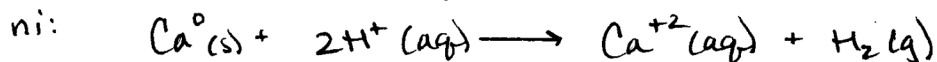
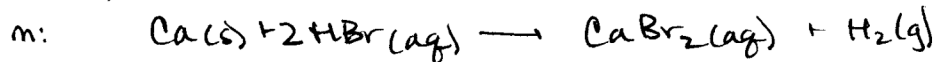


CHEM 100 Exam 3 Review SOLUTION

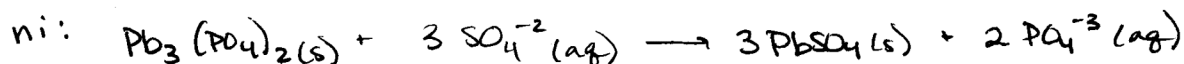
1. **Predicting Reactions.** Predict the products of the reaction described below. Please give the complete molecular equation and net ionic equation to each reaction. Identify the reaction as a double displacement or single displacement reaction. Also classify each reaction as Precipitation, Acid-Base or Redox.

a) The reaction of calcium metal and aqueous hydrobromic acid.



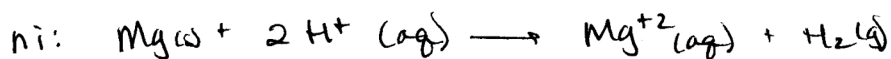
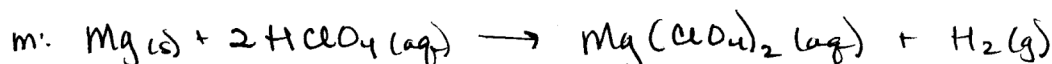
Single displacement, Redox

b) The reaction between lead (II) phosphate and sodium sulfate.



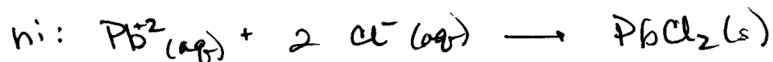
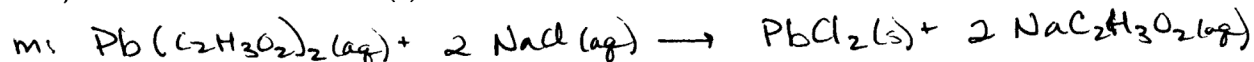
double displacement, precipitation

d) The reaction between magnesium and perchloric acid.



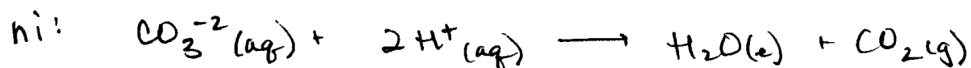
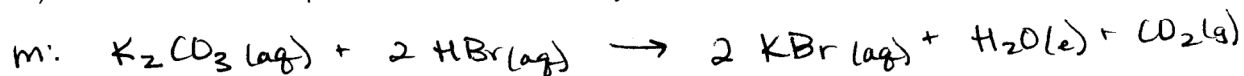
single displacement, redox

e) The reaction between lead (II) acetate and sodium chloride.

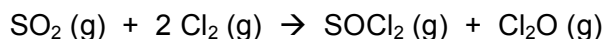


Double displacement, precipitation

f) The reaction between potassium carbonate and hydrobromic acid.



2. Chlorine gas reacts with sulfur dioxide to produce thionyl chloride (SOCl₂), a common reagent in organic synthesis, and dichlorine monoxide, according to the following balanced reaction:



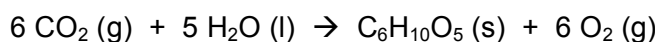
If you start with 150.0 g of each starting material, how many grams of thionyl chloride can be produced?

$$150.0 \text{ g SO}_2 \times \frac{\text{mol}}{64.06 \text{ g}} \times \frac{1 \text{ mol SOCl}_2}{1 \text{ mol SO}_2} \times \frac{134.97 \text{ g}}{\text{mol}} = 316.0 \text{ g SOCl}_2$$

$$150.0 \text{ g Cl}_2 \times \frac{\text{mol}}{70.906 \text{ g}} \times \frac{1 \text{ mol SOCl}_2}{2 \text{ mol Cl}_2} \times \frac{134.97 \text{ g}}{\text{mol}} = 142.8 \text{ g SOCl}_2$$

Cl₂ is the limiting reagent, so only 142.8 g SOCl₂ can be produced.

