 Name ______________________________

TEST 7 REVIEW Date __________________ Period _____

Test Review № 7

Reaction Types. Chemical reactions can be grouped into four basic types. They are direct combination or synthesis, decomposition, single replacement or substitution, and double replacement or exchange of ions.

An example of **synthesis** is shown below:

$$\mathbf{N_2}(g) + \mathbf{3H_2}(g) \xrightarrow[\Delta]{catalyst} \mathbf{2NH_3}(g)$$

Synthesis often results in the formation of only one product from two reactants, but not always. Combustion, as in the following example, $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O$, is also a form of synthesis because the oxygen combines with both the metal and the nonmetal to form two oxides.

Decomposition is the reverse of synthesis. One reactant breaks apart to form several products. This is what happens when hydrogen peroxide decomposes over time to leave behind plain, ordinary water [$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$].

During a **single replacement** reaction, a more active metal replaces a less active metal in a compound, or a more active nonmetal replaces a less active nonmetal in a compound. This is what happens when a metal becomes corroded by an acid [$2Fe(s) + 6HCl(aq) \rightarrow 2FeCl_3(aq) + 3H_2(g)$]. In single replacement reactions, an element is reacting with a compound.

Double replacement reactions occur between aqueous compounds. The cations and anions switch partners. If an insoluble precipitate forms, the reaction is an end reaction, otherwise the result is an aqueous mixture of ions. An example of a double replacement reaction is $AgNO_3(aq) + NaCl(aq) \rightarrow NaNO_3(aq) + AgCl(s)$.

Patterns of the Reaction Types

Legend:

- **A** and **C** = *metals*
- **B** and **D** = *nonmetals*

— ◆ —

Direct combination (synthesis)

A + B → AB

Decomposition

AB → A + B

Single Replacement (substitution)

AB + C → CB + A *or*

AB + D → AD + B

Double Replacement (Exchange of Ions)

AB + CD → AD + CB

Conservation of Mass. Matter is neither created nor destroyed. During a chemical reaction the mass does not change. A properly written equation shows conservation of mass. For example, $AgNO_3(aq) + NaCl(aq) \rightarrow NaNO_3(aq) + AgCl(s)$.

Silver Nitrate			Sodium Chloride			Sodium Nitrate			Silver Chloride		
$AgNO_3$			NaCl			$NaNO_3$			AgCl		
Ag =	1 × 108 =	108	Na =	1 × 23 =	23	Na =	1 × 23 =	23	Ag =	1 × 108 =	108
N =	1 × 14 =	14	Cl =	1 × 35 =	35	N =	1 × 14 =	14	Cl =	1 × 35 =	35
O =	3 × 16 =	48			58	O =	3 × 16 =	48			143
		170						85			

$AgNO_3(aq)$ + $NaCl(aq)$ → $NaNO_3(aq)$ + $AgCl(s)$

170 + 58 = 85 + 143

228 = 228

Balancing Equations. The equation at the top of the box to the right does *not* show conservation of mass. Starting with two molecules of hydrogen, as shown in the equation at the bottom of the box by writing a **coefficient** 2 in front of the hydrogen and forming two molecules of water by writing a **coefficient** 2 in front of the water shows conservation. Coefficients are used to **balance** equations. Coefficients make the number of atoms of each type the same on the reactant and product side. As a result, coefficients make the mass the same on the reactant and product side of the equation. Balancing is done by counting the number and type of atoms on the reactant and product side of the equation and making them equal.

$H_2 + O_2 \rightarrow H_2O$

$2 + 32 \neq 18$

$2H_2 + O_2 \rightarrow 2H_2O$

$2(2) + 32 = 2(18)$

$36 = 36$

Moles. A mole is a formula mass expressed in grams. (1 mole = 1 gram formula mass). Atomic mass units are too small to measure on a laboratory balance, but grams are not. An atom of carbon has a mass of 12 amu and a molecule of glucose has a mass of 180 amu. Each mass represents one particle. Since the mass ratios in formula masses and gram formula masses are the same (12 amu:180 amu::12 g:180 g), the ratio of particles must still be the same (1mole:1 mole). The gram formula mass (GFM) is the number of grams in 1 mole. This results in the mathematical relationships shown above and to the right.

