24. The velocity of a body of mass m changes by an amount Δv in a time Δt. The impulse given to the body is equal to
A. $m\Delta t$. B. $\Delta v/\Delta t$. C. $m(\Delta v/\Delta t)$. D. $m\Delta v$.

25. What is the average momentum of a 50-kg runner who covers 400 m in 50 s?

26. A 10-kg bowling ball moving at 4.0 m/s bounces off a spring at about the same speed that it had before bouncing. What is the change in momentum of the bowling ball?

27. A 10-kg cement block moving horizontally at 2.0 m/s plows into a pillow and comes to a stop in 0.5 s. What is the average impact force on the pillow?

28. If 270 million people in the United States jumped up in the air simultaneously, pushing off Earth with an average force of 800. N each for a time of 0.10 s, what would happen to the 5.98 X 10^{24} kg Earth? What would be its change in speed?Show a calculation that justifies your answer.

1.E 2. E 3. 97.0 kg • m/s 4. C 5. E 6. E 7. 10 N s 8. C
9. 98 N 10. 15 N 11. 170 N 12. B 13. 3.0 x 10^{1} m/s to the west 14. C 15. –1.8 kg m/s
16. –2.6 kg m/s 17. 20 kg m/s 18. –1.20 kg m/s
19. 18.1 kg m/s 20. 714 kN 21. *$\Delta t = \Delta d/v = = (0.0020\ m)/(10.0\ m/s)\ 2.0\ X\ 10^{-4}\ s$* *$F\ \Delta t = m\ \Delta v$* *$F = m\ \Delta v/\Delta t = 1200\ N$*
22. 20 N 23. D 24. D 25. 400 kg m/s 26. 80 kg m/s 27. 40 N
28. *$F\ \Delta t = m\ \Delta v$,* *$\Delta v = F\ \Delta t/ m = (270\ x\ 10^{6})(800.\ N)(0.10\ s)/(5.98\ X10^{24}\ kg) = 3.6\ X\ 10^{-15}\ m/s$*
Therefore, Earth's motion would not be measurable.

HON: HOMEWORK - CONSERVATION OF MOMENTUM

1. A swimmer with a mass of 75 kg dives off a raft with a mass of 500 kg. If the swimmer's speed is 4 m/s immediately after leaving the raft, what is the speed of the raft?

2. An astronaut with a mass of 70.0 kg is outside a space capsule when the tether line breaks. To return to the capsule, the astronaut throws a 2.0 kg wrench away from the capsule at a speed of 14 m/s. At what speed does the astronaut move toward the capsule?

3. A bullet with a mass of 5.00×10^{-3} kg is loaded into a gun. The loaded gun has a mass of 0.52 kg. The bullet is fired, causing the empty gun to recoil at a speed of 2.1 m/s. What is the speed of the bullet?

4. Two carts with masses of 1.5 kg and 0.7 kg, respectively, are held together by a compressed spring. When released, the 1.5 kg cart moves to the left with a velocity of 7 m/s. What is the velocity of the 0.7 kg cart? (Disregard the mass of the spring.)

5. A bowling ball with a mass of 7.0 kg strikes a pin that has a mass of 2.0 kg. The pin flies forward with a velocity of 6.0 m/s, and the ball continues forward at 4.0 m/s. What was the original velocity of the ball?

6. A clay ball with a mass of 0.35 kg strikes another 0.35 kg clay ball at rest, and the two balls stick together. The final velocity of the balls is 2.1 m/s north. What was the first ball's initial velocity?

7. An object of mass 3m, initially at rest, explodes breaking into two fragments of mass m and 2m, respectively. Which one of the following statements concerning the fragments after the explosion is true?

a. They may fly off at right angles.
b. They may fly off in the same direction.
c. The smaller fragment will have twice the speed of the larger fragment.
d. The larger fragment will have twice the speed of the smaller fragment.
e. The smaller fragment will have four times the speed of the larger fragment.

