Name_____ Date_____ Period_____

Topic: Formulas & Names, Equations, Moles, Molar Mass, & types of Reactions

Outline

1. A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can only be broken down by chemical means.

2. Chemical compounds can be represented by a specific formula and assigned a name based on the IUPAC system.

3. Types of chemical formulas include empirical, molecular, and structural.

- ✓ Empirical formulas show elements in their simplest whole number ratios. This may or may not be the same as the molecular formula.
- ✓ Molecular formulas show the actual number of atoms per element in a single molecule.
- ✓ Structural formulas show the number of each type of atom as well as their physical arrangement.

4. All chemical reactions show a conservation of mass, energy and charge.

5. A balanced chemical equation represents conservation of atoms.

6. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction, and can further be used to predict relationships about amounts between products and reactants.

7. The molar mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram formula mass) equals the mass of one mole of that substance.

8. The percent composition by mass of each element in a compound can be calculated mathematically.

9. Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

Equations & Stoichiometry – Practice Questions

1. Which substance has the greatest molecular mass?
   (1) H_2O_2 (2) NO (3) CF_4 (4) I_2

2. What is the gram formula mass of $Ca(OH)_2$?
   (1) 29 g (2) 34 g (3) 57 g (4) 74 g

3. What is the total number of moles of atoms present in 1 gram formula mass of $Pb(C_2H_3O_2)_2$?
   (1) 9 (2) 14 (3) 3 (4) 15

4. The percent by mass of carbon in $HC_2H_3O_2$ is equal to
   (1) $\frac{12}{60}\times 100$ (2) $\frac{24}{60}\times 100$ (3) $\frac{60}{24}\times 100$ (4) $\frac{60}{12}\times 100$

5. What is the empirical formula of C_3H_6?
   (1) CH (2) CH_2 (3) CH_3 (4) CH_6

6. The name of the compound $KClO_2$ is potassium
   (1) hypochlorite (3) chlorate
   (2) chlorite (4) perchlorate

7. Which formula is correct for ammonium sulfate?
   (1) NH_4SO_4 (2) $(NH_4)_2SO_4$ (3) $NH_4(SO_4)_2$ (4) $(NH)_3(SO_4)_2$

8. The molecular formula of a compound is represented by X_3Y_6. What is the empirical formula of this compound?
   (1) X_3Y (2) X_2Y (3) XY_2 (4) XY

9. The number of moles of molecules in a 12.0-gram samples of Cl_2 is
   (1) $\frac{12.0}{35.5}$ mole (2) $\frac{12.0}{71.0}$ mole (3) 12.0 moles (4) 12.0 x 35.5 moles

10. What is the total number of moles of sulfur atoms in 1 mole of $Fe_2(SO_4)_3$?
    (1) 1 (2) 15 (3) 3 (4) 17

11. Given the unbalanced equation:

$$\_\_\_\_ CaSO_4 + \_\_\_\_ AlCl_3 \rightarrow \_\_\_\_ Al_2(SO_4)_3 + \_\_\_\_ CaCl_2$$

What is the coefficient of $Al_2(SO_4)_3$ when the equation is completely balanced using the smallest whole-number coefficients?
(1) 1 (2) 2 (3) 3 (4) 4

12. Given the unbalanced equation:

$$\_\_\_Al\ (s) + \_\_\_\_O_2\ (g) \rightarrow \_\_\_\_Al_2O_3\ (s)$$

When this equation is correctly balanced using smallest whole numbers, what is the coefficient of O_2 (g)?

(1) 6 (2) 2 (3) 3 (4) 4

13. Given the reaction:

$$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$$

What is the total number of moles of NO produced when 1.0 mole of O_2 is completely consumed?

(1) 1.0 mole (2) 1.2 moles (3) 0.80 mole (4) 4.0 moles

14. Given the equation:

$$H_2\ (g) + Cl_2\ (g) \rightarrow 2\ HCl\ (g)$$

What is the total number of moles of HCl (g) produced when 3 moles of H_2 (g) is completely consumed?

