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ABSTRACT

This packet contains four science learning activities that can be used in agricultural education courses. The activities cover these topics: (1) determining the effect of air pressure on fluid flow; (2) how lubrication and oil viscosity affect friction; (3) determining relative strengths of wood fasteners; and (4) determining the effects of melting and freezing and their relationship to fusion welding. The lesson plans for the activities consist of the following elements: agricultural subjects and science principles included in the lesson, agricultural applications, student objectives, activity length, group size, vocabulary, materials required, instructional strategies and procedures (overview and results), key questions, and evaluation. One to three references are given for each activity, and each includes a data record and observation sheet. (KC)

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AGRICULTURAL EDUCATION SCIENCE ACTIVITY
Nos. AEM 1-4

Ohio Agricultural Education Curriculum Materials Service
254 Agricultural Administration Bldg.
The Ohio State University
2120 Fyffe Road
Columbus, OH 43210-1099

Agricultural Education Science Activity - No. AEM-1

# Determining the Effect of Air Pressure on Fluid Flow

## Agricultural Subject

■ Agricultural Engineering and Mechanics

## Activity Length

■ One class period

## Group Size

■ This activity can be conducted with an entire class or small groups (2 to 3 students).

## Science Principle

■ Whenever a gas or liquid flows through a closed flow path, pressure at or near the center of the stream is lower than the pressure at the outer edges of the stream. The greater the flow velocity, the lower the pressure. Thus, whenever the speed of a moving stream of fluid increases due to constriction, the pressure decreases.

## Agricultural Application

■ Pressures are used in many ways in agricultual mechanics. For example, pressures exerted on fluids and the effect of atmospheric pressures on fluids are used in equipment operation. Air pressures cause fuel to flow from the carburetor bowl to the carburetor. When working with engines it is necessary to understand the principles that make them work in order to repair and maintain them.

## Student Objective

■ To determine the effect of air pressure on fluid flow.

## Vocabulary

| | |
|---|---|
| velocity | atmospheric pressure |
| carburetor | carburetor bowl |
| venturi | liquid |
| gas | |

## Materials Required

1. Container to hold water (bottle or jar)
2. Two drinking straws
3. Air compressor
4. Safety glasses
5. Water
6. Paper and pen

## Instructional Strategies and Procedures

■ **Overview**: Fill the jar three-fourths full of water. Position one straw in the water. Using a second straw, force air across the top opening of the first straw. Note what happens to the water in the jar. Record your observations and discuss the results. Discuss how this demonstration is related to carburetor operation.

**Safety Note**: Prior to the demonstration, discuss the safety precautions to use when working with compressed air and pressures. Insist that students wear safety glasses. Do not direct the air flow toward anyone

## Instructional Strategies and Procedures

*(continued)*

1. Fill the jar three-fourths full of water (see Figure 1).
2. Place straw 1 into the jar and secure it. Make sure that the straw is positioned vertically in the center of the jar and not touching the bottom (see Figure 2).
3. Hold one end of straw 2 at a right angle to the top opening of straw 1. Using an air compressor, force air into the other end of straw 2 (see Figure 3). If done correctly this process will force air across the top opening of straw 1.
4. Note what happens to the water. Record observations on page 3.
5. Discuss how this process is related to carburetor operation.

■ **Results**: When air is forced over the opening of straw 1 it lowers the pressure in that straw. The atmospheric pressure in the jar is now greater than the lowered pressure in straw 1. Therefore, a **venturi** is created and water is forced from the jar into the air stream in straw 1. If done correctly, this produces a water spray from the top of straw 1.

## Key Questions

1. Why does the water move out of the jar and form a spray?
2. Will increasing or decreasing the air flow through straw 2 and over straw 1 affect the water flow out of the jar? If yes, how?
3. What part of an engine uses this principle during operation?
4. Can you think of other ways this principle could be used in agricultural mechanics?

