Name Answer Key
Physics
Period ____________

Date ______________________
Momentum WS #6
Mrs. Nadworny

Momentum Review

Directions: Solve the following problems using the GUESS method and proper significant figures. Be sure to show ALL work.

1. A mass having a momentum of 16.2 kg·m/s north receives an impulse of 15.3 N·s in the direction of motion. The final momentum of the mass is?

$$J = p_f - p_i$$

$$p_f = J + p_i = (15.3 N \bullet s) + (16.2 \tfrac{kg \cdot m}{s}) = 31.5 \tfrac{kg \cdot m}{s} \text{ north}$$

2. A force of 110 N acts forward for 0.55 seconds on a 1.2 kg baseball.
   a. What is the change in momentum of the ball?

$$\Delta p = Ft = (110 \text{ N})(0.55 \text{ s}) = 61 \text{ kg} \cdot \text{m/s forward}$$

   b. What is the impulse given to the ball?

$$J = \Delta p = 61 \text{ N} \bullet \text{s forward}$$

   c. What will its final velocity be (assuming it started at rest)?

$$m\Delta v = J$$

$$\Delta v = \frac{J}{m} = \frac{61 \text{ N} \cdot \text{s}}{1.2 \text{ kg}} = 51 \text{ m/s forward}$$

   d. What is the ball's acceleration?

$$a = \frac{F}{m} = \frac{+110 \text{ N}}{1.2 \text{ kg}} = 92 \text{ m/s}^2 \text{ forward} \quad \text{OR} \quad a = \frac{\Delta v}{t} = \frac{51 \text{ m/s}}{.55 \text{ s}} = 93 \text{ m/s}^2 \text{ forward}$$

The difference in accelerations is okay – it is the result of rounding and significant figures

3. During the Collisions and Explosions lab, the red car (of mass 2.0 kg) is traveling at 3.0 m/s south. The blue car is traveling north at 1.5 m/s and has a momentum of 6.0 kg-m/s. When the cars collide their Velcro locks them together.
   a. What is the momentum of the red car before the collision?

$$p = mv = (2.0kg)(-3.0 \tfrac{m}{s}) = 6.0 \tfrac{kg \bullet m}{s} \text{ south}$$

   b. What is the mass of the blue car before the collision?

$$m = \frac{p}{v} = \frac{6.0 \tfrac{kg \bullet m}{s}}{1.5 \tfrac{m}{s}} = 4.0 kg$$

   c. What is the speed of the two cars after the collision?

Before	After
P_{before} =	P_{after}
$p_1 + p_2$ =	$(m_1 + m_2) v_f$ =
6.0 kg•m/s + (-6.0 kg•m/s) =	(2.0 kg + 4.0 kg)(v_f) =
0 kg•m/s =	(6.0 kg) v_f
0 m/s =	v_f

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4. Later, during the Collisions and Explosions lab, the cars are placed together in the center of the track. The compressed spring is released, sending the red car (of mass 0.85 kg) to the West with a velocity 1.6 m/s. What is the velocity of the blue car (of mass 3.17 kg) after the explosion?

P_{before} =	P_{after}
P_{before} =	$m_1v_1 + m_2v_2$
0 kg-m/s =	(0.85 kg)(-1.6 m/s) + (3.17 kg)(v_2)
1.36 kg-m/s =	(3.17 kg)(v_2)
0.43 m/s East =	v_2

5. Even later, during the Collisions and Explosions lab, the red car (of mass 0.85 kg) is traveling to the right with a speed of 1.28 m/s. It is hit from behind by the blue car (of mass 3.17 kg), which is also moving to the right with a speed of 3.92 m/s. After they collide the red car continues to move to the right, but now at 4.18 m/s. What is the velocity with which the blue car continues to move after the collision?

P_{before} =	P_{after}
$m_1v_1 + m_2v_2$ =	$m_1v_1 + m_2v_2$ =
(0.85 kg)(+1.28 m/s) + (3.17 kg)(+3.92 m/s)	(0.85 kg)(+4.18 m/s) + (3.17 kg)(v_2) =
+13.5144 kg•m/s =	+3.553 kg•m/s + (3.17 kg)(v_2)
3.1 m/s right =	v_2

6. During the Egg Drop lab, two containers are released from a height of 2.0 meters. Each container (with egg) has the same mass of 2.41 kg. Container A crumples on the bottom, stopping in 1.2 seconds, keeping the egg safe. Container B compressed straws while stopping in 0.48 seconds, cracking the egg. Because they were dropped from the same height, they both hit the ground with an impact velocity of 6.3 m/s down.

   a. Calculate the change in momentum while stopping of Container A.

$$\Delta p = m\Delta v = m(v_f - v_i) = (2.41kg)(0\tfrac{m}{s} - (-6.3\tfrac{m}{s})) = 15\tfrac{kg\cdot m}{s}\text{ up}$$

Negative because going down

   b. Calculate the change in momentum while stopping of Container B.

$$\Delta p = m\Delta v = m(v_f - v_i) = (2.41kg)(0\tfrac{m}{s} - (-6.3\tfrac{m}{s})) = 15\tfrac{kg\cdot m}{s}\text{ up}$$

Negative because going down

   c. What is the impulse applied to Container A while stopping?

J = Δp = 15 N•s up

   d. What is the impulse applied to Container B while stopping?

J = Δp = 15 N•s up

   e. Calculate the force acting on the egg in Container A while stopping.

$$F = \frac{J}{t} = \frac{15N\cdot s}{1.2s} = 13N\text{ up}$$

   f. Calculate the force acting on the egg in Container B while stopping.

$$F = \frac{J}{t} = \frac{15N\cdot s}{0.48s} = 31N\text{ up}$$

   g. Why did the egg in Container A survive?

The decreased force from the increased stopping time of the crumple zone

Answers in size order: 0, 0.43, 3.1, 4.0, 6.0, 13, 15, 15, 15, 15, 31, 31.5, 51, 61, 61, 92 or 93