Welcome back, Bill Wiecking

>>Working in AP Physics B (SC651)

Momentum

Chapter 8: Momentum

Conceptual problems

8.C.1 **(5.00)** Two balls of equal mass move at the same speed in different directions. Are their momenta equal? Explain.

Yes No

8.C.2 **(5.00)** (a) If a particle that is moving has the same momentum and the same kinetic energy as another, must their masses and velocities be equal? If so, explain why, and if not, give a counterexample. (b) Describe the properties of two particles that have the same momentum, but different kinetic energies.

(a) Yes No

(b)

8.C.3 **(5.00)** Two balls are moving in the same direction. Ball A has half the mass of ball B, and is moving at twice its speed. (a) Which ball has the greater momentum? (b) Which ball has greater kinetic energy?

(a)

(b)

8.C.4 **(5.00)** Two salamanders have the same mass. Their momenta (considered as signed quantities) are equal in magnitude but opposite in sign. Describe the relationship of their velocities.

8.C.5 **(5.00)** A large truck collides with a small car. How does the magnitude of the impulse experienced by the truck compare to that experienced by the car?

8.C.6 **(5.00)** Object A is moving when it has a head-on collision with stationary object B. No external forces act on the objects. Which of the following situations are possible after the collision? Check all that are possible.

- A and B move in the same direction
- A and B move in opposite directions
- A moves and B is stationary
- A is stationary and B moves
- A and B are both stationary

8.C.7 **(5.00)** A cannonball is on track to hit a distant target when, at the top of its flight, it unexpectedly explodes into two pieces that fly out horizontally. You find one piece of the cannonball, and you know the target location. What physics principle would you apply to find the other piece? Explain.

8.C.8 **(5.00)** An object can have a center of mass that does not lie within the object itself. Give examples of two such objects.

Section 0: Introduction

8.0.1 **(5.00)** Use the information given in the interactive problem in Section 8.0 to answer the following questions. (a) Is it possible to have negative momentum? (b) Does the sum of the pucks' velocities remain constant before and after the collision? (c) Does the sum of the pucks' momenta remain constant?

(a) Yes No
(b) Yes No
(c) Yes No

Section 1: Momentum

8.1.1 **(5.00)** Belle is playing tennis. The mass of the ball is 0.0567 kg and its speed after she hits it is 22.8 m/s. What is the magnitude of the momentum of the ball?

kg·m/s

8.1.5 A net force of 30 N is applied to a 10 kg object, which starts at rest. What is

(7.00) the magnitude of its momentum after 3.0 seconds?

[ ] kg·m/s

Section 2: Momentum and Newton's second law

8.2.1 **(5.00)** A golden retriever is sitting in a park when it sees a squirrel. The dog starts running, exerting a constant horizontal force of 89 N against the ground for 3.2 seconds. What is the magnitude of the dog's change in momentum?

[ ] kg·m/s

Section 3: Impulse

8.3.1 **(5.00)** A 1400 kg car traveling in the positive direction takes *t* seconds to slow from 25.0 meters per second to 12.0 meters per second. What is the average force on the car during this time?

[ ] N

8.3.6 **(5.00)** A government agency estimated that air bags have saved over 14,000 lives as of April 2004 in the United States. (They also stated that air bags have been confirmed as killing 242 people, and they stress that seat belts are estimated to save 11,000 lives a year.) Assume that a car crashes and has come to a stop when the air bag inflates, causing a 75.0 kg person moving forward at 15.0 m/s to stop moving in 0.0250 seconds. (a) What is the magnitude of the person's impulse? (b) What is the magnitude of the average force the airbag exerts on the person?

(a) [ ] kg·m/s
(b) [ ] N

8.3.7 **(5.00)** Imagine you are a NASA engineer, and you are asked to design an airbag to protect the Mars Pathfinder from its impact with the Martian plain when it lands. Your system can allow an average force of up to 53,000 N on the spacecraft without damage. Your Pathfinder mock-up has a mass of 540 kg. If the spacecraft will strike the planet at 24 m/s, what is the minimum time for your airbag system to bring Pathfinder to rest so that the average force will not exceed 53,000 N?

[ ] s

8.3.8 **(5.00)** The graph shows the net force applied on a 0.15 kg object over a 3.0 s time interval. (a) What is the average force applied to the object over the 3.0 seconds? (b) What is the impulse? (c) What is its change in velocity?

