NATIONAL MATH + SCIENCE INITIATIVE
Transforming Math & Science Education

AP® Net Ionic Equation Attack Strategies

The Minimum Knowledge Required To Survive These Types Of Questions

Solubility rules:

1. Big Mamma: All nitrates are **soluble**.
2. Big Daddy: All IA metals and ammonium salts are **soluble**.
3. Halides: All are **soluble** except silver, mercury or lead.
4. Strong acids: **hydrochloric, hydrobromic, hydroiodic, nitric, perchloric, sulfuric**—WRITE THESE DISSOCIATED *except* concentrated sulfuric, it really is 97% H_2SO_4 and 3% water in the jug, so water is way outnumbered and the molecules don't dissociate completely. If carbonic acid is formed as a product dissociate immediately $\rightarrow CO_2 + H_2O$.
5. Strong bases: hydroxides [and oxides] of IA and IIA* metals—write these bases dissociated.

WRITE ALL WEAK ACIDS AND BASES AS MOLECULES—be on the look out for BF_3 and its cousins BCl_3, etc. They are classic Lewis acids and when reacting with ammonia (a classic weak Lewis base), the product is F_3BNH_3 (just smash everything together) since nitrogen donated its unshared electron pair to boron in an act of extreme generosity and formed a coordinate covalent bond. Lewis **A**cids **A**ccept an electron pair.

* The "little guys" in the IIA's have solubility issues, write Be and Mg UNdissociated—calcium can go either way, the big guys are soluble. HF is not a strong acid since it's the little guy as well in the halogen series. The little guys make a stronger bond with OH^- or H^+ and do not dissociate as much in water. Also remember that the IA metals are named the *alkali* metals and the IIA's are the *alkaline earth* metals. What does "alkaline" mean? BASIC, so put them in water as metals, they dissolve and you make OH^-. Put IA metals in water and KABOOM!
KABOOM = formation of explosive hydrogen gas, H_2.

TURN THIS PUPPY OVER FOR THE ATTACK STRATEGIES!

Attack Strategies

Before trying to figure out the "answers", ***scan the words*** on question 4 (a) thru (c) and do the following: [don't write any products until you've done all SIX things!]

1. Cross out the word ***nitrate*** ~~any tim~~e it appears on the page.

2. Circle any word that implies solid or gas. (powdered, turnings, chunk, vapor, etc.)

3. Cross out any IA meta~~l that yo~~u see UNLESS it is associated with a circled solid or gas word.

4. Underline **halides** then ask yourself if silver, mercury or lead is present—if not you can cross the halide off as well such as with hydro**chloric** acid. The ~~H^+ is t~~he reacting species. (Bring the halide back as a reacting ion IF you need to oxidize something $halide^{-1} \rightarrow halogen_2$.)

5. Circle "burned in air" or "combines with oxygen" or anything that implies combustion and celebrate! The products are the oxides of the nonmetal combusted.

6. Circle the word ***concentrated***. Get very excited if you see ***excess concentrated***. It means you have entered the land of complex coordinated ions (excess is not necessary, but often appears). Sounds scary, but VERY easy. LOSE THE FEAR!

   Complex Ion Tutorial:

   > Write the reactants. On the product side, open a set of brackets [ ]. Put the metal ion in the brackets first then open a set of parentheses [M ion( )]. Next put a subscript on the parentheses that is twice the charge on the metal—I'm not proud of this, but it will earn credit. For a +2 metal it becomes $[M^{2+}(\ )_4]$. Finally, plop the ligand inside the parentheses and do the math to get the charge. If the ligand is ammonia or water, the ligand is neutral, so our example carries a +2 overall charge, $[M^{2+}(\ )_4]^{2+}$, if the ligand is hydroxide or a halide, which are both negative one, then our example becomes $[M^{2+}(OH)_4]^{2-}$. Other ligands are possible, like SCN^-, the thiocyanate ion and other polyatomic ions you should recognize.

Additional knowledge that contributes to survival:

- metal oxides + water $\rightarrow$ bases (ask yourself strong or weak? Dissociate the strong)
- nonmetal oxides + water $\rightarrow$ acids (ask yourself strong or weak? Dissociate the strong)
- metal carbonate heated $\rightarrow$ CO_2 + metal oxide
- Redox, "acidified"? H^+ is a reactant and water is a product.
- React a metal with oxygen $\rightarrow$ metal oxide
- React a nonmetal with oxygen [combustion] $\rightarrow$ make oxides of the nonmetal(s), NOT always CO_2 & H_2O!