

Midterm 4 for Calculus-Based Physics-1: Mechanics (PHYS150-01)

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1 Definition of Momentum

1. Which of the following quantities has units of momentum?
 - 4 kg m/s
 - 8 kg m/s²
 - 10 N m
 - 3 m/s
2. Which two properties of a system must be true for momentum to be conserved?
 - The mass must be constant, and there must be no dissipative forces.
 - There must be no net external force, and the velocity vectors must sum to zero.
 - The mass must be constant, and there must be no net external force.
 - There must be no internal forces and $dP/dt \neq 0$.
3. In which of the following situations will momentum be conserved?
 - After a rocket has launched vertically upward, and has run out of fuel.
 - Two asteroids collide in space and merge into one asteroid.
 - A person floats downward at constant velocity using a parachute.
 - An object skids to a stop due to surface friction.
4. What is the momentum of a 1 kg meteorite traveling through space at 10 km/s?

2 Conservation of Momentum

1. A 200 gram meteorite breaks into two smaller ones. The two final velocities are observed to be equal, and in the same direction as the original velocity. What are the masses of the two pieces, if momentum is conserved?
2. A proton and a neutron interact and stick together. The mass of both particles is identical and cannot change. If one has a velocity of $v_1 = 10^6$ m/s, and the other has $v_2 = 0$ m/s, what is the final velocity? Draw a diagram of the initial state and the final state.

3 Classifying Interactions

1. What quantity is conserved in an *elastic* interaction but not in an *inelastic* interaction?
 - Acceleration (remains zero)
 - Momentum
 - Internal forces
 - Kinetic energy
2. If an interaction is *totally* inelastic, what is the final velocity?
 - Less than the initial velocity
 - Such that the kinetic energy decreases
 - Such that the final momentum is zero
 - The final velocity is zero
3. The notation $n \rightarrow n$ means many-to-many, or several particles scattering off of each other. Which of the following is true of $n \rightarrow n$ interactions?
 - They are usually elastic
 - They can be totally elastic
 - They must be inelastic
 - They can be totally inelastic
4. The notation $n \rightarrow 1$ means many-to-one, or several particles interacting and becoming one system. Which of the following is true of $n \rightarrow n$ interactions?
 - They are usually inelastic
 - They are always totally inelastic
 - They must be elastic
 - Momentum is not conserved if there are internal forces
5. A 1 kg particle has $v_1 = 0$ m/s, and it interacts with a 2 kg particle with velocity $v_2 = 4$ m/s. If the collision is inelastic, what is the final velocity of the combined system?
6. A 2 kg particle has $v_1 = -2$ m/s, and it interacts with a 2 kg particle with velocity $v_2 = 2$ m/s. If the collision is elastic, what is the final velocity of each particle?