

Lab #1: Measuring Techniques & Diagnostic Tests for H₂, O₂ and CO₂

Objectives:

1. To use and read various measuring instruments (graduated cylinder, pipet, and electronic balance) properly and accurately.
2. To light the Bunsen burner safely and properly.
3. To use various tests (burning and glowing splints, lime-water) to test for H₂, O₂ and CO₂ gases.

Hypothesis:

Comment on:

1. The accuracy level of a graduated cylinder to calculate the density of nickel.
2. Whether the beaker or the pipet is a more precise measuring instrument and why.

Predict what would happen when:

3. A burning splint is used to test for the presence of H₂ (g).
4. A glowing splint is used to test for the presence of O₂ (g).
5. Lime-water is used to test for the presence of CO₂ (g).

Materials:

Graduated Cylinder	Rubber Hose	MnO ₂ (s) – Manganese (IV) Oxide
10 mL Volumetric Pipet	Beakers	H ₂ O ₂ (aq) - Hydrogen Peroxide (3% v/v)
Pipet Bulb	Test-Tubes and Test-Tube Block	Zn (s) – Zinc Metal
Electronic Balance	Scoopula	Lime-Water (Saturated Ca(OH) ₂ (aq))
Wooden Splints	H ₂ SO ₄ (aq) – Sulfuric Acid (conc.)	Distilled and deionized H ₂ O (l)
Bunsen Burner and Starter	Baking Soda (NaHCO ₃ (s))	Nickel shots (Ni (s))

Pre-lab Exercise: Read the Handout on Laboratory Techniques prior to performing this lab.

Procedure:

A. Measuring Techniques:

1. Calibrate the Electronic Balance to 0.00 g
2. Measure and record the mass of an empty and clean graduated cylinder.
3. Put some distilled water into the graduated cylinder until it is half full. Record the volume to one uncertainty value. Indicate the smallest interval.
4. Measure and record the mass of the graduated cylinder with water.
5. Put one nickel shot into the graduated cylinder and record the new volume to one uncertainty value. (Use more nickel shots if the increased in volume is not significant.)
6. Measure and record the total mass of the graduated cylinder, water and the nickel shot(s).

B. Comparing Accuracy:

1. Calibrate the Electronic Balance to 0.00 g and dry the graduated cylinder you used in Part A.
2. Using the 10 mL volumetric pipet and pipet bulb, transfer exactly 10 mL of distilled water from a beaker to a graduated cylinder.
3. Measure and record the mass of the graduated cylinder and 10 mL of water from the pipet.
4. Pour out the water again and dry the graduated cylinder.
5. Measure 10 mL of water in a small beaker using the beaker's marker and transfer it into the graduated cylinder.
6. Measure and record the mass of the graduated cylinder and 10 mL of water from the small beaker.

C. Testing for H₂ (g):

1. Put a small strip of zinc into a test-tube.
2. Light the Bunsen Burner to a yellow flame.
3. Pour about 3 mL (2 fingernail's length) of H₂SO₄ (aq) (Sulfuric Acid) into the test tube.
4. Prepare a burning wooden splint (with a flame on the splint) using the Bunsen burner.
5. Quickly bring it to the mouth of the test tube.
6. Record all observations.

D. Testing for O₂ (g):

1. Using a scoopula, transfer a small quantity of Manganese (IV) Oxide (MnO₂ (s)) to a test tube.
2. Light the Bunsen Burner to a yellow flame.
3. Pour about 3 mL (2 fingernail's length) of H₂O₂ (aq) (Hydrogen Peroxide) into the test tube.
4. Prepare a glowing wooden splint (flame extinguished but still glowing red on the edge) using the Bunsen burner.
5. Quickly bring it to the mouth of the test tube.
6. Record all observations.

E. Testing for CO₂ (g):

1. Using a scoopula, transfer a small quantity of Baking Soda (NaHCO₃ (s)) to a test tube.
2. Pour about 3 mL (2 fingernail's length) of H₂SO₄ (aq) (Sulfuric Acid) into the test tube.
3. Pour about 1 mL (1 fingernail's length) of saturated Ca(OH)₂ (aq) (Limewater) into the test tube.
4. Record all observations.

