

Hydrogen Chlorine Gas

Student Worksheet

Name _____

Overview: Get ready to learn why the public pool has that distinctive odor. We are going to (very carefully!) experiment with hydrogen chlorine gas.

What to Learn: You should focus on the element chlorine, and understand that table salt (NaCl) can combine with sodium hydrogen sulfate (NaHSO₄) in a double replacement reaction to produce hydrogen chloride gas (HCl) and sodium sulfate (Na₂SO₄).

Materials

- Glass jar
- 90° bend glass tubing
- One-hole rubber stopper
- Chemistry stand
- Wire mesh
- 2 test tubes
- Test tube clamp
- Alcohol burner
- Lighter
- Tripod stand
- Sodium hydrogen sulfate ([MSDS](#)) **Sodium hydrogen sulfate is very toxic. Respect it, handle it carefully and responsibly. Do not take it for granted.**
- Salt
- One-hole cork
- Medicine dropper
- Water
- Solid rubber stopper
- Sodium bicarbonate, NaHCO₃ (baking soda) ([MSDS](#)) OR sodium carbonate, Na₂CO₃ (washing soda) ([MSDS](#)) for neutralizing acid for disposal

NOTE: Be very careful when handling the sodium hydrogen sulfate – it's highly corrosive and dangerous when wet. Handle this chemical only with gloves, and be sure to read over the MSDS before using.

Lab Time

1. Prepare equipment:
 - a. Put a wire mesh screen on the tripod stand.
 - b. Put the alcohol burner on the screen.
 - c. Attach a test tube clamp to the chemistry stand.
 - d. Insert the short end of a 90° glass tube into a 1-hole rubber stopper.
 - e. Insert medicine stopper in 1-hole cork
 - f. Fill glass jar with water

2. Add 7 spoonfuls of sodium hydrogen sulfate (NaHSO_4) to a test tube. Add 7 spoonfuls of sodium chloride (NaCl). Stopper and shake to mix. Remove stopper and insert 1-hole rubber stopper with 90° glass tube attached.
3. Insert test tube in test tube clamp. Angle test tube slightly downward. Place the long end of the 90° glass tube into a clean, dry test tube.
4. With adult help, light the alcohol burner. Heat the solids, allowing the hydrogen chlorine gas to flow into the test tube. You may notice condensation forming on the mouth of the test tube with the solids. This is normal.
5. When you notice a smell, it is time to stop. Remember, hydrogen chlorine gas is poisonous and highly corrosive! Do not inhale this gas!
6. Put cap on the alcohol burner. Quickly take out the 90° glass tube and insert the cork with the medicine dropper. Invert the test tube and place it in the jar with water. This allows water to be sucked into the hydrogen chlorine gas, changing it into hydrochloric acid.
7. Use pH paper to determine if HCl is an acid or a base.
8. Disposal: HCl needs to be neutralized before disposal. Put a bit of baking soda or washing soda into the test tube. The contents should bubble as the neutralization is taking place. After neutralization, the liquid is safe, and can be washed down the drain. Solids are thrown in the trash.

Cleanup: We are going to clean everything thoroughly after we finish the lab. After cleaning with soap and water, rinse thoroughly. Chemists use the rule of “three” in cleaning glassware and tools. After washing, chemists rinse out all visible soap and then rinse three times more.

Storage: Place cleaned tools and glassware in their respective storage places.

Hydrogen Chlorine Gas Data Table

Item/Object	Observations
sodium chloride, NaCl	
sodium hydrogen sulfate, NaHSO_4	
hydrogen chloride gas, HCl (g)	
sodium sulfate, Na_2SO_4	

hydrochloric acid, HCl (aq) (aq stands for aqueous, or in solution)	
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Exercises Answer the questions below:

1. How was hydrochloric acid produced in this experiment?
2. I just finished making hydrochloric acid. Can I wash it down the drain?
3. Write the chemical equation for this experiment and explain why it is a double replacement reaction.
4. Where did the sodium sulfate end up?
5. Name at least two uses for hydrochloric acid

Exercises

1. How was hydrochloric acid produced in this experiment? (We combined table salt and sodium hydrogen sulfate to produce hydrogen chloride gas, then bubbled that gas into water to make hydrochloric acid.)
2. I just finished making hydrochloric acid. Can I wash it down the drain? (No, it must first be neutralized with baking soda or washing soda.)
3. Write the chemical equation for this experiment and explain why it is a double replacement reaction. ($\text{NaCl} + \text{NaHSO}_4 \rightarrow \text{HCl} + \text{Na}_2\text{SO}_4$. Heating the two products caused a positive hydrogen ion and a positive sodium ion to be produced. Because their charges are alike, they cannot bond, but they can take each other's place. They form bonds with the other atoms, which now have a negative charge, making it a double replacement reaction.)
4. Where did the sodium sulfate end up? (It was a solid, left in the test tube after the reaction.)
5. Name at least two uses for hydrochloric acid. (Answers will vary.)

Closure: Before moving on, ask your students if they have any recommendations or unanswered questions that they can work out on their own. Brainstorming extension ideas is a great way to add more science studies to your class time.