# SPECIFIC HEAT CAPACITY

Specific Heat Capacity of Metals Lab

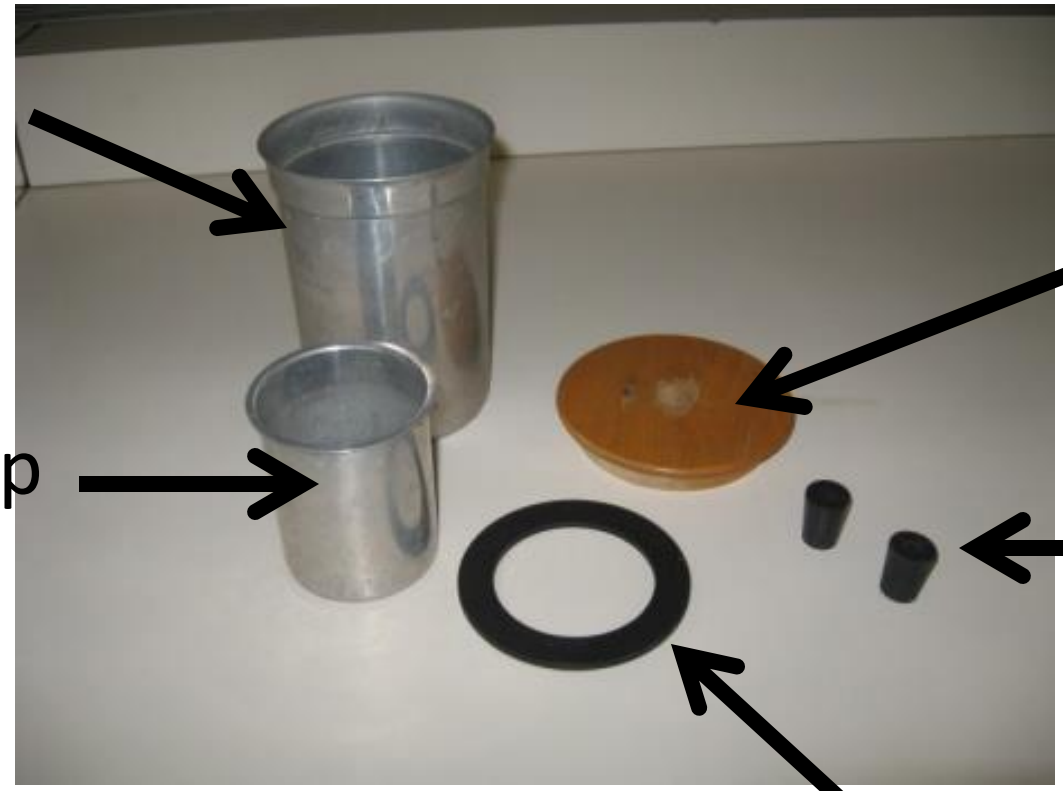
# The Goal:

- Determine the specific heat capacity of a an unknown type of metal using the Law of Conservation of Energy.
- Comparison of the specific heat values found during the lab versus the actual known values of specific heat capacity of the metal used.
- Calculate the percent error using the comparison values.

# The setup:

- Gather the following materials:
  - 1 metal cylinder (unknown metal)
  - 1 string or metal tongs
  - 1 balance
  - 1 hot plate
  - 1 calorimeter (aluminum)
  - Celsius thermometer
  - 2 beakers filled half-way with water (room temp.)
  - 1 Graduated cylinder
  - Pipette (dropper)

# CALORIMETER CUP

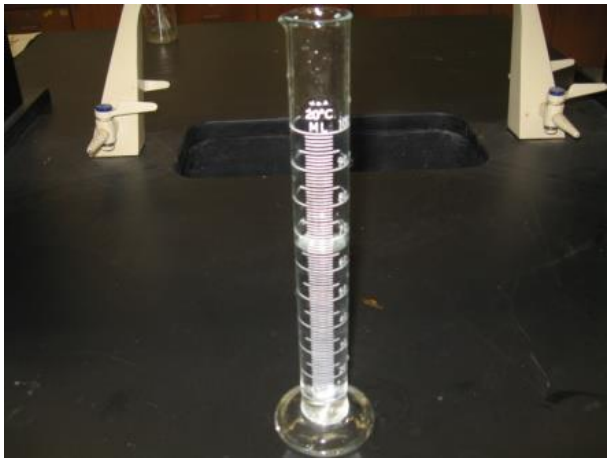


# PROCEDURES:



- Fill the beaker half way with water, place on the hot plate and bring the water to a boil.
- While waiting for this to boil, setup the calorimeter ***away*** from the hot plate.
- This involves using the balance which must be zeroed or “tared” prior to use.
- Record the mass of the empty aluminum inner cup.

