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Chapter 9 Practice Worksheet:
Reactions in Aqueous Solutions

1a. List the three general classes of chemical reactions described in Chapter 9:

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b. List the 6 reaction types from the laboratory report "Chemical Reactions" in CHM 151.

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2. How can you identify each of the three reaction types above (e.g., what characteristic defines each one?)? What method or information can you use to predict whether this type of reaction will proceed or not?

3. List one strong electrolyte (a strong acid or a soluble salt) and describe/draw how it behaves when placed in water. You may wish to illustrate the behavior with a beaker picture.

4. List one weak electrolyte (a weak acid or a weak base) and describe/draw how it behaves when placed in water. You may wish to use a beaker picture.

5. List one non-electrolyte (insoluble salt or unreactive molecular compound) and describe/draw how it reacts when placed in water. You may wish to use a beaker picture.

6. Determine if the following compounds will be soluble or insoluble in water:

$CrPO_4$

Na_2S

$PbBr_2$

Ag_2SO_4

$Ca(ClO_3)_2$

K_3PO_4

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For the following double-displacement reactions, complete the equation and determine if there are any insoluble products (precipitates). If there is a precipitate, write the balanced molecular, complete ionic and net ionic equations. If there is no precipitate, write the balanced molecular and complete ionic equations.

7. ___ NaBr (aq) + ___ KI (aq) →

8. ___ NaOH (aq) + ___ $Ni(NO_3)_2$ (aq) →

9. ___ $MgCl_2$ (aq) + ___ $(NH_4)_2CO_3$ (aq) →

10. ___ $Sr(NO_3)_2$ (aq) + ___ K_3PO_4 (aq) →

11. Give Arrhenius' definitions of an acid and a base. Give an example of each in a reaction.

12. Identify each of the following substances as acids or bases (or both):

HCl	KOH
NaOH	HNO_3
HF	H_2O
$Ca(OH)_2$	

13. Identify the oxidation numbers of **each element** in the following compounds or ions:

H_3PO_4	Zn (s)
K_2O_2	$SrSO_4$
O_2 (g)	$NiCO_3$
$CoCl_2$	OH^-
$FeBO_3$	$Mg(NO_3)_2$

14. List the three types of redox reactions and describe how you can identify them:

15. For the following redox reactions, identify the species being oxidized, the species being reduced, the oxidizing agent, and the reducing agent:

___ Ni (s) + ___ Cl_2 (g) → ___ $NiCl_2$ (s)

___ $Fe(NO_3)_2$ (aq) + ___ Al (s) → ___ Fe (s) + ___ $Al(NO_3)_3$ (aq)

___ Na (s) + ___ H_2O (l) → ___ NaOH (aq) + ___ H_2 (g)

16. Describe when to use the Solubility Rules and when to use the Activity Series of Metals.

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17. For the following reactions, use the Activity Series of Metals to determine if a reaction will occur and if so, what the products will be. If no reaction will occur, write NR for the product.

$Zn\ (s) + KNO_3\ (aq) \rightarrow$

$Ca\ (s) + Cd(NO_3)_2\ (aq) \rightarrow$

$Sn\ (s) + Pb(NO_3)_2\ (aq) \rightarrow$

$Cu\ (s) + Fe(NO_3)_2\ (aq) \rightarrow$

$Mg\ (s) + HNO_3\ (aq) \rightarrow$

$Ag\ (s) + HNO_3\ (aq) \rightarrow$

$Co\ (s) + Ni(NO_3)_2\ (aq) \rightarrow$

$Zn\ (s) + Sn(NO_3)_2\ (aq) \rightarrow$

Complete, balance, and identify the reaction type for each of the following equations:

Type

18. ___ $MgO\ (s)$ + ___ $H_2O\ (l) \rightarrow$

19. ___ $Zn\ (s)$ + ___ $Cu(NO_3)_2\ (aq) \rightarrow$

20. ___ $Ba(NO_3)_2\ (aq)$ + ___ $MgSO_4\ (aq) \rightarrow$

21. ___ $H_2SO_4\ (aq)$ + ___ $NaOH\ (aq) \rightarrow$

22. ___ $H_2CO_3\ (aq)\ (heated) \rightarrow$

23. ___ $Al\ (s)$ + ___ $O_2\ (g) \rightarrow$

24. ___ $Cu(OH)_2\ (s)$ + ___ $HClO_4\ (aq) \rightarrow$

25. ___ $Mn\ (s)$ + ___ $HBr\ (aq) \rightarrow$

26. ___ $HgO\ (s)\ (heated) \rightarrow$

27) **Concentrations of Reactants in Solution: Molarity**

a. How many moles of solute are in the following solutions?

