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ANSWER KEY

1. $P = MV$
 $M = 300 \text{ grams} = 0.3 \text{ kg}$
 $V = 2.5 \text{ m/s}$
 $P = ?$
 $P = 0.75 \text{ kg}\cdot\text{m/s}$
= CAROL B

2. $F_{\text{net}} = \Delta p / \Delta t$
 $P_1 = MV$
 $P_2 = 3 \text{ [mv]}$
 $P_2 = 3P$
 P_2 IS 3 TIMES LARGER THAN P_1

3. 2 m/s 0 m/s 0 m/s $V_f = ?$
BEFORE COLLISION AFTER COLLISION
 $K = K$
 $\frac{1}{2} M_1 V_1^2 = \frac{1}{2} M_2 V_2^2$
 $M_1 = 0.5 \text{ kg}$
 $M_2 = 0.75 \text{ kg}$
 $V_1 = 2 \text{ m/s}$
 $V_2 = ?$
 $V_f = 1.63 \text{ m/s}$
BUT BOTH WITH ELASTIC COLLISIONS

4. 2 m/s 0 m/s 1 m/s 0.5 m/s
BEFORE COLLISION AFTER COLLISION
 $K_1 = \frac{1}{2} M_1 V_1^2 = \frac{1}{2} (0.75) (2 \text{ m/s})^2 = 1.5 \text{ J}$
 $K_2 = \frac{1}{2} M_2 V_2^2 = \frac{1}{2} (0.75) (0 \text{ m/s})^2 = 0 \text{ J}$
 $K_3 = \frac{1}{2} M_3 V_3^2 = \frac{1}{2} (1.5) (0.5 \text{ m/s})^2 = 0.45 \text{ J}$
* SINCE THE TOTAL KINETIC ENERGY IS NOT CONSERVED, ENERGY MUST HAVE BEEN DISSIPATED IN THE COLLISION. THIS IS AN INELASTIC COLLISION.

NL9 Δp ANOTHER WAY TO CALCULATE AN OBJECT'S MOMENTUM CHANGE IS TO MULTIPLY THE NET FORCE BY SOMETHING ELSE - WHAT?
HINT: WHAT UNITS ARE USED FOR MOMENTUM & FORCE?

H.W. 25-26
RECEDES
IMPULSE
IMPULSE AND Δp
SHOCK & LONG IMPULSES
IMPULSE MATR

$\vec{F}_{\text{net}}$ IS MEASURED IN NEWTONS = $\text{kg} \frac{\text{meters}}{\text{second}^2}$
 $\Delta \vec{p}$ IS MEASURED IN $\text{kg} \frac{\text{meters}}{\text{second}}$, SO WE MUST ADJUST $\frac{1}{\text{second}}$ FROM Δt IS MEASURED IN SECONDS
(CHANGE) (FORCE) (TIME) (CHANGE) $\Delta \vec{p} = \vec{F}_{\text{net}} \Delta t$ $\text{kg} \frac{\text{meters}}{\text{second}} = (\text{newton})(\text{seconds})$
(IMPULSE) IMPULSE IS A VECTOR
 $\vec{F}_{\text{net}} m \Delta t = m \frac{\Delta \vec{v}}{\Delta t} \Delta t$ $\vec{F}_{\text{net}} \Delta t = m \frac{\Delta \vec{v}}{\Delta t} \Delta t = \Delta \vec{p}$ (NET) (MOMENTUM) (IMPULSE)
IMPULSE = $1 \text{ kg} \frac{\text{meters}}{\text{second}}$

NOTE: A BIG FORCE FOR A SHORT TIME $\vec{F} \Delta t = \Delta \vec{p}$ CAN BOTH PROVIDE THE SAME
OR A SMALL FORCE FOR A LONG TIME $\vec{F} \Delta t = \Delta \vec{p}$ MOMENTUM CHANGE
(IE, SAME $\Delta \vec{p} = m \Delta \vec{v}$ SO SAME $\Delta \vec{v}$)

