Momentum Worksheet

Full Name-Element Here:

0 Formulas

- $\vec{F}\Delta t = \Delta\vec{p} = m\Delta v$
- $\vec{p} = m\vec{v}$
- $\Delta\vec{x} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$
- $\vec{F}_g = m\vec{g}$
- $\Delta E = W = FD$

1 Multiple Choice

1. Two ice skaters are skating across a flat pond, both are traveling in the positive $\hat{x}$ direction. One has more momentum, the other has more energy. A constant force is applied in order to stop the skiers. Which of these statements is true?

   A. The skater with more energy will take a longer time to stop, but the skater with more momentum will go further before stopping.

   B. The skater with more momentum will take a longer time to stop, but the skater with more energy will go further before stopping.

   C. The skater with more momentum will take a longer time to stop, and go further before stopping.

   D. The skater with more energy will take a longer time to stop, and go further before stopping.

2. A vandal pushes a car (mass $m = 1000$ kg) off the edge of a parking garage. It initially has a momentum of 0.

   (a) What will be the momentum after a time t?

   A. $-mgt\ \hat{z}$
   B. $-mgh\ \hat{z}$
   C. $-gt\ \hat{z}$
   D. $-mg\ \hat{z}$
   E. 0

   (b) Explain how the situation conserved the momentum of the universe.

3. Which of these describes conservation of momentum and energy correctly?

   A. Anything that does not violate energy conservation can happen.

   B. Anything that does not violate momentum conservation can happen.

   C. Anything that does not violate energy conservation and does not violate momentum conservation can happen.

   D. There exist sequences of events that cannot ever happen in spite of obeying energy and momentum conservation

   E. None of the above are correct.

2 Free Response

1. A model rocket with mass m_c has a constant momentum of $\vec{p}_c$.

   (a) What will be the rocket's displacement at time t? Use only variables given in the problem.

   (b) If $m_c = 20$ kg and $\vec{p}_c = 20 \text{ kg}\frac{\text{m}}{\text{s}}\hat{z}$, find the displacement of the rocket at $t = 10$ s.

2. Explain how an air bag can make a driver safer.

3. The driver of a car decided to check his text messages while driving. As a result, two cars collide.

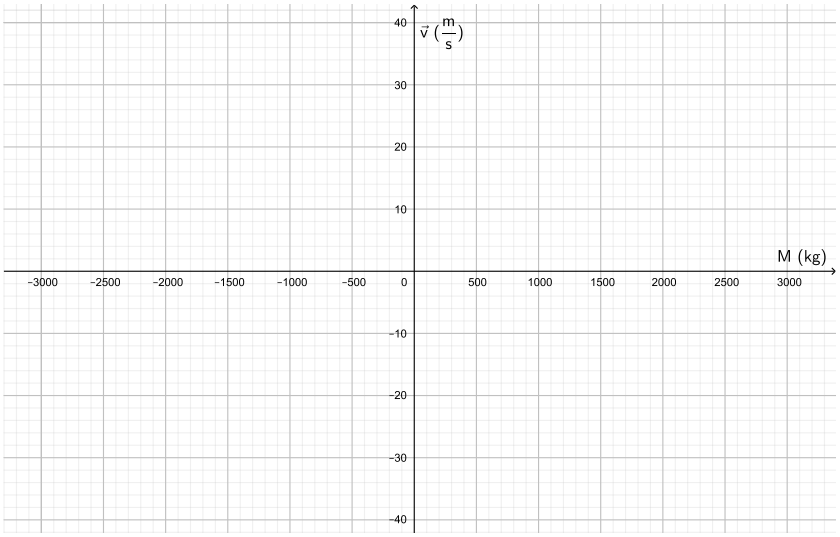
   - Car 1: $M_1 = 1000$ kg and $v_{1,i} = 20 \ \frac{\text{m}}{\text{s}}$ right.
   - Car 2: $M_2 = 2000$ kg and $v_{2,i} = 40 \ \frac{\text{m}}{\text{s}}$ left.

   After the collision, Car 1 has a velocity of $v_{1,f} = 20 \ \frac{\text{m}}{\text{s}}$ left

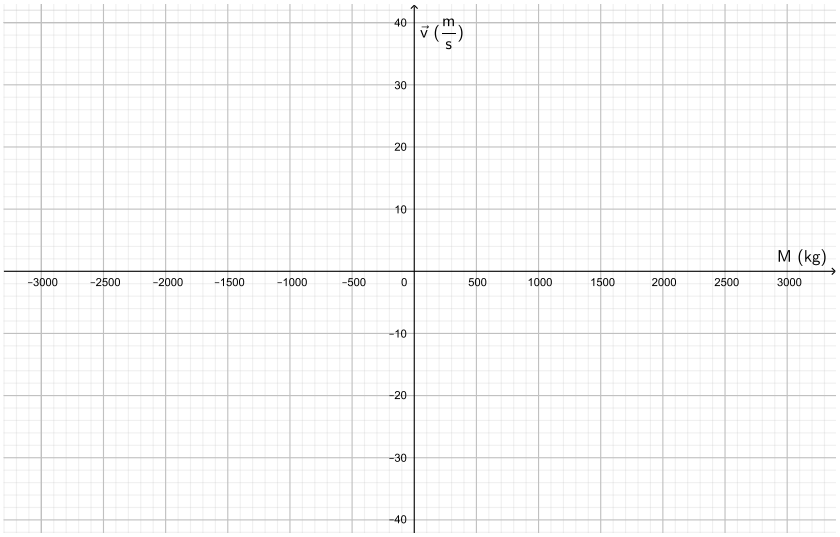
   (a) Make a diagram of the situation.

   (b) Solve for the final velocity of car 2.

(c) On the empty velocity/mass graph below, draw rectangles that represent the momentum of each car before the collision.



(d) On the empty velocity/mass graph below, draw rectangles that represent the momentum after the collision.



(e) Classify the collision as perfectly elastic, partially elastic, or perfectly inelastic. Explain your answer.

4. Two objects collide. The first object has a mass of 200 kg and the second object has a mass of 400 kg. Their velocities are given by

$$\vec{v}_{1i} = \left(\frac{1}{2}\hat{\mathrm{x}} - \frac{1}{2}\hat{\mathrm{y}}\right) \ \frac{\mathrm{m}}{\mathrm{s}}$$

$$\vec{v}_{2i} = \left(\frac{-1}{2}\hat{\mathrm{x}} + \frac{1}{2}\hat{\mathrm{y}}\right) \ \frac{\mathrm{m}}{\mathrm{s}}$$

5 seconds later they have velocities that are given by

$$\vec{v}_{1f} = \left(-\hat{\mathrm{x}} + \frac{1}{2}\hat{\mathrm{y}}\right) \ \frac{\mathrm{m}}{\mathrm{s}}$$

$$\vec{v}_{2f} = \left(\hat{\mathrm{x}} + \frac{1}{2}\hat{\mathrm{y}}\right) \ \frac{\mathrm{m}}{\mathrm{s}}$$

What was the average net external force on the system?

5. Determine if each item violated momentum or energy conservation. If it violated one, explain how using words and possibly equations.

   (a) A car turns a corner in the absence of external forces.

   (b) An object is initially at rest. It explodes and pieces fly off in all directions.

   (c) Two objects initially moving in the same direction collide. The collision deforms both objects. After the collision, the objects are stopped. No external forces act on the system.

   (d) On Earth, two object are on a ramp. At some starting time, one object is moving up and the other is moving down with equal speeds. After the collision, both objects are sliding down the ramp.