## Evaluation

■ Ask students to write a report based on what they have observed.

## Bibliography


1. *Service and Repair Instructions*, Briggs and Stratton Corp., Milwaukee, WI.
2. Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. Albany, NY: Delmar Publishers Inc., 1987.
3. Jacobs, Clinton O., and William R. Harrell. *Agricultural Power and Machinery*. New York: Gregg Division, New McGraw-Hill Book Company, 1983.


Demonstration submitted by Tom Oglesby, Production Agriculture Instructor, Hillsboro High School, Hillsboro, OH 45133.

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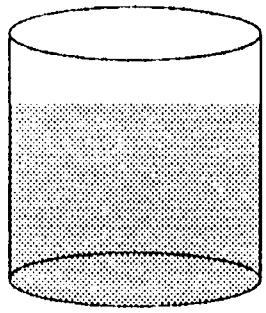

**Figure 1.** Fill a jar three-fourths full of water.

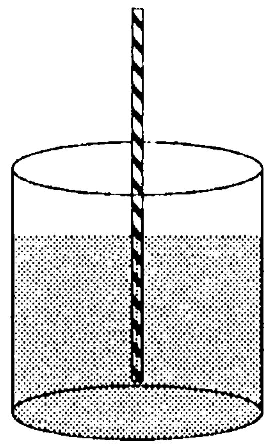

**Figure 2.** Place straw 1 in the jar.

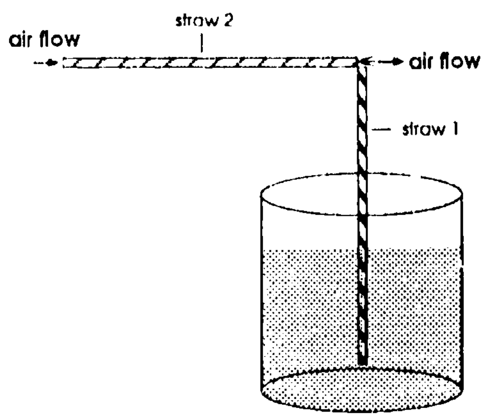


**Figure 3.** Force air through straw 2 and across the opening of straw 1.

# DATA RECORD AND OBSERVATION SHEET

Name ______________________________ Date __________ Period ______

**Determining the Effect of Air Pressure on Fluid Flow**

## Objective

What are you trying to demonstrate?

## Procedure

What did you do?

## Observations and Results

What did you observe? When did it happen? What caused it to happen?

## Conclusions

What principle was demonstrated?

Agricultural Education Science Activity – No. AEM-2

# How Lubrication and Oil Viscosity Affect Friction

## Agricultural Subject

■ Agricultural Engineering and Mechanics

## Activity Length

■ Twenty-five minutes

## Group Size

■ This activity can be conducted with the entire class.

## Science Principles

■ **Friction:** Friction transforms mechanical energy to heat. The frictional coefficient is related to the forces pressing surfaces together and the smoothness of those surfaces. Generally, friction is greater between surfaces of like materials than between surfaces of unlike materials. The contact area of these materials does not affect friction; however, the speed of these sliding materials has a very slight effect on friction.

■ **Flow and viscosity:** Provided all other factors remain constant, fluid flow decreases as viscosity increases.

## Agricultural Application

■ Friction can damage mechanical equipment, including farm machinery. Proper lubrication is a must for efficient and safe equipment operation. Therefore, agriculture students need a basic understanding of the principles of friction, fluid flow, and viscosity. This knowledge is essential in order to properly operate and maintain mechanical equipment.

## Student Objectives

■ To determine the effect of lubrication on friction.

■ To determine how oil viscosity affects friction.