(a) ______ N
(b) ______ kg·m/s
(c) ______ m/s

8.3.10 **(7.00)** For a movie scene, an 85.0 kg stunt double falls 12.0 m from a building onto a large inflated landing pad. After touching the landing pad surface, it takes her t s to come to a stop. What is the magnitude of the average net force on her as the landing pad stops her?

______ N

8.3.11 **(7.00)** A relative of yours belly flops from a height of 2.50 m (ouch!) and stops moving after descending 0.500 m underwater. Her mass is 62.5 kg. (a) What is her speed when she strikes the water? Ignore air resistance. (b) What is the magnitude of her impulse between when she hit the water, and when she stopped? (c) What was the magnitude of her acceleration in the pool? Assume that it is constant. (d) How long was she in the water before she stopped moving? (e) What was the magnitude of the average net force exerted on her after she hit the water until she stopped? (f) Do you think this hurt?

(a) ______ m/s
(b) ______ kg·m/s
(c) ______ m/s^2
(d) ______ s
(e) ______ N
(f) ○ Yes ○ No

8.3.12 **(7.00)** Nitrogen gas molecules, which have mass 4.65×10^{-26} kg, are striking a vertical container wall at a horizontal velocity of positive 440 m/s. 5.00×10^{21} molecules strike the wall each second. Assume the collisions are perfectly elastic, so each particle rebounds off the wall in the opposite direction but at the same speed. (a) What is the change in momentum of each particle? (b) What is the average force of the particles on the wall?

(a) ______ kg·m/s

(b) [ ] N

Section 6: Conservation of momentum

8.6.1 **(5.00)** A probe in deep space is infested with alien bugs and must be blown apart so that the icky creatures perish in the interstellar vacuum. The craft is at rest when its self-destruction device is detonated, and the craft explodes into two pieces. The first piece, with a mass of 6.00×10^{8} kg, flies away in a positive direction with a speed of v1 m/s. The second piece has a mass of 1.00×10^{8} kg and flies off in the opposite direction. What is the velocity of the second piece after the explosion?

[ ] m/s

8.6.2 **(5.00)** A 332 kg mako shark is moving in the positive direction at a constant velocity of 2.30 m/s along the bottom of a sea when it encounters a lost 19.5 kg scuba tank. Thinking the tank is a meal, it has lunch. Assuming momentum is conserved in the collision, what is the velocity of the shark immediately after it swallows the tank?

[ ] m/s

8.6.3 **(5.00)** A rifle fires a bullet of mass 0.0350 kg which leaves the barrel with a positive velocity of 304 m/s. The mass of the rifle and bullet is 3.31 kg. At what velocity does the rifle recoil?

[ ] m/s

8.6.4 **(7.00)** A cat stands on a skateboard that moves without friction along a level road at a constant velocity of 2.00 m/s. She is carrying a number of books. She wishes to stop, and does so by hurling a 1.20 kg book horizontally forward at a speed of 15.0 m/s with respect to the ground. (a) What is the total mass of the cat, the skateboard, and any remaining books? (b) What mass book must she now throw at 15.0 m/s with respect to the ground to move at −2.00 m/s?

(a) [ ] kg

(b) [ ] kg

Section 10: Collisions

8.10.1 **(5.00)** A steel ball of mass 0.76 kg strikes a brick wall in an elastic collision. Incoming, it strikes the wall moving 63° directly above a line normal (perpendicular) to the wall. It rebounds off the wall at an angle of 63° directly below the normal line. The ball's speed is 8.4 m/s immediately before and immediately after the collision, which lasts 0.18 s. What is the magnitude of the average force exerted by the ball on the wall?

[ ] N

Section 11: Sample problem: elastic collision in one dimension

8.11.1 **(7.00)** Two balls collide in a head-on elastic collision and rebound in opposite directions. One ball has velocity 1.2 m/s before the collision, and −2.3 m/s after. The other ball has a mass of 1.1 kg and a velocity of −4.2 m/s before the collision. (a) What is the mass of the first ball? (b) What is the velocity of the second ball after the collision?

(a) [ ] kg
(b) [ ] m/s

8.11.2 **(7.00)** Two identical balls collide head-on in an elastic collision and rebound in opposite directions. The first ball has speed 2.3 m/s before the collision and 1.7 m/s after. What is the speed of the second ball (a) before and (b) after the collision?

