Remember that on the AP exam you may only use the periodic table and the Reduction Potential chart. No solubility chart.

1. Solutions of zinc sulfate and sodium phosphate are mixed.

2. Hydrofluoric acid is combined with a solution of lead(II) nitrate.

3. Solid calcium sulfide is sprinkled into dilute hydrochloric acid.

4. An aqueous solution of lead(II) acetate reacts with hydrochloric acid.

5. Solid sodium carbonate is stirred into hydrobromic acid.

6. Nitric acid is reacted with an aqueous solution of calcium acetate.

7. Hydrochloric acid is poured over powdered potassium carbonate.

8. An aqueous solution of cadmium chloride is reacted with an aqueous solution of potassium phosphate.

9. A solution of hydrofluoric acid is poured over barium carbonate crystals.

10. Hydroiodic acid is poured over potassium sulfite.

11. An aqueous solution of barium hydroxide is reacted with an aqueous solution of iron(III) sulfate.

12. A solution of sodium hydroxide is poured into a solution of magnesium chloride.

13. Aqueous lead(II) nitrate is combined with potassium iodide.

Before you check the answer, read the hint and reconsider your own answer to see if you can improve it.

1. *We can only hope for the uncomplicated precipitation reaction.*

   $3Zn^{2+} + 2PO_4^{3-} \rightarrow Zn_3(PO_4)_2$

2. *Remember to write weak acids as molecules. Fluorides are not particularly soluble compounds.*

   $HF + Pb^{2+} \rightarrow PbF_2 + 2H^+$

3. *Dihydrogen sulfide is a gas that forms and drives the reaction. Crystals/solid/powdered all refer to a compound that should not be dissociated.*

   $CaS + 2H^+ \rightarrow H_2S + Ca^{2+}$

4. *Lead ions precipitate with most everything except, except nitrates and acetates. Don't forget that weak acids should be represented as molecules, not ions.*

   $Pb^{2+} + C_2H_3O_2^- + H^+ + Cl^- \rightarrow PbCl_2 + 2HC_2H_3O_2$

5. *Remember that whenever carbonic acid shows up as a product, decompose it.*

   $2H^+ + Na_2CO_3 \ (\rightarrow H_2CO_3) \rightarrow H_2O + CO_2 + 2Na^+$

6. *Watch for the formation of molecular weak acids - they may show up on the product side.*

   $H^+ + C_2H_3O_2^- \rightarrow HC_2H_3O_2$

7. *Watch for the word solid... and don't forget the decomposing weak acid.*

   $2H^+ + K_2CO_3 \rightarrow CO_2 + H_2O + 2K^+$

8. *Whew, another uncomplicated precipitation reaction.*

   $3Cd^{2+} + 2PO_4^{3-} \rightarrow Cd_3(PO_4)_2$

9. *Remember that fluoride salts are often insoluble, weak acids should be represented as molecules, watch for the phantom − the carbonic acid that decomposes.*

   $2HF + BaCO_3 \rightarrow H_2O + CO_2 + BaF_2$

10. *Since it does not say "solution" of potassium sulfite and the acid is "poured over," the implication is the potassium sulfite is solid.*

    $2H^+ + K_2SO_3 \rightarrow H_2O + SO_2 + 2K^+$

11. *Beware of the rarely occurring, but actually possible, double precipitate reaction !*

    $3Ba^{2+} + 6OH^- + 2Fe^{3+} + 3SO_4^{2-} \rightarrow 3BaSO_4 + 2Fe(OH)_3$

12. *Yippee ! another uncomplicated precipitation reaction.*

    $2OH^- + Mg^{2+} \rightarrow Mg(OH)_2$

13. *Yeah, one of your favorite , very yellow, precipitation reaction.*

    $2I^- + Pb^{2+} \rightarrow PbI_2$

Remember that on the AP exam you may only use the periodic table and the Reduction Potential chart. No solubility chart.

1. A solution of nitric acid is combined with a suspension of magnesium hydroxide.

2. A solution of sulfuric acid is added to a solution of barium hydroxide until the same number of moles of each compound has been added.

3. Hydrogen sulfide gas is bubbled through a solution of potassium hydroxide.

4. A solution of sodium hydroxide is added to a solution of sodium dihydrogen phosphate until the same number of moles of each compound has been added.

