Hammer Time!

Standard III:

Students will understand the relationship between the force applied to an object and resulting motion of the object.

Objective 2:

Demonstrate that the greater the force applied to an object, the greater the change in speed or direction of the object.

Intended Learning Outcomes:

1. Use Science Process and Thinking Skills.
2. Manifest Scientific Attitudes and Interests.
3. Understand Science Concepts and Principles.
4. Communicate Effectively Using Science Language and Reasoning.

Content Connections:

Mathematics III-1; Geometric Shapes, Mathematics IV-1; Measurement

Science Standard III

Objective 2

Connections

Background Information

Prior to teaching this lesson, 3rd Grade Science Standard III, Objective 1 should already have been taught. Students will already understand that push and pull are two forces. They will understand how simple machines work. Students should also understand the Math concepts of right angles, and angles that are greater than or less than a right angle. See *Science Standard III Previously Taught at the Elementary CORE Academy* sheet.

Students will already know the following terms: push, pull, forces, motion, acute, obtuse, right, greater, less, simple machines, pulley, wheel & axle, inclined plane, lever, screw, wedge.

Research Basis

MacKenzie, A. H. (2001).The role of teacher stance when infusing inquiry questioning into middle school science classrooms. *School Science and Mathematics*. 101, number 3, 143-153.

This study was done to show how teacher attitude about science affected student attitude about science. Student wonder and "not knowing" is emphasized and valued. Science is not absolute knowledge, but rather contextual. Students learn to synthesize their own knowledge through exploration and experimentation. They are required to use their imagination to solve problems and reach scientific goals. Class discussion is important, as is student inquiry. This article explains how to accomplish this in the classroom.

Caram, C. A., & Davis, P. B. (2005). Inviting student engagement with questioning. *Kappa Delta Pi Record*. Fall, 18-23.

Questioning is important in the classroom. It taps into children's natural curiosity. This article gives a list of strategies to use to encourage questioning. It also has a Thinking Skills Model to give examples of all levels of questioning, so that all learners' needs are met.

Materials

- ❑ Straws
- ❑ 2" x 2" pieces of paper
- ❑ 2" x 2" pieces of cardboard
- ❑ *Science Standard III Previously Taught at the Elementary CORE Academy*
- ❑ *Swinging Hammer Construction Instructions*
- ❑ *Swinging Hammer Diagram*
- ❑ *Hammer Time!* Data Sheets
- ❑ 5 feet of (Schedule 40) 1/2" PVC Pipe
- ❑ 6 non-threaded PVC 1/2" Caps
- ❑ 3 non-threaded PVC 1/2" Standard T's
- ❑ 1 non-threaded PVC 3/4" x 3/4" x 1/2" Bullhead T
- ❑ 2 non-threaded PVC 1/2" Standard 90's (aka Elbows)
- ❑ 1 metal fingernail file or fine sandpaper
- ❑ petroleum jelly
- ❑ 2-3 cotton swabs
- ❑ PVC pipe cutter or PVC saw
- ❑ retractable tape measure
- ❑ pencil
- ❑ 1 40 mm stone/glass/ metal sphere
- ❑ 1 golf ball
- ❑ 1 ping pong ball

Invitation to Learn

When the students come in from recess, have the straw, paper, and cardboard waiting for them on their desk. Tell them to put the paper and the cardboard next to each other on the edge of their desk and try to blow them off. When they've had a chance to try each one, have them set down their straws and ask them which one was easier to blow off their desk. Ask them why. Discuss how some kids can blow harder than others, etc.

