

## Newton's 3<sup>rd</sup> Law

### Pre-Test

1. Does a stick of dynamite contain any force? Explain your reasoning.
2. A truck is traveling down the road, in terms of forces, what is the force that is moving the car down the road? Explain your reasoning.
3. We know that the Earth pulls on the moon. That is why it travels around us. Does the moon also pull on the Earth? If so, which pull is stronger? Explain your reasoning.
4. Is Newton's Third Law violated for the following situation: your friend says that there is no way you can kick a soccer ball and get it to move, because the reaction force by the kicked ball is equal and opposite to the force you provide by kicking the soccer ball. Hence the soccer ball will not move. The net force would be zero! Explain your reasoning.
5. You blast off in a spaceship set to travel through space our closest star Alpha Centauri. The ship is controlled remotely by commanders on Earth. The commanders mistakenly drop you (only you, nothing else!) off in the middle of empty space, far from everything. You are left with nothing but yourself and your space suit. Will you ever be able to return to Home on your own? Why?
  - a. No, this is not possible. In order for you to return to Earth, you must accelerate in the direction towards Earth. But to do this, there must arise a force equal in quantity and opposite in direction to propel me in the direction of my destination. As for this case no other paired force exists. In other words, you are stuck in the same place forever.
  - b. No, this is not possible. The force that you exert is not enough to propel you in the direction that you want to go. Thus you are stuck there forever!
  - c. Yes, this is possible. One of Newton's laws says that for an object of mass to be accelerated it must have a nonzero net force. The force I exert (due to my legs, and arms) will be sufficient to propel me in the direction towards Earth.
  - d. Not enough information given.
6. Same situation as above with the exception that upon being ejected out of the spaceship, your leg gets tangled up with the ejector seat and the ejector seat manages to come along for the ride. Do you stand a chance of returning to Home? Why?

- a. No, in fact you will be gravitationally attracted towards that chair and thus never able to return to home.
- b. No, one of Newton's Laws says that if no net forces are acting on an object, it will not be accelerated. The chair cannot exert a force (net force) and thus I will be unable to return home regardless.
- c. Yes this is possible. If I push with my feet on the chair I will be able to exert a force on it, to which the chair can exert a force equal in quantity but opposite in direction. If I push on the ejector seat, away from Earth I will move in the direction of Earth.
- d. Yes this is possible. If I push with my feet on the chair I will be able to exert a force on it, to which the chair can exert a force equal in quantity but opposite in direction. If I push on the ejector seat, towards Earth I will move in the direction of Earth.
- e. None of the responses are correct.

7. Your friend comes to you with his hand in a sling. He says that he couldn't control his temper when he found he failed his exam earlier that day. You asked him why then did he have his hand in a sling. He responds by saying. "Well I was a little mad, but it was the wall that hit me and sprained my hand!" Does his statement have a hint of truth to it?

8. You and your classmates are playing tug-of-war. Five minutes later, no one is anywhere further than where they originally started. In an effort to minimize you and your partners' diminishing strength, you decide to secretly attach a rope to a hook in the ground. You tell all of your partners to "pretend" as if they are pulling. If a spring scale were attached to the middle of the rope, how would the two scale readings differ for both situations? Why?

- a. The scale would read with a much greater force for the first case because you have two forces acting in opposite directions, increasing the spring scale reading.
- b. The scale would read with a much less force for the first case because the two forces are acting in opposite directions. At least in the second case you have the force that your competing partners are exerting to provide a reading for the scale.
- c. The scale would read with a much greater force for the first case because you have only one force acting on the rope in the second scenario, thus only one quantity of force giving a reading on the spring scale.
- d. The scale reading would be the same for both. The force that the hook exerts is the same quantity that your partners exerted in the first scenario.
- e. More than one answer is correct.

9. The Earth exerts a sizable gravitational force on objects located on Earth. The gravitational force is an attractive force that will exert a force proportional to  $1/R^2$  ( $R$  = distance of separation from both objects' center of mass) on any object with mass, from any distance. By how much different is the magnitude (quantity) of force due to

gravitational attraction of the Earth on you in comparison to the gravitational attraction that you exert on the Earth?

- a. The magnitude of the force of attraction for both cases is the same. There is no difference because the force the Earth exerts on you is paired with the force you exert on the Earth. They are equal in magnitude and opposite in direction.
- b. The magnitude of the force of attraction that the Earth exerts is much greater than what you would exert. This is because the Earth is much more massive and as you increase the mass of an object the greater will be its gravitational force.
- c. The magnitude of the force of attraction will be less because as the mass of an object is increased, it will be much harder to accelerate, and thus have a smaller gravitational force of attraction.

**Web Site URL to learn the concepts:**

<http://www.glenbrook.k12.il.us/gbssci/phys/Class/newtlaws/u2l4a.html>

(Access Lesson 4; proceed through “Newton’s Third Law” and “Action and Reaction Force Pairs”.)

### **Post-Test**

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