EX) IF A 5.0 NEWTON NORTHWARD FORCE IS APPLIED TO AN OBJECT FOR 12 SECONDS, CALCULATE THE IMPULSE THE OBJECT RECEIVES:
 $\vec{F} \Delta t = (5.0 \text{ newtons})(12 \text{ sec}) = 60 \text{ newtons}\cdot\text{sec} = 60 \text{ kg}\cdot\text{m/s}$ NORTH
CALCULATE THE CHANGE IN THE OBJECT'S MOMENTUM:
 $\Delta \vec{p} = \vec{F} \Delta t = 60 \text{ newtons}\cdot\text{sec} = 60 \text{ kg}\cdot\text{m/s}$ NORTH
SUPPOSE THIS IMPULSE IS APPLIED TO A 2.0 kg OBJECT INITIALLY MOVING SOUTHWARD AT $15 \frac{\text{meters}}{\text{second}}$, WHAT WOULD ITS VELOCITY BE NOW?
 $\Delta \vec{p} = m \Delta \vec{v}$ $\Delta \vec{v} = \vec{v} - \vec{v}_0$ $\Delta \vec{p} = m(\vec{v} - \vec{v}_0)$ $\vec{v} - \vec{v}_0 = \frac{\Delta \vec{p}}{m}$
 $\vec{v} = \vec{v}_0 + \frac{\Delta \vec{p}}{m} = 15 \frac{\text{meters}}{\text{second}} - \frac{60 \text{ kg}\cdot\text{m/s}}{2 \text{ kg}} = 15 \frac{\text{meters}}{\text{second}}$ NORTH
SAME PROBLEM WITHOUT USING IMPULSE OR MOMENTUM:
 $\Delta \vec{v} = \vec{a} \Delta t$ $\vec{a} = \frac{\vec{F}}{m}$ $\Delta \vec{v} = \frac{\vec{F}}{m} \Delta t$ $\Delta \vec{v} = \vec{v} - \vec{v}_0$ $\vec{v} - \vec{v}_0 = \frac{\vec{F}}{m} \Delta t$
 $\vec{v} = \vec{v}_0 + \frac{\vec{F}}{m} \Delta t = 15 \frac{\text{meters}}{\text{second}} + \frac{5 \text{ newtons}}{2 \text{ kg}} (12 \text{ sec}) = 15 \frac{\text{meters}}{\text{second}}$ NORTH

(B) A mass of 0.40 kg is attached to the spring. Calculate the energy stored in the spring. energy = _____ J [1]

4. A ball B of mass 1.2 kg travelling at constant velocity collides head-on with a stationary ball S of mass 3.6 kg, as shown in Fig. 2.1.

Fig. 2.1

Fictional forces are negligible.
The variation with time of the velocity v of ball B before, during and after colliding with ball S is shown in Fig. 2.2.

Fig. 2.2

(a) State the significance of positive and negative values for v in Fig. 2.2. [2]

(b) Use Fig. 2.2 to determine, for ball B during the collision with ball S,
(i) the change in momentum of ball B,

Name _____
Period _____ Date _____

Momentum Packet 3

Collision Analysis

For each problem:

- Complete the momentum bar chart.
- Write the Momentum Conservation equation.
- Use the equation to calculate the requested quantity.

1. A 10-kg medicine ball is thrown at a velocity of 15 km/hr to a 50-kg skater who is at rest on ice. The skater catches the ball and subsequently slides with the ball across the ice. Determine the velocity of medicine ball and the skater after the collision. PSYW

Initial
Object / Mass / Velocity

Final
Object / Mass / Velocity

Momentum Conservation Equation:

2. A large fish with a mass of 1-kg is in motion at 45 cm/s when it encounters a smaller fish ($m=0.25 \text{ kg}$) that is at rest. The large fish swallows the smaller fish and continues in motion at a reduced speed. Determine the velocity of the large and the small fish after the collision. PSYW

Initial
Object / Mass / Velocity

Final
Object / Mass / Velocity

Momentum Conservation Equation:

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Name: Joey Kelly Date: 11-2-13

Momentum Conservation

READ

Just like the third law of motion says that forces are equal and opposite, changes in momentum are equal and opposite. This is because when objects exert forces on each other, their motion is affected.

The law of momentum conservation states that if interacting objects in a system are not acted on by outside forces, the total amount of momentum in the system cannot change.

The formula below can be used to find the new velocity of object 1 both keeping momentum of the collision.

the momentum of a system before = the total momentum of a system after

$$m_1 v_{1i} + m_2 v_{2i} (\text{initial}) = m_1 v_{1f} (\text{final}) + m_2 v_{2f} (\text{final})$$

If two objects are initially at rest, the total momentum of the system is zero.

the momentum of a system before a collision = 0

For the final momentum to be zero, the objects must have equal momenta in opposite directions.

$$0 = \text{the momentum of a system after a collision}$$
$$0 = m_1 v_{1f} + m_2 v_{2f}$$
$$m_1 v_{1f} = -m_2 v_{2f}$$

Example 1: What is the momentum of a 0.2-kilogram steel ball that is rolling at a velocity of 3.0 m/sec?

$$\text{momentum} = m \times v = 0.2 \text{ kg} \times \frac{3 \text{ m}}{\text{sec}} = 0.6 \text{ kg} \cdot \frac{\text{m}}{\text{sec}}$$

Example 2: You and a friend stand facing each other on ice skates. Your mass is 50 kilograms and your friend's mass is 60 kilograms. As the two of you push off each other, you move with a velocity of 4 m/sec to the right. What is your friend's velocity?

Looking for	Solution
Your friend's velocity to the left.	$m_1 v_1 = -(m_2 v_2)$ $(50 \text{ kg})(4 \text{ m/sec}) = -(60 \text{ kg})(v_2)$
Given	
Your mass of 50 kg	$\frac{200 \text{ kg} \cdot \text{m/sec}}{-60 \text{ kg}} = v_2$
Your friend's mass of 60 kg	-60 kg
Your velocity of 4 m/sec to the right.	$-3.33 \text{ m/sec} = v_2$
Relationship	Your friend's velocity to the left is 3.33 m/sec.
$m_1 v_1 = -(m_2 v_2)$	

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