INTERMEDIATE **ACTIVITY: Calibrating Thermometers**

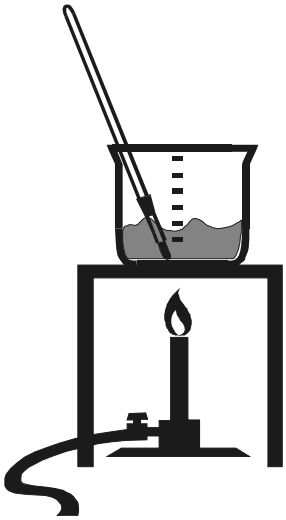
GOALS: To develop students' critical thinking skills and introduce them to concepts of heat transfer by having them calibrate thermometers with guidance, but without specific instructions.

To reinforce students' ability to convert temperature from Fahrenheit to Celsius and vice versa.

PREPARATION & MATERIALS:

1 Place students in six groups.

2 Make the following equipment and materials accessible to the students, but do not instruct them in which equipment or materials to use. For example, tell the students they can use any of the equipment and materials on a given shelf.



- ☐ 6 Uncalibrated thermometers*
- ☐ 6 100 ml beakers
- ☐ 6 Permanent, fineline, waterproof markers
- ☐ 6 Ring stands or tripods
- ☐ 6 Bunsen burners or alcohol lamps
- ☐ Lab tongs
- ☐ Safety glasses
- ☐ Water
- ☐ Ice

PROCEDURE:

1 Give each group of students an uncalibrated thermometer and a marker.

2 Instruct the students to work together to devise a method to calibrate their thermometers from -10°C to 120°C. *Another option is to require them to calibrate the thermometers to both Celsius and Fahrenheit scales.*

3 Instruct each group to write down the materials they will need and the procedure they plan to use, and show it to you for approval. If the list of materials and the procedure are safe and reasonable, allow the group to proceed, even if they may not accomplish the objective.

4 If a group has difficulty devising a plan, ask questions to guide them in the right direction, but do not tell them how to proceed. *(For example, under what conditions could you predict the temperature of water?)*

5 If students require additional materials or need to modify their procedure as they progress, instruct them to obtain your approval before proceeding.

6 After 15–30 minutes, evaluate the activity with the students, checking their calibrations by placing the thermometers in boiling water (100°C—212°F) and at the top of a beaker of ice water (0°C—32°F). The calibrations between these markers should be uniform. Students can use body temperature (37°C—98.6°F) to validate the calibrations.

EXTENSION: Converting from Fahrenheit to Celsius and Vice Versa

Have students estimate the the Fahrenheit correlation of several Celsius temperatures (10, 38, 64, 85) using their thermometers. Have students estimate the Celsius correlation for several temperatures (49, 89, 172, 225) using their thermometers. Have the students determine the exact correlations by using the following conversion formulas:

Celsius to Fahrenheit: $t^oF = 9/5(t^oC + 32^o)$ **Fahrenheit to Celsius: $t^oC = 5/9(t^oF - 32^o)$**

t = temperature

Students can check their conversions on the Internet at www.megaconverter.com.

** Call NEED at 1-800-875-5029 for information about obtaining uncalibrated thermometers.*

INTERMEDIATE **ACTIVITY: EXPLORING DENSITY**

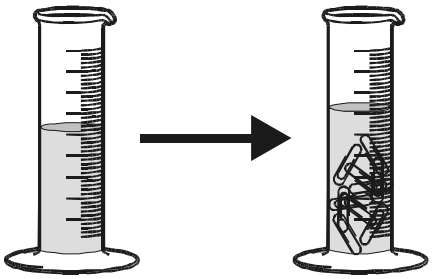
GOALS: To develop students' critical thinking skills and introduce them to the relationship between mass, volume and density by having them determine if two objects are made of the same material when given information and equipment, but not the procedure for determining volume by the amount of water an object displaces.

To reinforce students' ability to calculate an object's density using its mass and volume (D = m/V).

MATERIALS:

1. Make the following equipment and materials accessible to the students, but do not tell them which equipment to use. For example, tell the students they can use any of the equipment on a given shelf.

