# Chemistry: Measurement and Instruments Lab

SENIOR HIGH SCHOOL

**This lab is different from most of our upcoming labs. You will visit several stations and do short activities. Because of this, your "Pre-Lab" will be different than it will be for most labs. Follow the directions very carefully!**

**Instructions for your lab notebook writeup:**

1. **In your notebook, the first page for this lab will only have the following:**
    - **Title, Date, Partner name, Purpose and Pre-Lab Questions.**
    - **All other parts will go on different pages (see instructions below)**
2. **You will only need 1 "Purpose" section for the entire lab. You do not need a new one for each station.**
3. **You will only need 1 "Pre-Lab Questions" section for the entire lab. You do not need a new one for each station.**
4. **Each station needs to be on a new page. There are 6 stations. For each station include the following:**
    - **Heading in margin:** Station Number and Station Name
    - **Safety Concerns:** list all safety concerns for that station
    - **Procedure:** Description of the instructions that proves that you have read and understand the instructions.
    - **Data/Observations:** Make space for this and leave it blank. You will add the data when you do the lab.

---

**Introduction:**
Chemistry is a lab-based course. Therefore, it is required that you have a thorough understanding of the concepts, measurements and equipment needed in the lab as well as how to use them safely. This activity is designed to expose you to a few of the essential tools in the lab and to practice your measurement and math skills.

**Safety Concerns:**
*Safety concerns must be included with each station. Identify the safety concerns by reading the procedure and listing them in your "Safety Concerns" section*

**Background:**
*You will not need a background section for this lab or for any of the stations*

**Pre-Lab Questions:**
*****You may use the internet to help answer these questions

1. Define **Mass**
2. Define **Volume**
3. Explain **Volume Displacement**
4. Define **Density**
5. Define **pH**
6. Define **Acid**
7. Define **Base**

8. What does **temperature** measure?
   a. On a molecular level, how is water at high temperature different from water at cooler temperature?
9. How do you convert from °C to °F?
10. How do you convert from °F to °C?
11. Define **Kelvin**
12. How do you convert from °C to K?
13. Define **percent error.**
14. Explain how you calculate **percent error**.

---

## Station 1: Measuring Temperature

## Station 1a "Old School Temperature"

(If you have not yet set up Vernier Graphical Analysis on your Chromebook follow this step) Set up your Chromebook and Bluetooth sensor before starting this station. Follow the instructions here: Vernier Graphical Analysis Setup for Chromebook

**-Using an alcohol filled thermometer:**

1. Get a cold cup of water, record the temperature ___________ deg. C
2. Convert your answer above to deg. F
3. Get a hot cup of water, record the temperature ___________deg. C
4. Convert your answer above to deg. F

## Station 1b "New School Temperature"

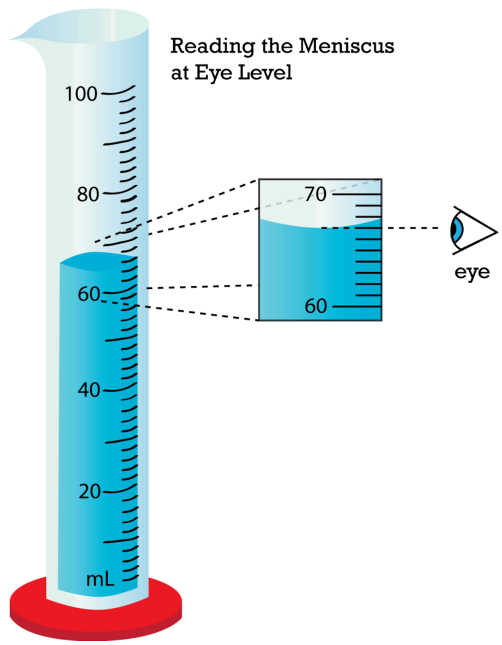
**-Using the temperature probe and computer:**

1. Set up your Chromebook and Bluetooth sensor before starting this station. Follow the instructions here: Vernier Graphical Analysis Setup for Chromebook
2. Get a cold cup of water, record the temperature ___________ deg. C
3. Convert your answer above to deg. F
4. Get a hot cup of water, record the temperature ___________deg. C
5. Convert your answer above to deg. F

