**A Penny Puzzle**

Today you will do some measuring and some calculating. You will need the following formulae

Density = mass/volume volume of a cylinder = πr2h

**Background information:**

You will be measuring the mass and volume of two different sets of pennies. One set of pennies is from before 1996, the other set is from after 2000. If you measure and calculate carefully, you should be able to detect a difference between the densities of the two groups. Using this information, you will be able to determine something about what the different pennies are made of.

**Materials (per group)**

One graduated cylinder, 2 cups of pennies (A and B), cm ruler with mm marked on it

**Materials (shared)**

Balance

**Procedure:**

**Part A – using a ruler to measure the pennies**

1. Begin with your group A pennies. Make sure you keep the group A and B pennies separate throughout the experiment.
2. Using a ruler, measure the thickness of one penny. Record in your data table (in cm)
3. Measure the diameter of the penny. Record in your data table
4. Divide the diameter by 2 to get the radius. Record in your data table
5. Measure the thickness of a stack of 5 pennies. Record in your data table.
6. Divide the thickness of the stack by 5 to get the thickness of one penny. Record in your data table.
7. Repeat steps 2-6 for the group B pennies

|  |  |  |
| --- | --- | --- |
|  | Group A | Group B |
| Thickness of 1 penny (cm) |  |  |
| Diameter of penny (cm) |  |  |
| Radius of penny (cm) |  |  |
| Thickness of 5 pennies(cm) |  |  |
| Thickness of 5 pennies/5 (cm) |  |  |

**Part B – finding the mass of the pennies**

1. Make sure the balance is zeroed before you begin.
2. Find the mass of one group A penny. Record in your data table
3. Find the mass of 5 group A pennies. Record in your data table
4. Divide the mass found in #3 by 5 to get the mass of one penny. Record in your data table
5. Repeat steps 1-4 for the group B pennies.

|  |  |  |
| --- | --- | --- |
|  | Group A | Group B |
| Mass of 1 penny (g) |  |  |
| Mass of 5 pennies (g) |  |  |
| Mass of 5 pennies/5 (g) |  |  |

Part C – finding the volume of the pennies by displacement. Note – 1 mL = 1 cm3

1. Partially fill your graduated cylinder with tap water. Measure and record the volume of water
2. Place one group A penny into the cylinder. Record the new volume of the water.
3. Subtract volume #1 from volume #2 to get the volume of one penny.
4. Place the other four group A pennies into the cylinder. Record the new volume.
5. Subtract volume #1 from volume #4 to get the volume of the 5 pennies. Record the volume
6. Divide the volume of the 5 pennies to get the volume of 1 penny. Record the volume.
7. Repeat steps 1-6 with the group B pennies

|  |  |  |
| --- | --- | --- |
|  | Group A | Group B |
| Volume of water in cylinder (mL) |  |  |
| Volume of water + 1 penny (mL) |  |  |
| Volume of 1 penny (cm3) |  |  |
| Volume of water + 5 pennies (mL) |  |  |
| Volume of 5 pennies (cm3) |  |  |
| Volume of 5 pennies/5 (cm3) |  |  |

**Part D – clean up**

1. Dry off pennies and return to their proper cups
2. Return cups of pennies and empty graduated cylinders to their appropriate locations.

**Analysis - Calculations**

1. Using your radius and height/thickness data, calculate the volume of both the group A and the group B pennies. You should do this both with the height you measured for one penny and the height of the stack divided by 5. Show your work.

|  |  |
| --- | --- |
| Group A | Group B |

1. Using your volumes calculated above and the masses you found, calculate the densities of the group A and group B pennies. You may use the mass of the single penny or the 5 pennies divided by 5, whichever you feel is more accurate. Show your work.

|  |  |
| --- | --- |
| Group A | Group B |

1. Using the volumes found by displacement and the masses, find the densities of each group of pennies. Which of the displacement volumes will you use for this calculation? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| Group A | Group B |

Analysis – Application

1. What was the point of measuring the height, volume, or mass of 5 pennies and then dividing instead of just a single one?
2. Look at a table of metal densities (the teacher has several) and see if you can find some that are close to the densities you determined for your group A and group B pennies. What do you think the two groups of pennies are made of?
3. Why might the Royal Canadian Mint have changed the composition of the penny?
4. Jewellers can use density to find out if a piece of “gold” jewellery is really gold. Describe how they might do this.