(a) [ ] m/s
(b) [ ] m/s

Section 14: Physics at play: elastic collisions and sports

8.14.1 **(7.00)** Two steel balls are suspended on (massless) wires so that their centers align. One ball, with mass 2.30 kg, is pulled up and to the side so that it is 0.0110 m above its original position. Then it is released and strikes the other ball in an elastic collision. If the second ball has a mass of 3.10 kg, to what height does it rise above its original position?

[ ] m

Section 16: Sample problem: elastic collision in two dimensions

8.16.1 **(7.00)** Ball A collides with stationary ball B. Both balls have the same mass. After the collision, ball A has a speed of 2.7 m/s and moves at an angle of 17° from its original path of motion. Ball B has a speed of 2.2 m/s after the collision. (a) What is the angle (in degrees) between the directions of motion of the two balls after the collision? (b) What is the initial speed of ball A? (c) Is this an elastic collision?

(a) ___ °

(b) ___ m/s

(c) Yes No

Section 17: Interactive problem: multi-dimensional collision

8.17.1 **(5.00)** Use the information given in the interactive problem in Section 8.17 to calculate the initial velocity of the cue ball required to sink the eight ball. Test your answer using the simulation.

___ m/s

Section 18: Inelastic collisions

8.18.2 **(5.00)** During a snowball fight, two snowballs travelling towards each other collide head-on. The first is moving east at a speed of vi1 m/s and has a mass of 0.450 kg. The second is moving west at 13.5 m/s. When the snowballs collide, they stick together and travel west at 3.50 meters per second. What is the mass of the second snowball?

___ kg

8.18.3 **(5.00)** Three railroad cars, each with mass 2.3×10^4 kg, are moving on the same track. One moves north at 18 m/s, another moves south at 12 m/s, and third car between these two moves south at 6 m/s. When the three cars collide, they couple together and move with a common velocity. What is their velocity after they couple?

___ m/s

8.18.4 **(7.00)** A 110 kg quarterback is running the ball downfield at 4.5 m/s in the positive direction when he is tackled head-on by a 150 kg linebacker moving at −3.8 m/s. Assume the collision is completely inelastic. (a) What is the velocity of the players just after the tackle? (b) What is the kinetic energy of the system consisting of both players before the collision? (c) What is the kinetic energy of the system consisting of both players after the collision?

(a) ___ m/s

(b) ___ J

(c) ___ J

Section 19: Sample problem: ballistic pendulum

8.19.1 **(5.00)** A dart gun suspended by strings hangs in equilibrium. The mass of the gun is 355 grams, not including a dart. The gun fires a 57.0 gram dart, causing it to swing backwards. The gun swings up to a height of 18.3 centimeters. What was the dart's speed in meters per second just after firing?

[ ] m/s

8.19.2 **(7.00)** A 0.0541 kg bullet is fired into a 3.25 kg block on a ballistic pendulum. The bullet goes straight through the block (without changing the mass of either object) and exits with a speed of 183 m/s. The block rises to a maximum height of 0.177 m. What was the initial speed of the bullet?

[ ] m/s

Section 20: Center of mass

8.20.1 **(5.00)** How far is the center of mass of the Earth-Moon system from the center of the Earth? The Earth's mass is 5.97×10^{24} kg, the Moon's mass is 7.4×10^{22} kg, and the distance between their centers is 3.8×10^{8} m.

[ ] m

8.20.2 **(5.00)** Four particles are postioned at the corners of a square that is 4.0 m on each side. One corner of the square is at the origin, one on the positive *x* axis, one in the first quadrant and one on the positive *y* axis. Starting at the origin, going clockwise, the particles have masses 2.3 kg, 1.4 kg, 3.7 kg, and 2.9 kg. What is the location of the center of mass of the system of particles?

([ ] , [ ]) m

Additional problems

8.A.2 **(5.00)** A 10.5 kg block, attached to the left end of a horizontal massless spring, sits on a frictionless table. The right end of the spring is attached to a vertical piece of wood that is firmly nailed to the table. A 0.0500 kg projectile is fired, from left to right, into the block at 85.5 m/s and stops inside it (this is a completely inelastic collision). The spring constant is k = 105 N/m. How many meters does the spring compress? The potential energy due to the compression of the spring can be calculated with the following formula: $PE = (1/2)kx^2$.

m

Back to assignments list

Current server time is: 2008-02-17 16:28