

ROUND 5

Formation of a Gas

Common gases formed in metathesis reactions are listed in the table below.

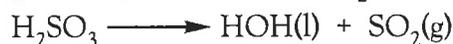
Common Gases	
H ₂ S	Any sulfide (salt of S ²⁻) plus any acid form H ₂ S(g) and a salt.
CO ₂	Any carbonate (salt of CO ₃ ²⁻) plus any acid form CO ₂ (g), HOH and a salt.
SO ₂	Any sulfite (salt of SO ₃ ²⁻) plus any acid form SO ₂ (g), HOH and a salt.
NH ₃	Any ammonium salt (salt of NH ₄ ⁺) plus any soluble strong hydroxide react upon heating to form NH ₃ (g), HOH and a salt.

Reactions that produce three of the gases (CO₂, SO₂, and NH₃) involve the initial formation of a substance that breaks down to give the gas and HOH.

Example 1. The reaction of Na₂SO₃ and HCl produces H₂SO₃:



Bubbling is observed in this reaction because the H₂SO₃ (sulfurous acid) is unstable and immediately decomposes to give HOH and SO₂ gas:



The molecular equation for the complete reaction, therefore, is:



Example 2. A typical reaction of a carbonate and an acid is:



Bubbling is also observed in this reaction. Theoretically H₂CO₃, carbonic acid, is formed, but the acid is unstable and immediately decomposes to form carbon dioxide gas and water according to the following equation:



Example 3. Ammonium salts and soluble bases react as follows (particularly when the solution is warmed):



The odor of ammonia gas is noted and moist blue litmus paper held near the mouth of the container will turn blue. Theoretically NH₄OH, ammonium hydroxide, is produced (also known as ammonia water). The compound is unstable and decomposes into ammonia gas and water:



Example 4. The odor of rotten eggs and bubbling are noted when an acid is added to a sulfide. A typical reaction producing hydrogen sulfide gas is:



Helpful Tip: Be aware of reactions involving the formation of carbon dioxide, sulfur dioxide, ammonia, and hydrogen sulfide gases on the AP Chemistry Examination. Over the years these reactions have appeared many, many times. Know these four gases and how they are produced!

Exercise 9-2: Predict and balance the following metathesis reactions. Use the abbreviations (s), (l), (g), and (aq) for the reactants and products. All reactants are aqueous unless otherwise stated.

1. ammonium sulfate and potassium hydroxide are mixed together
2. ammonium sulfide is reacted with hydrochloric acid
3. cobalt(II) chloride is combined with silver nitrate
4. solid calcium carbonate is reacted with sulfuric acid
5. potassium sulfite is reacted with hydrobromic acid
6. potassium sulfide is reacted with nitric acid
7. ammonium iodide + magnesium sulfate
8. solid titanium(IV) carbonate + hydrochloric acid
9. solid calcium sulfite + acetic acid
10. strontium hydroxide + ammonium sulfide