Unit 4 Problem Set

Learning Objectives

- *Categorize and predict the products for metathesis, combination, decomposition, acid/base, oxidation and precipitation reactions*
- *Define and distinguish between Arrhenius and Bronsted-Lowry acids and bases*

Read about these topics: Section 4.2, and Section 4.1

1. Identify which solid precipitates when the two solutions are mixed
   a. $Na_3PO_{4(aq)}$ and $CaCl_{2(aq)}$
   b. $AgNO_{3(aq)}$ and $MgCl_{2(aq)}$

2. Identify which solid precipitates when the two solutions are mixed
   a. $Ba(OH)_{2(aq)}$ and $FeCl_{3(aq)}$
   b. $CaI_{2(aq)}$ and $K_2SO_{4(aq)}$

3. Identify all of the spectator ions in the following reactions
   a. $Na_2S_{(aq)} + Fe(NO_3)_{2(aq)} \rightarrow FeS_{(s)} + 2NaNO_{3(aq)}$
   b. $2LiF_{(aq)} + Pb(C_2H_3O_2)_{2(aq)} \rightarrow 2LiC_2H_3O_{2(aq)} + PbF_{2(s)}$

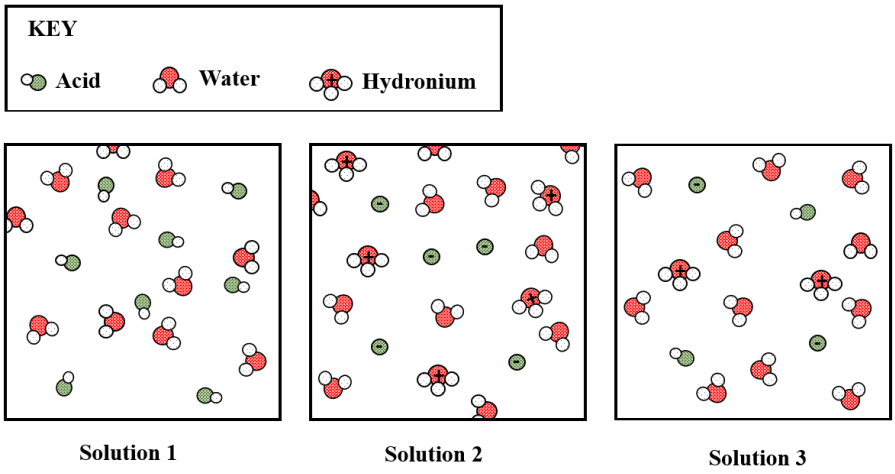
4. Identify all of the spectator ions in the following situations
   a. $CuF_{2(aq)}$ is mixed with $K_2CO_{3(aq)}$
   b. $CuClO_{4(aq)}$ is mixed with $NaBr_{(aq)}$

5. Write the net ionic equation for the following reactions
   a. $NH_4Cl_{(aq)} + AgNO_{3(aq)} \rightarrow$
   b. $KOH_{(aq)} + CuNO_{3(aq)} \rightarrow$

6. In each of the following reactions, identify which compound is acting as the base and which compound is acting as the acid.
   a. $H_2SO_{3(aq)} + 2NaOH_{(aq)} \rightarrow 2H_2O_{(l)} + Na_2SO_{3(aq)}$
   b. $HClO_{3(aq)} + KOH_{(aq)} \rightarrow H_2O_{(l)} + KClO_{3(aq)}$

Unit 4 Problem Set

7. Which of the depicted solutions is a weak acid solution? Which of the depicted solutions is a strong acid solution?



8. What is the oxidation number of X in each of the following compounds?

a. XO_3^{-2}

b. XO_4^{-3}

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9. Give the oxidation number for each element in the given compounds

a. $PbSO_4$

b. $FeCO_3$

10. Give the oxidation number for each element in the given compounds

a. MnO_2

b. H_2O

11. In the following reaction, identify what is being oxidized, what is being reduced, the oxidizing agent and the reducing agent

$H_{2(g)} + 2OH^-_{(aq)} + Ni^{2+}_{(aq)} \rightarrow Ni_{(s)} + 2H_2O_{(l)}$

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12. In the following reaction, identify what is being oxidized, what is being reduced, the oxidizing agent and the reducing agent

$NO_3^-{}_{(aq)} + 4H^+_{(aq)} + Cr_{(s)} \rightarrow Cr^{3+}_{(aq)} + NO_{(g)} + 2H_2O_{(l)}$

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Unit 4 Problem Set

Learning Objective: *Balance chemical reactions*
Read more about this topic: Section 4.1

13. Balance the reaction: $Fe_2O_{3(s)} + CO_{(g)} \rightarrow Fe_{(l)} + CO_{2(g)}$

14. Balance the reaction: $C_9H_{20(l)} + O_{2(g)} \rightarrow H_2O_{(l)} + CO_{2(g)}$

15. Balance the reaction: $Li_{(s)} + H_2O_{(l)} \rightarrow LiOH_{(aq)} + H_{2(g)}$

16. Balance the reaction: $CaCl_{2(aq)} + Li_3PO_{4(aq)} \rightarrow LiCl_{(aq)} + Ca_3(PO_4)_{2(s)}$

Learning Objective: *Perform calculations relating quantities in chemical reactions, including limiting reactant, theoretical yield, and percent yield calculations*
Read more about this topic: Section 4.3 and Section 4.4