Substance	Formula Mass	Gram Formula Mass
carbon	12 amu	12 g
sodium chloride (NaCl)	58 amu	58 g
glucose ($C_6H_{12}O_6$)	180 amu	180 g

1. $GFM = \frac{g}{mole}$
2. g = GFM × mole
3. $mole = \frac{g}{GFM}$

Stoichiometry. Stoichiometry is the branch of chemistry that deals with the application of the laws of definite proportions and of the conservation of mass and energy to chemical activity. It shows the quantitative relationship between constituents of a chemical reaction. Stoichiometric calculations are based on several assumptions. It is assumed that the reaction has no side reactions, the reaction goes to completion, and the reactants are completely consumed. One type of problem that can be solved stoichiometrically is based on the mole ratios of a balanced equation. A sample problem is shown to the right.

Sample Problem

How many moles of oxygen are consumed when 0.6 moles of hydrogen burns to produce water?

Step 1: Write a balanced equation and determine the mole ratios from the equation

Step 2: Identify the known and the unknown

Step 3: Set up a proportion and solve for the unknown

	$2\,H_2(g)$	$+\ O_2(g)$	$\rightarrow 2\,H_2O$
mole ratio	2	1	2
moles	known 0.6	unknown x	

- $\frac{2}{0.6mol} = \frac{1}{x}$
- $2x = 0.6mol$
- $x = 0.3mol$

Answer the questions below by circling the number of the correct response

1. When the equation $H_2 + Fe_3O_4 \rightarrow Fe + H_2O$ is completely balanced using *smallest* whole numbers the coefficient of H_2 would be (1) 1 (2) 2 (3) 3 (4) 4
2. When the equation __C_2H_4 + __O_2 → __CO_2 + __H_2O is correctly balanced, using *smallest* whole-numbered coefficients, the sum of all the coefficients is (1) 16 (2) 12 (3) 8 (4) 4
3. When the equation $NH_3 + O_2 \rightarrow HNO_3 + H_2O$ is completely balanced using smallest whole numbers, the coefficient of O_2 would be (1) 1 (2) 2 (3) 3 (4) 4
4. When the equation __Na(s) + __$H_2O(\ell)$ → __NaOH(aq) + __$H_2(g)$ is correctly balanced using smallest whole numbers, the coefficient of the water is (1) 1 (2) 2 (3) 3 (4) 4
5. When the equation __Al(s) + __$O_2(g)$ → __$Al_2O_3(s)$ is correctly balanced using the smallest whole numbers, the coefficient of Al(s) is (1) 1 (2) 2 (3) 3 (4) 4
6. Given the unbalanced equation:
   __$Al_2(SO_4)_3$ + __$Ca(OH)_2$ → __ $Al(OH)_3$ + __$CaSO_4$
   When the equation is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 15 (2) 9 (3) 3 (4) 4
7. When the equation __ H_2 + __ Cl_2 → __ HCl is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 1 (2) 2 (3) 3 (4) 4
8. When the equation
   __ $Ca(NO_3)_2$ + __ H_2SO_4 → __ $CaSO_4$ + __ HNO_3 is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 2 (3) 3 (4) 4
9. When the equation __ Fe + __ Cl_2 → __ $FeCl_3$ is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 8 (2) 7 (3) 3 (4) 4
10. When the equation __ Fe + __ O_2 → __Fe_2O_3 is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 15 (2) 9 (3) 7 (4) 4
11. When the equation __ Zn + __ HCl → __ $ZnCl_2$ + __ H_2 is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 9 (3) 3 (4) 4
12. When the equation
    __ Cu + __ $AgCH_3COO$ → __$Cu(CH_3COO)_2$ + __ Ag is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 6 (3) 3 (4) 4

13. When the equation __ H_2SO_4 + __ NaOH → __Na_2SO_4 + __ H_2O is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 6 (3) 3 (4) 4

14. When the equation __ N_2 + __ H_2 → __ NH_3 is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 6 (3) 3 (4) 4

15. When the equation __ CH_4 + __ O_2 → __ CO_2 + __ H_2O is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 5 (2) 6 (3) 3 (4) 4

16. When the equation __ S + __ O_2 → __ SO_3 is completely balanced using the smallest whole-number coefficients, the sum of the coefficients is (1) 15 (2) 9 (3) 7 (4) 4

For each of the reactions described in questions 17-27, write the correct number to indicate whether the reaction type is (1) DECOMPOSITION, (2) DIRECT COMBINATION, (3) SINGLE REPLACEMENT, or (4) DOUBLE REPLACEMENT

