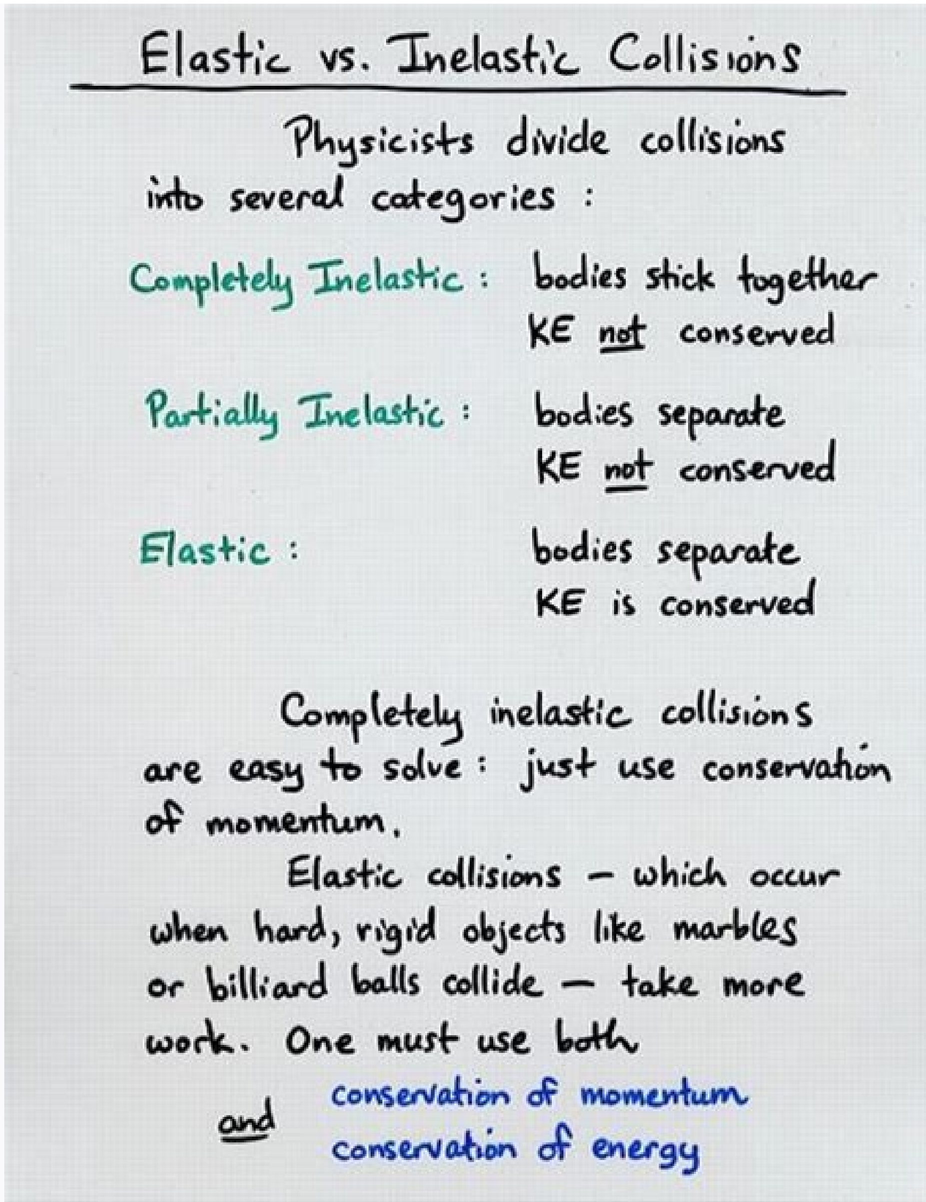
   $P = mv$ $2 kg \cdot 12 m/s$ $24 kg \cdot m/s$

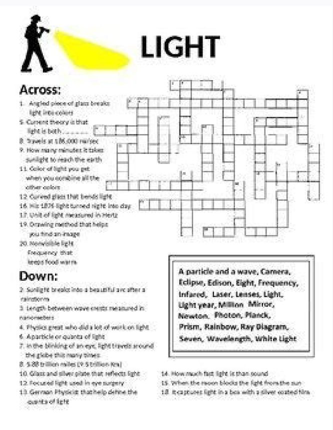
   b. ... a 3.5-kg wagon moving along the sidewalk at 1.2 m/s.