Instructional Procedures

1. Construct the swinging hammer according to the directions on the *Swinging Hammer Construction Instructions* sheet prior to the lesson.
2. Have the students get out their journals. Pass out one *Hammer Time! Data Sheet* to each student. Have them write their name on it. It doesn't matter where, because they will be cutting them out later to tape into their journals.
3. Tell the students that you are going to explore forces and motion further today.
4. Find the place in your room on the floor that has the longest straight shot for a ball to roll, then setup the swinging hammer there. Carpet is best so that the ball is less likely to roll away before the hammer hits it. If you only have tile, you can make a tee by punching a hole in a piece of cardboard.
5. Tell the students that we are going to explore different forces first. We'll use the golf ball on each of three swings so that we have the same weight.
6. Have two student volunteers help you by each holding down one side of the stand. This will insure that it doesn't move during the swinging. Arrange the rest of the class around you so that they don't obstruct the path of the ball.
7. Move the hammer back about 30° to form an acute angle. Place the golf ball on the floor exactly in the center of the stand. Ask the students what they think might happen. Tell them to

record their predictions in their journals. Then, let the hammer swing. It will hit the ball, and the resulting movement will be relatively slow, with the golf ball traveling a relatively short distance. Use the measuring tape to measure how far the golf ball went. Have them record it on their data sheet . Remind them to include the units, not just the number.

8. Repeat the procedure with a right angle and an obtuse (about 150°) angle. Discuss the results with the students. Have them record their observations in their journals.
9. Get out the ping pong ball and the stone sphere. This time, use a right angle for all three swings. Repeat the procedure three more times, using the ping pong ball, golf ball, and stone sphere. Be sure to discuss and record as before.

Assessment Suggestions

- Have the students cut out *Same Weight, Different Force* and *Same Force, Different Weight* from their *Hammer Time! Data Sheet* paper. Students should then tape them into their journals and record their observations in complete sentences, using correct vocabulary.
- As a game or center, use a flat circle (paper works fine) and set it on the ground between one and ten feet away from the swinging hammer (also on the floor). Then students must choose the correct weight of ball and use the correct swinging force to get the ball in the circle without it going past. Each person takes a turn until someone gets it in the circle. Then, move the circle and do it again.

Curriculum Extensions/Adaptations/ Integration

- For advanced learners, find spheres of approximately the same weight, but different material (e.g. rubber, cork, wood, clay, etc.). They don't have to be the same size, just the same weight. Have them use a right angle for each swing, and then observe what happens when each sphere is struck. Have them write down their theories as to why some balls go further than others when they are the same weight and the same force is applied.
- For advanced learners, find objects with the same weight, but not the same shape (e.g. sphere, cone, cube, toy car, rock, candle, etc.). Have them use a right angle for each swing, and

then observe what happens when each object is struck. Have them write down their theories as to why the objects don't respond the same, even though they are the same weight and the same force is applied.

- For advanced learners, ask them how each of the simple machines could be used to alter the swinging hammer. Have them demonstrate if possible.
- Make additional swinging hammers so that students can work in small groups to conduct the activity and further explorations.

Family Connections

- Make additional swinging hammers that students may check out and take home to show family members what they have learned in school by giving a mini lesson.
- Make additional swinging hammers that students may check out to take home. Students would experiment with their family using different balls and then share their findings with the class.

Additional Resources

Web sites

http://www.miamisci.org/www/exhibits/newton/vrtour.html

http://www.usoe.k12.ut.us/CURR/Science/sciber00/8th/forces/sciber/forcmot.htm

http://classroom.jc-schools.net/sci-units/force.htm

Science Standard III Previously Taught at the Elementary CORE Academy

Objective 1 – How forces cause changes in speed or direction

a. Objects at rest **Bump On A Log (2005), Rock-A-Bye Pendulum (2005), It's Un-Can-ny (2005), Peaceful Penny (2004), Peaceful Washers (2003)**

b. Push & pull **It's Un-Can-ny (2005), Moving Possibilities (2004), Riddles and Charades (2003), Zoom Balls (2003)**

c. Simple machines **Simple Machines Song (2003)**

   i. Pulley – lift (flagpole, crane) **Lifting the Load (2005), Flag Raiser – Fixed Pulley (2004)**

   ii. Wheel & axle – spin to move (wheel, doorknob) **Lifting the Load (2005) All Geared Up – Wheels and Axles (Gears) (2004), Rolling Along (2003)**

