**1.** A young girl slides down a rope. As she slides faster and faster she tightens her grip, increasing the force exerted on her by the rope. What happens when this force is equal in magnitude to her weight? Explain.

**2.** A drag-racing car accelerates forward because of the force exerted on it by the road. Why, then, does it need an engine? Explain.

**3.** An astronaut on a space walk discovers that his jet pack no longer works, leaving him stranded 50 m from the spacecraft. If the jet pack is removable, explain how the astronaut can still use it to return to the ship.

**4.** Two untethered astronauts on a space walk decide to take a break and play catch with a baseball. Describe what happens as the game of catch progresses.

**5.** Wilbur asks Mr. Ed, the talking horse, to pull a cart. Mr. Ed replies that he would like to, but the laws of nature just won’t allow it. According to Newton’s third law, he says, if he pulls on the wagon it pulls back on him with an equal force. Clearly, then, the net force is zero and the wagon will stay put. How should Wilbur answer the clever horse?

**6.** A whole brick has more mass than half a brick, thus the whole brick is harder to accelerate. Why doesn’t a whole brick fall more slowly than half a brick? Explain.

**7.** The force exerted by gravity on a whole brick is greater than the force exerted by gravity on half a brick. Why, then, doesn’t a whole brick fall faster than half a brick? Explain.

**8.** Is it possible for an object at rest to have only a single force acting on it? If your answer is yes, provide an example. If your answer is no, explain why not.

**9.** Is it possible for an object to be in motion and yet have zero net force acting on it? Explain.

**10.** Suppose you jump from the cliffs of Acapulco and perform a perfect swan dive. As you fall, you exert an upward force on the Earth equal in magnitude to the downward force the Earth exerts on you. Why, then, does it seem that you are the one doing all the accelerating? Since the forces are the same, why aren’t the accelerations?

**11.** A friend tells you that since his car is at rest, there are no forces acting on it. How would you reply?

**12.** If you step off a high board and drop to the water below, you plunge into the water without injury. On the other hand, if you were to drop the same distance onto solid ground, you might break a leg. Use Newton’s laws to explain the difference.

**13.** Is it possible for an object to be moving in one direction while the net force acting on it is in another direction? If your answer is yes, provide an example. If your answer is no, explain why not.

**14.** Since a bucket of water is “weightless” in space, would it hurt to kick the bucket? Explain.

**15.** A small car collides with a large truck. **(a)** Is the force experienced by the car greater than, less than, or equal to the force experienced by the truck? Explain. **(b)** Is the acceleration experienced by the car greater than, less than, or equal to the acceleration experienced by the truck? Explain.

**P1.** • Two crewmen pull a raft through a canal. One crewman pulls with a force of 130 N at an angle of 34° relative to the forward direction of the raft. The second crewman, on the opposite side of the canal, pulls at an angle of 45°. With what force should the second crewman pull so that the net force of the two crewmen is in the forward direction?

**P2.** •• To give a 19-kg child a ride, two teenagers pull on a 3.7-kg sled with ropes. Both teenagers pull with a force of 55 N at an angle of 35° relative to the forward direction, which is the direction of motion. In addition, the snow exerts a retarding force on the sled that points opposite to the direction of motion, and has a magnitude of 57 N. Find the acceleration of the sled and child.

P3. A generic man pushes a 20 kg generic lawn mower at an angle of 55 degrees relative to the horizontal with a force of 100 N. The man starts the lawn mower from rest at and gets it up to a horizontal speed of 1 m/s, in 2 sec. First, find the acceleration on the lawn mower. Second, find the normal force on the lawn mower from the ground. Third, find the net force. Fourth, find the kinetic friction which exists as the man pushes the lawn mower.

P4. Ryan pulls a wagon loaded with a case of turnip greens along a sidewalk. The wagon and greens have a mass of 20 kg total. Ryan pulls the wagon with a force of 100 N at an angle that is 25 degrees relative to the horizontal. The coefficient between the wagon’s wheels and the sidewalk is 0.15.

a) What is the normal force between the wagon and sidewalk?

b) What frictional force impedes Ryan’s motion?

c) What is the net Force on the wagon in the x direction?

d) Consequently, what is the wagon’s acceleration?

e) How long did the acceleration last (in seconds) if the wagon achieves a phenomenal 10 m/s (vf) (vi = 0 m/s) during the motion?

P5. A sports car has a mass of 1254 kg. Starting from rest, the car generates a horizontal force of 4400 N. The frictional force opposing this motion is 280 N. a) If the car moves along a horizontal road, what acceleration is produced? b) If the car produces this acceleration for 9 seconds, how far did it travel?

P6. You push a 12 kg crate across the floor at a constant velocity. Using a force detector, you notice the force needed to push the crate against friction is 30 N.

What is the coefficient of kinetic friction between the crate and the floor?

P7. My 25 kg chair, initially at rest on a horizontal floor, requires a 365 N horizontal force to set it into motion. Once the chair is in motion, a 327 N horizontal force keeps it moving at constant velocity. Find the coefficients of static and kinetic friction between the chair and the floor.