   $3.5 kg \cdot 1.2 m/s = 4.2 kg \cdot m/s$
4. With what velocity must a 0.53-kg softball be moving to equal the momentum of a 0.31-kg baseball moving at 21 m/s?

   $P = mv \rightarrow v = \frac{P}{m} =$ $.31 \cdot 21 m/s = 6.51 kg \cdot m/s$

   $v_{softball} = \frac{6.51}{.53 kg} = 12.2 m/s$





We talked in depth about movement, in particular trying to relate what we know about movement with kinetic energy. Recall our definition of kinetic energy: Kinetic energy - the ability or ability of a moving object to move another object. And the key features of kinetic energy, mass and velocity, which can be observed from the equation: . But there's more to the story. We've talked about moving objects causing other objects to move, but we haven't actually looked at those situations yet – to do that we have to talk about collisions, and collisions are all about momentum. Objectives Define and calculate the momentum of an object. Determine the impulse given to an object. Use the impulse to solve a variety of problems. Interpret and use force versus temporal graphs. Apply momentum retention to solve a variety of problems. Distinguish between elastic and inelastic collisions. Calculate the center of mass for a point particle system. Study Topics Video Tutorial Momentum & Impulse Impulse-Momentum Theorem Conservation of Momentum Ref: APlusPhysics: RPE Ch. 6 Agenda: Conservation of Momentum Practice Problems HW: Watch the video \\\"Conservation of Momentum\\\" and answer questions by midnight on Sunday Finish Momentum and Impulse Packet for Friday HW: Watch video: Impulse-Momentum Theorem & Answer Questions End of Page 1 of Momentum \\\/ Impulse Practice Questions HW: Watch the video: Impulse-momentum theorem and answer questions Finish page 1 of Questions about the practice of the moment \\\/ impulse Now that we have talked about momentum in an isolated system, where no external force acts, we can say that momentum is always conserved. Put simply, in any closed system, the total momentum of the system remains constant. In the case of a collision or explosion (an event), if you add up the individual momentum vectors of all objects before the event, you will find that they are equal to the sum of the momentum vectors of the objects after the event. Written mathematically: . This is a direct result of Newton's 3rd law. Momentum tables In the analysis of collisions and explosions, a momentum table can be a powerful problem-solving tool. To create a momentum table, follow these basic steps: Identify all objects in the system. List them vertically in the left column. Determine the time of the objects before the event. Use variables for any unknowns. Determine the time of the objects after the event. Use variables for any unknowns. Sum all the moments before the event and set them equally to the moment after the event. Solve the resulting equation for any unknowns. Collision a collision is an event in which two or more objects approach and interact strongly for a short period of time. Let's take a look at how our troubleshooting strategy can be applied to a simple collision: Question: A 2000 kg car traveling at 20 m\\\/s collides with a 1000 kg car at rest at a stop sign. If the 2000 kg car has a speed of 6.67 m\\\/s after the collision, find the speed of the 1000 kg car after the collision. Answer: We call the 2000 kg car Car A and the 1000 kg car Car B. We can then create a table of momentum as shown below: Objects Momentum before (kg×m\\\/s) Momentum after (kg×m\\\/s) Car A 2000*20=40000 2000*6.67=13,340 Auto B 1000*0=0 1000*vb Total 40,000vb+13,340 Since momentum is stored in any closed system, the total momentum before the event must be equal to the total momentum after the event. Therefore, we can write: 40,000 = 1000vb + 13,340. Solving for vb, we find that vb must be equal to 26.67 m \\\/ s. Explosions Not all problems are so simple, but the troubleshooting steps remain consistent. Let's look at another example that emphasizes the vector nature of momentum while examining an explosion. In physical terms, an explosion occurs when an object is divided into two or more fragments. Question: A 4-kilogram rifle fires a 20-gram projectile with a speed of 300 m\\\/s. Find the recoil speed of the rifle. Answer: Again, we can use a momentum table to organize our problem solving. To compile the table, we must realize that the initial momentum of the system is 0, and we can consider the rifle and the projectile as a single system with a mass of 4.02 kg: Momentum Objects Before (kg×m \\\/ s) Momentum After \\\/ s) Rifle 4.02 * 0 = 0 4 * vr Bullet 300 * 0.02 = 6 Total 0 4vr + 6 Due to the conservation of momentum, we can again say that the total momentum before must be equal to the total momentum after, or 0=4vr+6. Solving for the speed of the rifle, we find that vr=-1.5 m\\\/s, where the negative sign indicates the direction of the rifle... if the projectile has traveled forward at 300 m\\\/s, the rifle must travel in the opposite direction. Let's see if you can't