The Case of the Pilfered Pin
A Measurement Inquiry Activity

SLED
Science Learning through
Engineering Design

Grade Level:	**Total Time Required:**
3rd – 4th grade	~2-3 class sessions (30 minute each)

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Lesson Objectives:
Students will be able to:
1. Make length, mass, and temperature measurements in SI units.
2. Use measurements and computation to solve a given problem.

Indiana Standards:

Process Standards:
- Use measurement skills and apply appropriate units when collecting data.
- Make predictions and formulate testable questions.
- Compare the results of an investigation with the prediction.

Content Specific:
- **Science, Engineering and Technology 3.4.1**
  Choose and use the appropriate tools to estimate and measure length, mass and temperature in SI units.

Equipment, Materials, and Tools

Tools/Equipment	*Materials*	
Centimeter/millimeter rulers	Beakers	Hot plate or lab burner
Gram balances or scales	Water	Variety of U.S. coins
Celsius thermometers	Ice	Copies of worksheets

Concepts and Vocabulary

Science Concepts / Vocabulary:

Term	*Defined by a scientist or engineer / SI units*	*Defined by a 3rd or 4th grade student*
Length	The measurement of the longest dimension of an object, or, in three dimensions, the horizontal measurement of an object as opposed to the height (vertical measurement) and width (depth).	*How long something is
	The standard SI unit for length is the meter. The centimeter (1/100th of a meter) and millimeter (1/1000th of a meter) are used for smaller length measurements. 1 meter = 39.37 inches 1 inch = 2.54 centimeters	
Mass	The quantity of matter in an object. Mass, at a given location, can be measured as weight in units such as grams or kilograms. However, the mass of an object is constant, while weight (which is the force on an object due to gravity) can change depending on the location.	*How much something weighs or *How heavy something is
	The standard SI unit for mass is the kilogram. The gram (1/1000th of a kilogram) is used to measure smaller masses. 1 kilogram = 2.2 pounds 1 ounce = 28.35 grams	
Temperature	The measurement, on a numerical scale, of the hotness or coldness of something. Temperature measures the average kinetic energy of the molecules in something. Heat, though often confused with temperature, refers to the total kinetic energy in something. If you have two containers of water, one large and one small, at the same temperature, the larger container has more heat.	*How hot or cold something is
	The standard SI unit for temperature is degrees Celsius. In everyday life, we often measure temperature on a different scale called the Fahrenheit scale. The freezing point of water is 0°C but 32°F. Scientists use Celsius or the Kelvin scale, which has the same degrees as Celsius but which begins with zero at -273.15°C, the coldest possible temperature, which is known as absolute zero.	

Notes and Comments

This activity is intended as a fun way for students to apply basic measurement skills. Students must measure temperature, mass, and length to solve the puzzle of who pilfered a pin from the local museum and how it was done. Prior instruction on how to read a thermometer, use a balance or scale, and use a ruler is assumed.

The activity can be implemented in various ways. Students may work in teams to solve the case, or they work on it individually. The three areas of measurement – temperature, mass, and length – can be set up simultaneously as stations, or students can work through them sequentially. The temperature measurement activity involves one beaker of very hot water, so the teacher may wish to do this as a demonstration or take precautions so that students are not injured. The measurement of coin masses is the most time-consuming aspect of the activity. It helps to have multiple balances or scales available for student use.

The temperature part of the activity is intended to reinforce that the freezing point of water is 0°C while the boiling point of water is 100°C. Typical room temperature is about 22-25°C. Human body temperature, on the other hand, is about 37°C. The clue, that the museum's temperature sensor was set to near 98.6°C, is meant to be intentionally misleading. Many students may know that normal body temperature is 98.6° but this is on the Fahrenheit scale rather than the Celsius scale that is used in scientific measurements. So, the sensor was set to near the temperature of boiling water rather than the temperature of a human body.

The mass activity allows students to measure the mass of coins in grams. Since students may not be familiar with decimal numbers, and single coins have small masses, the activity is designed to be done by having students measure 10 coins to the nearest gram. The actual masses of ten coins are as follows: pennies – 25g, nickels – 50g, dimes – about 23g, and quarters – about 57g. The U.S. mint publishes the actual masses of coins in grams in its website at http://www.usmint.gov/about_the_mint/?action=coin_specifications. Since the pin weighed 50g, the thief would have used 10 nickels to fool the weight sensor. Other combinations of coins would have been possible. For example, 20 pennies weigh the same as 10 nickels. Students can explore other combinations that might add up to 50g if time permits.

