

When objects do not separate after colliding, the collision is described as **completely inelastic**, such that $m_1\mathbf{v}_1 + m_2\mathbf{v}_2 = (m_1 + m_2)\mathbf{v}_3$.

Collisions in Two or Three Dimensions

Conservation of momentum can be applied to multidimensional situations, such that momentum for each coordinate axes is conserved.

In two dimensions, the vector sum relies on trigonometry, in which the positive x axis of the frame of reference can be defined in the direction of one object's motion. For $p_x, p_{1x} + p_{2x} = p'_{1x} + p'_{2x}$ and for $p_y, p_{1y} + p_{2y} = p'_{1y} + p'_{2y}$.

For Additional Review

Without using the relative speed relation for elastic collisions, solve an elastic collisions question involving conservation of linear momentum and kinetic energy using the quadratic formula.

Multiple-Choice Questions

- In an inelastic collision in which there are no net nonzero external forces, which of the following are NOT true?
 - Total vector momentum is conserved.
 - Kinetic energy is conserved.
 - Total energy is conserved.(A) I only
(B) II only
(C) III only
(D) I and II
(E) I, II, and III
- Two equally weighted objects of mass m are moving in opposite directions, one with half the velocity of the other. If they collide and stick together, what is the resultant velocity in terms of the faster object's velocity, v ?
 - $m/2v$
 - $mv/2$
 - $v/4$
 - $4/mv$
 - $2/v$
- What is the ratio of the momentum and the kinetic energy for a body traveling horizontally at a constant velocity?
 - v^2
 - m/v
 - v^2/m
 - $2/v$
 - $4v/m$
- A 10 kg object at rest explodes into four pieces. Each of three of these pieces has a mass of 2.0 kg, and the pieces travel due south, due east, and due west, respectively, at 3.0 m/s. What is the magnitude of velocity of the remaining piece?
 - 1.0 m/s
 - 1.5 m/s
 - 3.0 m/s
 - 4.5 m/s
 - 6.0 m/s
- Two equally weighted objects are moving in opposite directions, one at 4 m/s and the other at 3 m/s. They collide inelastically and stick together. What percentage of the kinetic energy is lost in the collision?
 - 22%
 - 43%
 - 52%
 - 81%
 - 98%

6. A 5 kg object has a momentum of 15 kg m/s. What is the net force required to accelerate the object to 8 m/s over 15 seconds?
 (A) 0.35 N
 (B) 1.7 N
 (C) 5.1 N
 (D) 11 N
 (E) 23 N
7. What is the linear momentum of a 15 kg object traveling at a constant velocity that has 270 joules of kinetic energy?
 (A) 60 kg·m/s
 (B) 75 kg·m/s
 (C) 90 kg·m/s
 (D) 110 kg·m/s
 (E) 125 kg·m/s
8. How much energy is lost when a 0.1 kg projectile traveling at 120 m/s becomes imbedded in a 2 kg block initially at rest?
 (A) 34 J
 (B) 90 J
 (C) 440 J
 (D) 690 J
 (E) 720 J
9. What is the magnitude of the average impulse of a wall on a 525 gram ball that strikes horizontally at 25 m/s and rebounds horizontally at 25 m/s?
 (A) 20 kg·m/s
 (B) 26 kg·m/s
 (C) 45 kg·m/s
 (D) 78 kg·m/s
 (E) 99 kg·m/s
10. A 15 kg mass moving at 8 m/s collides elastically with a 5 kg mass at rest. What is the speed of the 15 kg mass after the collision?
 (A) 4.0 m/s
 (B) 8.0 m/s
 (C) 12 m/s
 (D) 20 m/s
 (E) 36 m/s

Free-Response Questions

- A 3 kg mass moving laterally at 5 m/s collides with a 5 kg mass at rest. As a result, the 5 kg mass travels at 2 m/s at a 26° angle counterclockwise from the direction of the motion of the initial mass. The 5 kg mass then collides with a 4 kg mass at rest. The 4 kg mass then leaves at 1 m/s at a 30° angle counterclockwise from the direction of motion of the 5 kg mass.
 - Find the final magnitude and direction for the velocity of each of the first two masses.
 - Are these collisions elastic? Why or why not?
- An electron, mass 1.66×10^{-27} kg fired at 100 m/s, collides elastically head-on with a gold nucleus of mass 3.27×10^{-25} kg at rest.
 - Find each of the resulting velocities.
 - How much kinetic energy is lost in the collision?
 - What would the resulting velocity be if the collision had been completely inelastic?

ANSWERS AND EXPLANATIONS

on, an inelastic collision is one in which kinetic energy is lost. In an inelastic collision, the total kinetic energy and total vector momentum are