Title: Acting and Reacting

Objectives: The students will be able to….

- observe and experiment with a system that moves due to equal and opposite actions and reactions.
- explain how Newton’s Third Law applies to a given situation.
- give examples of Newton's third law of motion as it occurs in everyday experiences.

Grade: 8th grade

Time: 15-20 minutes

Corresponding TEKS:

(6) Force, motion, and energy. The student knows that there is a relationship between force, motion, and energy. The student is expected to: (C) investigate and describe applications of Newton's law of inertia, law of force and acceleration, and law of action-reaction such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

* We will only be focusing on Newton’s third law.

Materials:

(Pictures of materials are provided below pg. 4 and pg. 5)

1. Turntable
2. Bicycle Wheel
3. Display Board - pictures and diagram of wheel/turntable experiment
4. Newton’s Cradle
5. Basketball
6. Worksheet
7. Laptop (for video)
Safety considerations:

Students will need to be supervised when doing the different activities to avoid any injuries. Volunteers should be given verbal step-by-step instructions prior to their participation.

Possible Misconceptions:

Forces that are equal and opposite of one another must cancel out. Confusion arises because if it were true motion altogether would cease to exist. Address the misconception by explaining (with the pictures) that in order to identify a force pair for Newton's third law:

- They must be the same type of force (ex: gravity or normal force).
- They must be acting on two different objects and thus never cancel each other out.
- They must be equal in magnitude and opposite in direction.

Vocabulary:

- Force- can cause an object to start, stop or change direction. Also, a push or pull exerted on an object.

Instructional Procedure:

1. We will begin the lesson by viewing a video intended to guide thinking and engage students from the beginning.

2. Continue by demonstrating Newton’s third law using Newton’s cradle. Start by pulling back one ball at a time. Ask students to predict what will happen when three or four balls are pulled back.

   NOW LET KIDS TEST THIS NOTION FOR THEMSELVES

3. Before moving forward assess their understanding by asking participants to restate Newton’s third law - “For every action there is an equal and opposite reaction”. Now drop the rubber ball from a height of one meter. Catch it when it bounces back up to its maximum height and ask: How can we apply this to Newton’s third law?

   - The floor exerts an upward force on the ball that stops the ball and gives it acceleration upward. This upward force from the floor will cause the ball to deform or change shape while it is in contact with the floor.

4. We will follow this by showing pictures of sports activities, a rocket launch, and Newton’s third law found in nature. Highlight the fact that forces always occur in pairs. Newtonian forces are of the same type acting on different things.
• Fish- as the fish propels through water its fins pushes down on the water. The water reacts by pushing on the fish’s fins in an equal but opposite direction causing the fish to propel forward while the water is pushed backwards.

• Bird- as a bird flies its wings push down on air. The air reacts by pushing on the bird’s wings in an equal but opposite direction moving the bird forward as the air is moved backwards.

• Baseball player-as the bat hits the ball. The baseball player can feel the ball reacting and pushing against the bat through a tug.

• Shooting clays- when a gun is fired, the force of the gas produced by burning gunpowder hurls out the bullet. By Newton's law, the gun itself recoils backwards.

• Rocket- as the burning fuel slowly accelerated outward through the back end. There is a built up force on the ground that allows it to accelerate upward.

5. Proceed with the wheel/turntable demonstration. Students will sit on the turntable with their legs crossed. They need to be very still in order for this demonstration to work. We will spin the bicycle wheel and carefully handle it over to the student. Instruct them to hold the wheel at a safe distance away from their body to keep them from accidentally hurting him/herself. The student will twist the wheel and notice an opposing force counteracting his efforts. Spin control depends on how much the wheel is turned. That is, if the wheel goes from a vertical (spinning perpendicular to ground) to a completely horizontal position the student will experience a greater velocity than if it was slightly turned.

Presenters should model how to do the activity before allowing students to test it and explain how forces interact with each other.

*Safety Note: Younger children should sit on the turntable; older children can do the activity standing up.

6. **Final Review:** Newton’s third law states?

• Forces interact with each other
• Acting forces occur in pairs
• Total change in a system is zero
• Both force and size occur for the same amount of time
Assessment:

Administered the worksheet at the end of the presentation. This is a summative worksheet that will help teachers assess student knowledge. Invite students to work in pairs and give everyone the opportunity to showcase their understanding using verbal or nonverbal language, such as drawings or gestures. (This facilitates ELLs participation when they are unable to do so orally)

Informal assessment: Questions are distributed throughout the presentation in order to evaluate progress and understanding from start to finish. (Questions are shown in red)

Pictures of Tools/Diagram/Worksheet:

<table>
<thead>
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<th>Pictures of Tools</th>
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<td>Turntable</td>
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<td>Wheel</td>
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<td>Newton’s Cradle</td>
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Diagram of Wheel/Turntable Experiment

Action and Reaction
1. The wheel, rotating in a vertical plane, is given to the person on the turntable.
2. When the wheel is turned horizontally, the turntable system (of which the wheel is a part) rotates with equal angular momentum but in an opposite direction.
3. When the first position is resumed the turntable stops.

References:

TEKS
www.tea.state.tx.us/index2.aspx?id=6148

PICTURES
GOOGLE Images
www-istp.gsfc.nasa.gov/stargaze/Snewton3.htm
education.jlab.org/jsat/powerpoint/newtons_laws_of_motion.ppt
http://www.health.uottawa.ca/biomech/courses/apa2313/lab8-00.pdf

VIDEO- http://www.youtube.com/watch?v=sbknP8yHBio

WORKSHEET