Penny Plop: An Exploration of Surface Tension

Background and Key Concepts

When water is gently dropped onto a flat surface like a penny, it stays together, forming a small drop, rather than running off the penny. This is due to surface tension, which results from water molecules being attracted to one another. As you drop more and more water on the penny, the water will form a dome shape with a curved upper surface. Eventually, however, the dome becomes too big, and the surface tension can't hold the dome together. The water then spills off the penny's surface. Just how strong is the surface tension of water? How many drops of water do you think one penny can hold?

Hawai'i Content & Performance Standards (HCPS III)

The following standards and benchmarks can be addressed using this lesson:

Math Standard 11: Data Analysis, Statistics, and Probability: FLUENCY WITH DATA: Pose questions and collect, organize, and represent data to answer those questions.

Grade 3 Benchmarks for Math:

Benchmark MA.3.11.1 Pose questions, collect data using surveys, and organize the data into tables and graphs.

Grade 4 Benchmarks for Math:

Benchmark MA.4.11.1 Pose questions, collect data using observations and experiments, and organize the data into tables or graphs.

Math Standard 12: Data Analysis, Statistics, and Probability: STATISTICS: Interpret data using methods of exploratory data analysis.

Grade 4 Benchmarks for Math:

Benchmark MA.4.12.1 Compare related data sets (e.g., height of 4th grade boys vs. height of 4th grade girls) with an emphasis on how the data are distributed.

Grade 5 Benchmarks for Math:

Benchmark MA.5.12.1 Determine the range, median, mode, and mean for a data set.

Grade 6 Benchmarks for Math:

Benchmark MA.6.12.1 Determine and interpret the measures of center (mean, median, mode) of a data set and explain what each measure indicates about the data set.

Math Standard 13: Data Analysis, Statistics, and Probability: DATA ANALYSIS: Develop and evaluate inferences, predictions, and arguments that are based on data.

Grade 4 Benchmarks for Math:

Benchmark MA.4.13.1 Propose and justify conclusions/predictions based on data.

Grade 5 Benchmarks for Math:

Benchmark MA.5.13.1 Design studies to further investigate the conclusion/predictions made based on data.

Science Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.

Grade 3 Benchmarks for Science:
Benchmark SC.3.1.1 Pose a question and develop a hypothesis based on observations.
Benchmark SC.3.1.2 Safely collect and analyze data to answer a question.

Grade 4 Benchmarks for Science:
Benchmark SC.4.1.1 Describe a testable hypothesis and an experimental procedure.

Grade 5 Benchmarks for Science:
Benchmark SC.5.1.1 Identify the variables in scientific investigations and recognize the importance of controlling variables in scientific experiments.
Benchmark SC.5.1.2 Formulate and defend conclusions based on evidence.

Grade 6 Benchmarks for Science:
Benchmark SC.6.1.1 Formulate a testable hypothesis that can be answered through a controlled experiment.
Benchmark SC.6.1.2 Use appropriate tools, equipment, and techniques safely to collect, display, and analyze data.

Materials

- Penny
- Water
- Paper towel (or small dish)
- Medicine dropper (or plastic pipette)

Procedure

1) How many drops of water will fit on a penny before the water runs off? Record your prediction, or hypothesis, here: _____
2) Place the penny on a piece of paper towel (or on a small dish)
3) Drop water onto the penny using the medicine dropper (or pipette), counting the number of drops as you go.
4) Keep dropping water and counting the drops until the water finally runs off the penny.
5) Record the number of drops in Table 1.1 below (the last drop that caused the water to run off should not be included in your total).
6) Perform a second trial, record the number of drops in the table, and calculate the average number of drops that the penny held in your two trials.
7) Compare your results to your prediction. Are you surprised?

Table 1.1

Trial #	Number of drops
1	
2	
Average	

8) Ask three other students how many drops they put on the penny (use their averaged values). Record their values in Table 1.2 below.

Table 1.2

Other Students	Number of drops
Student #1	
Student #2	
Student #3	
Average	

9) Was the average number of drops you put on the penny the same as for the other students? If not, list three reasons that could explain why you may have gotten different results:

   a.

   b.

   c.

Explanation

There are many reasons why the maximum number of drops of water a penny can hold may vary. Some pennies might be old and rough, and others shiny and new. Some students may have squeezed out bigger drops, or held their dropper at a greater height. Some may have used the "head" side of the coin, others the "tail"side. Does the side of the coin make a difference? Why not do an experiment to find out?

Extensions

Extension 1:

1) Do you think the surface tension of the water is affected by the side of the penny on which it is dropped? Record your hypothesis here:

2) Which side of the penny did you use the first time? Heads Tails (Circle One)

3) Repeat the experiment, this time using the other side of the coin. Record your results in Table 1.3 below.

Table 1.3

Trial #	Number of drops
1	
2	
Average	

4) Was the number of drops you put on this side of the penny the same number as you got using the other side of the penny?

5) If not, list three reasons why the results might not be the same:

   a.

   b.

   c.

6) Which of the following did you apply in your investigation? Circle all that you used.
   a) Posed a question
   b) Made a prediction (hypothesis)
   c) Designed and conducted a simple investigation
   d) Collected data
   e) Analyzed the data
   f) Identified variables (factors which could affect the results)
   g) Made a conclusion
   h) Asked another question for further investigation.

Extension 2**:** Explore the surface tension of other liquids such as milk, soapy water, or salt water.