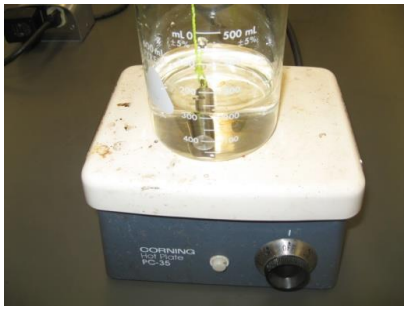
# PROCEDURES:

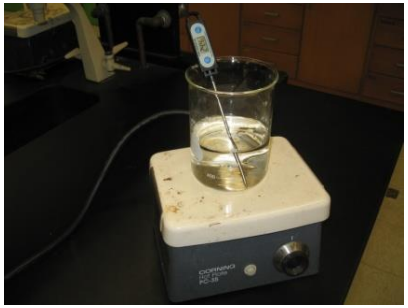


1 mL of water = 1 gram

- Using a graduated cylinder and a pipette, ***<u>carefully</u>*** measure out **60.0 mL** of cool water and then pour into the calorimeter cup. This must be exact!!!
- Re-mass the cup with the water.
- Using a pipette carefully increase the amount of water in the cup so that the amount of water is equal to 60.0 mL. (think about why you need to do this).
- Place the inner cup into the outer cup of the calorimeter and cover quickly with the lid and stoppers

# PROCEDURES:

- Measure the mass of unknown metal.
- Using a string or metal tongs, lower the metal mass into the boiling water and allow to boil for a few minutes.
- Using the same thermometer for all temperature readings, measure the temperature of the boiling water in °C. You will need to wait until you are sure the thermometer has reached the highest value.
- This will be the **initial** temperature of the unknown metal.

# PROCEDURES:

- Cover the large center hole of the assembled calorimeter with the stopper.
- ***Cool the thermometer*** (run it under cool water) and then place it in the calorimeter (use the small hole).
- Record the temperature of the cool water in the calorimeter ***immediately before*** the hot metal is placed into the calorimeter.
- This will be the **initial** temperature of the cool water and the aluminum calorimeter cup.

