

- 710 N 1. A 140 gm baseball travelling initially at 30 m/sec is hit by a bat and leaves travelling at 36 m/sec in the opposite direction. If it was in contact with the bat for .013 sec, what average force did the bat exert on the ball?
- 3.7 m/sec 2. A 450 kg cannon fires a 4.3 kg ball at a velocity of 390 m/sec. What is the recoil velocity of the cannon?
- 1.4 m/sec 3. A 40,000 kg railroad car at 3.1 m/sec collides with a second car of mass 50,000 kg that is initially at rest on the same track. The two cars couple together. What is their speed after the collision?
- 1.7 m/sec 4. A 42,000 kg railroad car moving at 2.8 m/sec collides with a second car of mass 60,000 kg that is moving at .9 m/sec in the opposite direction on the same track. The two cars couple together. What is their speed after they collide?
- Honors only 5. A ball of mass M travelling at 10 m/sec makes a head on, elastic collision with a second ball of mass SKIP 2M that is initially at rest. After the collision, the first ball (of mass M) will have a velocity of what?
- Honors only 6. A ball of mass M travelling at 10 m/sec makes head on collision with a second ball of mass 2M that is initially at rest. After the collision, the first ball recoils at a velocity of -1.4 m/sec. What is the 5.7 m/sec velocity of the second ball after the collision?
- Honors only 7. Two cars collide at an intersection. Car of mass 1400 kg is travelling north at 17.5 m/sec while car 9.351 $\hat{x}$ -6.985 $\hat{y}$  m/sec, 11.672 m/sec, 140 deg 2 of mass 1220 kg is travelling west at 15 m/sec. After the collision, they stick together and move as one mass. What is their velocity (hat notation and magnitude) after the collision? In what direction do they slide?
- Honors only 8. Two balls are rolling towards each other, the first with a velocity of 5.1 m/sec, the second with a 5:3 velocity of -2.8 m/sec. After the collision they are both travelling in the same direction, the first with a velocity of 2.1 m/sec and the second with a velocity of 2.2 m/sec. What is the ratio of the mass of the first ball to the second?
- 8.4 m/sec 9. A 20 kg child is riding on a 8 kg bicycle going 3.9 m/sec north. Seeing that she is about to crash jumps off the bicycle lands on the ground still moving at 2.1 m/sec north. How fast is the bicycle now travelling?
- Honors only 10. A 1296 kg car moving north at 26.6 m/sec collides with a 2126 kg car moving east at 17.6 m/sec. They 14.868 m/sec, 42.6 deg stick together. In what direction and at what speed do they move after the collision?
- 5.6 m/sec 11. A mass of 100 grams with a speed of 5040 cm/sec strikes a mass of 800 grams initially at rest. If the two masses remain in contact after the collision, find their common speed.
- 133 m/sec 12. A man weighing 500 N jumps out of a stationary canoe with a forward speed of 80 m/sec. If the canoe weighs 300 N, find the canoe's backward speed.
- 1.5 m/sec 13. In a freight yard, a train is being made up. An empty freight car, coasting at 10 m/sec, strikes a loaded car that is stationary, and the two cars couple together. Each of the cars has a mass of 3000 kg when empty, and the loaded car contains 14,000 kg of bottled soft drinks. With what speed does the combined mass start to move?
- 1 m/sec 14. A 80 kg fullback is moving at a speed of 6 m/sec; he is tackled head on by a 100 kg linebacker who is approaching him at 3 m/sec. With what speed and in what direction do the pair of players move after the tackle?
- 1.193 m/sec, 1.7 m 15. A 5 kg duck sitting on a pole 10 m tall is struck by a 30 gram bullet that is moving horizontally at 200 m/sec. The bullet embeds in the bird. A) What horizontal velocity does the bird acquire? B) How far from the base of the pole does the bird land?
- Honors only 16. A life raft of mass 200 kg carries two swimmers of mass 50 kg and 80 kg respectively. The raft is initially .6 m/sec in direction of 50 kg at rest; then the two swimmers jump off in opposite directions, each with a velocity of 4 m/sec. With what speed and in what direction does the raft move?
- 7 m/sec 17. A ball of mass 3 kg moving at 8 m/sec westward overtakes and collides with a ball of mass 1 kg moving at 4 m/sec westward. The balls stick together after impact. Calculate the magnitude and direction of the velocity after impact.

- 2 m/sec 18. A ball of mass 3 kg moving at 2 m/sec eastward strikes a ball of mass 1 kg moving at 2 m/sec eastward. The balls stick together after impact. Calculate the magnitude and direction of the velocity after impact.
- $6.1 \times 10^3$  m/sec 19. A space vehicle is travelling at 4300 km/hr relative to the Earth when the exhausted rocket motor is disengaged and sent backward with a speed of 82 km/hr relative to Earth. The mass of the motor is 4 times the mass of the module. What is the speed of the module relative to earth after separation?
- 5.1 m/sec 20. A 75 kg man is riding on a 39 kg cart travelling at a speed of 2.3 m/sec. He jumps off with zero horizontal speed. What is the speed of the cart after the jumps off?
- Honors only ? 21. A radioactive nucleus, initially at rest, decays by emitting an electron and a neutrino perpendicular to each other. (A neutrino is one of the fundamental particles of physics) The linear momentum of the electron is  $1.2 \times 10^{-22}$  kg m/sec and that of the neutrino is  $6.4 \times 10^{-23}$  kg m/sec. Find the direction of the magnitude of the linear momentum of the nucleus as it recoils.
- Honors only ? 22. A 4 kg mass sliding on a frictionless plane explodes into two 2 kg masses. After the explosion the velocities of the 2 kg masses are 3 m/sec due south and 5 m/sec due east. What was the original speed of the 4 kg mass?
- ? 23. A 2140 kg railroad flatcar, which can move with negligible friction, is motionless next to a platform. A 242 kg sumo wrestler runs at 5.3 m/sec along the platform (parallel to the track) and then jumps on the flat car. What is the speed of the flatcar and wrestler?
- ? 24. A rocket sled with a mass of 2900 kg moves at a speed of 250 m/sec on a set of rails. At a certain point, a scoop on the sled dips into a trough of water located between the tracks and scoops water into an empty sled. By applying the conservation of momentum, determine the speed of the sled after 920 kg of water have been scooped out.
- 10 m/sec 25. A man weighing 50 N and a boy weighing 25 N push against each other while they are on ice skates standing on a frozen pond. The man moves away with a speed of 5 m/sec. What is the speed of the boy?
- Honors only 3v 26. A railroad car of mass  $M$  moving at a speed of 3 m/sec collides with and couples to another car of mass  $2M$  at rest. The speed of both cars after impact was  $v$ , what was the speed of the first car before impact?
- Honors only ? 27. You are on an iceboat on frictionless, flat ice. you and the boat have a combined mass of  $M$ . Along with are two stones, with mass  $m_1$  and  $m_2$  such that  $M = 6m_1 + 12m_2$ . To get the boat moving, you throw the rocks rearward, either in succession or together, but in each case with a certain speed  $v_{\text{rel}}$  relative to the boat. What is the resulting speed of the boat if you throw A) the stones together? B) first  $m_1$  then  $m_2$ ? and C) first  $m_2$  then  $m_1$ ?