Team: 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(captain) 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (timer) 5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(cleaner)

 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(recorder) 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(fetcher) 6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Carefully read and follow each step. Pay close attention to the number of sig figs and use the rules for doing calculations with significant figures and rounding. Check-in with teacher after completing each Part.

**Part I. Calculate Surface of Lab Table Check-in \_\_\_\_\_\_\_\_\_**

1. Measure the length and width of your lab table and calculate the surface area. Each member of the team must measure individually. Put results in data table. Surface area = length x width

|  |  |  |  |
| --- | --- | --- | --- |
| Member | Length (cm) | Width (cm) | Surface area (cm2) |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| AVG |  |  |  |
| Range |  |  |  |
|  ± |  |  |  |
| % error |  |  |  |
| Final |  ± |  ± |  ± |

1. How many places after the decimal should each measurement have? Why?

**Part II. Determine Mass of Objects Check-in \_\_\_\_\_\_\_\_\_**

1. Using a 3-beam balance, determine the mass of each of the metal slug. Calculate the volume of each cylinder. **Perform four trials using four different members**.

|  |  |  |
| --- | --- | --- |
| Member | Aluminum (Al) slug | Copper (Cu) slug |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| AVG |  |  |
| Range |  |  |
|  ± |  |  |
| % error |  |  |
| Final Mass |  |  |

**Part III. Calculate volume of a cylinder. Check-in \_\_\_\_\_\_\_\_\_**

Perform four trials with four different members. Record final answer using ±. The formula for volume of a cylinder is: Volume = $πr^{2}h$

|  |  |  |
| --- | --- | --- |
|  | Aluminum slug | Copper slug |
| Member | Diameter (cm) | Radius *r* (cm) | Height *h* (cm) | Volume (cm3) | Diameter (cm) | Radius r (cm) | Height h (cm) | Volume (cm3) |
| 2 |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |
| AVG |  |  |  |  |  |  |  |  |
| Range |  |  |  |  |  |  |  |  |
|  ± |  |  |  |  |  |  |  |  |
| % error |  |  |  |  |  |  |  |  |
| Final |  |  |  |  |  |  |  |  |

Final calculated volume of aluminum slug = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ± \_\_\_\_\_\_\_\_\_\_\_\_.

Final calculated volume of copper slug = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ± \_\_\_\_\_\_\_\_\_\_\_\_.

1. What is the capacity and the precision of the balance?

**Part IV. Determine Volume by Displacement. Check-in \_\_\_\_\_\_\_\_**

1. Determine the volume of each cylinder by water displacement. Perform three trial using three different members.
	1. Fill the cylinder about half way with water. Read the volume of the water. Record in table.
	2. Tilt the cylinder and slide the slide into the water. Be careful not to splash and lose water.
	3. Record the water level. Calculate volume of slug using subtraction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metal slug | Member | Volume of water (mL) | Volume of water and slug (mL) | Volume (mL) |
| Al slug | 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Cu slug | 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |

1. Calculate average, range, ± amount and % error for each metal slug. Record your final result below.

Final determined volume of aluminum (Al) slug: \_\_\_\_\_\_\_\_\_\_\_\_\_\_± \_\_\_\_\_\_\_mL

Final determined volume of copper (Cu) slug: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_± \_\_\_\_\_\_\_mL

**Part V. Volume Comparison Check-in \_\_\_\_\_\_\_\_**

1. Let’s check your measuring accuracy by comparing your calculated volume in Part 3 to your determined volume in Part 6. Calculate the percent error using the formula below.

% error = $\frac{calculated volume-determined volume}{determined volume}$ x 100%

|  |  |  |
| --- | --- | --- |
|  | Al slug | Cu slug |
| Calculated volume (mL) |  |  |
| Determined volume (mL) |  |  |
| Difference |  |  |
| % error\* |  |  |

\* Drop the negative sign if you have one.

1. What is the capacity of the graduate cylinder?

**Part VI. Measuring the Temperature. Check-in \_\_\_\_\_\_\_\_\_\_**

1. Use the thermometer to record the room temperature using the correct number of sig figs.

Room temperature = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_°C

1. Allow the thermometer in a beaker of cold water for 1 minute then record the temperature.

Water temperature = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_°C

1. Calculate and record the difference in temperature using the correct sig figs.

Difference = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_°C

**Part VII. Questions.**

**Each team member must hand in his/her own answers to the questions on a separate sheet of paper.**

1. The precision of an instrument is limited by how close together the lines are on the instrument. The lines are called **hatch marks**. What is the precision of the meter sticks used in class? In other words, what is the last decimal digit that can be estimated using the hatch marks? Report answers in centimeters and explain why it is this way.
2. Compare the precision of your area and volume calculations with the precision of your length measurements. Which is more precise? Why?
3. What is the theoretical precision of the 3-beam balance based on the hatching? Explain your reasoning.
4. What is the plus/minus amount for the 3-beam balance based on the data collected by your team members? Is this better or worse that the theoretical plus/minus amount in Q14?
5. Explain why members were seldom (if ever) able to get the same measurement even when everyone was carefully measuring the same way?
6. What are significant figures and what they tell about a measurement?
7. Look the following data: 456.324 cm, 455.995 cm, 456.198, 455.884 cm
	1. Calculate the average, range, plus/minus, and percent error. Report answer using proper number of sig figs with the ± amount.
8. How can you use a set of data which you collected to figure out the proper number of sig figs? Consider the calculations you just completed in Q8.
9. What is human error? Give two examples.
10. What is systematic error? Give two examples.
11. What is random error? Giver two examples.
12. You calculated the percent error for Parts I-V in this experiment. Determine your level of precision. Excellent precision (<1%) Good precision (1-3%) Poor precision (>3%)

 Part I \_\_\_\_\_\_\_\_\_\_ Part II \_\_\_\_\_\_\_\_\_\_ Part III \_\_\_\_\_\_\_\_\_\_ Part IV \_\_\_\_\_\_\_\_\_\_ Part V \_\_\_\_\_\_\_\_\_\_