Acid-Base Lab Worksheet

Solutions and the three acid-base definitions · Logical Home Schooling

Name: _____ **Date:** _____ **Period:** _____

In this lab you will use Acid-Base Lab to watch substances dissolve, test solutions for conductivity, and compare the Arrhenius, Brønsted-Lowry, and Lewis definitions of acids and bases at the particle level.

Link: www.logicalhomeschooling.com/acid-base-lab.html

Objectives

By the end of this lab you will be able to:

- Identify the solute and solvent in a solution and describe how ionic and molecular substances dissolve.
- Classify solutions as strong, weak, or nonelectrolytes, and explain the difference between strong and weak acids.
- Describe acids and bases using the Arrhenius, Brønsted-Lowry, and Lewis definitions.
- Identify conjugate acid-base pairs and decide which definitions describe a reaction.

Materials: a computer or tablet with Acid-Base Lab open, a pencil, this worksheet. Time: about 50 minutes.

Three definitions. Arrhenius: acid makes H^+ (H_3O^+) in water; base makes OH^- in water. **Brønsted-Lowry:** acid = proton (H^+) donor; base = proton acceptor. **Lewis:** acid = electron-pair acceptor; base = electron-pair donor.

Part 1: Pre-lab

1. When you stir sugar into tea, which is the solute and which is the solvent?

   _____

2. List two acids and two bases you can find at home.

   _____

Part 2: Stage 1, Solutions

Dissolving. Stir in the salt and the sugar, then fill in the table.

Substance	Ionic or molecular?	Sketch of the dissolved particles	What do the water molecules do?
Salt (NaCl)			
Sugar			

In salt water, the solute is _____ and the solvent is _____.

3. Around Na^+, the oxygen side of each water molecule points toward the ion. Around Cl^-, the hydrogen side does. Why?

Conductivity. Test all six solutions.

Solution	Bulb (bright / dim / off)	Strong, weak, or nonelectrolyte?
Pure water		
Sugar water		
Salt water (NaCl)		
Hydrochloric acid (HCl)		
Vinegar (acetic acid)		
Sodium hydroxide (NaOH)		

4. What has to be present in a solution for it to conduct electricity? Why does vinegar make the bulb glow only dimly?

Part 3: Stage 2, Arrhenius

Added to water	Ions formed	Acid or base? Why?
HCl		
NaOH		

1. Why do chemists write H_3O^+ (hydronium) instead of a bare H^+?

2. In the Strong vs. weak activity, how many of 6 molecules ionized for HCl? _____ For acetic acid? _____ Which solution has the lower pH, and why?

3. Explain the difference between a *strong* acid and a *concentrated* acid.

4. Write the balanced equation for the neutralization of HCl by NaOH. Then write the net ionic equation (just the particles that react).

5. Ammonia (NH_3) is a base. Why can't the Arrhenius definition explain this?

Part 4: Stage 3, Brønsted-Lowry

For each reaction, label the acid, base, conjugate acid, and conjugate base. Draw an arrow showing where the H^+ moves.

Reaction	Acid	Base	Conjugate acid	Conjugate base
$HCl + H_2O \rightarrow Cl^- + H_3O^+$				
$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$				
$CH_3COOH + NH_3 \rightarrow CH_3COO^- + NH_4^+$				

1. Water acts as a base in the first reaction and an acid in the second. What is a substance like this called?

2. How does a conjugate pair always differ?

Part 5: Stage 4, Lewis

Reaction	Lewis acid	Lewis base	What moves?
$NH_3 + BF_3 \rightarrow F_3B–NH_3$			
$NH_3 + H^+ \rightarrow NH_4^+$			

1. Why is BF_3 a Lewis acid even though it contains no hydrogen at all?

2. Explain why every Brønsted-Lowry base is also a Lewis base.

Sort the definitions. Check every definition that describes the reaction.

Reaction	Arrhenius	Brønsted-Lowry	Lewis
HCl dissolving in water (as the acid)			
NaOH dissolving in water (as the base)			
$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$ (NH_3 as the base)			
$BF_3 + NH_3 \rightarrow F_3B–NH_3$ (BF_3 as the acid)			
$Cu^{2+} + 4\ NH_3 \rightarrow Cu(NH_3)_4^{2+}$ (Cu^{2+} as the acid)			

Part 6: Practice problems

Answer these **without** Acid-Base Lab.

1. Identify the solute and solvent in a solution of 5 g of KNO_3 in 100 mL of water. Is KNO_3 an electrolyte? Explain.

2. Label the acid, base, conjugate acid, and conjugate base: $HNO_3 + H_2O \rightarrow NO_3^- + H_3O^+$

3. Label the acid, base, conjugate acid, and conjugate base: $HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$

4. Write the conjugate base of H_2SO_4 and the conjugate acid of HPO_4^{2-}.

5. HF and HCl are both acids, but HF is a weak electrolyte and HCl is strong. What does this tell you about how each one behaves in water?

6. In the reaction $Ag^+ + 2\ NH_3 \rightarrow Ag(NH_3)_2^+$, identify the Lewis acid and Lewis base. Is it a Brønsted-Lowry reaction?

Conclusion

Write 3 to 5 sentences comparing the three acid-base definitions. Explain why chemists needed a broader definition each time. Use the words **solution**, **H^+ (proton)**, **OH^-**, **conjugate pair**, and **electron pair**.