# PROCEDURES:

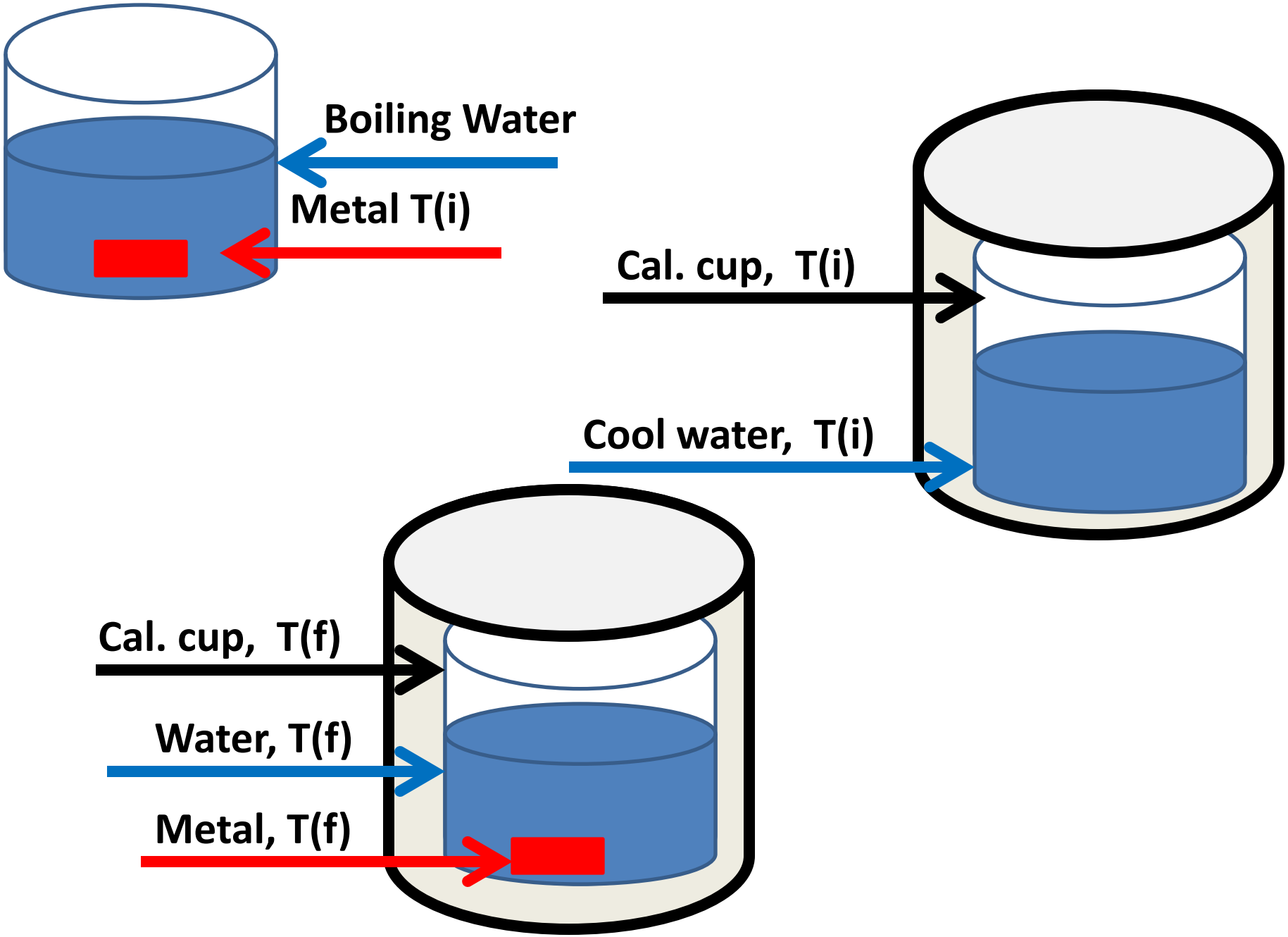

- After a few minutes of boiling, remove the metal mass and ***quickly*** place into the calorimeter.
- Be sure the metal cylinder is on its side in the calorimeter cup.
- Cover the large center hole with the stopper.
- Keep the thermometer in the smaller hole.
- Swirl the calorimeter gently.
- When the temperature of the water reaches its ***highest point***, record that as the **final temperature** of the cool water, the aluminum calorimeter cup, and the metal being tested.

# REMINDERS:

Calculating Specific Heat: $Q = mC\Delta T$

- Q = heat energy in joules
- m = mass in kilograms or grams
- C = specific heat of the substance (J/kg°C)
- (J/g°C)
- ΔT = change in temperature (T2 – T1)
- You will have ΔT for the unknown metal, the aluminum calorimeter, and the cool water.
- Find the average specific heat value found by all lab groups. That will be the basis of determining what type of metal you have.

- _____Mass of the unknown metal
- _____Mass of the Cool Water
- _____Mass of the Aluminum Calorimeter Cup
- _____Initial temperature of the Aluminum Calorimeter Cup
- _____Initial temperature of the Cool water in the Calorimeter Cub
- _____Initial temperature of the unknown metal (in the boiling water)
- _____Final temperature of the Aluminum Calorimeter Cup (after the unknown metal is placed in the cup)
- _____Final temperature of the Cool Water (after the unknown metal is placed in the calorimeter cup)
- _____Final temperature of the unknown metal (after the unknown metal is placed in the calorimeter cup)


Boiling Water
Metal T(i)
Cal. cup, T(i)
Cool water, T(i)
Cal. cup, T(f)
Water, T(f)
Metal, T(f)

# EQUATIONS:

- Heat gained by the cool water and calorimeter cup as it heats up is lost by the metal as it cools down. "Conservation of heat energy)

$$Q = mc\Delta T$$

Q gained = $(m_{coolwater}c_{coolwater}\Delta T_{coolwater}) + (m_{Al}c_{Al}\Delta T_{Al})$

Q lost = $m_{unknown}c_{unknown}\Delta T_{unknown}$

Q gained by the cool water & calorimeter cup = Q lost by the unknown metal

$(m_{cw}c_{cw}\Delta T_{cw}) + (m_{Al}c_{Al}\Delta T_{Al}) = m_{um}c_{um}\Delta T_{um}$

- Manipulate the formula to find $c_{um}$ (specific heat of the unknown metal)

# WHAT IS THE UNKNOWN METAL?

- Use the Specific Heat chart to see what the metal is.
- Once the type of metal is determined, calculate the percent error.

| Specific Heat J/g°C | |
|---|---|
| Water | 4.186 |
| Aluminum | 0.900 |
| Copper | 0.386 |
| Steel | 0.448 |
| Tin | 0.210 |
| Zinc | 0.390 |

# PERCENT ERROR:

$$\% \text{ error} = \frac{\text{Accepted Value} - \text{Experimental Value}}{\text{Accepted Value}} \times 100$$

- In order to find out how close the measurements of specific heat are to the “accepted” or actual value, the measured or “experimental” values are compared to the “accepted” values.
- Use the class average of specific heat as the “experimental” value.

# DATA & ANALYSIS TABLES

- Design a data table to accommodate all the data you need to collect.
- Design an

The end…