(1) 5 moles (2) 2 moles (3) 3 moles (4) 6 moles

Formulas, Equations & Stoichiometry Review – questions from previous Regents exams

1. Which equation shows conservation of atoms?
   (1) $H_2 + O_2 \rightarrow H_2O$
   (2) $H_2 + O_2 \rightarrow 2\ H_2O$
   (3) $2\ H_2 + O_2 \rightarrow 2\ H_2O$
   (4) $2\ H_2 + 2\ O_2 \rightarrow 2\ H_2O$

2. Which substance can be broken down by a chemical change?
   (1) antimony (3) hexane
   (2) carbon (4) sulfur

3. What is the gram formula mass of $Ca_3(PO_4)_2$?
   (1) 248 g/mol (3) 279 g/mol
   (2) 263 g/mol (4) 310 g/mol

4. In which compound is the ratio of metal ions to nonmetal ions 1 to 2?
   (1) calcium bromide
   (2) calcium oxide
   (3) calcium phosphide
   (4) calcium sulfide

5. Given the balanced equation representing a reaction:
   $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
   What is the mole ratio of $CO(g)$ to $CO_2(g)$ in this reaction?
   (1) 1:1 (3) 2:1
   (2) 1:2 (4) 3:2

6. Given the balanced equation representing a reaction:
   $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell) + 55.8\ kJ$
   In this reaction there is conservation of
   (1) mass, only
   (2) mass and charge, only
   (3) mass and energy, only
   (4) mass, charge, and energy

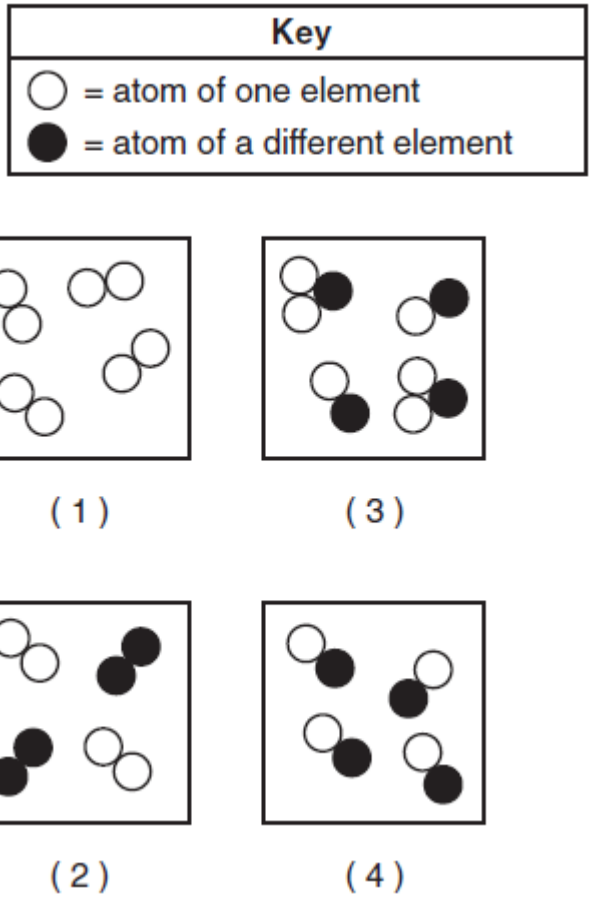
7. Which polyatomic ion contains the greatest number of oxygen atoms?
   (1) acetone (3) hydroxide
   (2) carbonate (4) peroxide

8. Which formula represents an ionic compound?
   (1) H_2 (3) CH_3OH
   (2) CH_4 (4) NH_4Cl

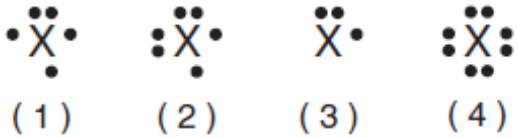
9. What is the total number of different elements present in NH_4NO_3?
   (1) 7 (3) 3
   (2) 9 (4) 4

10. Which formula represents lead (II) chromate?
   (1) $PbCrO_4$ (3) Pb_2CrO_4
   (2) $Pb(CrO_4)_2$ (4) $Pb_2(CrO_4)_3$

11. Which particle diagram represents a sample of one compound, only?



12. An atom in the ground state contains a total of 5 electrons, 5 protons, and 5 neutrons. Which Lewis electron-dot diagram represents this atom?