overcome a problem on your own using the momentum table strategy: suppose there's a car hurtling towards you, out of control without brakes, at a speed of 27 m\\\/s (60 mph). Can you stop it by standing in front of it and reaching out your hand? Why Why Unless you're Superman, you probably don't want to try to stop a moving car by reaching out. It is too big and moves too fast. Attempting such a feat would involve a series of physics demonstrations on your body, all of which would hurt. We can't stop the car because it has too much momentum. Momentum is a vector quantity, given the symbol p, which measures how difficult it is to stop a moving object. Of course, larger objects have more momentum than smaller objects, and faster objects have more momentum than slower objects. We can then calculate momentum using the equation: momentum is the product of the mass of an object multiplied by its velocity, and its units must be the same as units of mass [kg] times velocity [m\\\/s], so the units of momentum must be [kg×m\\\/s], which can also be written as newton-second [N×s]. Question: Two trains, Big Red and Little Blue, have the same speed. Big Red, however, has twice the mass of Little Blue. Compare their moment. Answer: Because Big Red has twice the mass of Little Blue, and Big Red must have twice the momentum of Little Blue. Let us prove one: since momentum is a vector, the direction of the momentum vector is the same as the direction of the velocity of the object. Question: A supersonic bomber A-5 Vigilante, with a mass of 21000 kg, departs from its air base with a speed of 400 m\\\/s to the east. What is the momentum of the jet? Answer: Now, suppose the jet abandons its payload and has burned most of its fuel as it continues its journey to its destination airfield. Question: If the new mass of the jet is 16,000 kg and, thanks to its low weight, the pilot increases the cruising speed to 550 m\\\/s, what is the new momentum of the jet? Answer: Impulse As you can see, momentum can change, and a change in momentum is known as momentum. In Regents Physics, the vector quantitative pulse is represented by a capital J, and since it is a change in momentum, its units are the same as those for momentum, [kg×m\\\/s], and can also be written as newton-second [N×s]. Question: Suppose the A-5 bomber, which had a momentum of 8.8×106 kg×m\\\/s, stops on the ground. What pulse is applied? Answer: Suppose that the east is the positive direction: Impulse-momentum theorem Since momentum is equal to mass and velocity, we can write that . We also know that the impulse is a change of momentum, so the impulse can be written as . If we combine these equations, we find: Since the mass of a single object is constant, a change in the product of mass and velocity is equivalent to the product of mass and change in velocity. Specifically: so we are talking about speed changes ... but what do we call speed changes? Of course, acceleration! And what causes an acceleration? A strength! And does it matter if the force is applied for a very short or very long time? Absolutely yes: common sense tells us that the longer the force is applied, the longer the object will accelerate, the greater the change in momentum of the object! We can prove it using the trick of an old mathematician : if we multiply the right side of our equation by 1, of course we get the same thing. And if we multiply the right side of our equation by Δt\\\/Δt, which is 1, we still get the same thing. Take a look: if you look carefully at this equation, you can find a Δv \\\/ Δt, which is, by definition, acceleration. We replace Δv\\\/Δt with the acceleration a in the following equation. One last step... maybe you can already see it. On the right side of this equation, we have maΔt. Using Newton's 2nd law, I can replace the product of mass and acceleration with the force F, giving us the final form of our equation, often referred to as the impulse-momentum theorem: this equation, which can be found on your reference table, relates the impulse with the change in momentum in force applied over a time interval. To sum up: when an unbalanced force acts on an object for a period of time, a change in momentum, known as an impulse, is produced. Question: A tow truck applies a force of 2000N on a 2000 kg car for a period of 3 seconds. What is the extent of the change in the momentum of the car? Answer: Question: If the car starts at rest, what will be its speed after 3 seconds? Answer: Let's make you try one yourself... Not constant forces But not all forces are constant... what do you do if a changing force is applied over a period of time? In that case, we can a graph of the force applied on the y-axis with respect to time on the x-axis. The area under the Force-Time curve is the pulse, or change in momentum. For the case of the sample graph on the right, we could determine the applied pulse by calculating the area of the triangle under the curve. In this case: case: case:

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