3. CO₂ is removed from the atmosphere by trees and converted into cellulose. The basic reaction for this is:

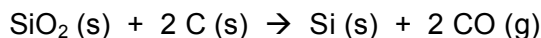


$$44.01 \text{ g/mol} \quad 18.01 \text{ g/mol} \quad 162.1 \text{ g/mol} \quad 32.00 \text{ g/mol}$$

You decide to start a business making cellulose for paper from CO₂, reducing greenhouse gases, and saving trees in the process. You run a test reaction with 1.00 x 10³ g of CO₂. What is the maximum amount of cellulose, in grams, that will be produced by this reaction?

$$1.00 \times 10^3 \text{ g CO}_2 \times \frac{1 \text{ mol}}{44.01 \text{ g}} \times \frac{1 \text{ mol C}_6\text{H}_{10}\text{O}_5}{6 \text{ mol CO}_2} \times \frac{162.1 \text{ g}}{1 \text{ mol}} = 614 \text{ g C}_6\text{H}_{10}\text{O}_5$$

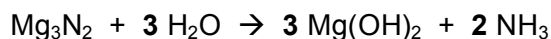
4. Silicon metal can be produced by heating sand (SiO₂) with graphite in an electric arc furnace, according to the following reaction.



If you begin with 55.0 g of SiO₂, what is the maximum amount of elemental silicon that can be formed? *MWs: SiO₂ = 60.084 g/mol; Si = 28.0855 g/mol.*

$$55.0 \text{ g SiO}_2 \times \frac{1 \text{ mol}}{60.084 \text{ g}} \times \frac{1 \text{ mol Si}}{1 \text{ mol SiO}_2} \times \frac{28.0855 \text{ g}}{1 \text{ mol}} = 25.7 \text{ g Si}$$

5. Ammonia can be made in the reaction of magnesium nitride and water, as in the following unbalanced reaction.



- a. Balance the reaction.
b. If we start with 58.1 g of Mg₃N₂ how much ammonia gets produced, in g?

$$58.1 \text{ g Mg}_3\text{N}_2 \times \frac{1 \text{ mol}}{100.95 \text{ g}} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol Mg}_3\text{N}_2} \times \frac{17.03 \text{ g}}{1 \text{ mol}} = 19.6 \text{ g NH}_3$$

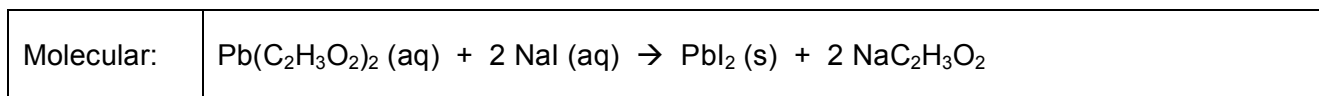
- c. How many grams of water are needed to react with the Mg₃N₂?

$$58.1 \text{ g Mg}_3\text{N}_2 \times \frac{1 \text{ mol}}{100.95 \text{ g}} \times \frac{3 \text{ mol H}_2\text{O}}{1 \text{ mol Mg}_3\text{N}_2} \times \frac{18.02 \text{ g}}{1 \text{ mol}} = 31.1 \text{ g H}_2\text{O}$$

- d. If only 10.68 g of ammonia is produced, what is the percent yield of the reaction?

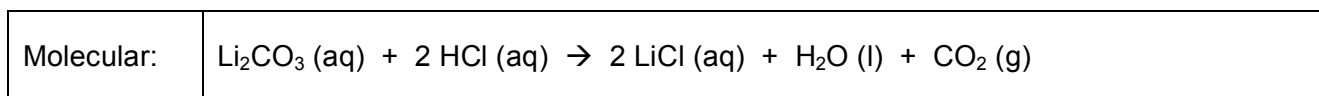
$$\frac{10.68 \text{ g}}{19.6 \text{ g}} \times 100 = 54.5\%$$

6. Write balanced molecular equations for the following reactants. Be sure to list all phase labels. Classify the reaction as a double displacement or single displacement reaction. Also classify each reaction as a precipitation, acid-base, or redox reaction.
- a. The reaction between lead (II) acetate and sodium iodide.



