Newton's 3rd Law
ACTION-REACTION FORCES

1. According to Newton's third law, each team in a tug of war pulls with equal force on the other team. What, then, determines which team will win?

2. According to Newton's third law, every force is accompanied by an equal and opposite *reaction* force. The reason that these forces do not cancel each other is ____.

a. the action force acts for a longer time period

b. the two forces are not always in the same direction

c. one of the two forces is greater than the other

d. the two forces act upon different objects; only forces on the same object can balance each other.

e. ... nonsense! They do cancel each other. Objects accelerate because of the 3 of a third force.

3. When a rifle shoots a bullet, Newton's Third Law says that the force that the rifle exerts on the bullet is exactly the same size as the force that the bullet exerts on the rifle - yet the bullet gets a **much** greater acceleration than the rifle. How can this be?

4. Tam Anh grabs Sarah by the hand and tries to pull her. She tries to remain standing without moving. A student analyzes the situation as follows. "If Tam Anh's force on Sarah is greater than her force on him, he can get her to move. Otherwise, she'll be able to stay where she is." What's wrong with this analysis?

5. When jumping from a boat to shore, it is always advisable to tie up the boat before jumping. Why?

6. When a small bug is splattered across a fast moving windshield what experiences more force- the bug or the windshield?

7. Why does the force have a greater effect on the bug?

8. If we find a body that we know to be acted on by a force, but that is not moving, what inference can we draw about its state of motion?

9. In a tug-of-war, what is the net force acting on the rope when the participants each pull with opposing forces of 500 N? _____ What is the tensional force within the rope? _____

10. Why can you exert greater force on the pedals of a bicycle if you pull up on the handlebars?

Worksheet 3 Newton's 3rd Law **Answer Key: ACTION-REACTION FORCES**

1. Answer: Since the tension in the rope is equal for both teams, its the force of friction on their feet that wins the tug of war. For the team that pushes forward on the ground with the largest force, the ground pushes back and moves them away from their starting point in the right direction and moves the other team towards the center line.

2. Answer: D: Action and reaction forces always act upon the interacting objects for the same amount of time with the same magnitude. So if object A pushes on object B, then object B simultaneously pushes on object A with the same amount of force. The force on object B will be one of perhaps many forces which will govern is motion. But the reaction force is on object A and cannot contribute to object B's motion since it is not acting upon object B. Action-reaction forces can NEVER cancel each other.

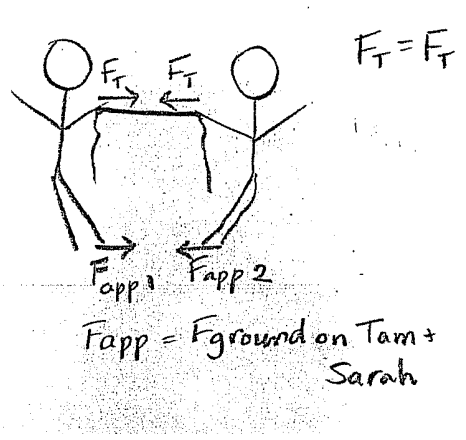
3. Answer: It is absolutely true that the forces on the rifle and on the bullet are exactly the same size. However, don't forget that Newton's Second Law says that **two factors** affect the acceleration of an object - the net force on it and its mass (inertia).

The acceleration of the bullet equals the force that the rifle exerts on it divided by the mass of the bullet.

The two forces are equal, but since the mass of the rifle is much greater than the mass of the bullet, the acceleration of the rifle is much less than the bullet's acceleration.

4. Answer: Newton's Third Law really does say that if A pulls B, then B pulls A with an equal and opposite force. However, **these forces DO NOT CANCEL because they influence the motion of different objects**. The force that A exerts on B influences B's motion, and the force that B exerts on A influences A's motion. The force on B can cancel with other forces on B - but **NOT** with forces on A(and vice versa). In fact, it's the force that the ground exerts on Tam's feet that would push her and thereby pull Sarah in Tam's direction of intended movement. However, if the force that the ground exerts on Sarah's feet is greater than the force exerted on Tam's feet then Tam will be pulled in Sarah's direction. If they both have equal force exerted on their feet by the ground, they will remain stationary, no matter who is pulling on the other's hand with greater force

See Diagram:



5. Answer: If you don't, as your legs accelerate your body towards shore, they apply an equal and opposite force to the boat, pushing it away.

6. Answer: They both experience the same force as indicated by Newton's Third Law: **For every action, there is an equal and opposite reaction.**

7. Answer: Since the bug is so small, the force it exerts on the bus as it accelerates to a stop is very small. Since the bus is so large, it barely notices this force, and has a infinitely small acceleration (deceleration) due to the force of the bug. But we all no what happens to the bug (squash) as it decelerates quickly to a stop as the bus plows forward.

8. Answer: More than one force is acting on the body and these forces are balanced and therefore $F_{net} = 0$.

9. Answer: The $F_{net} = 0$, because two equal and opposite forces are applied to the rope. They sum to 0. Since the rope isn't accelerating, the net force on the rope is zero.
The tension in the rope is 500 N, not 1000 N. If something is pulling on an unmoving rope with a force of 500 N, the tension is 500 N regardless of what applies the opposing force.

10. Answer: When you pull up on the handle bars, the handle bars pull down on you causing you to push down with a greater force on the pedals of the bicycle.