   iii. Inclined plane – move loads (ramp, slide) **Uphill – Inclined Plane (2004)**

   iv. Lever – lift (seesaw, scissors) **Weighty Mistakes (2003)**

   v. Screw – hold together (screw, drill) **Twirling Helicopter – Screw (2004)**

   vi. Wedge – cut or split (ax, shovel) **Soap Carving – Wedge (2004)**

Objective 2 – greater force = greater change

a. Force applied to object **Rock-A-Bye Pendulum (2005), Peaceful Penny (2004)**

b. Same force, different weight **Move It, Sir Isaac! (2005), Over the Edge (2003)**

c. Different force, same weight **Move It, Sir Isaac! (2005), Rock-A-Bye Pendulum (2005), Sudden Stop! (2004), Wind Wheel (2004), Marshmallow Launcher (2004), What A Load (2003), Straw Rocket (2003)**

Swinging Hammer Construction Instructions

1. Measure and cut the 5' of PVC pipe to the following lengths:

   2 lengths @ 11/2"
   1 length @ 6"
   1 length @ 9"
   2 lengths @ 10"
   4 lengths @ 51/2"

   You should have no excess. Cut the 51/2" lengths last. If one of them is a tad short, cut the other three 51/2" pieces to the same length.

2. Clean the edges of the cut ends with the metal fingernail file. Be sure that any lip is filed off and the ends are smooth.

   NOTE: If you are planning to disassemble and reassemble your swinging hammer, each time you put a fitting together swab both the male and female end with petroleum jelly. If you never want to take it apart again, don't bother with the jelly.

3. Place the Swinging Hammer Diagram where you can see it for a visual during the rest of the directions.

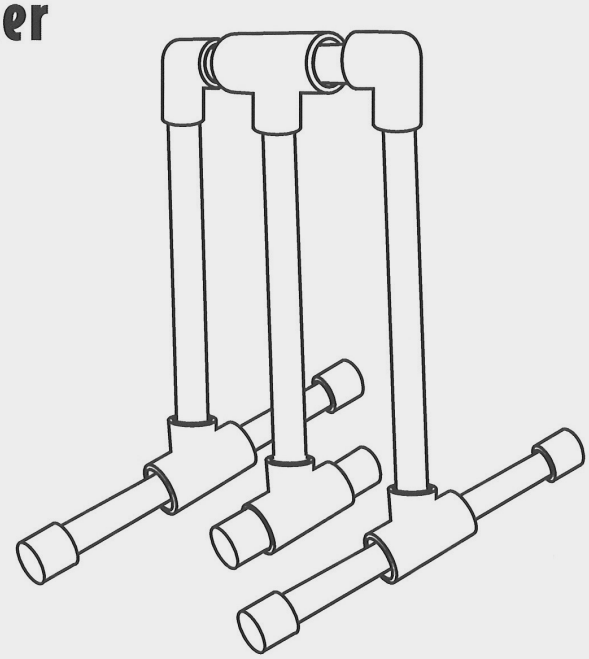
4. Fit one cap on each of the 11/2" lengths, then fit one cap on each of the 51/2" lengths.

