Lab #2: Measuring Techniques & Diagnostic Tests for H_2, O_2 and CO_2

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 H_2, O_2 and CO_2 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 $H_{2\,(g)}$.
4. A glowing splint is used to test for the presence of $O_{2\,(g)}$.
5. Lime-water is used to test for the presence of $CO_{2\,(g)}$.

Materials:

Graduated Cylinder	Rubber Hose	$MnO_{2\,(s)}$
10 mL Volumetric Pipet	Beakers	$H_2O_{2\,(aq)}$ (3% v/v)
Pipet Bulb	Test-Tubes and Test-Tube Block	$Zn_{(s)}$
Electronic Balance	Scoopula	Lime-Water (Saturated $Ca(OH)_{2\,(aq)}$)
Wooden Splints	$H_2SO_{4\,(aq)}$ (3 M)	Distilled and deionzed $H_2O_{(l)}$
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 $H_{2\,(g)}$:

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 $H_2SO_{4\,(aq)}$ 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 $O_{2\,(g)}$:

1. Using a scoopula, transfer a small quantity of $MnO_{2\,(s)}$ to a test tube.
2. Light the Bunsen Burner to a yellow flame.
3. Pour about 3 mL (2 fingernail's length) of $H_2O_{2\,(aq)}$ 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 $CO_{2\,(g)}$:

1. Using a scoopula, transfer a small quantity of $NaHCO_{3\,(s)}$ to a test tube.
2. Pour about 3 mL (2 fingernail's length) of $H_2SO_{4\,(aq)}$ into the test tube.
3. Pour about 1 mL (1 fingernail's length) of saturated $Ca(OH)_{2\,(aq)}$ 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 $H_{2\,(g)}$

1. The physical characteristics of zinc are:
2. Observations after $H_2SO_{4\,(aq)}$ is added to the zinc:
3. Observations when burning splint encountered $H_{2\,(g)}$ produced:

Part D: Testing for $O_{2\,(g)}$

1. The physical characteristics of $MnO_{2\,(s)}$ are:
2. Observations after $H_2O_{2\,(aq)}$ is added to $MnO_{2\,(s)}$:
3. Observations when glowing splint encountered $O_{2\,(g)}$ produced:

Part E: Testing for $CO_{2\,(g)}$

1. The physical characteristics of $NaHCO_{3\,(s)}$ are:
2. Observations after $H_2SO_{4\,(aq)}$ is added to $NaHCO_{3\,(s)}$:
3. Observations when saturated $Ca(OH)_{2\,(aq)}$ encountered $CO_{2\,(g)}$ 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 $H_{2\,(g)}$, $O_{2\,(g)}$, $CO_{2\,(g)}$

The following chemical equations outline the method you used to generate the three different gases. For each chemical equation, change them into word equations. Do NOT balance the equations.

1. Part C: $Zn_{(s)} + H_2SO_{4\,(aq)} \rightarrow ZnSO_{4\,(aq)} + H_{2\,(g)}\uparrow$ ($\uparrow$ emphasizes that a gas is released)
2. Part D: $H_2O_{2\,(aq)} \xrightarrow{MnO_2} H_2O_{(l)} + O_{2\,(g)}\uparrow$ ($MnO_{2\,(s)}$ is a catalyst – define catalyst)
3. Part E: $H_2SO_{4\,(aq)} + NaHCO_{3\,(s)} \rightarrow Na_2SO_{4\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}\uparrow$

Evaluation:

1. Given that the density of nickel is 8.906 g/mL at 20^{o}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^{o}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 dies 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.
5. From your experience in the last lab, describe another way to test for carbon dioxide gas. How come the limewater test is a better diagnostic method to confirm the presence of carbon dioxide gas?

Conclusion:

1. Revisit your hypothesis and comment on your predictions.
2. Choose one of the reactions from Part C to Part E, write a statement of understanding (phenomena, evidences, reasoning from a particle perspective, and claim) explaining what had happened.