The length activity is designed to give students practice measuring in millimeters and centimeters. Only the Step Van is able to fit into the parking place. Although the Delivery Truck is nearly the same size as the parking place, it would not be able to get in. Of the available suspects, three drove a Step Van, but Sneaky Pete is the likely culprit because he was carrying nickels (which were used to fool the weight sensor). In the final measurement activity, students should measure the length and width of the card and calculate the perimeter to come up with the three numbers to the combination of the safe. The figure of the card was drawn to be 9 x 6 cm (so the combination should be 9, 6, 30) but printing variations may cause the actual dimensions to vary slightly. Have students round to the nearest whole number when measuring.

Inquiry Activity:
The Case of the Pilfered Pin

The local museum needs your help to solve a mystery. A valuable piece of jewelry, a heart-shaped pin, was on display at the museum. One night, someone took it. Your job is to figure out who pilfered (stole) the pin and how it was done.

The Museum

The Pilfered Pin
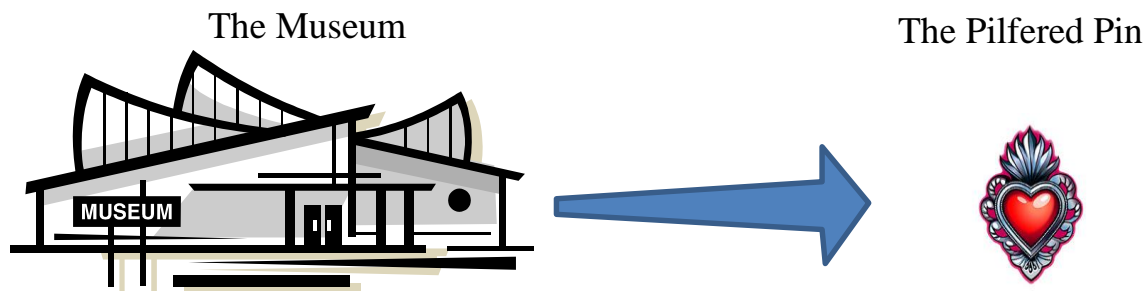
The museum had a security system in place but the pin was stolen anyway. The doors were locked, but at night someone broke in. A temperature sensor in the room with the pin was supposed to sound an alarm if it sensed the body heat from a person in the room, but the alarm did not sound. A weight sensor was supposed to sound an alarm if the weight of the pin was removed, but the thief was able to fool the sensor. Someone passing by the museum on the night of the robbery noticed a truck parked between two cars. It probably belonged to the thief, but no one is sure how to identify the truck.

To solve the mystery, you will need to pay attention to the clues and make measurements. The museum is counting on you to solve the mystery and recover the pilfered pin.
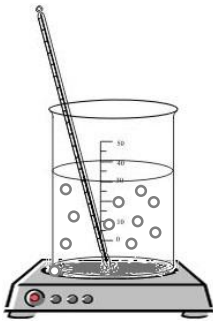
Part 1: Temperature

> *Clue*: The museum had a temperature sensor in the room where the pin was on display. It was supposed to sound an alarm if it detected the body heat from a person in the room. The sensor alarm was set to go off if it detected a temperature near 98.6°C. On the night the pin was stolen the alarm did not sound.
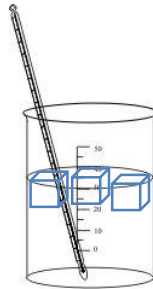
Temperature is a measure of how hot or cold something is. To measure temperature, we use a thermometer. In science, we use thermometers that measure in degrees Celsius.
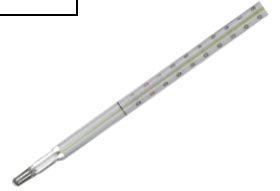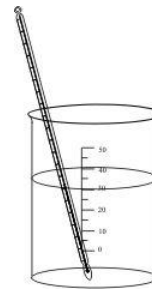
1. Measure the temperature of three beakers of water: (1) hot water (near boiling), (2) ice water, and (3) room temperature water. Write the temperature you measured under each beaker.

   (1) Hot Water   (2) Ice Water   (3) Room Temp Water
   _____ °C   _____ °C   _____ °C

2. What do you think your body temperature is in degrees Celsius? Predict what you think it will be, and write your prediction.

