Physics 201 Examples 7

Feb 13, 2013

1. A lumberjack (mass = 98 kg) is standing at rest on one end of a floating log (mass = 230 kg) that is also at rest. The lumberjack runs to the other end of the log, attaining a velocity of +3.6 m/s relative to the shore, and then hops onto an identical floating log that is initially at rest. Neglect any friction and resistance between the logs and the water. (a) What is the velocity of the first log just before the lumberjack jumps off? (b) Determine the velocity of the second log if the lumberjack comes to rest on it.

(a) $v = -1.53$ m/s.
(b) $v = 1.08$ m/s

2. Two people are standing on a 2.0-m-long platform, one at each end. The platform floats parallel to the ground on a cushion of air, like a hovercraft. One person throws a 6.0-kg ball to the other, who catches it. The ball travels nearly horizontally. Excluding the ball, the total mass of the platform and people is 118 kg. Because of the throw, this 118-kg mass recoils. How far does it move before coming to rest again?

0.096 m

3. The earth and moon are separated by a center-to-center distance of $3.85\text{E}^8 m$. The mass of the earth is 5.98×10^{24} kg and that of the moon is 7.35×10^{22} kg. How far does the center of mass lie from the center of the earth?

4. A 5.00-kilogram ball, moving to the right at a velocity of 2.00 m/s on a frictionless table, collides head-on with a stationary 7.50-kilogram ball. Find the final velocities of the balls if the collision is (a) elastic and (b) completely inelastic.

(a) $u_1 = -0.400$ m/s, $u_2 = +1.60$ m/s
(b) $u = +0.800$ m/s

5. A baseball (mass = 0.149 kilograms) approaches a bat horizontally at a speed of 40.2 m/s and is hit straight back at a speed of 45.6 m/s. If the ball is in contact with the bat for a time of 1.10 milliseconds, what is the average force exerted on the ball by the bat? Neglect the weight of the ball, since it is so much less than the force of the bat. Choose the direction of the incoming ball as the positive direction.

-11600 newtons

6. In a football game, a receiver is standing still, having just caught a pass. Before he can move, a tackler, running at a velocity of 4.5 m/s, grabs him. The tackler holds onto the receiver, and the two move off together with a velocity of 2.6 m/s. The mass of the tackler is 115 kilograms. Assuming that momentum is conserved, find the mass of the receiver.

84 kilograms

7. A fireworks rocket is moving at a speed of 45.0 m/s. The rocket suddenly breaks into two pieces of equal mass, which fly off with velocities $\vec{v}_1$ and $\vec{v}_2$, as shown in Figure 1. What is the magnitude of (a) $\vec{v}_1$ and (b) $\vec{v}_2$?
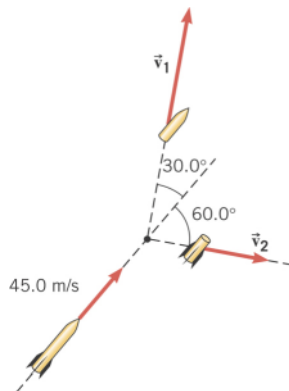
(a) 77.9 m/s
(b) 45.0 m/s

Figure 1: Problem 7.22

8. A ball is attached to one end of a wire, the other end being fastened to

(a) 4.85 m/s
(b) -0.979 m/s

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the ceiling. The wire is held horizontal, and the ball is released from rest (see Figure 2). It swings downward and strikes a block initially at rest on a horizontal frictionless surface. Air resistance is negligible, and the collision is elastic. The masses of the ball and block are, respectively, 1.60 kilograms and 2.40 kilograms, and the length of the wire is 1.20 meters. Find the velocity (magnitude and direction) of the ball (a) just before the collision, and (b) just after the collision.
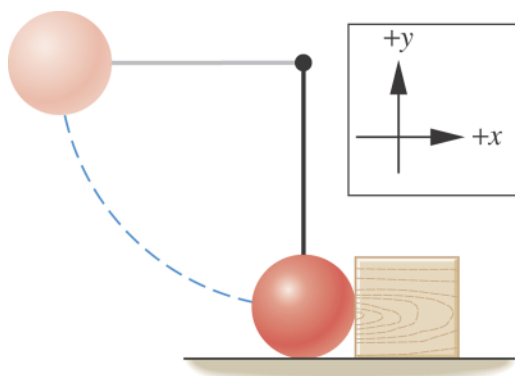

Figure 2: Problem 7.38

9. An automobile has a mass of 2100 kilograms and a velocity of 17 m/s. It makes a rear-end collision with a stationary car whose mass is 1900 kilograms. The cars lock bumpers and skid off together with the wheels locked. (a) What is the velocity of the two cars just after the collision? (b) Find the impulse (magnitude and direction) that acts on the skidding cars from just after the collision until they come to a halt (c) If the coefficient of kinetic friction between the wheels of the cars and the pavement is 0.68, determine how far the cars skid before coming to rest.

(a) 8.93 m/s
(b) -35700 kg-m/s
(c) 5.98 meters

10. Two balls are approaching each other head-on. Their velocities are +9.70 and -11.8 m/s. Determine the velocity of the center of mass of the two balls (a) if they have the same mass and (b) if the mass of the first ball is twice the mass of the second.

(a) -1.05 m/s
(b) +2.53 m/s

11. A 62.0-kilogram person, standing on a diving board, dives straight down into the water. Just before striking the water, her speed is 5.50 m/s. At a time of 1.65 seconds after she enters the water, her speed is reduced to 1.10 m/s. What is the net average force (magnitude and direction) that acts on her when she is in the water?

165 newtons, pointing up

12. The lead female character in the movie src{Diamonds Are Forever} is standing at the edge of an offshore oil rig. As she fires a gun, she is driven back over the edge and into the sea. Suppose the mass of a bullet is 0.010 kg and its velocity is 720 m/s. Her mass (including the gun) is 51 kg. (a) What recoil velocity does she acquire in response to a single shot from a stationary position, assuming that no external force keeps her in place? (b) Under the same assumption, what would be her recoil velocity if, instead, she shoots a blank cartridge that ejects a mass of 5.0×10^{-4} at a velocity of 720 m/s?

(a) -0.14 m/s
(b) -7.1×10^{-3} m/s

13. Two balls are approaching each other head-on. The first has a mass of 1.0 kilograms and is moving to the right with a velocity of +2.0 m/s. The second has a mass of 4.0 kilograms and is moving the left with a velocity of -8.0 m/s. Their collision is perfectly elastic. What is the rebound speed of the first ball?

-14 m/s

14. A 2.0-kilogram block of wood rests on a tabletop. A 7.0-gram bullet is shot straight up through a hole in the table beneath the block. The bullet lodges in the block, and the block flies 0.25 meters above the tabletop. How fast was the bullet going initially?

630 m/s

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