5. Equal volumes of 0.1-molar sulfuric acid and 0.1-molar potassium hydroxide are mixed.

6. A solution of ammonia is added to a dilute solution of acetic acid.

7. Excess potassium hydroxide solution is added to a solution of potassium hydrogen phosphate

8. A solution of ammonia and hydrofluoric acid are mixed.

Answers

1. *Remember to check the solubility of magnesium hydroxide − but the very fact that it says "suspension", you are being told solid particles.*

   $2H^+ + Mg(OH)_2 \rightarrow 2H_2O + Mg^{2+}$

2. *Pay close attention to whether or not you are working with strong or weak acids and bases, and be on the lookout for any precipitates that may form during the neutralization. In this case, "*until the same number of moles of each compound has been added" *is a distractor and does not change how you would write the reaction.*

   $H^+ + SO_4^{2-} + Ba^{2+} + OH^- \rightarrow H_2O + BaSO_4$

3. *Remember that gases are always written as molecular species, which means that any ions that result from them may not be eliminated as spectator ions.*

   $H_2S + OH^- \rightarrow H_2O + S^{2-}$

4. *Remember that the dihydrogen ion has just that; two hydrogens attached to the phosphate ion.*

   $OH^- + H_2PO_4^- \rightarrow H_2O + HPO_4^{2-}$

5. *We can only hope that you get a simple strong acid/strong base combination on the AP exam.*

   $H^+ + OH^- \rightarrow H_2O$

6. Ammonia is a molecular compound that acts as a base − accepting a proton (H^+). Don't forget that acetic acid is a weak acid.

   $NH_3 + HC_2H_3O_2 \rightarrow NH_4^+ + C_2H_3O_2^-$

7. Hydrogen phosphate, in contrast to dihydrogen phosphate has only on hydrogen attached to the phosphate ion

   $OH^- + HPO_4^{2-} \rightarrow H_2O + PO_4^{3-}$

8. *Watch out for weak acids and bases, remember that they must be written as molecules not ions.*

   $NH_3 + HF \rightarrow NH_4^+ + F^-$

Remember that on the AP exam you may only use the periodic table and the Reduction Potential chart. No solubility chart.

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

2. Aluminum metal is dropped into an solution of zinc chloride

3. Aluminum foil is dropped into a solution of nitric acid.

4. Solid barium is added to chlorous acid

5. Potassium metal is dropped into water

6. Chromium(II) nitrate solution is combined with iron(III) nitrate solution.

7. Iron(II) nitrate solution is mixed with cobalt(III) chloride solution

8. Liquid bromine is added to an aqueous sodium iodide solution

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

10. Small chunks of solid sodium is added to water.

11. Magnesium metal is added to a dilute solution of nitric acid.

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

1. *The magnesium will replace the silver in solution. Remember to leave out the spectator ions.*

$Mg + 2Ag^{+} \rightarrow Mg^{+2} + 2Ag$

2. *Remember that zinc always forms 2+ charge. Be sure and eliminate spectator ions, and remember that charge must also balance.*

$2Al + 3Zn^{2+} \rightarrow 3Zn + 2Al^{3+}$

3. When hydrogens are replaced, and "take their electron back" they must leave as a diatomic molecule.

$2Al + 6H^{+} \rightarrow 2Al^{3+} + 3H_2$

4. Be alert for weak acids which must be written as molecules.

$Ba + 2HClO_2 \rightarrow Ba^{2+} + H_2 + ClO_2^{-}$

5. *When alkali metals replace hydrogen in water, it might be easier to remember the products if you think of water as HOH, and it is the first H^{+} that is what is being replaced, this is why sodium hydroxide is a product, not sodium oxide.*

$2K + 2H_2O \rightarrow 2K^{+} + 2OH^{-} + H_2$

6. *At first it might appear as if nothing would happen, but a reaction will always happen on the AP exam questions. Since there can not be any precipitation formation, and it clearly is not an acid base reaction, can think single replacement. Remember that one element must be oxidized while another is reduced. You can use your blue Reduction table to give you ideas of what charge state is preferred.*

$Cr^{2+} + Fe^{3+} \rightarrow Cr^{3+} + Fe^{2+}$

7. *This is the same type of reaction as #6, Since the cobalt is being reduced, it*

$Fe^{2+} + Co^{3+} \rightarrow Fe^{3+} + Co^{2+}$

8. *Halogens can replace each other.*

$Br_2 + I^{-} \rightarrow I_2 + Br^{-}$

9. *In this reaction that should look like a single replacement, the hydrogen is more likely to behave as a positive ion, thus it will replace the copper not the oxygen.*

$H_2 + CuO \rightarrow H_2O + Cu$

10. *This is analogous to #5*

$2Na + 2H_2O \rightarrow 2Na^{+} + 2OH^{-} + H_2$

11. *This is analogous to #3*

$Mg + H^{+} \rightarrow Mg^{2+} + H_2$

12. *This is analogous to #8*

13. $Cl_2 + I^{-} \rightarrow I_2 + Cl^{-}$