   Predicted body temperature: _____ °C

   Hold the end of a thermometer under your arm (in your armpit) for at least two minutes. What is your body temperature? Write your actual body temperature, in degrees Celsius.

   Actual body temperature: _____ °C

3. Given what you learned from your measurements, why did the body temperature alarm in the museum not go off when the thief was in the room?

Part 2: Mass

> *Clue*: The museum had a weight sensor that was supposed to sound an alarm if the weight of the pin was removed, but the thief was able to fool the sensor by leaving coins in place of the pin. The coins weighed the same as the pin, and so the alarm did not go off.

Mass is the amount of matter in an object. Mass in a particular location can be measured as weight using an instrument such as a scale or balance. In science, we measure mass in units such as grams or kilograms.

1. Predict the mass (weight) of 10 of each type of common U.S. coin in grams. Then, use a balance or a scale to measure the mass of 10 of each type of coin to the closest gram. Write the masses in the table below. Calculate the mass of one coin of each type, and write your calculation in the table.

Coin	Predicted Mass of 10 Coins	Actual Mass of 10 Coins	Calculated Mass of 1 Coin
Penny	g	g	g
Nickel	g	g	g
Dime	g	g	g
Quarter	g	g	g

2. Museum records show that the pilfered pin weighed 50g. If the thief replaced the pilfered pin with 10 coins (all of the same type), which coin did the thief use?

   Is there another way the thief could have replaced the weight of the pilfered pin with coins? How?

Part 3: Length

> *Clue*: Someone passing by the museum on the night of the robbery noticed a truck parked between two cars. It probably belonged to the thief, but no one is sure how to identify the truck. The length of the parking place can be measured. Can you use that to identify the truck?

Length is the measurement of the longest dimension of an object. We can measure length with a ruler or a tape measure. In science, we measure length in units called meters. For smaller objects, we use centimeters (there are 100 centimeters in one meter) and millimeters (there are 10 millimeters in one centimeter).

1. Here is a scale drawing of the parking place where the truck was seen. Measure the parking place in millimeters, and write the measurement below.

Length of Parking Place: _____ mm

2. Here are four trucks that were seen in the area. Estimate the length of each truck. Then, measure the length of each truck in millimeters.

Box Truck

Estimated length _____ mm
Measured length _____ mm

Delivery Truck

Estimated length _____ mm
Measured length _____ mm

Step Van

Estimated length _____ mm
Measured length _____ mm

Dump Truck

Estimated length _____ mm
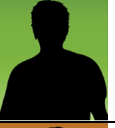Measured length _____ mm

3. Which truck could have fit into the parking place?

The Suspects

The police rounded up a set of suspects from the area. Information about each of the suspects is given in the table below.

Suspect	Name	Vehicle Driven	Other Information
	Annie aka "Artful Annie"	Box Truck	Annie told police she collects coins.
	Buster aka "Buster the Rustler"	Step Van	When police picked him up, Buster had a roll of quarters.
	Coco aka "Loco Coco"	Sports Car	When police picked her up, Coco had lots of coins in her purse.
	Dan aka "Dastardly Dan"	Delivery Truck	Dan had a bag of pens in his truck when the police stopped him.
	Molly aka "Mean Molly"	Dump Truck	Molly told the police she likes jewelry.
	Pete aka "Sneaky Pete"	Step Van	When police picked him up, Pete had a pocket full of nickels.
	Susie aka "Susie Q"	Delivery Truck	Susie told the police she sometimes delivers to the museum.
	Will aka "Chilly Willy"	Step Van	Will told the police he always feels cold.

Based on the clues and your investigation, which suspect do you think pilfered the pin?

The police arrested Sneaky Pete. At his place, they found a safe. The police think Sneaky Pete put the pilfered pin in his safe. But, they don't have the combination. But, they did find a clue – the card shown below. Can you figure out the combination to the safe to recover the pilfered pin? (Round numbers to the nearest centimeter.)

Combination

First number: card length (cm)

Second number: card width (cm)

Third number: card perimeter (cm)

What do you think is the combination to Sneaky Pete's safe? Write your answer in the boxes below.

1st number	2nd number	3rd number

Thank you for your help in solving the Case of the Pilfered Pin! For your help, the Museum awards you a certificate of appreciation.