**SE 3.6A: Push/Pull**
**Concept Page for Teachers**

**Objective: (3.6A) Measure and record changes in the position and direction of the motion of an object to which a force such as a push or pull has been applied.**

**Scientific Question**: What changes occur when force is applied to an object?

**Background Information:** We are all familiar with the concept of motion. Sometimes the terms can be confusing, so we will need to clarify some vocabulary. When an object has a change in position relative to its surroundings, that can be called its speed. A velocity of an object is just the speed of that object in a certain direction. Acceleration is defined to be a change in speed, or a change in velocity. A positive acceleration means something is getting faster. A negative acceleration is when something is slowing down.

Since force is defined as mass (weight) times acceleration, then any time a force is exerted on an object, it is changing its acceleration. The object might be speeding up, or the object might be slowing down. Additionally, an object traveling in a curve can be going the same speed yet accelerating because it is changing direction.

This particular learning objective will be describing how we apply a force when we change the position and direction of an object. We will be using terms such as push and pull. When something is pushed, that is acceleration in one direction. In general a pull is acceleration in another direction, since a push is generally away from a person, and a pull is generally toward a person.

**Points to clarify with students:** Pushing and pulling are examples of applying force. Acceleration is change in speed or velocity. Acceleration can be positive or negative. Mass is a physical measure of the amount of substance of an object. The heavier the mass, the greater the force needed to move an object.

**Vocabulary: mass, friction, force, push, pull, motion**

- **mass –** a physical measure of the amount of substance
- **friction –** resistance to a motion
- **force –** an influence that causes an object to change its acceleration
- **push –** to apply a force in a way that causes the object to move away from the force
- **pull –** to apply force in a way that causes the object to move toward the force
- **motion** - to move or change position or direction

**Materials list:** rope for tug of war, masking tape, pencil, paper, digital or regular camera (optional)

**Classroom introduction for students:** Today we are going to play a game you have probably played before, called tug of war. When we get outside, you are going to need to follow my instructions exactly so that we can turn the game of tug of war into a scientific experiment.

**Procedure:** Take your students outside. (You may wish to begin a "Science Wall of Knowledge", by having a student photographer take pictures of this event to post on your bulletin board, or in the hallway, along with your students' completed activity sheets.) Divide your class into two somewhat equal groups. Have the students mark the center of the rope with a piece of masking tape. Designate a marking on the ground to be the dividing line between the two groups that will be tugging on the rope. This marking can be any item such as a rock, a curb, or a piece of material.

Have all students get ready. Align the masking tape at the center of the rope, over the rock or marking on the ground. When you say "go", have each team attempt to pull the other side across the center point. The turn is over when the first person of either team crosses the marking on the ground. The team that crosses over "loses".

At the conclusion of the first turn, ask the students why the winning team won. *(They were stronger, had taller students, etc.*) Ask if this activity was an example of "push" or "pull". (*pull)*

Set the two teams up again, then remove two students from one side and add them to the other. Ask the students what will happen during this turn. (*The team that has "extra people" will win.)* Ask why they will win. (*They have more people. It's unfair…)* Let the teams repeat the tug of war activity at this point. After it is over, ask if we applied the same amount of force as we did before. (*Yes, we have the same number of students.)* Then why did the winning team win? *(Because more force was applied in one direction than the other.)*

Next take four more students from the smaller team, and add them to the larger team. Repeat the tug of war activity again. When the game is over ask why the winning team won. (*The answer you are looking for from the students is that the winning team exerted a greater force. <u>The total amount of force did not change.</u> There are still the same number of students. But again, more force was applied in one direction than the other.)*

Take the students back into the classroom at this point. Talk them thru the following illustration: Imagine if instead of a pulling contest, we had a block of wood out there. We again divided you into two equal teams, and we each pushed on the wood from opposite sides. What would happen? (*If the teams were exactly equal, nothing would happen. Just like if the tug of war teams had been exactly equal, everyone the same size and strength, nothing would happen.)* If we moved two of you from one side to the other, what would happen then? (*The block of wood would move toward the team that was exerting less force, away from the team that was exerting the greater force.)*

Now let's think about if we were all on one side of an object. What if instead of a block of wood, we had a block the same size, but made out of lead, which weighs a lot more than wood? *(You would have to push much harder, i.e. exert a greater force, to move it.)* What if the block was made out of Styrofoam? (*much easier to move, much less force required).* And what if the block was sitting on an ice skating rink instead of our blacktop? *(It would be easier to move, less force, because it was sitting on a smooth, nearly frictionless, surface.)* The block of lead too? Would it be easier to move on a skating rink than on our blacktop? *(Yes, same principal. The smooth surface of an ice skating rink would cause the lead block to move easier, with less force, than that same block of lead sitting on our rough blacktop. The rough blacktop is an example of a surface that has much greater friction than does the nearly frictionless ice.)*

Force can be applied as a push or a pull. An object changes direction, or moves, in relation to the greatest force. Also, the heavier an object, the greater the force needed to make the object move. Lighter objects require less force. The surface the object is sitting on can also affect the amount of force needed to move the object.

**Extension:** If you have a student taking digital photographs, you can actually run this lab like a science fair project. Student teams could develop a hypothesis based on the scientific question "What happens when force is applied to an object?" Following the tug of war, each team would then complete a science board using the hypothesis, list the steps in their experiment, and utilize the digital pictures to demonstrate their conclusion.

**Name**___________________________ **Date**________________________________

**Push/Pull**

**Objective: (3.6A) Measure and record changes in the position and direction of the motion of an object to which a force such as a push or pull has been applied.**

**Scientific Question:** What changes occur when force is applied to an object?

**Materials List:** Rope, masking tape, pencil, paper; digital cameras if desired

**Procedure:** Students will play "tug of war" with a rope. The first time the game is run with two evenly divided teams. For the next turn, two students are moved from one side to join the other team. The game is then repeated. Then four more students are moved from the original side to join the other team, and the game is repeated a third time.

After the tug of war is concluded, your teacher will continue the discussion in your classroom.

**Draw a picture of the tug of war, indicating the direction of the force with arrows.**

**Observations:** ____________________________________________________________

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**Conclusion:** When we talked about using force on other objects, I learned that ___________

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______________________________________________________________________________

The Student Expectation we studied in this lab was ____________________________________

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