HW: Momentum Introduction

Full Name, Period, AP/Honors: **due: 9/18**

1 formulas

- $\vec{p} = m\vec{v}$
- $\vec{F}\Delta t = \Delta\vec{p}$
- $\vec{r} = \vec{r_i} + \vec{v_i}t + \frac{1}{2}\vec{a}t^2$
- $\vec{v} = \vec{v_i} + \vec{a}t$
- $KE = \frac{1}{2}mv^2$

2 Multiple Choice

1. Two objects with the same mass initially moving different speeds in the same direction undergo the same change in their kinetic energies. Which of these statements are **definitely** true? **Select all that apply**.
   A. They have the same change in speed.
   B. They have the same change in momentum.
   C. They have the same change in total energy.
   D. They have the same displacement during this time.
   E. None of the above.

2. Two objects collide elastically. After the collision, each object has the velocity that the other object did before the collision. Which of these must be true? **Select all that apply**.
   A. The objects had the same mass.
   B. Momentum was conserved.
   C. Kinetic Energy was conserved.
   D. The initial velocities did not lie in the same plane.

3. Why isn't your name at the top of your paper?
   A. It is!
   B. Because I forgot.
   C. Because I don't want credit.

4. If a block with mass m has a constant (non-zero) momentum, it will also have a constant (non-zero)... **Select all that apply.**
   A. Acceleration
   B. Speed
   C. Kinetic Energy
   D. Direction

5. I have two objects initially at rest on a flat, frictionless surface. They have different masses. I apply the same force to each of them for the same amount of time. Which of these will be true? **Select all that apply**.

   A. They will have the same final momentum.

   B. They will have the same final velocity.

   C. They will have the same final kinetic energy.

   D. They will have the same final direction of motion.

6. Two objects going in opposite directions collide. Object A is more massive and was moving faster. Which of these describes a possible result of the collision? Object A was moving in the $+\hat{x}$ direction.

   A. Both objects move in the $+\hat{\mathrm{x}}$ direction.

   B. Both object move in the $-\hat{\mathrm{x}}$ direction.

   C. Both objects come to a stop.

   D. Object A comes to a stop, but object B continues to move in the $-\hat{\mathrm{x}}$ direction.

7. Which of these scenarios is **NOT DISALLOWED** by momentum conservation? All scenarios involve isolated systems.

   A. 2 objects moving in the same direction impact each other and stop.

   B. 2 objects that are initially not moving begin moving in opposite directions

   C. 2 objects are initially moving in the $+\hat{\mathrm{x}}$ direction. They collide and end up both moving in the $-\hat{\mathrm{x}}$ direction.

   D. 2 objects are initially moving in the $+\hat{\mathrm{x}}$ direction. They collide and end up both moving in the $+\hat{\mathrm{y}}$ direction.

8. Two object are traveling in the x-y plane before a collision. After the elastic collision they both have only negligible velocities in the $x - y$ plane, instead they are traveling along the z axis in opposite directions. Is this allowed to occur?

   A. No. It is disallowed by energy conservation

   B. No. It is disallowed by momentum conservation.

   C. No. It is disallowed by Newton's third law.

   D. Yes. This can happen.

9. A 1000 kg dragon is at rest sleeping in outer space. A 50 kg unicorn runs into the dragon with a velocity of 600 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$. The final velocity of the dragon is 40 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$. What is the final velocity of the unicorn?

   A. 20 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

   B. 0 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

   C. -20 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

   D. -200 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

10. The (1000 kg) dragon from a previous problem was angered by the unicorn and decides to ram him back. This time the dragon's initial velocity is -15 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$, and the (50 kg) unicorn's initial velocity is 400 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$. If the unicorn's horn impales the dragon so that they get stuck together, find the final velocity.

    A. 2.1400 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

    B. 4.8 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

    C. 10.5 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

    D. 21.2 $\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$

3 Short answer

For short answer questions, you must show work to receive credit!

1. A block has initial velocity v_i and mass m. After applying a net force $\vec{F}$ to the block for a time Δt, what will be it's final velocity ($\vec{v}_f$)?

2. A car with mass m_c has a constant momentum of $\vec{p}_c$.

   (a) What is the velocity of the car?

   (b) What will be the car's displacement at time t?

   (c) If $m_c = 10$ kg and $\vec{p}_c = 10\ \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{z}}$, find the displacement of the car at $t = 10$ s.

3. A 10 kg block has a momentum of $30\ \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}\hat{\mathrm{x}}$. What is its kinetic energy?

4 A toy car

1. A toy car (on a flat, frictionless surface) has initial kinetic energy KE_i and initial momentum $\vec{p}_i$. A constant net force of $\vec{F}$ is applied to it. Find the velocity of the car at time t.