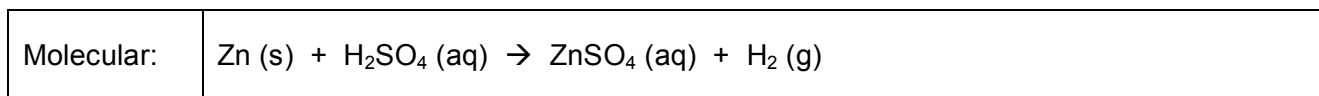
This reaction is a: (circle all that apply)	Precipitation	Acid-Base	Redox
	Double Displacement	Single displacement	Combination

- b. The reaction between lithium carbonate and hydrochloric acid.



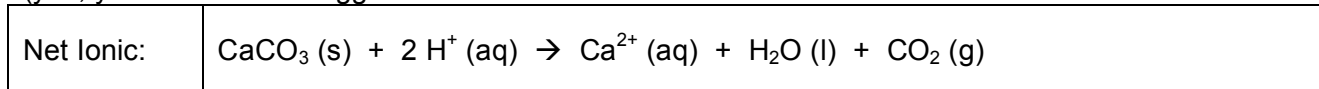
This reaction is a: (circle all that apply)	Precipitation	Acid-Base	Redox
	Double Displacement	Single displacement	Combination

- c. The reaction of zinc and sulfuric acid.

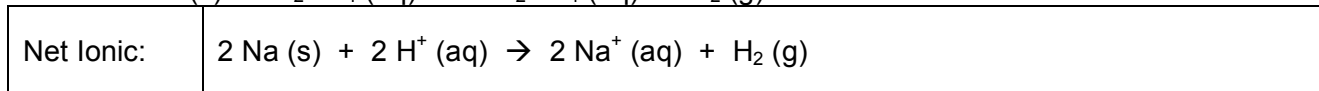


This reaction is a: (circle all that apply)	Precipitation	Acid-Base	Redox
	Double Displacement	Single displacement	Combination

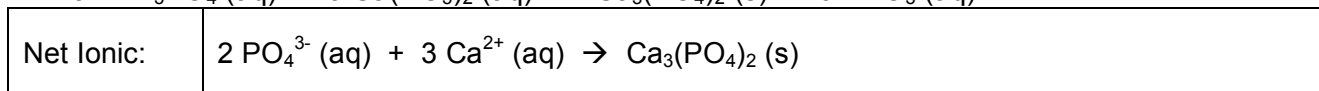
7. Give the net ionic equation for the following balanced molecular equations. Be sure to include all charges and phase labels.
- a. $\text{CaCO}_3 (\text{s}) + 2 \text{HCl} (\text{aq}) \rightarrow \text{CaCl}_2 (\text{aq}) + \text{H}_2\text{O} (\text{l}) + \text{CO}_2 (\text{g})$
(yes, you can dissolve eggshells in acid! This reaction will work!)



- b. $2 \text{Na} (\text{s}) + \text{H}_2\text{SO}_4 (\text{aq}) \rightarrow \text{Na}_2\text{SO}_4 (\text{aq}) + \text{H}_2 (\text{g})$



- c. $2 \text{K}_3\text{PO}_4 (\text{aq}) + 3 \text{Ca}(\text{NO}_3)_2 (\text{aq}) \rightarrow \text{Ca}_3(\text{PO}_4)_2 (\text{s}) + 6 \text{KNO}_3 (\text{aq})$



8. All the following equations are balanced **EXCEPT**

- a. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{N}_2\text{O} + \text{Cr}_2\text{O}_3 + 4\text{H}_2\text{O}$. There are 8 oxygens on the product side!
 b. $2\text{NH}_4\text{SCN} + \text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O} \rightarrow 2\text{NH}_3 + 10\text{H}_2\text{O} + \text{Ba}(\text{SCN})_2$.
 c. $\text{C}_{12}\text{H}_{22}\text{O}_{11} \rightarrow 12\text{C} + 11\text{H}_2\text{O}$.
 d. $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} + 2\text{H}_2\text{O}$.
 e. $2\text{Mg} + \text{CO}_2 \rightarrow 2\text{MgO} + \text{C}$.