8. An 80-kg astronaut carrying a 20-kg tool kit is initially drifting toward a stationary space shuttle at a speed of 2 m/s. If she throws the tool kit toward the shuttle with a speed of 6 m/s as seen from the shuttle, her final speed is

9. A 58.5-kg astronaut is floating toward the front of her stationary ship at 0.15 m/s, relative to the ship. She wishes to stop moving, relative to the ship. She decides to throw away the 2.50-kg book she's carrying. What should the speed and direction of the book be to achieve her goal?

10. A 3.0-kg cart moving to the right with a speed of 1.0 m/s has a head-on collision with a 5.0-kg cart that is initially moving to the left with a speed of 2 m/s. After the collision, the 3.0-kg cart is moving to the left with a speed of 1 m/s. What is the final velocity of the 5.0-kg cart?

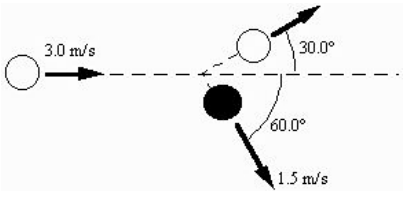
11. A 1000-kg car traveling east at 20 m/s collides with a 1500-kg car traveling west at 10 m/s. The cars stick together after the collision. What is their common velocity after the collision?

12. A 75-kg man is riding in a 30-kg cart at 2.0 m/s. He jumps off in such a way as to land on the ground with no horizontal velocity. The resulting change in speed of the cart is:

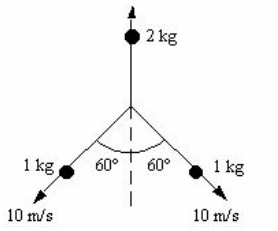
13. A 7.30-kg bowling ball strikes a 1.60-kg pin at rest head-on. Before the collision, the velocity of the ball is +6.00 m/s. After the collision, the velocity of the ball is +5.40 m/s. What is the velocity of the pin after the collision?

14. A 0.50-kg bomb is sliding along an icy pond (frictionless surface) with a velocity of 2.0 m/s to the west. The bomb explodes into two pieces. After the explosion, a 0.20-kg piece moves south at 4.0 m/s. What are the components of the velocity of the 0.30-kg piece?

15. In the game of billiards, all the balls have approximately the same mass, about 0.17 kg. In the figure, the cue ball strikes another ball such that it follows the path shown. The other ball has a speed of 1.5 m/s immediately after the collision. What is the speed of the cue ball after the collision?



16. A stationary 4-kg shell explodes into three pieces. Two of the fragments have a mass of 1 kg each and move along the paths shown with a speed of 10 m/s. The third fragment moves upward as shown.



What is the speed of the third fragment?

17. If all people, animals, trains and trucks all over the world began to walk or run towards the east, then
a. the earth would spin a bit faster.
b. the earth would spin a bit slower.
c. the earth's spin would not be affected at all.

18. Suppose an astronaut in outer space wishes to play a solitary "throw, bounce, and catch" game by tossing a ball against a very massive and perfectly elastic concrete wall. If the ball is as massive as the astronaut, then
a. the astronaut will catch one bounce only.
b. the astronaut will never catch the first bounce.
c. the astronaut's time between catches will decrease as the game progresses.
d. none of the above

19. On a pool table, a moving cue ball collides with the eight ball, which is at rest. Is it possible for both balls to be at rest after the collision? Use the law of conservation of momentum to explain your reasoning.

1. 0.6 m/s 2. 0.4 m/s 3. 220 m/s 4. 15 m/s to the right 5. 5.7 m/s
6. 4.2 m/s to the north 7. C 8. 1 m/s toward the shuttle 9. 3.7 m/s, toward the front of the ship
10. 0.8 m/s to the left 11. 2 m/s, east 12. 5.0 m/s 13. +2.7 m/s 14. 2.7 m/s north, 3.3 m/s west
15. 2.4 m/s 16. 5 m/s 17. B 18. B

19. No, the final momentum can equal zero only if the initial momentum was zero. Because the cue ball was moving, its initial momentum was not zero. Therefore, both balls cannot be at rest after the collision.