

## **Pre Lab Questions**

### **Asking a Question**

1. What are some uses of ammonia ( $\text{NH}_3$ )?
2. How do we make  $\text{NH}_3$ ? What methods are currently used?
3. What is the balanced reaction for  $\text{NH}_3$  production from  $\text{N}_2$ ? Is this reaction endothermic or exothermic?
4. What are potential downsides of industrial  $\text{NH}_3$  production?
5. Are there any alternative methods available? If so, what are they?

### **Formulate a Hypothesis**

6. How do you think we can harness electrical energy to make ammonia from water and air?  
Fill in the hypothesis “if, then” statement below

If I [....], then I will [make/not make (choose one)] ammonia from water and air.

- 7.. Balance the following half-cell reactions relevant to nitrogen reduction and water oxidation.
  - a. Water Oxidation:  $\underline{\text{H}_2\text{O}} \rightarrow \frac{1}{2}\text{O}_2 + \underline{\text{H}^+} + 6e^-$
  - b. Nitrogen Reduction:  $\text{N}_2 + \underline{\text{H}^+} + 6e^- \rightarrow 2\text{NH}_3$

8. Combine the two half-cell reactions to complete the full-cell electrochemical nitrogen fixation reaction.

- a. Balanced reaction:  $\underline{\hspace{1cm}} \text{H}_2\text{O} + \underline{\hspace{1cm}} \text{N}_2 \rightleftharpoons \underline{\hspace{1cm}} \text{O}_2 + \underline{\hspace{1cm}} \text{NH}_3$
- b. Expected ratio of gas: \_\_\_\_\_

### **Preparing to Run Your Experiment**

9. What hazards might be encountered when using electrical energy during a chemistry experiment?

10. List some examples of observations that would indicate a chemical reaction is happening.

## **Observation Sheet**

### **Running the Electrolysis**

1. Before the electrolysis, record the liquid level in each syringe at the (−) and (+) battery terminals.
  - a. (−) level: \_\_\_\_\_
  - b. (+) level: \_\_\_\_\_
2. Write down your observations of what happens when you connect the thumbtack electrodes to the battery.
3. After the electrolysis, record the liquid level in each syringe at the (−) and (+) battery terminals.
  - a. (−) level: \_\_\_\_\_
  - b. (+) level: \_\_\_\_\_

  

1. Determine how much gas you formed in each syringe:
  - a. (−) gas amount: \_\_\_\_\_
  - b. (+) gas amount: \_\_\_\_\_
  - c. Ratio of gas formed: \_\_\_\_\_

**Post Lab Questions:**

**Analyzing Results**

1. Balance the following half-cell reactions relevant to proton reduction (a competing process) and water oxidation.

a. Proton Reduction:  $\underline{\hspace{2cm}} \text{H}^+ + 6 e^- \rightarrow \underline{\hspace{2cm}} \text{H}_2$

b. Water Oxidation:  $\underline{\hspace{2cm}} \text{H}_2\text{O} \rightarrow \underline{\hspace{2cm}} \text{O}_2 + \underline{\hspace{2cm}} \text{H}^+ + 6 e^-$

2. Combine the two half-cell reactions to complete the balanced full-cell hydrogen production reaction.

a. Balanced reaction:  $\underline{\hspace{2cm}} \text{H}_2\text{O} \rightarrow \underline{\hspace{2cm}} \text{O}_2 + \underline{\hspace{2cm}} \text{H}_2$

b. Expected ratio of gas: \_\_\_\_\_

3. Think back to the prelab questions. What is the combined half-cell reactions for the electrochemical nitrogen fixation reaction? (Hint: think about prelab question 8!)

a. Balanced reaction:

b. Expected ratio of gas: \_\_\_\_\_

4. What ratio of gasses did you observe in the experiment?

Observed ratio of gas: \_\_\_\_\_

5. Which ratio of gaseous products best aligns with our experimental result? What gases did you actually form?

6. Does this support your hypothesis or not? What are some things we could change about this experiment to try and achieve a different result? (Hint: check out the conclusions of the lab manual!)

## Communicating Outcomes

Communicating results is a key part of science. Scientists often do this by publishing articles and giving presentations. Write a short paragraph that you could use to tell a friend or family member about the experiment you completed today. Be sure to tell them what the initial problem is, why it is important, what experiment you did to test a relevant hypothesis, your results, and what changes you could make in future attempts.

## Learning More about Studying Chemistry!

As undergraduate and graduate students, we spend a lot of our time working through the scientific method that you practiced today in order to try to solve problems and learn new things. Did you know that PhD students in chemistry even get paid to attend graduate school and have fun in the lab?! And there is a wide range of [careers](#) that scientists explore after graduate school. One of the many places to learn more about graduate school in chemistry is a UNC website called [The Scoopula](#). But before graduate school, many of us discovered our love for research through working on chemistry research projects as undergraduates. If you're interested in learning more about studying chemistry in college, the American Chemical Society has some great resources on [undergraduate chemistry degrees](#), [planning for college](#), [conducting research as an undergraduate](#), and more under their content for students.