PHYS:1200 Physics of Everyday Experience

Review questions and exercises for Lecture 8 (M-7)

1. Two objects A and B have the same mass m. Object A moving with velocity v_0 collides with object B which is initially at rest. After the collision, object A is at rest and object B moves off with velocity v_0. Explain this collision using the law of conservation of momentum.
2. Does the kinetic energy of an object depend on which direction it is moving?
3. What is the difference between an elastic, inelastic, and completely inelastic collision?
4. Object A has a mass of 2 kg and moves with a velocity of 15 m/s. It collides with object B which has a mass of 4 kg and sticks to it. What is the speed of the combination after the collision?
5. In a class demonstration a tennis ball on top of a basketball are dropped. When the basketball hits the ground, the tennis ball strongly rebounds upward. Why?
6. When you fire a rifle you experience a "kickback" or recoil. Explain this in terms of conservation of momentum.
7. Explain the motion of a rocket engine in terms of conservation of momentum.
8. What is the definition of WORK? In what units is it measured?
9. You lift a heavy weight over your head and hold it there. When are you doing work?
10. You carry a 200 N weight over a distance of 7 m. How much work do you do?
11. A force F = 100 N is used to move a crate a distance of 5 m. How much work is done by F?
12. What is the physics definition of a machine?

Answers: (Try to do the problems before looking at the solutions.)

1. Before the collision the total momentum of the system (objects A and B) is mv_0, after the collision the total momentum of the system is mv_0 → momentum is conserved.

2. $K = ½ mv^2$, since K depends of the square of the velocity, the direction is irrelevant. K is what we call a scalar quantity.

3. In an elastic collision, the total kinetic energy of the objects before and after the collision is the same. In an inelastic collision the kinetic energy is not the same, it is usually less after the collision. In a totally inelastic collision, the objects stick together after they collide. In a totally inelastic collision, the loss of kinetic energy is as large as possible.\

4. Apply conservation of momentum:

   total momentum before collision = total momentum after collision

   $$(2\,kg)(15\,m/s) = (2\,kg + 4\,kg)v_f$$
   $$30\,kg\,m/s = 6v_f \rightarrow v_f = 30/6 = 5\ m/s.$$

   The speed of the objects after they stick together is less that the initial speed because the combined mass is larger.

5. The tennis ball gets a big "kick" because its mass is much less than the mass of the basketball.

6. Before the rifle is fired both it and the bullet are stationary, so the initial momentum of the system (rifle and bullet) is zero. Conservation of momentum then requires that the system momentum must remain zero after the rifle is fired. Since the bullet moves in one direction (away from the rifle) the rifle gets a kick in the opposite direction in order to conserve momentum.

7. When the hot gases are ejected from the rocket engine, the rocket gets a kick in the opposite direction which propels it. Rocket science is really very simple!

8. In physics work is done when a force is applied to an object to move it through a certain distance. The work is the force x the distance. Units Work in Joules (J), Force in Newtons, and distance in meters. One Joule (J) is one N x 1 m.

9. Work is done while you are lifting the weight. No work is done when you just hold it over your head.

10. No work is done because the motion and the force are not in the same direction.

11. W = F d = 100 N x 5 m = 500 N m = 500 J.

12. A machine is any device that allows us to accomplish a task more easily