## Vocabulary

| | | |
|---|---|---|
| viscosity | friction | mechanical |
| lubrication | oil | energy |
| coefficient | | |

## Materials Required

1. Two or more engines damaged by poor lubrication
2. Two steel plates (10" by 10")
3. Access to refrigerator or freezer
4. 10-weight oil (some at room temperature and some cooled in a refrigerator or freezer)
5. 90-weight oil (some at room temperature and some cooled in a refrigerator or freezer)
6. One or two glass squares (10" by 10")
7. Four test tubes and rack
8. Several ball bearings of the same size
9. Hook or long-handled spoon to retrieve ball bearings from test tubes
10. Stopwatch (optional) or watch with second hand
11. Eyedropper
12. Paper and pen

## Instructional Strategies and Procedures

■ **Overview:** Produce friction by rubbing together the surfaces of two steel plates. Apply room temperature oil of any weight to the plates and rub them together again. Note the differences. Next, apply drops of different weight oils to a glass square; tilt the glass. Note which oil runs down the glass at a faster rate. Then drop ball bearings into test tubes filled with different weight oils at room temperature. Record the time it takes each ball bearing to reach the bottom of the test tube. Repeat the ball bearing test using chilled oils. Discuss the results.

# Instructional Strategies and Procedures

*(continued)*

1. Examine engines damaged by poor lubrication. Point out specific engine parts.

2. Rub together the surfaces of two nonlubricated steel plates. Note the noise and heat produced by friction.

3. Now, place room temperature oil on the surfaces of the steel plates. Rub them together again. Note the difference in the amount of noise and heat produced. Record observations on page 4.

4. To demonstrate the effects of oil viscosity, place several drops of room temperature, 10-weight oil on a glass square (10 inches by 10 inches). Place several drops of room- emperature, 90-weight oil on the same glass square.

5. Tilt the glass square at a 45° angle (see Figure 1).

6. Note which drops of oil flow down the glass at a faster rate. Record observations on page 4.

7. Next, pour equal amounts of room temperature, 10-weight and 90-weight oil into separate test tubes. Place the test tubes in a rack.

8. With a stopwatch ready, drop a ball bearing into each test tube (see Figure 2). Note the time it takes each ball bearing to reach the bottom of the test tube. Record your observations on page 4.

9. Repeat steps 7 and 8 using oil samples that have been refrigerated. Note the time it takes each ball bearing to reach the bottom of the test tube. Record your observations on page 4. Compare these times with those resulting from the tests using room temperature oils.

## ■ Results:

- When the surfaces of two nonlubricated steel plates are rubbed together, noise and heat are produced. Adding room temperature oil to the surfaces of the steel plates reduces this noise and friction.

- Room temperature, lower viscosity (10-weight) oil flows down a tilted glass square at a faster rate than the higher viscosity (90-weight) oil.

- Ball bearings dropped in test tubes containing lower viscosity oil fall at a faster rate than bearings dropped in higher viscosity oil, regardless of oil temperature.

- Lower oil temperatures increase the amount of time it takes each ball bearing to reach the bottom of the test tube, regardless of oil viscosity.

