Chapter 5
Exercises

7. (a) Action; bat hits ball. Reaction; ball hits bat. (b) While in flight there are two interactions, one with the Earth's gravity and the other with the air. (1) Action; Earth pulls down on ball (weight). Reaction; ball pulls up on Earth. (2) And, action; air pushes ball, and reaction, ball pushes air.

15. The forces must be equal and opposite because they are the only forces acting on the person, who obviously is not accelerating. Note that the pair of forces do *not* comprise an action-reaction pair, however, for they act on the *same* body. The downward force, the man's weight, *Earth pulls down on man*; has the reaction *man pulls up on Earth*, not the floor pushing up on him. And the upward force of the floor on the man has the reaction of man against the floor, not the interaction between the man and Earth. (If you find this confusing, you may take solace in the fact that Newton himself had trouble applying his 3rd law to certain situations. Apply the rule, A on B reacts to B on A, as in Figure 5.5.)

20. The forces do not cancel because they act on different things – one acts on the horse, and the other acts on the wagon. It's true that the wagon pulls back on the horse, and this prevents the horse from running as fast as it could without the attached wagon. But the force acting on the wagon (the pull by the horse minus friction) divided by the mass of the wagon, produces the acceleration of the wagon. To accelerate, the horse must push against the ground with more force than it exerts on the wagon and the wagon exerts on it. So tell the horse to push backward on the ground.

25. Both will move. Ken's pull on the rope is transmitted to Joanne, causing her to accelerate toward him. By Newton's third law, the rope pulls back on Ken, causing him to accelerate toward Joanne.

30. The writer apparently didn't know that the reaction to exhaust gases does not depend on a medium for the gases. A gun, for example, will kick if fired in a vacuum. In fact, in a vacuum there is no air drag and a bullet or rocket operates even better.

37. The tension indeed changes, and more than the weight of the bird depending on the amount of sag. To exaggerate, if the wire drooped so as to be almost vertical, the added tension would be almost half the bird's weight. If the wires make an angle of 30° with the horizontal, the added tension would equal the bird's weight. Angles less than 30° produce added tension greater than the bird's weight. If this is hard to visualize, you might justify it in your mind by imagining tightening up the clothesline, that is increasing the tension, to reduce the sag.

42. The other interaction is between the stone and the ground on which it rests. The stone pushes down on the ground surface, say action, and the reaction is the ground pushing up on the stone. This upward force on the stone is called the *normal force*.

Problems

1. $F = ma = m\Delta v/\Delta t$ = (0.003 kg)(25 m/s)/(0.05 s) = **1.5 N**, which is about 1/3 pound.

2. The wall pushes on you with 40 N. $a = F/m$ = 40 N/80 kg = **0.5 m/s²**.

4. $a = F/m$, where $F = \sqrt{[(3.0\text{ N})^2 + (4.0\text{ N})^2]}$ = 5 N. So a = F/m = 5 N/2.0 kg = **2.5 m/s²**.

6. (a) $V = \sqrt{[(3.0\text{ km/h})^2 + (4.0\text{ km/h})^2]}$ = **5 km/h**. (b) To reach a destination directly across the river, paddle upstream at an angle that is more than 45 degrees to the straight-across direction. The resultant velocity will be less than 4 km/h. (Exact calculation shows that the angle should be abut 49 degrees to the straight-across direction (41 degrees to the shore), giving a resultant velocity of 2.6 km/h across the river.)