

## KEY TO AP CHEMISTRY EQUATIONS BY TYPE

### Double Replacement

1. Hydrogen sulfide is bubbled through a solution of silver nitrate.  
$$\text{H}_2\text{S} + 2\text{Ag}^+ \rightarrow \text{Ag}_2\text{S} + 2\text{H}^+$$
2. An excess of sodium hydroxide solution is added to a solution of magnesium nitrate.  
$$2\text{OH}^- + \text{Mg}^{2+} \rightarrow \text{Mg}(\text{OH})_2$$
3. Solutions of sodium iodide and lead nitrate are mixed.  
$$2\text{I}^- + \text{Pb}^{2+} \rightarrow \text{PbI}_2$$
4. A solution of ammonia is added to a solution of ferric chloride.  
$$3\text{NH}_3 + 3\text{H}_2\text{O} + \text{Fe}^{3+} \rightarrow 3\text{NH}_4^+ + \text{Fe}(\text{OH})_3$$
5. Solutions of silver nitrate and sodium chromate are mixed.  
$$2\text{Ag}^+ + \text{CrO}_4^{2-} \rightarrow \text{Ag}_2\text{CrO}_4$$
6. Excess silver acetate is added to a solution of trisodium phosphate.  
$$3\text{Ag}^+ + \text{PO}_4^{3-} \rightarrow \text{Ag}_3\text{PO}_4$$
7. Manganese(II) nitrate solution is mixed with sodium hydroxide solution.  
$$\text{Mn}^{2+} + 2\text{OH}^- \rightarrow \text{Mn}(\text{OH})_2$$
8. A saturated solution of calcium hydroxide is added to a solution of magnesium chloride.  
$$\text{Mg}^{2+} + 2\text{OH}^- \rightarrow \text{Mg}(\text{OH})_2$$
9. Hydrogen sulfide gas is added to a solution of cadmium nitrate.  
$$\text{H}_2\text{S} + \text{Cd}^{2+} \rightarrow \text{CdS} + 2\text{H}^+$$
10. Dilute sulfuric acid is added to a solution of barium acetate.  
$$2\text{H}^+ + \text{SO}_4^{2-} + \text{Ba}^{2+} + 2\text{C}_2\text{H}_3\text{O}_2^- \rightarrow \text{BaSO}_4 + 2\text{HC}_2\text{H}_3\text{O}_2$$
11. A precipitate is formed when solutions of trisodium phosphate and calcium chloride are mixed.  
$$2\text{PO}_4^{3-} + 3\text{Ca}^{2+} \rightarrow \text{Ca}_3(\text{PO}_4)_2$$
12. A solution of copper(II) sulfate is added to a solution of barium hydroxide.  
$$\text{Cu}^{2+} + \text{SO}_4^{2-} + \text{Ba}^{2+} + 2\text{OH}^- \rightarrow \text{Cu}(\text{OH})_2 + \text{BaSO}_4$$
13. Equal volumes of dilute equimolar solutions of sodium carbonate and hydrochloric acid are mixed.  
$$\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{HCO}_3^-$$
14. Solid barium peroxide is added to cold dilute sulfuric acid.  
$$\text{BaO}_2 + 2\text{H}^+ + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$$
15. Excess hydrochloric acid solution is added to a solution of potassium sulfite.  
$$2\text{H}^+ + \text{SO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{SO}_2$$
16. Dilute sulfuric acid is added to a solution of barium chloride.  
$$\text{SO}_4^{2-} + \text{Ba}^{2+} \rightarrow \text{BaSO}_4$$
17. A solution of sodium hydroxide is added to a solution of ammonium chloride.  
$$\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$$
18. Dilute hydrochloric acid is added to a solution of potassium carbonate.  
$$2\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{CO}_2$$
19. Gaseous hydrogen sulfide is bubbled through a solution of nickel(II) nitrate.  
$$\text{H}_2\text{S} + \text{Ni}^{2+} \rightarrow \text{NiS} + 2\text{H}^+$$

20. A solution of sodium sulfide is added to a solution of zinc nitrate.  

$$\text{OH}^- + \text{HS}^- + \text{Zn}^{2+} \rightarrow \text{ZnS} + \text{H}_2\text{O}$$
21. Concentrated hydrochloric acid is added to solid manganese(II) sulfide.  

$$2\text{H}^+ + \text{MnS} \rightarrow \text{H}_2\text{S} + \text{Mn}^{2+}$$
22. Solutions of tri-potassium phosphate and zinc nitrate are mixed.  

$$2\text{PO}_4^{3-} + 3\text{Zn}^{2+} \rightarrow \text{Zn}_3(\text{PO}_4)_2$$
23. Dilute acetic acid solution is added to solid magnesium carbonate.  