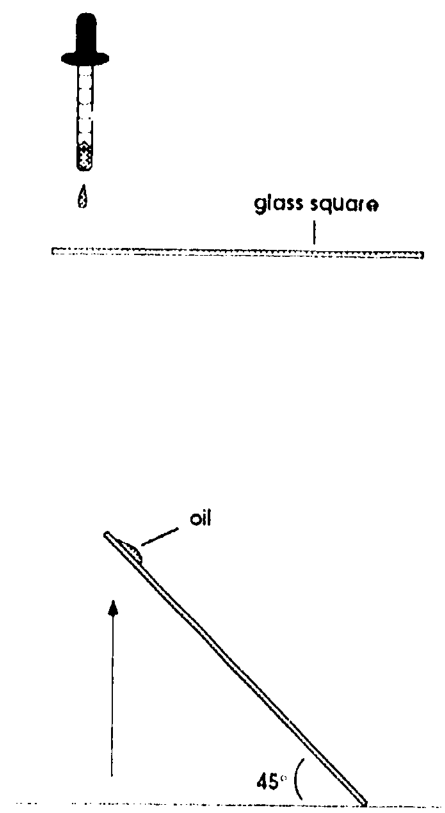


**Figure 1.** Drop oil on a glass square. Then tilt the square at a 45° angle.

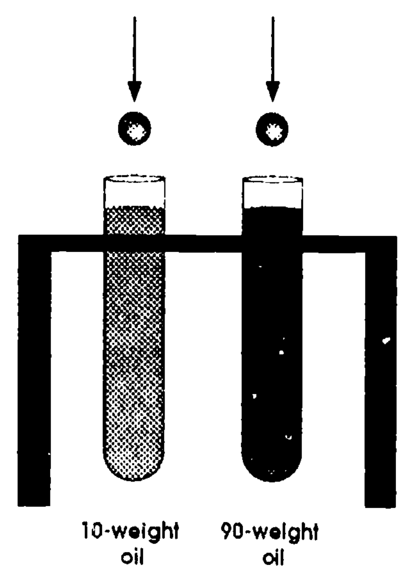


**Figure 2.** Drop a ball bearing into each test tube.

## Evaluation

■ Ask students to write a report based on what they have learned.

## Key Questions

1. What is friction?
2. Why should you lubricate engines and other mechanical equipment?
3. What is viscosity?
4. What environmental factors affect viscosity?

## Bibliography

O'Brien, Michael. *Demonstrations in Farm Mechanics*. Danville, IL: Interstate Printers, 1957.

Demonstration submitted by Michael Rossfeld, Production Agriculture Instructor, Wayne Trace High School, Haviland, OH 45851.

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# DATA RECORD AND OBSERVATION SHEET

## How Lubrication and Oil Viscosity Affect Friction

Name ______________________________ Date ____________ Period ________

| | Observations | |
|---|---|---|
| Steel Plates | Nonlubricated | Lubricated |
| Glass Squares | 10-weight Oil | 90-weight Oil |
| Ball Bearing Test (room temperature oil) | 10-weight Oil | 90-weight Oil |
| Ball Bearing Test (chilled oil) | 10-weight Oil | 90-weight Oil |

## Agricultural Subject

■ Agricultural Engineering and Mechanics

## Activity Length

■ Two class periods on successive days.

## Group Size

■ This activity can be conducted with an entire class or small groups (2 to 4 students).

## Science Principles

■ Fasteners have varying holding capacities due to the following factors:
- type of fastener
- amount of fastener penetration into the wood
- relationship of the fastening device to the wood grain

## Agricultural Application

■ Fastening wood together with nails, wood screws, bolts, and/or glue is a common practice on most farms. Therefore, agriculture students must know which fasteners will provide sufficient strength for a particular job.

Agricultural Education Science Activity - No. AEM-3

# Determining Relative Strengths of Wood Fasteners

## Student Objective

■ To determine the relative strengths of four types of wood fasteners.

## Vocabulary

| | | |
|---|---|---|
| resin glue | withdrawal loading | countersink |
| penny (d) | lateral loading | penetration |
| clinching nails | casein glue | |

## Materials Required

1. Thirty-two 2" by 6" boards - each one foot long
2. Forty-eight 10d nails
3. Twenty-four #10 wood screws - three inches long
4. Twenty-four nuts and bolts - 1/4" by 3 1/2"
5. One bottle casein glue
6. Vise (preferably one that opens to one foot)
7. Assorted hand tools: hammer, screwdriver, countersink, electric drill, 1/8" drill bit, wrenches, and clamps
8. Safety glasses
9. Ruler and pencil
10. Paper and pen

## Instructional Strategies and Procedures

■ **Overview:** Compare the relative strengths of pairs of boards joined together with four types of fasteners: nails, screws, bolts, and glue. Apply four types of stress to pairs of boards joined with different fasteners. Record observations and discuss results.