10.76 mL of 1.54 M HF

250.0 mL of 0.99 M glucose ($C_6H_{12}O_6$)

50.1 mL of a 0.145 M solution of H_2SO_4

b. What is the concentration of a solution made by adding 15.5666 g of KOH in a 250.0 mL flask?

c. What mass of $AgNO_3$ is needed to make 500.0 mL of a 1.500 M solution?

d. Calculate the molarity of a solution that contains 0.0345 mol NH_4Cl in 400 mL of solution.

e. How many grams of HNO_2 are present in 35.0 mL of a 2.20 M solution of nitric acid?

f. What is the concentration of 156 mL of solution made from 2.5 grams of KCl?

g. How many milliliters of 1.50 M KOH solution are needed to give 0.125 mol of KOH?

h. How many grams of $KMnO_4$ are needed to make 500 mL of solution whose concentration is 1.75 M?

28) **Diluting Concentrated Solutions**

a. You have a 1.00 L bottle of 12.0 M HCl on your lab bench. How would you make a 250.0 mL solution of 1.00 M HCl?

b. What is the concentration of a solution made by adding 15.0 mL of 18.0 M H_2SO_4 to 100.0 mL of water?

c. A bottle of 15.0 M HCl has 27.5 mL left. What will the concentration of HCl be if water is added to the bottle to fill it to the 500.0 mL mark?

d. 260.0 mL of water are added to 37.8 mL of 1.66 M HCl. What is the concentration of the diluted solution?

e. How many milliliters of 3.0 M H_2SO_4 are required to make 450 mL of 0.10 M H_2SO_4?

f. How would you prepare 1.45×10^3 mL of a 1.45 M HNO_3 solution using 12.0 M stock solution of HNO_3? (How much water must be added to the stock solution?)

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29) **Solution Stoichiometry**

a. ___$CaCO_3$ (s) + ___ HCl (aq) → ___$CaCl_2$ (aq) + ___H_2O (l) + ___CO_2 (g)

What mass of $CaCO_3$ is required to react with 25.0 mL of 0.750 M HCl?

b. ___ HNO_3 (aq) + ___ NaOH (aq) → ___ $NaNO_3$ (aq) + ___ H_2O (l)

250.0 mL of 0.100 M HNO_3 is combined with an excess of NaOH. How much H_2O (in g) will be produced by this reaction?

c. You add 500 mL of 0.100 M $AgNO_3$ solution to a solution containing an excess of NaCl. How many grams of AgCl precipitate will you form? (Hint: Write a net ionic equation for the precipitation of AgCl.)

d. If you mix 0.200 L of 0.100 M $Pb(NO_3)_2$ and 0.300 L of 0.200 M NaCl, how much $PbCl_2$ precipitate will you form? (Hint: Limiting reactant problem!)

f. A 156.7 mL solution of 1.50 M $AgNO_3$ is mixed with a 4.22 g of solid K_3PO_4. When mixed together, a new solid forms. Identify the precipitate. Determine what mass of precipitate will form. Calculate the percent yield if only 6.045 g of precipitate was formed in lab.

g. Calculate the mass of the precipitate formed when 2.27 L of 0.0820 M $AgNO_3$ are mixed with 3.06 L of 0.0664 M K_2SO_4.

30) **Titration**

a. How many milliliters of 0.155 M HCl are needed to neutralize completely 35.0 mL of 0.101 M $Ba(OH)_2$ solution? (Hint: Write a balanced equation first.)

b. How many milliliters of 2.50 M H_2SO_4 are needed to neutralize 75.0 g of NaOH? (Hint: Write a balanced equation first.)

c. What is the molarity of a hydrochloric acid solution if it took 30.0 mL to neutralize 48.0 mL of 0.100 M NaOH? (Hint: Write a balanced equation first.)

d. 25.0 mL of 0.050 M $Ba(OH)_2$ neutralized 40.0 mL of nitric acid (HNO_3). Determine the concentration of the acid.

e. What is the concentration of NaOH if it takes 25 mL of 0.75 M HCl to neutralize 16.7 mL of NaOH? (Write a balanced equation first.)

f. How many grams of solid NaOH are required to neutralize 48.2 mL of 1.25 M H_2SO_4? (Write a balanced equation first.)