(TA INITIALS)

FIRST NAME (PRINT) LAST NAME (PRINT) BROCK ID (AB17CD) (LAB DATE)

Experiment 1

Archimedes' principle

In this experiment you will determine the unknown ratio of copper (Cu) to aluminum (Al) in a simulated "alloy" of the two metals . The experimental apparatus consists of a precise digital weight scale, a volumetric flask, a pipette, distilled water, a long bar of Cu, a long bar of Al, and a simulated Al/Cu "alloy" made up of two short bars of Al and Cu.

For each of the three metals (Al, Cu and the Al/Cu "alloy") you will need to perform three separate measurements, as summarized in Fig. 1.1:

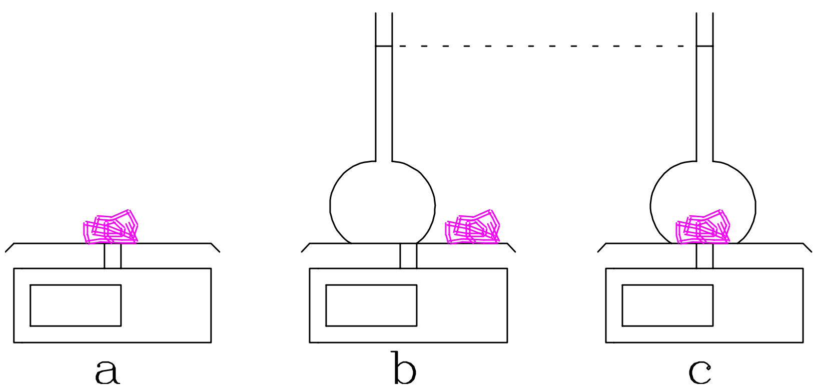

Figure 1.1: The three steps must be repeated for each metal

(**a**) weight $w_{\mathbf{a}}$ of the piece of metal;

(**b**) weight $w_{\mathbf{b}}$ of the piece of metal and of the volumetric task filled with distilled water to the exact mark on the neck of the flask;

(**c**) weight $w_{\mathbf{c}}$ of the piece of metal *submerged in* the volumetric task filled with distilled water to the exact same mark.

You will need to withdraw some water from the volumetric flask between steps (**b**) and (**c**). This is best achieved by simply pouring off some water and then adding the required amount back, drop-by-drop from the pipette when the level gets close to the target mark.

These weight measurements rely heavily on your experimental technique. To avoid introducing errors, be careful not to have any stray water droplets on the piece of metal, on the body of the flask or on the scale platform itself.

To get a feeling for how these experimental errors affect your results, you will repeat steps (**a**)–(**c**) several times and perform a statistical analysis of the data to determine the sample average $\langle w \rangle$ and the standard deviation $\sigma(w)$, which is a measure of how closely your data is distributed around $\langle w \rangle$.

Part 1: Aluminum bar

$\boxed{?}$ A major source of random error in this experiment is the precision with which you can reproduce the exact same water level time after time. How much does the water level rise after a drop is added?

- Starting with the aluminum bar, fill in Table 1.1. Proceed column by column.
- Close any open Physicalab windows, then start a new Physicalab session by clicking on the desktop icon and login with your Brock student ID. You will be emailing yourself all the graphs that you create for later inclusion in your lab report.

Al	1	2	3	4	5	6	7	8	9	$\langle w \rangle$	$\sigma(w)$
Metal bar, $w_{\mathbf{a}}$											
Metal & flask, $w_{\mathbf{b}}$											
Metal in flask, $w_{\mathbf{c}}$											

Table 1.1: Experimental data for aluminum bar

- In Physicalab, click `File, New` to clear the data entry window, then enter in a column the data points from step (**a**) for the aluminum metal bar. Click `Edit, Insert X index` to insert a column of indices to your data points, then select `scatter plot` and click **Draw** to view the variation in your data.
- Select `bellcurve` and click `bargraph` to view the distribution of your data. Physicalab has calculated the average $\langle w \rangle$ and standard deviation $\sigma(w)$ of your data set and these values are shown in the graph window as $\langle w \rangle \pm \sigma(w)$. Enter these two values in the $\langle w \rangle$ and $\sigma(w)$ columns of Table 1.1.
- Repeat the above steps for the `Metal & flask` data set and the `Metal in flask` data set.
- You can now determine the specific gravity S_{Al} of aluminum with the aid of Equation 1.4 and your results from Table 1.1:

$$S_{Al} \;=\; \ldots\ldots\ldots\ldots\ldots\ldots \;=\; \ldots\ldots\ldots\ldots\ldots\ldots \;=\; \ldots\ldots\ldots\ldots\ldots\ldots$$

$$\Delta(S_{Al}) \;=\; \ldots\ldots\ldots\ldots\ldots\ldots \;=\; \ldots\ldots\ldots\ldots\ldots\ldots \;=\; \ldots\ldots\ldots\ldots\ldots\ldots$$

Part 2: Copper bar

- Proceed to acquire data and fill in Table 1.2 for the copper bar.

Cu	1	2	3	4	5	6	7	8	9	$\langle w \rangle$	$\sigma(w)$
Metal bar, $w_{\mathbf{a}}$											
Metal & flask, $w_{\mathbf{b}}$											
Metal in flask, $w_{\mathbf{c}}$											

Table 1.2: Experimental data for copper bar

S_{Cu} = ... = ... = ...

$\Delta(S_{Cu})$ = ... = ... = ...

Part 3: Alloy bar

- Complete Table 1.3 for the Al/Cu alloy bar composed of the two short Al, Cu bars.

Alloy	1	2	3	4	5	6	7	8	9	$\langle w \rangle$	$\sigma(w)$
Metal bar, $w_{\mathbf{a}}$											
Metal & flask, $w_{\mathbf{b}}$											
Metal in flask, $w_{\mathbf{c}}$											

Table 1.3: Experimental data for Al/Cu alloy bar

S_{alloy} = ... = ... = ...

$\Delta(S_{alloy})$ = ... = ... = ...

Part 4: Results

- Measure the weight m_{Al} of the short bar of aluminum and the weight m_{Cu} of the short bar of copper that make up the alloy bar. Include the error in these measurements. These are the theoretical values that will be used to compare to your experimental results based on the previously calculated specific gravities of the various materials.

m_{Al} = ... $\pm$ .... m_{Cu} = ... $\pm$ ....

- From these measurements, determine the theoretical mass ratio of your "alloy" and the magnitude of uncertainty, or error, in this result:

$$\frac{m_{\mathrm{Al}}}{m_{\mathrm{Cu}}} = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots$$

$$\Delta\left(\frac{m_{\mathrm{Al}}}{m_{\mathrm{Cu}}}\right) = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots$$

- Use Equation 1.5 to calculate the experimental mass ratio and the associated error for your "alloy":

$$\frac{m_{\mathrm{Al}}}{m_{\mathrm{Cu}}} = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots$$

$$\Delta\left(\frac{m_{\mathrm{Al}}}{m_{\mathrm{Cu}}}\right) = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots$$

! Important! Be sure to have this printout signed and dated by a TA before you leave at the end of the lab session. All your work needs to be kept for review by the instructor, if so requested.

Lab report

Go to the "Lab Documents" web page to access the online lab report template for this experiment. Complete the template as instructed and submit it to Turnitin before the lab report submission deadline, late in the evening six days following your scheduled lab session. Do not wait until the last minute. Turnitin will not accept overdue submissions. Unsubmitted lab reports are assigned a grade of zero.