**Safety Note:** Prior to the demonstration, discuss the cautions to be observed when working with wood and hand tools. Wear safety glasses and follow safety rules when building fasteners and conducting strength tests.

## Instructional Strategies and Procedures

*(continued)*

1. Prior to the demonstration, cut your boards into one-foot pieces. If your vise does not open to one foot, you can cut the boards in shorter pieces.
2. ***Fastener 1* - Nails***: Position two boards together as shown in Figure 1. The two boards should measure no more than one foot end to end when nailed together. First, evenly space the twelve nails. The nails should be clinched over, either *with* the wood grain or *across* the wood grain. (Across the grain provides 20 percent added holding strength.) The boards can also be fastened at right angles to each other (see Figure 2).

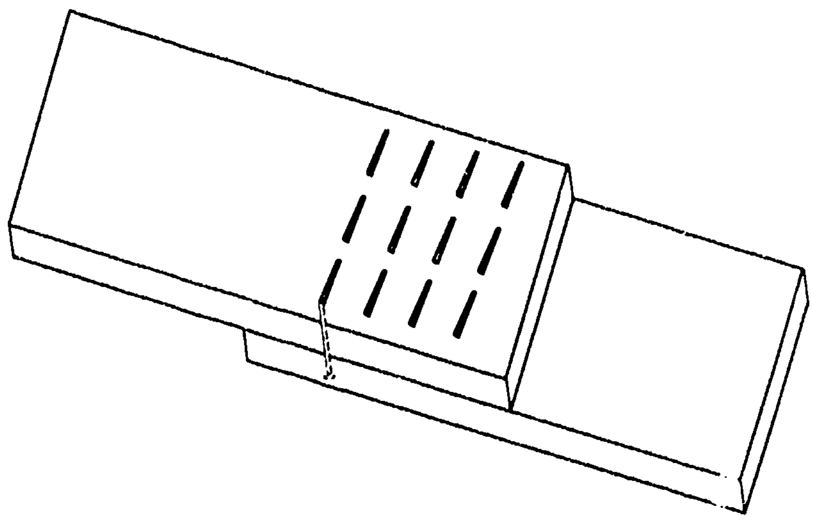

**Figure 1.** Fastener 1: bottom view - the nails are clinched over across the wood grain.

3. ***Fastener 2* - Screws***: The next two boards must be screwed together. First, evenly space six screws. Then drill the holes, countersink the screw holes, and place the screws (see Figure 3). These boards can also be fastened at right angles.
4. ***Fastener 3* - Bolts***: Bolt together the next two boards. First, measure and evenly space six holes for the bolts. Drill 1/4-inch diameter holes through the boards. Position the bolts and tighten the nuts (see Figure 4). These boards can also be fastened at right angles.
5. ***Fastener 4* - Glue***: Glue together the final two boards. First, measure the boards to determine where to apply glue. Apply the glue and clamp the boards together. Make sure the glue makes contact with both boards. The boards can also be glued at right angles.
6. Using a pencil, draw lines on each pair of boards as indicated in Figures 5 and 6. These lines allow you to determine if the boards move when stress is applied.
7. Now test the strength of the different fasteners by applying the following stress tests:

**TEST 1**

a. Place a fastened pair of boards in a vise (see Figure 7).
b. Slowly tighten the vise. Determine the number of turns of the vise handle needed to move a board past the pencil line.
c. Conduct this test with each type of fastener (nails, screws, bolts, and glue).
d. Record results on page 5.

*If you intend to use all four test methods, join four separate pairs of boards using this type of fastener (2 pairs parallel and end over end; 2 pairs at right angles).

