More Practice Problems for Momentum Quest 5 (80 pt test)

1. Suppose that your mass is 80 kg. How fast would you have to run to have the same momentum as a 1600 kg car slowly rolling forward at 1.2 m/s?
2. A 2100 kg truck traveling north at 16 m/s turns east and accelerates to 19 m/s. a) What is the magnitude and direction of the change in momentum? b) What is the change in the kinetic energy of the truck?
3. A cue stick strikes a stationary pool ball, exerting an average force of 52 N over a time of 11 ms. If the ball has a mass of 0.20 kg, what speed does it have after the impact?
4. In an air hockey game a 0.250 kg puck with a speed of 6.0 m/s strikes a wall at an angle of 30° to the wall and rebounds with the same speed and angle to the wall. It is in contact with the wall for 8.3 ms. a) What is the impulse on the puck? b) What is the average force exerted by the puck on the wall?
5. A 2140 kg railroad flatcar, which can move with negligible friction, is at rest next to a platform. A 242 kg sumo wrestler runs at 5.3 m/s along the platform (parallel to the track) and then jumps onto the flatcar. What is the speed of the flatcar if he then a) stands on it, b) continues running at 5.3 m/s relative to the flatcar in his original direction, c) or turns and runs at 5.3 m/s relative to the flatcar opposite to his original direction?

(Hint: There’s a little formula you can use to determine different velocities in different frames of reference: VAC = VAB + VBC Read this as “the velocity of object A relative to object C is equal to the velocity of object A relative to object B plus the velocity of object B relative to object C. “

Here: “the velocity of the sumo relative to the ground is equal to the velocity of the sumo relative to the flatcar + the velocity of the flatcar relative to the ground.” What we care about in our formula is the velocity of objects relative to the same frame of reference…the ground.)

1. An alpha particle (mass 4 u) experiences an elastic head-on collision with a gold nucleus (mass 197 u) that is originally at rest. What percentage of its original kinetic energy does the alpha particle lose?
2. A bullet of mass 4.5 g is fired horizontally into a 2.4 kg wooden block at rest on a horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.20. The bullet comes to rest in the block, which moves 1.8 m. a) What is the speed of the block immediately after the bullet comes to rest within it? b) What is the speed of the bullet fired?
3. An unstable nucleus spontaneously decays emitting two particles, one with a mass of 16.7 x 10-27  kg moving at 6.00 x 106 m/s perpendicular to a second one with a mass of 8.35 x 10-27  kg moving at 8.00 x 106 m/s. What is the magnitude and direction of the daughter nucleus, which has a mass of 11.7 x 10-27 kg?
4. A billiard ball moving at a speed of 2.2 m/s strikes an identical stationary ball at a glancing blow. After the collision, one ball is found to be moving at a speed of 1.1 m/s in a direction making a 60° angle with the original line of motion. a) Find the velocity of the other ball. b) Determine if this collision is elastic or inelastic.

Answers

1. 24 m/s
2. a) 52000 kgm/s at -40° (Remember momentum is a vector so you need to work in 2D and find the change – final minus initial- in the x direction and the change in the y direction. Then use those components to change back into magnitude and direction) b) 110 kJ
3. 2.86 m/s
4. a) 1.5 kgm/s at 90° b) 180 N
5. a) 0.538 m/s b) 0 m/s c) 1.08 m/s (twice of part a)
6. 7.8% (trust me, the velocities all cancel out in the end)
7. a) 2.66 m/s b) 1420 m/s
8. 1.03 x 107 m/s at 236° (For the direction, your answer may vary some depending on how you drew you picture. As long as your direction is 124° away from the direction of the smaller particle and 146° from the direction of the larger particle, you’re still correct.)
9. a) 1.9 m/s b) Elastic. (There’s two reasons why.)