Observations:**Part A: Measuring Techniques**

Mass of Empty Graduated Cylinder	
Mass of Graduated Cylinder and Water	
Mass of Graduated Cylinder, Water and Nickel Shot(s)	
Smallest Interval Marking on the Graduated Cylinder	
Volume of Water used in Graduated Cylinder	
Volume of Water and Nickel shot(s)	

Part B: Comparing Accuracy

Mass of Graduated Cylinder and 10 mL of Water from pipet	
Mass of Graduated Cylinder and 10 mL of water from beaker	

Part C: Testing for H₂ (g)

1. The physical characteristics of zinc are:
2. Observations after H₂SO₄ (aq) (Sulfuric Acid) is added to the Zinc:
3. Observations when burning splint encountered when Hydrogen (H₂ (g)) is produced:

Part D: Testing for O₂ (g)

1. The physical characteristics of Manganese (IV) Oxide (MnO₂ (s)) are:
2. Observations after Hydrogen Peroxide (H₂O₂ (aq)) is added to Manganese (IV) Oxide (MnO₂ (s)):
3. Observations when glowing splint encountered Oxygen (O₂ (g)) is produced:

Part E: Testing for CO₂ (g)

1. The physical characteristics of NaHCO₃ (s) (Baking Soda) are:
2. Observations after H₂SO₄ (aq) (Sulfuric Acid) is added to NaHCO₃ (s) (Baking Soda):
3. Observations when saturated Ca(OH)₂ (aq) (Limewater) encountered CO₂ (g) (Carbon Dioxide) is produced:

Analysis:**Part A: Measuring Techniques**

1. Determine the experimental density of nickel.

Part B: Comparing Accuracy

1. Determine the experimental density of water that was transferred from the pipet.
2. Determine the experimental density of water that was transferred from the small beaker.

Part C to Part E: Testing for H₂ (g), O₂ (g), CO₂ (g)

The following chemical equations outline the method you used to generate the three different gases. For each reaction, state the name of the reactant(s) and products.

1. Part C:
$$\text{Zn}_{(s)} + \text{H}_2\text{SO}_4_{(aq)} \rightarrow \text{ZnSO}_4_{(aq)} + \text{H}_2_{(g)} \uparrow$$
 (↑ emphasizes that a gas is released)
2. Part D:
$$\text{H}_2\text{O}_2_{(aq)} \xrightarrow{\text{MnO}_2} \text{H}_2\text{O}_{(l)} + \text{O}_2_{(g)} \uparrow$$
 (MnO₂ (s) is a catalyst – define catalyst)
3. Part E:
$$\text{H}_2\text{SO}_4_{(aq)} + \text{NaHCO}_3_{(s)} \rightarrow \text{Na}_2\text{SO}_4_{(aq)} + \text{H}_2\text{O}_{(l)} + \text{CO}_2_{(g)} \uparrow$$

Evaluation:

1. Given that the density of nickel is 7.78 g/mL at 20°C, calculate the % error of the density of nickel in Part A, comment on the accuracy of the graduated cylinder.
2. Given that the density of water is 0.9982 g/mL at 20°C, calculate the % errors of the density of water in Part B, comment on the accuracy of the pipet versus the beaker.
3. For Part C to Part E, how do you know the changes are chemical reactions?
4. Research on the Internet at <http://www.gcsescience.com/itestsforgases.htm>:
 - a. Why does the burning splint cause a “pop” sound in a test-tube full of hydrogen gas? Explain by stating the correct chemical reaction.
 - b. Why does the glowing splint “relit” in the presence of oxygen gas?
 - c. Why does the presence of carbon dioxide gas cause the limewater to precipitate? Explain by stating the correct chemical reaction. Identify the precipitate.

Conclusion:

1. Revisit your hypothesis and comment on your predictions.
2. Summarize what you have learned from this lab.