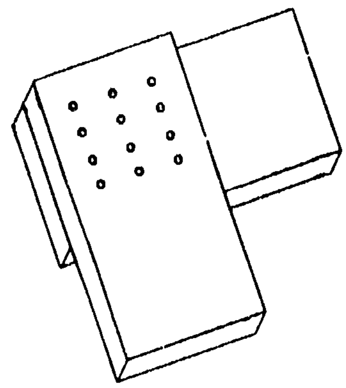

**Figure 2.** Top view: the boards can also be nailed together at right angles.

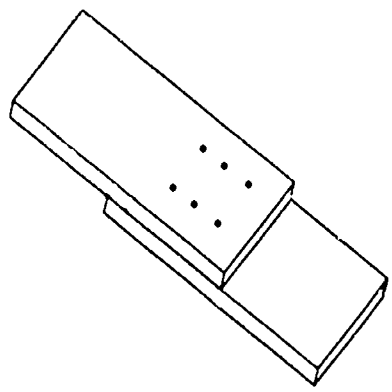

**Figure 3.** Fastener 2: the screws are spaced evenly.

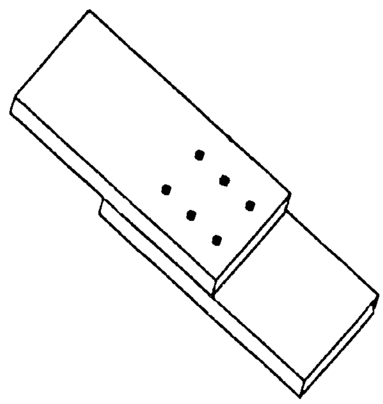

**Figure 4.** Fastener 3: the bolts are spaced evenly.

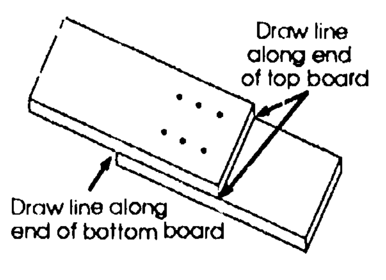


**Figure 5.** Draw the lines as indicated here

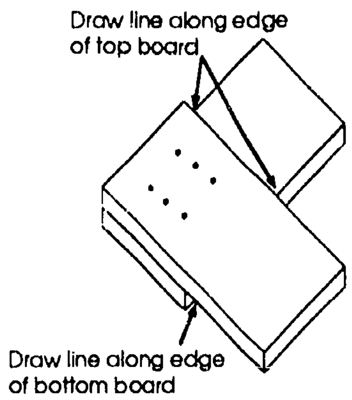

**Figure 6.** For boards at right angles: draw the lines as indicated here.

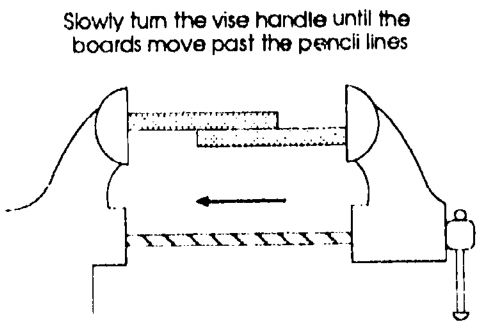

**Figure 7.** Test 1: place th boards in a vise as shown here.

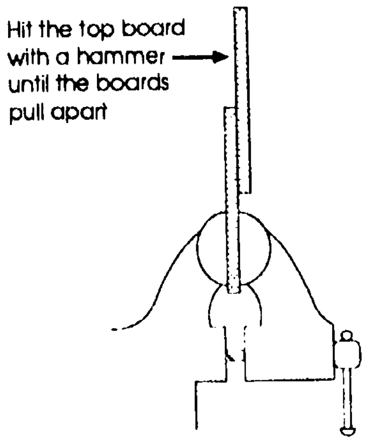

**Figure 8.** Test 2: place the boards in a vise as shown here.

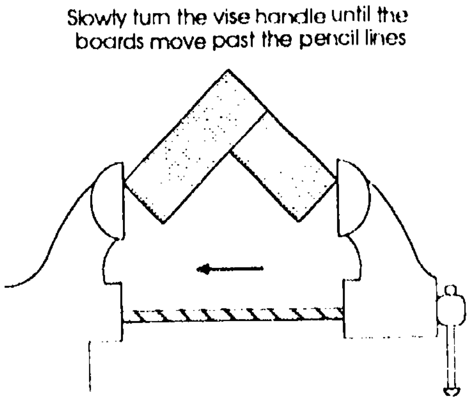

**Figure 9.** Test 3: if the boards are at right angles, place them in a vise as shown here.

## Instructional Strategies and Procedures

*(continued)*

### TEST 2

a. Place a fastened pair of boards upright in a vise. Place only one board against the vise jaws (see Figure 8).
b. Slowly tighten the vise.
c. Hit the top board with a hammer until the boards start to pull apart. Determine the number of blows needed to reach this point. *Be careful to swing the hammer with the same amount of force each time.*
d. Conduct this test with each type of fastener.
e. Record results on page 5.

### TEST 3

*Use this test if the boards are fastened together at a 90° (right) angle.*
a. Place the pair of boards in a vise as shown in Figure 9.
b. Slowly tighten the vise. Determine the number of turns of the vise handle needed to move a board past the pencil mark.
c. Conduct this test with each type of fastener (if applicable).
d. Record results on page 5.