17. A reaction occurs in which only one reactant is present.

18. Magnesium burns.

19. Two salt solutions react with each other.

20. Two elements unite to form a compound.

21. A compound breaks down.

22. $2KClO_3(s) \xrightarrow[\Delta]{MnO_2(s)} 2KCl(s) + 3O_2(g)$

23. $2Fe + 6HCl \rightarrow 2FeCl_3 + 3H_2$

24. $2Mg + O_2 \rightarrow 2MgO$

25. $CuSO_4(aq) + K_2CrO_4(aq) \rightarrow K_2SO_4(aq) + CuCrO_4(s)$

26. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

27. $HCl + NaOH \rightarrow NaCl + H_2O$

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28. What is the total mass of iron in 1.0 mole of Fe_2O_3? (1) 160 g (2) 72 g (3) 112 g (4) 56 g

29. What is the mass, in grams, of 1.0 mole of $(NH_4)_2S$? (1) 50. (2) 54 (3) 64 (4) 68

30. What is the gram atomic mass of the element chlorine? (1) 17 g (2) 35 g (3) 52 g (4) 70. g

31. The mass in grams of 1.00 mole of $CaSO_4 \cdot 2H_2O$ is (1) 172 g (2) 154 g (3) 136 g (4) 118 g

32. The gram molecular mass of CO_2 is the same as the gram molecular mass of (1) CO (2) C_2H_4 (3) SO_2 (4) C_3H_8

33. What is the mass of 2 moles of potassium nitrate [KNO_3]? (1) 101 g (2) 202 g (3) 303 g (4) 404 g

34. What is the mass of 0.5 moles of aluminum oxide [Al_2O_3]? (1) 102 g (2) 51 g (3) 26 g (4) 204 g

35. What is the mass of 0.1 mole of silver acetate [$AgCH_3COO$]? (1) 16.7 g (2) 84 g (3) 167 g (4) 118 g

36. What is the mass of 0.25 moles of calcium sulfate [$CaSO_4$]? (1) 172 g (2) 154 g (3) 136 g (4) 34 g

37. How many moles are in 447 g of ammonium phosphate [$(NH_4)_3PO_4$]? (1) 1 (2) 2 (3) 3 (4) 4

38. How many moles are in 392 g of sulfuric acid? [$H_2SO_4(aq)$]? (1) 1 (2) 2 (3) 3 (4) 4

39. How many moles are in 216. g of dinitrogen pentoxide [N_2O_5]? (1) 1 (2) 2 (3) 3 (4) 4

40. How many moles are in 780 g of tin IV fluoride [SnF_4]? (1) 1 (2) 2 (3) 3 (4) 4

41. According to the equation $HCl + NaOH \rightarrow NaCl + H_2O$, the total number of moles of HCl that can be neutralized by 2 moles of NaOH is (1) 1.0 (2) 2.0 (3) 3.0 (4) 4.0

42. Given the balanced equation: $NaOH + HCl \rightarrow NaCl + H_2O$
What is the total number of moles of H_2O produced when 3 moles of the product, NaCl, is formed? (1) 1.0 (2) 2.0 (3) 3.0 (4) 4.0

43. Given the reaction: $4Al + 3O_2 \rightarrow 2Al_2O_3$
How many moles of Al_2O_3 will be formed when 2.0 moles of Al reacts completely with O_2? (1) 1.0 (2) 2.0 (3) 0.50 (4) 4.0

44. Given the equation: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
When 1.0 mole of C_2H_6 is completely burned, the total number of moles of CO_2 produced is (1) 1.0 (2) 2.0 (3) 8.0 (4) 4.0

45. Given the reaction: $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$
how many moles of H_2O are produced when 0.5 moles of Cu is completely consumed? (1) 1.0 mol (2) 2.0 mol (3) 0.5 mol (4) 4.0 mol

Answers

1.	4	10.	2	19.	4	28.	3	37.	3
2.	3	11.	1	20.	2	29.	4	38.	4
3.	2	12.	2	21.	1	30.	2	39.	2
4.	2	13.	1	22.	1	31.	1	40.	4
5.	4	14.	2	23.	3	32.	4	41.	2
6.	2	15.	2	24.	2	33.	2	42.	3
7.	4	16.	3	25.	4	34.	2	43.	1
8.	1	17.	1	26.	4	35.	1	44.	2
9.	2	18.	2	27.	4	36.	4	45.	1