## Station 2 "Density of an Unknown Metal"

Purpose: Determine the density of an unknown metal using the "Water Displacement Method"

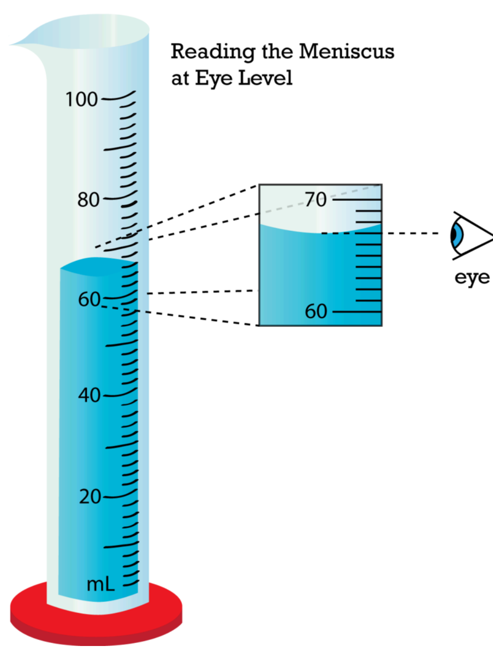
1. Obtain a piece of the unknown metal and record the mass.
2. Using volume displacement, determine the volume displaced by the metal.
    a. Do you know how to measure the volume of liquid in a graduated cylinder by measuring at the bottom of the meniscus? If not, see the picture for an example →
    b. Add distilled water to a 10 ml graduated cylinder up to the 5 ml line and record the exact volume to the proper number of significant figures
    c. Hold the graduated cylinder at an angle and slide the metal gently down the side without splashing any water or breaking the glass cylinder
    d. The water level should rise
    e. Record the new volume of the water exactly
    f. Subtract the initial volume from the final volume to determine the volume of the metal.
3. Calculate the **density** of the unknown metal




## Station 3 "Finding the Density of Water"

To get an accurate mass, press the "tare" button before you place anything on the balance. It should now read 0.00 grams. Place the object on the balance and record the data.

1. Find the mass of an empty Dixie cup_________g
2. Accurately measure 10 mL of distilled water in a graduated cylinder and pour into the cup from above, find the mass of cup and water __________g
    a. Do you know how to measure the volume of liquid in a graduated cylinder by measuring at the bottom of the meniscus? If not, see the picture for an example →



3. Subtract the mass of the empty cup from the mass of the cup with water _________g (this is the mass of the water).
4. Find the density of the water (remember, you used a volume of 10mL) ____________g/mL

---

## Station 4 “Measuring Irregular Objects”

This is a “problem solving” station to see if you can use the equipment provided to collect the needed data. Be creative and think critically.
To get an accurate mass with a digital balance, press the “tare” button before you place anything on the balance. This resets the scale to 0. It should now read 0.00 grams. Place the object on the balance and record the data.

1. Find the mass of a ping pong ball ________ g
2. Find the mass of a golf ball ________g
3. Find the volume of the ping pong ball _________ (label?)
4. Find the volume of the golf ball __________ (label?)
5. Calculate the density of the golf ball _________(label?) and ping pong ball _________ (label?)
6. Which of the following characteristics is closest to the same between the ping pong ball and golf ball *mass*/*volume*/*density*.

---

## Station 5: “Fire”

A thermocouple is a rugged sensor designed to measure temperatures from -200°C to 1400°C. When using, only put the tip of the wire itself in the flame, not the insulated portion. Do not leave the wire in the flame for too long or it can melt.