### TEST 4

*Use this test if the boards are fastened together at a 90° (right) angle.*
a. Holding the free ends of the boards in your hands, attempt to push the two ends together as shown in Figure 10.
b. Determine the relative amount of pressure needed to move a board past the pencil mark. The person applying the pressure must determine which type of fastener required the most pressure.
c. Conduct this test with each type of fastener (if applicable).
d. Record results on page 5.

■ **Results:** The relative strengths of the four types of fasteners are as follows (from strongest to weakest):

1) Glued boards (greatest loading capacity)
2) Bolted boards
3) Screwed boards
4) Boards with clinched nails: the boards having across-the-grain clinch are stronger than those having with-the-grain clinch.

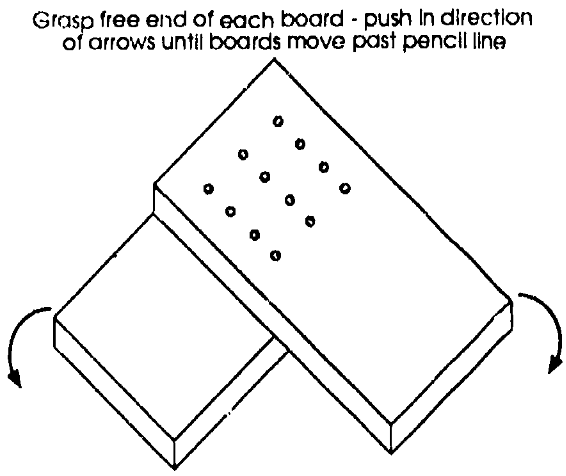

**Figure 10.** Test 4: if the boards are at right angles, hold the free ends in your hands and apply pressure in the directions indicated by the arrows.

## Key Questions

1. Which fastener has the greatest withdrawal loading (amount of pull required to withdraw fastener from wood)?

2. Which fastener has the greatest lateral loading (amount of pull at right angles to the fastener that is required to withdraw fastener from wood)?

3. How should nails be clinched to provide the best holding or loading capacity?

## Evaluation

■ Ask students to write a report based on what they have observed.

## Bibliography

1. *Fasteners.* Moline, IL.: Deere and Company, 1979.
2. Wakeman, and McCoy. *The Farm Shop.* NY: MacMillan Co., 1960.

Demonstration submitted by Tom Roetgerman, Production Agriculture and Agriculture Business Instructor, New Bremen High School, New Bremen, OH 45869.