17. How many mols of HCl are required to complete react 0.447 mols of aluminum according to the following, balanced chemical reaction:
$2Al(s) + 6\ HCl_{(aq)} \rightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$

18. If 0.376 mols of aluminum are reacted with excess HCl, how many mols of hydrogen gas will be produced?
$2Al(s) + 6\ HCl_{(aq)} \rightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$

19. Urea ($CO(NH_2)_2$) can be synthesized via the following chemical reaction. If 2.60 g of ammonia is reacted with excess carbon monoxide, how many grams of urea are formed?
$2NH_{3(g)} + CO_{(g)} \rightarrow CO(NH_2)_{2(s)} + H_2O_{(l)}$
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20. Formaldehyde, a naturally occur organic molecule that historically was used to preserve animal species, is carcinogenic, and has been observed in interstellar medium can be synthesized from methanol using the following reaction:
$CH_3OH_{(g)} \rightarrow CH_2O_{(g)} + H_{2(g)}$
If 15.14 g of methanol (CH_3OH) is reacted, how many grams of formaldehyde (CH_2O) are produced?
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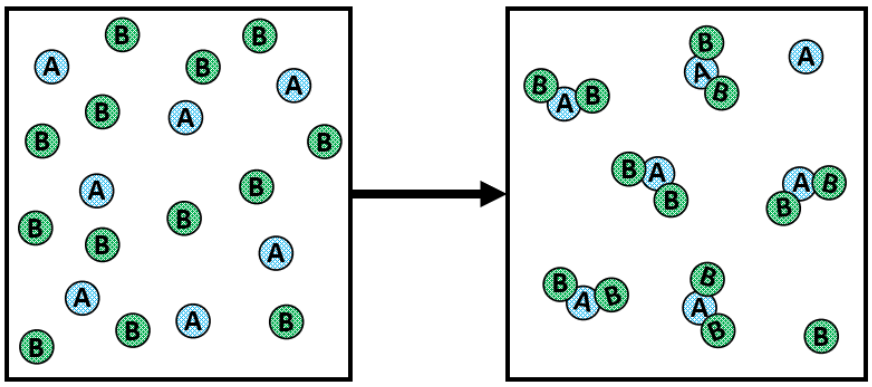
Unit 4 Problem Set

21. Incomplete combustion leads to the formation of toxic compounds like carbon monoxide. How many grams of oxygen would be necessary to completely combustion 15.69 g of octane?
$2C_8H_{18(l)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(g)}$

22. Hydrochloric acid is reacted with iron (II) sulfide to form hydrogen sulfide according to the balanced chemical equation. If 1.92 mols of hydrochloric acid are reacted with 1.34 mols of iron (II) sulfide, how many mols of hydrogen sulfide are formed?
$2HCl_{(aq)} + FeS_{(s)} \rightarrow H_2S_{(aq)} + FeCl_{2(aq)}$

23. In the following reaction, which reactant is the limiting reactant?



Reactants Products

24. How many grams of precipitant are formed when 23.23 mL of a 0.76 M aqueous solution of magnesium bromide is combined with 23.24 mL of a 0.18 M aqueous solution of silver nitrate?
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25. Hydrazine can be synthesized via the following reaction:
$2NH_{3(aq)} + Cl_{2(g)} + 2NaOH_{(aq)} \rightarrow N_2H_{4(aq)} + 2NaCl_{(aq)} + 2H_2O_{(l)}$
What is the theoretical yield when 1.10 g NH_3 is reacted with 7.17of Cl_2 and excess sodium hydroxide?
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26. Based on the balanced chemical reaction, how many mols of excess reactant is left when 0.27 g of magnesium is reacted with 42.34 mL of 1.16 M of hydrochloric acid?
$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$
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27. If 5.9 g of copper(II) oxide is reacted with excess hydrogen gas and 3.02 g of copper is collected, what is the percent yield?
$CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}$

Unit 4 Problem Set

***Learning Objective**: Titrations*
Read more about this topic: Section 4.5

28. It requires 47.18 mL of 0.79 M NaOH to fully titrate 43.78 mL of HCl, what is the molarity of the acid?

29. Potassium hydrogen phthalate (KHP) is a monoprotic weak acid that is often used to standardize solutions for titrations. If it requires 54.3 mL of a sodium hydroxide solution to completely react 1.64 g of KHP (Molar Mass: 204.222 g/mol), what is the molarity of the sodium hydroxide?

30. How many mL of 1.03 M HCl would be required to completely react 2.90 g of $CaSO_3$
$CaSO_{3(s)} + 2HCl_{(aq)} \rightarrow SO_{2(g)} + H_2O_{(l)} + CaCl_{2(aq)}$
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