(If you have not yet set up Vernier Graphical Analysis on your Chromebook follow this step) Set up your Chromebook and Bluetooth sensor before starting this station. Follow the instructions here: Vernier Graphical Analysis Setup for Chromebook

There are two adjustments for the Bunsen burners

1) The bottom turn knob controls the amount of gas to the burner
2) The barrel of the burner controls the amount of air (oxygen) to the burner

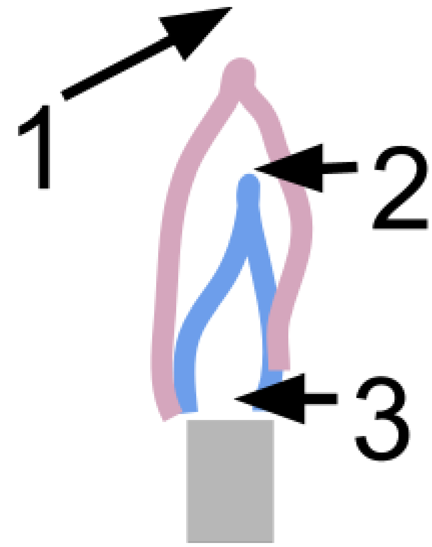
Before lighting the burner, be sure to move anything flammable away from the burner and have long hair tied back

1) Light the match first, then have your partner turn the gas valve on the lab table all the way on (in line with the gas tube)

2) Bring the match towards the burner from the bottom side and slowly raise the match until the burner lights
3) If the burner does not light, turn the gas off and repeat (the gas control knob or barrel may have to be adjusted to light the burner)

After your burner is lit

1) Adjust the burner until you get the "refinery flame" (A large bright yellow flame)
2) Adjust the burner until you get the "roaring flame" (A blue dancing, noisy flame)
3) Adjust the burner until you get an inner blue cone with little to no roaring noise




1. Turn on the Vernier Thermocouple and pair it with your chromebook. (Need help? Click here [Vernier Graphical Analysis Setup for Chromebook])
2. Set your bunsen burner to have a perfect blue cone flame. **Draw a diagram** of a perfect blue Bunsen burner flame and measure the temperatures with the thermocouple. Record the temperature of the flame in each of the three areas listed on the example to the right.
3. Turn off the gas
4. Turn off the Thermocouple

---

## Station 6: Measuring pH

### Station 6a: "pH1 Acid or Base"

1. Obtain 5 strips of pH paper (do not allow them to get wet).
2. Drip one drop of solution A on one strip of pH paper over a beaker (to catch any runoff), analyze the color by comparing to the chart to determine the pH.
3. Create a chart in your lab notebook showing the solution, and pH of each solution.
4. Repeat for solutions B-E.
5. Discard all pH paper in the garbage and clean up the station.

### Station 6b: "pH with precision probeware"

The Vernier pH probe has a small amount of electricity running through the tip. As the sensor encounters free floating Hydrogen ions in the solution (free floating H ions determine acidity), the voltage changes allowing the sensor inside to determine the pH. The sensor can easily be damaged by dropping or by leaving solutions on it for prolonged periods. *Be sure to rinse the sensor with distilled water after each use AND store in the plastic bottle before you leave the station.*

1. (If you have not yet set up Vernier Graphical Analysis on your Chromebook follow this step) Set up your Chromebook and Bluetooth sensor before starting this station. Follow the instructions here: Vernier Graphical Analysis Setup for Chromebook
2. Carefully drip 30 drops of solution A into the large test tube.
3. Insert pH probe and record solution letter and pH in a data table in your lab notebook.
4. Carefully pour into the sink.
5. Rinse the probe with water.
6. Repeat steps 1-4 for test tube solutions B-E.
7. Rinse pH probe and test tube with distilled water and put the bulb end into its protective liquid before moving to 6c.

## Station 6c: "pH2 Using Universal Indicator"

Determine the pH of each using Universal Indicator. Universal Indicator is a mixture of several compounds that react with pH by changing color depending on the concentration of the acid or base.

1. Create a data table and record the color and the pH (use the chart to compare color/pH)
2. Drip 5 drops of each solution into the "wells" on the white porcelain well plate. (You will need to keep track of which well contains each solution)
3. Drop 5 drops of Universal Indicator into the well with solution A.
4. Record your data in observations in "Data and Observations"
5. Continue until you have tested each solution with Universal Indicator

Clean up:

6. Rinse off the porcelain plate with water and dry with a paper towel. Please be sure the station is clean and ready for the next group.