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# DATA RECORD AND OBSERVATION SHEET

## Determining Relative Strengths of Wood Fasteners

Name ______________________________

Date ______________________________

Period ____________

| Test | Fastener #1 NAILS | Fastener #2 SCREWS | Fastener #3 BOLTS | Fastener #4 GLUE |
|---|---|---|---|---|
| #1 Number of vise handle turns needed to move a board past the pencil line | | | | |
| #2 Number of hammer blows needed to separate the boards | | | | |
| #3 Number of vise handle turns needed to move a board past the pencil mark. | | | | |
| #4 Amount of pressure needed to move a board past the pencil line. Rate on a scale of 1 to 4. (4 = most pressure needed) | | | | |

Agricultural Education Science Activity – No. AEM-4

# Determining the Effects of Melting and Freezing and Their Relationship to Fusion Welding

## Agricultural Subject

■ Agricultural Engineering and Mechanics

## Activity Length

■ Five to ten minutes are required for this activity.

## Group Size

■ This activity can be conducted with an entire class or small groups.

## Science Principle

■ **Fusion welding**: The process of joining two similar materials by heating them until they liquify; bringing them in contact with each other; and then cooling them until they solidify.

## Agricultural Application

■ Manufacture of agricultural machinery often requires metals to be joined by fusion welding. Therefore, agriculture students need a basic understanding of the principle behind this process when dealing with machinery manufacture.

## Student Objective

■ To determine the effects of melting and freezing similar materials and how this relates to fusion welding.

## Vocabulary

| | |
|---|---|
| welding | melting |
| fusion | freezing |
| base metals | Bunsen burner |
| liquid | solid |

## Materials Required

1. Two ice cubes
2. A direct heat source (e.g., match, candle, or Bunsen burner)
3. Paper and pen

## Instructional Strategies and Procedures

■ **Safety Note:** Prior to demonstration, discuss the cautions to be observed when working with matches and other heat sources.

1. Hold two ice cubes one inch apart.
2. Position a match or other heat source between the two ice cubes (see Figure 1).
3. When the ice begins to melt, remove the heat source.
4. Place the ice cubes together so they touch; allow them to refreeze (see Figure 2).
5. Record your observations on page 3 and discuss results.

■ **Results**: When the melting ice cubes touch, the melted surfaces refreeze; the ice cubes fuse together.

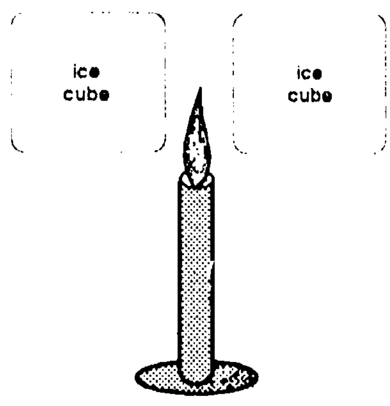


**Figure 1.** Position two ice cubes near a heat source until they begin to melt.

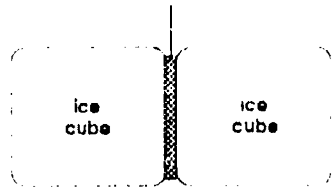


**Figure 2.** Ice cubes refreeze when they touch.

## Key Questions

1. What two states of matter are covered in this demonstration? What is the third state?
2. What causes the ice cubes to melt?
3. Why do the ice cubes refreeze when they touch?
4. Do you think all materials melt at the same temperature as the ice cubes?

## Evaluation

■ Ask students to report what they have observed.

Experiment submitted by Tim Niemeyer, Agriculture Education Instructor, Magaretta High School, Castalia, OH 44824.

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# DATA RECORD AND OBSERVATION SHEET

Name ____________________ Date __________ Period ______

**Determining the Effects of Melting and Freezing and Their Relationship to Fusion Welding**

**Objective**

**Procedure**

**Observations and Results**

**Conclusions**