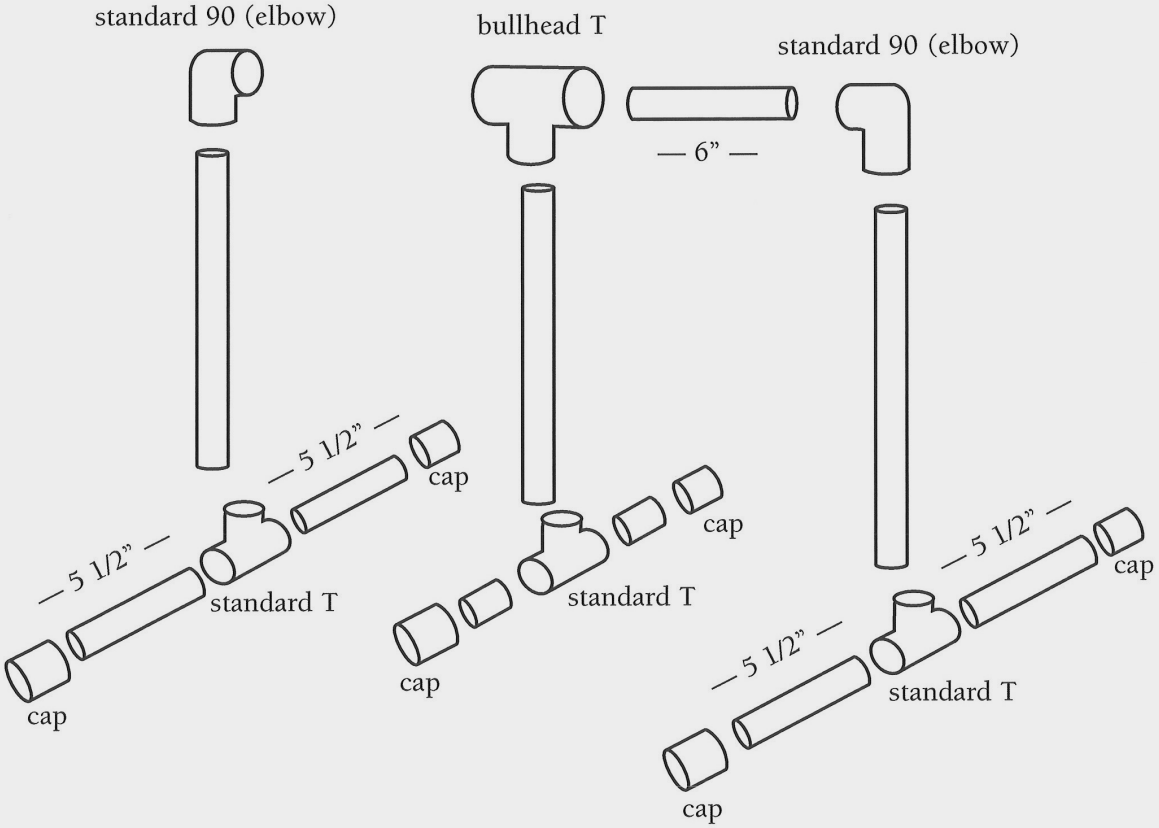
5. Fit the two capped 11/2" lengths into the cross piece of one 1/2" standard T. You should not see any of the 11/2" length of pipe when they are fitted together properly. The standard T and the caps will be flush. Fit the four capped 51/2" lengths into the cross pieces of two 1/2" standard T's.

6. Fit the 9" piece into the standard T with the 11/2" capped pieces. Fit the 10" pieces into the two standard T's with the 51/2" capped pieces.

7. Fit the other end of the 9" piece into the bottom portion of the bullhead T. The top of the T and the bottom of the hammer should be perpendicular to each other.

Swinging Hammer Diagram





Hammer Time! Data Sheet

Same Weight, Different Force	
Hammer Angle	Distance/Speed
less than right angle weak 	
right medium 	
greater than right angle strong 	

Same Force, Different Weight	
Sphere Weight	Distance/Speed
light ping pong	
medium golf	
heavy stone	

Hammer Time! Data Sheet

Same Weight, Different Force	
Hammer Angle	Distance/Speed
less than right angle weak 	
right medium 	
greater than right angle strong 	

Same Force, Different Weight	
Sphere Weight	Distance/Speed
light ping pong	
medium golf	
heavy stone	

Name_____

Forces With Levers—Hammers and Balls

Height of the Hammer In Centimeters	Yellow Solid Ball Distance Measured In Centimeters	White Hollow Ball Distance Measured In Centimeters
Acute Angle 		
Right Angle 		
Obtuse Angle 		
Straight Angle 		

1. What pattern do you see in the **Yellow Solid Ball** and **White Hollow Ball** columns?

_____

_____

2. What are your conclusions about this?

A. _____

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B. _____

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C. _____

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