- ☐ 6 triple beam balances
- ☐ 6 graduated cylinders (100 ml)
- ☐ 180 large metal paper clips
- ☐ 180 small metal paper clips
- ☐ Water
- ☐ Calculators *(optional)*



PROCEDURE:

1. Place students into six groups. Give each group approximately 30 large paper clips, 30 small paper clips, and the assignment below. Tell them where the equipment is that they can use.
2. Instruct the students to work together to determine a procedure and complete the assignment.
3. If a group has difficulty devising a procedure, ask questions to guide them in the right direction, but do not tell them how to proceed. *(For example, how can you use water to determine the volume of the paper clips?)*
4. After 15 minutes, evaluate the activity with the students. *(The mass of the paper clips is determined using the triple beam balance. The volume is determined by measuring how much water the paper clips displace in the graduated cylinder. The density is determined by dividing the mass in grams by the volume in cubic centimeters.)*

EXTENSION/ALTERNATIVE: Determine if small pieces of anthracite and bituminous coal have different densities. Teachers may obtain free coal samples from the American Coal Foundation at www.wgcn.com/acf.htm.

Question: Are the small and large paper clips made of the same material?

Hypothesis:

Facts: Mass (m) is the amount of matter in an object. Mass is measured in grams (gm).
Volume (V) is the amount of space an object takes up and is measured in cubic centimeters (cc).
Density (D) is the amount of matter in a specific volume and is calculated as D = m/V.
Different materials have different densities.

Conversion: One cubic centimeter is equal to one milliliter (1cc = 1ml)

Procedure:

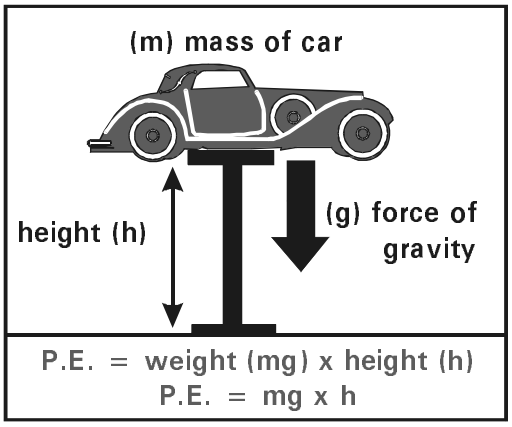
Results:

Conclusion:

INTERMEDIATE **ACTIVITY: EXPLORING POTENTIAL ENERGY**

GOALS: To develop students' critical thinking skills and introduce them to concepts of potential energy.

To reinforce students' ability to calculate the potential energy of an object as the product of the object's weight and the height the object is raised (P.E. = mg x h).



MATERIALS:

- ☐ 6 free-rolling metal toy cars
- ☐ 12 heavy magnets
- ☐ 6 spring scales
- ☐ 6 wooden ramps (2' long)
- ☐ 6 meter sticks

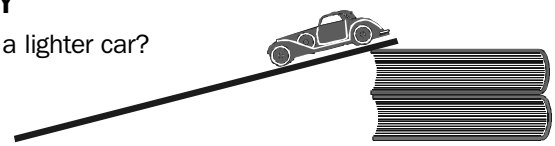
PROCEDURE:

1. Place students into six groups. Give each group a spring scale, meter stick, ramp, toy car, and two magnets. Have the students use four books (of the same size) to raise the height of the ramp.
2. Using the diagram above, explain that the weight of an object is the force of gravity applied to the object's mass. Instruct the students to work together to complete the assignment below.
3. After 20 minutes, discuss and evaluate the activity with the students.

POTENTIAL ENERGY

Questions: Will a heavier car roll proportionally farther than a lighter car?

If the height of a ramp is doubled, will a car roll twice as far?



Hypotheses:

Formula: The potential energy of an object is the product of the weight of the object and the height the object is raised. Potential Energy (P.E.) = weight (mg) X height (h) P.E. = mgh

Procedure:

1. Make a ramp with two books. Calculate the potential energy of the car at the top of the ramp.
2. Roll the car down the ramp five times, measuring the distance it travels each time. Calculate the average distance the car traveled.
3. Make a ramp with four books. Calculate the potential energy of the car at the top of the ramp.
4. Determine the average distance the car rolls with five trials.
5. Place one magnet on the car. Repeat Step 1 and estimate the distance the car will roll.
6. Repeat Steps 2–4.
7. Place both magnets on the car. Repeat Step 1 and estimate the distance the car will roll.
8. Repeat Steps 2–4.

Results:

Conclusion: Were your estimates correct? What factors may have affected your results?