## **Post Lab Questions**

**In your lab notebook, post lab questions and conclusion will start on a new page after your data and observation page for Station 6**

1. Convert 100 deg F to deg C. (Show your work. No work, no credit!)
2. Convert 100 deg C to deg F. (Show your work. No work, no credit!)
3. Convert 100 deg C to K. (Show your work. No work, no credit!)
4. Did you know: that density can have several different units depending on how you measured and calculated it. If you use liquid measurements or displacement for volume, you would have density units of g/**ml** (grams per milliliter). If you used a ruler to get length in cm for the volume your units would be g/**cm$^3$** (grams per cubic centimeter). But, here is a neat trick - if you had a cube that was 1cm x 1cm x 1cm it would have a volume of 1

$cm^3$ and it would hold exactly 1 ml of liquid. So, a 1 $cm^3$ cube has a volume of 1 ml! Therefore, $cm^3$ and ml are interchangeable! In other words, something with a density of 1 g/ml also has a density of 1 $g/cm^3$!

a. What did you calculate for the density of the metal at Station 2 (include the units)?

5. The chart below shows the known densities of several metals. Using the chart below, determine the metal at station 2:

| Metal | Lead | Iron | Aluminum | Nickel | Tin |
|---|---|---|---|---|---|
| Density | 11.3 g/cm3 | 8 g/cm3 | 2.7 g/cm3 | 8.9 g/cm3 | 7.6 g/cm3 |

6. The unknown metal at Station 2 is Aluminum. Reflect on any possible experimental error explaining why you may not have gotten exactly 2.7 $g/cm^3$.
7. If you fill a small cube that is 1 cm on each side (1 $cm^3$ or 1 cubic centimeter or 1 cc) the cube will hold exactly 1 ml of water! Which means that you can easily convert between cubic centimeters and ml. Convert 10.0 $g/cm^3$ to g/ml.
8. Water has a density of 1.0 g/ml. Determine the percent error from your measurements at Station 3. Show your work.
9. Why did you not get exactly 1.0 g/ml for the density of water? (critical thinking question – most groups will not get exactly 1.0 g/ml, explain why this might be)
10. At station 4 you calculated the density of a golf ball. The actual density should be very close to 1.26 g/ml. Determine the **percent error** from your measurements. Show your work.
11. Was your answer correct (or very close) for the density of the golf ball? **Yes / No** If not, explain any possible experimental errors.
12. At station 4 you calculated the density of a ping pong ball. The actual density should be very close to 0.0840 g/ml. Determine the **percent error** from your measurements. Show your work.
13. Was your answer correct (or very close) for the density of the ping pong ball? **Yes / No** If not, explain any possible experimental errors.
14. Did you know: water has a density of 1.0 g/ml. Anything with a density greater than 1.0 g/ml will sink and anything with a density less than 1.0 g/ml will float! Did your ping pong ball sink or float? Did the golf ball sink or float? Explain why they did what they did!
15. The hottest point in your flame for station 5 should have been right above the inner blue cone. Was your temperature at that location above 1050 deg C? **Yes / No** If not, make a note in your lab notebook that the temperature should be greater than or equal to 1050 deg C so you have the correct info for the final.
16. Station 6: All of the solutions labeled “A” were the same solution for each station (as were the solutions for B and C and...etc). Did you get the same pH for letters A – E at each station? Explain your results and give rationale for why your answers for the pH may not have been the same at each station.

## Conclusion

****You only need ONE well written and thorough conclusion for this lab, you do not need one for each individual station. Write this as the last page of the lab (after the Post-Lab Questions)****

Some help with your conclusion: This will be different from most other labs because you are doing several small activities at several stations. This is practice for the more complicated and in-depth labs in the figure.

For the conclusion, focus on the stations where you calculated an answer - explain what you learned, what possible errors might exist, etc. In the Conclusion, you can refer to how accurate (or inaccurate) your measurements and calculations were at those stations and what you would do differently if you were to complete that station again. Follow the format below to ensure you have a well constructed conclusion.

## RSVCP

Write a paragraph in RSVCP format that describes the results of the lab.

- **R**e**s**tate the purpose of the lab.
- **V**erify conclusion by providing 3 or more results. This should include all numerical findings and their significance.
- Provide a **c**ounterclaim by addressing specific experimental error and suggest possible experimental improvements.
- **P**rovide importance of the experimental process by providing a specific real-world application.