9. All the following reactions can be described as displacement reactions **EXCEPT**

- a. $\text{Zn}(\text{s}) + \text{FeCl}_2(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{Fe}(\text{s})$.
 b. $\text{CuSO}_4(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{FeSO}_4(\text{aq})$.
 c. $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$.
 d. $\text{C}_6\text{H}_6(\text{l}) + \text{Cl}_2(\text{g}) \rightarrow \text{C}_6\text{H}_5\text{Cl}(\text{l}) + \text{HCl}(\text{g})$. There are no ionic compounds in the reactant!

10. All the following are strong electrolytes in aqueous solution **EXCEPT**

- a. Na_3PO_4 .
 b. $\text{NH}_4\text{H}_2\text{PO}_4$.
 c. NH_3 .
 d. Na_2HPO_4 .
 e. NaH_2PO_4 .

Electrolytes are soluble ionic compounds.

11. Which of the following ionic compounds is **INSOLUBLE** in water?

- a. $(\text{NH}_4)_2\text{CO}_3$
 b. **AgBr**
 c. CuSO_4
 d. KI
 e. LiNO_3

12. A precipitate is expected when an aqueous solution of potassium iodide is added to an aqueous solution of **Write out reactions of KI + the following:**

- a. sodium sulfate.
 b. iron(II) chloride.
 c. calcium perchlorate.
 d. barium hydroxide.
 e. **lead nitrate. It forms lead iodide.**

13. What products result from the addition of aqueous solutions of $\text{Cu}(\text{NO}_3)_2$ and $(\text{NH}_4)_2\text{S}$? **A double displacement reaction! Watch phase labels and charges!**

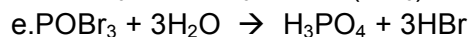
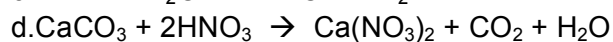
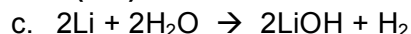
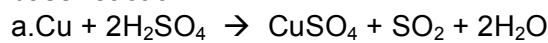
- a. $\text{CuS}(\text{aq})$ and $\text{NH}_4\text{NO}_3(\text{s})$
 b. $\text{CuS}(\text{s})$ and $\text{NH}_4\text{NO}_3(\text{s})$
 c. **$\text{CuS}(\text{s})$ and $\text{NH}_4\text{NO}_3(\text{aq})$**
 d. $\text{Cu}_2\text{S}(\text{s})$ and $\text{NH}_4\text{NO}_3(\text{aq})$
 e. $\text{CuS}(\text{s})$, $\text{NH}_3(\text{g})$, and $\text{H}_2\text{S}(\text{g})$

14. All the following equations are double-displacement reactions **EXCEPT**

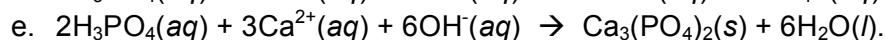
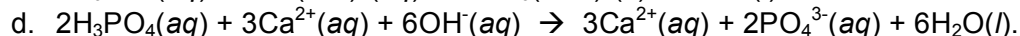
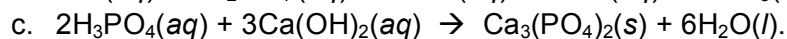
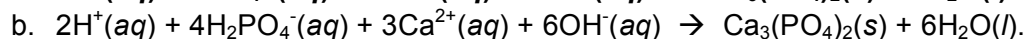
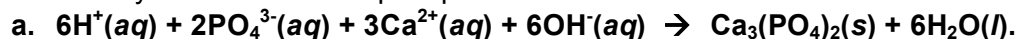
A double displacement reaction begins with 2 ionic compounds.

- a. $\text{Na}_2\text{CO}_3(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$.
 b. $2\text{NaOH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$.
 c. $2\text{NaOH}(\text{aq}) + (\text{NH}_4)_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$.
 d. $\text{Na}_2\text{CO}_3(\text{aq}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{CuCO}_3(\text{s})$.
 e. **$\text{Cl}_2(\text{g}) + \text{Na}_2\text{SO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{HCl}(\text{aq})$. It has 3 starting materials!**

15. Which of the following reactions could be classified both as a precipitation reaction and an acid base reaction?



16. The net ionic equation for the reaction of the weak acid phosphoric acid with a dilute solution of calcium hydroxide to form a precipitate is



17. The net ionic equation for the reaction of nitric acid with lithium hydroxide is