$$2\text{HC}_2\text{H}_3\text{O}_2 + \text{MgCO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Mg}^{2+} + 2\text{C}_2\text{H}_3\text{O}_2^-$$
24. Gaseous hydrofluoric acid reacts with solid silicon dioxide.  

$$4\text{HF} + \text{SiO}_2 \rightarrow 2\text{H}_2\text{O} + \text{SiF}_4$$
25. Equimolar amounts of trisodium phosphate and hydrogen chloride, both in solution, are mixed.  

$$\text{PO}_4^{3-} + \text{H}^+ \rightarrow \text{HPO}_4^{2-}$$
26. Ammonium chloride crystals are added to a solution of sodium hydroxide.  

$$\text{NH}_4\text{Cl} + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O} + \text{Cl}^-$$
27. Hydrogen sulfide gas is bubbled through a solution of lead(II) nitrate.  

$$\text{H}_2\text{S} + \text{Pb}^{2+} \rightarrow \text{PbS} + 2\text{H}^+$$
28. Solutions of silver nitrate and sodium chromate are mixed.  

$$2\text{Ag}^+ + \text{CrO}_4^{2-} \rightarrow \text{Ag}_2\text{CrO}_4$$
29. Solutions of sodium fluoride and dilute hydrochloric acid are mixed.  

$$\text{F}^- + \text{H}^+ \rightarrow \text{HF}$$
30. A saturated solution of barium hydroxide is mixed with a solution of iron(III) sulfate.  

$$3\text{Ba}^{2+} + 6\text{OH}^- + 2\text{Fe}^{3+} + 3\text{SO}_4^{2-} \rightarrow 3\text{BaSO}_4 + 2\text{Fe}(\text{OH})_3$$
31. A solution of ammonium sulfate is added to a potassium hydroxide solution.  

$$\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$$
32. A solution of ammonium sulfate is added to a saturated solution of barium hydroxide.  

$$2\text{NH}_4^+ + \text{SO}_4^{2-} + \text{Ba}^{2+} + 2\text{OH}^- \rightarrow 2\text{NH}_3 + 2\text{H}_2\text{O} + \text{BaSO}_4$$
33. Dilute sulfuric acid is added to solid calcium fluoride.  

$$2\text{H}^+ + \text{SO}_4^{2-} + \text{CaF}_2 \rightarrow \text{CaSO}_4 + 2\text{HF}$$
34. Dilute hydrochloric acid is added to a dilute solution of mercury(I) nitrate.  

$$2\text{Cl}^- + \text{Hg}_2^{2+} \rightarrow \text{Hg}_2\text{Cl}_2$$
35. Dilute sulfuric acid is added to a solution of lithium hydrogen carbonate.  

$$\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{O} + \text{CO}_2$$
36. Dilute hydrochloric acid is added to a solution of potassium sulfite.  

$$2\text{H}^+ + \text{SO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{SO}_2$$
37. Carbon dioxide gas is bubbled through water containing a suspension of calcium carbonate.  

$$\text{CO}_2 + \text{CaCO}_3 + \text{H}_2\text{O} \rightarrow \text{HCO}_3^- + \text{Ca}^{2+}$$
38. Excess concentrated sulfuric acid is added to solid calcium phosphate.  

$$3\text{H}_2\text{SO}_4 + \text{Ca}_3(\text{PO}_4)_2 \rightarrow 2\text{H}_3\text{PO}_4 + 3\text{CaSO}_4 \text{ (or } \text{Ca}^{2+} + \text{SO}_4^{2-}\text{)}$$
39. Hydrogen sulfide gas is bubbled into a solution of mercury(II) chloride.  

$$\text{H}_2\text{S} + \text{Hg}^{2+} \rightarrow \text{HgS} + 2\text{H}^+$$
40. Solutions of zinc sulfate and sodium phosphate are mixed.  

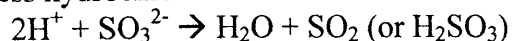
$$3\text{Zn}^{2+} + 2\text{PO}_4^{3-} \rightarrow \text{Zn}_3(\text{PO}_4)_2$$
41. Solutions of silver nitrate and lithium bromide are mixed.  

$$\text{Ag}^+ + \text{Br}^- \rightarrow \text{AgBr}$$

42. Solutions of manganese(II) sulfate and ammonium sulfide are mixed.

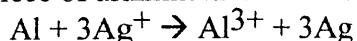


43. Excess hydrochloric acid solution is added to a solution of potassium sulfite.

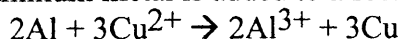


### Single Replacement

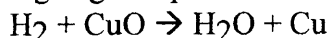
1. A piece of aluminum metal is added to a solution of silver nitrate.



