### Part A: Writing Equations and Classifying Reactions

1. Write balanced chemical equations for each reaction described below, then classify them as either combination, decomposition, combustion, single displacement or double displacement reactions.

   a. Phosphoric acid reacts with pure sodium metal to form pure hydrogen and aqueous sodium phosphate.
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   b. Benzene liquid ($C_6H_6$) burns in oxygen to form carbon dioxide and water (and heat).
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   c. Calcium nitrate ($aq$) reacts with lithium sulfide ($aq$) forming solid calcium sulfide and lithium nitrate ($aq$).
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   d. Sodium bicarbonate when heated will form solid sodium carbonate, carbon dioxide and water vapor.
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   e. Sulfur naturally exists as $S_8$ molecules. Sulfur reacts with pure fluorine to form gaseous sulfur hexafluoride.
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   f. Cobalt(III) bromide ($aq$) reacts with pure chlorine forming pure bromine and cobalt(III) chloride ($aq$).
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   g. Aqueous potassium hydroxide reacts with sulfuric acid to form water and aqueous potassium sulfate.
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________

   h. Iron(II) oxide reacts with pure oxygen to form iron(III) oxide.
      
      Equation: ____________________________________________________________________
      
      Classification: __________________________
Part B: The Solubility of Ionic Compounds

1. In the presence of water, what will be the state of a soluble ionic compound? ________________
   an insoluble ionic compound? ________________

2. Use your solubility rules to determine which of the following ionic compounds are soluble in water and which are insoluble in water.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na₃PO₄</td>
<td>soluble</td>
</tr>
<tr>
<td>AlCl₃</td>
<td>insoluble</td>
</tr>
<tr>
<td>Fe(OH)₃</td>
<td>insoluble</td>
</tr>
<tr>
<td>MgCrO₄</td>
<td>soluble</td>
</tr>
<tr>
<td>PbBr₂</td>
<td>insoluble</td>
</tr>
<tr>
<td>Zn(NO₃)₂</td>
<td>soluble</td>
</tr>
</tbody>
</table>

Part C: Double-Displacement Reactions (Exchange Reactions)

1. Determine whether a precipitation reaction would occur for the following sets of reactants. If yes, • predict the names and states of the products • write the balanced molecular equation for the reaction • explicitly identify the precipitate by circling it in the balanced equation • write the complete ionic equation for the reaction • write the net ionic equation for the reaction.

   a. Aqueous ammonium sulfide + aqueous copper(II) nitrate

      Does a reaction occur? Why/why not? ________________
      Product Names and States: __________________________
      Molecular Equation: _______________________________
      Complete Ionic Equation: ___________________________
      Net Ionic Equation: _______________________________

   b. Aqueous iron(III) chloride + aqueous sodium carbonate

      Does a reaction occur? Why/why not? ________________
      Product Names and States: __________________________
      Molecular Equation: _______________________________
      Complete Ionic Equation: ___________________________
      Net Ionic Equation: _______________________________

   c. Aqueous zinc iodide + aqueous lithium sulfate

      Does a reaction occur? Why/why not? ________________
      Product Names and States: __________________________
      Molecular Equation: _______________________________
      Complete Ionic Equation: ___________________________
      Net Ionic Equation: _______________________________
d. *Aqueous potassium chromate + aqueous lead(II) nitrate*

Does a reaction occur? Why/why not? ________________________________

Product Names and States: ________________________________

Molecular Equation: ________________________________

Complete Ionic Equation: ________________________________

Net Ionic Equation: ________________________________

e. *Aqueous cobalt(III) bromide + aqueous silver acetate*

Does a reaction occur? Why/why not? ________________________________

Product Names and States: ________________________________

Molecular Equation: ________________________________

Complete Ionic Equation: ________________________________

Net Ionic Equation: ________________________________

2. Write balanced molecular equations for the **neutralization reactions** that occur between the following sets of reactants.

a. *Aqueous barium hydroxide + acetic acid*

______________________________

b. *Phosphoric acid + aqueous sodium hydroxide*

______________________________

c. *Aqueous lithium hydroxide + nitric acid*

______________________________

3. Write balanced molecular equations for the **gas-forming reactions** that occur between the following sets of reactants.

a. *Hydrochloric acid + solid calcium sulfite*

______________________________

b. *Aqueous potassium carbonate + oxalic acid*

______________________________

c. *Aqueous sodium hydroxide + aqueous ammonium nitrate*

______________________________
4. In lab, what specific observations would you make if

a precipitation reaction occurred? __________________________________________________________________________

a neutralization reaction occurred? __________________________________________________________________________

a gas-forming reaction occurred? __________________________________________________________________________

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Part D: Single Displacement Reactions

1. For each of the following sets of reactants,

   • determine whether or not a **single displacement reaction** would occur and explain your choice,
   • if a reaction does occur, predict the names and states of the products, then write the balanced molecular equation for the reaction.

a. **Aluminum metal + aqueous lead(II) nitrate**
   
   Does the reaction occur? Why/why not? __________________________________________________________________________
   
   Product Names and States: __________________________________________________________________________
   
   Molecular Equation: __________________________________________________________________________

b. **Nickel metal + hydrobromic acid**
   
   Does the reaction occur? Why/why not? __________________________________________________________________________
   
   Product Names and States: __________________________________________________________________________
   
   Molecular Equation: __________________________________________________________________________

c. **Tin metal + aqueous calcium acetate**
   
   Does the reaction occur? Why/why not? __________________________________________________________________________
   
   Product Names and States: __________________________________________________________________________
   
   Molecular Equation: __________________________________________________________________________

d. **Copper metal + aqueous gold(III) sulfate**
   
   Does the reaction occur? Why/why not? __________________________________________________________________________
   
   Product Names and States: __________________________________________________________________________
   
   Molecular Equation: __________________________________________________________________________

e. **Zinc metal + phosphoric acid**
   
   Does the reaction occur? Why/why not? __________________________________________________________________________
   
   Product Names and States: __________________________________________________________________________
   
   Molecular Equation: __________________________________________________________________________