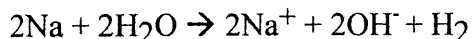
2. Aluminum metal is added to a solution of copper(II) chloride.



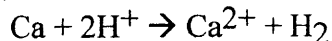
3. Hydrogen gas is passed over hot copper(II) oxide.



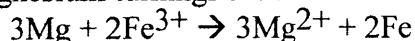
4. Small chunks of solid sodium are added to water.



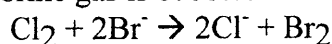
5. Calcium metal is added to a dilute solution of hydrochloric acid.



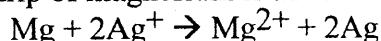
6. Magnesium turnings are added to a solution of iron(III) chloride.



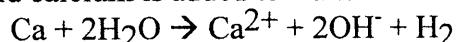
7. Chlorine gas is bubbled into a solution of sodium bromide.



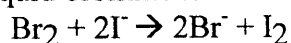
8. A strip of magnesium is added to a solution of silver nitrate.



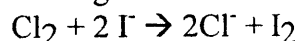
9. Solid calcium is added to warm water.



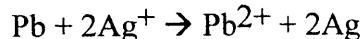
10. Liquid bromine is added to a solution of potassium iodide.



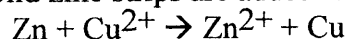
11. Chlorine gas is bubbled into a solution of potassium iodide.



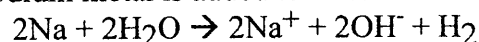
12. Lead foil is immersed in silver nitrate solution.



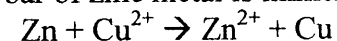
13. Solid zinc strips are added to a solution of copper(II) sulfate.



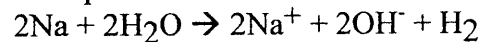
14. Sodium metal is added to water.



15. A bar of zinc metal is immersed in a solution of copper(II) sulfate.

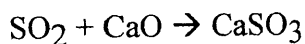


16. A small piece of sodium metal is added to distilled water.



## Addition

1. The gases boron trifluoride and ammonia are mixed.  
$$\text{BF}_3 + \text{NH}_3 \rightarrow \text{F}_3\text{BNH}_3$$
2. A mixture of solid calcium oxide and solid tetraphosphorus decaoxide is heated.  
$$6\text{CaO} + \text{P}_4\text{O}_{10} \rightarrow 2\text{Ca}_3(\text{PO}_4)_2$$
3. Solid calcium oxide is exposed to a stream of carbon dioxide gas.  
$$\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$$
4. Solid calcium oxide is heated in the presence of sulfur trioxide gas.  
$$\text{CaO} + \text{SO}_3 \rightarrow \text{CaSO}_4$$
5. Calcium metal is heated strongly in nitrogen gas.  
$$3\text{Ca} + \text{N}_2 \rightarrow \text{Ca}_3\text{N}_2$$
6. Excess chlorine gas is passed over hot iron filings.  
$$3\text{Cl}_2 + 2\text{Fe} \rightarrow 2\text{FeCl}_3$$
7. Powdered magnesium oxide is added to a container of carbon dioxide gas.  
$$\text{MgO} + \text{CO}_2 \rightarrow \text{MgCO}_3$$
8. A piece of lithium metal is dropped into a container of nitrogen gas.  
$$6\text{Li} + \text{N}_2 \rightarrow 2\text{Li}_3\text{N}$$
9. Magnesium metal is burned in nitrogen gas.  
$$3\text{Mg} + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2$$
10. Sulfur dioxide gas is passed over solid calcium oxide.



11. Samples of boron trichloride gas and ammonia gas are mixed.  
$$\text{BCl}_3 + \text{NH}_3 \rightarrow \text{Cl}_3\text{BNH}_3$$

## Decomposition

1. A solution of hydrogen peroxide is heated.  
$$2\text{H}_2\text{O}_2 \rightarrow \text{O}_2 + 2\text{H}_2\text{O}$$
2. Solid magnesium carbonate is heated.  
$$\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$$
3. A solution of hydrogen peroxide is catalytically decomposed.  
$$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$$
4. Solid potassium chlorate is heated in the presence of manganese dioxide as a catalyst.  
$$2\text{KClO}_3 \xrightarrow{\text{MnO}_2} 2\text{KCl} + 3\text{O}_2$$
5. Sodium hydrogen carbonate is dissolved in water.  
$$\text{NaHCO}_3 \rightarrow \text{Na}^+ + \text{HCO}_3^-$$
6. Solid ammonium carbonate is heated.  
$$(\text{NH}_4)_2\text{CO}_3 \rightarrow \text{CO}_2 + 2\text{NH}_3 + \text{H}_2\text{O}$$