(1) (2) (3) (4)

13. Given the balanced equation representing the reaction between propane and oxygen:

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

According to this equation, which ratio of oxygen to propane is correct?

(1) $\frac{5 \text{ grams } O_2}{1 \text{ gram } C_3H_8}$ (3) $\frac{10 \text{ grams } O_2}{11 \text{ grams } C_3H_8}$

(2) $\frac{5 \text{ moles } O_2}{1 \text{ mole } C_3H_8}$ (4) $\frac{10 \text{ moles } O_2}{11 \text{ moles } C_3H_8}$

14. Which substance can be decomposed by chemical means?

(1) tungsten (3) krypton
(2) antimony (4) methane

15. Given the balanced equation representing a reaction:

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

What is the *minimum* number of moles of O_2 that are needed to completely react with 16 moles of NH_3?

(1) 16 mol (3) 64 mol
(2) 20. mol (4) 80. mol

16. Element *X* reacts with iron to form two different compounds with the formulas Fe*X* and Fe_2X_3.

To which group on the Periodic Table does element *X* belong?

(1) Group 8 (3) Group 13
(2) Group 2 (4) Group 16

17. The molar mass of $Ba(OH)_2$ is

(1) 154.3 g (3) 171.3 g
(2) 155.3 g (4) 308.6 g

18. Given the balanced equation representing a reaction:

$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$

Which type of reaction is represented by this equation?

(1) decomposition
(2) neutralization
(3) single replacement
(4) synthesis

19. A hydrated compound contains water molecules within its crystal structure. The percent composition by mass of water in the hydrated compound $CaSO_4 \cdot 2H_2O$ has an accepted value of 20.9%. A student did an experiment and determined that the percent composition by mass of water in $CaSO_4 \cdot 2H_2O$ was 21.4%.

Calculate the percent error of the student's experimental result. Your response must include *both* a correct numerical setup and the calculated result. [2]

20. Write the empirical formula for the compound C_8H_{18}. [1] _____

Some dry chemicals can be used to put out forest fires. One of these chemicals is $NaHCO_3$. When $NaHCO_3(s)$ is heated, one of the products is $CO_2(g)$, as shown in the balanced equation below.

$$2\ NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

21. Show a correct numerical setup for calculating the percent composition by mass of carbon in the product Na_2CO_3. [1]

22. Identify whether the reaction is endothermic or exothermic. [1] _____

23. Determine the total number of moles of $CO_2(g)$ produced when 7.0 moles of $NaHCO_3(s)$ is completely reacted. [1]

_____ moles

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24. Balance this chemical equation: [1]

_____ $S(s)$ + _____ $KClO_3(s) \rightarrow$ _____ $SO_2(g)$ + _____ $KCl(s)$ + energy

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Base your answers to questions 25 through 27 on the information below.

Rust on an automobile door contains $Fe_2O_3(s)$. The balanced equation representing one of the reactions between iron in the door of the automobile and oxygen in the atmosphere is given below.

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

25. Identify the type of chemical reaction represented by this equation. [1] _____

26. Determine the gram-formula mass of the product of this reaction. [1]

27. Write the IUPAC name for Fe_2O_3. [1] _____

Ozone gas, O_3, can be used to kill adult insects in storage bins for grain without damaging the grain. The ozone is produced from oxygen gas, O_2, in portable ozone generators located near the storage bins. The concentrations of ozone used are so low that they do not cause any environmental damage. This use of ozone is safer and more environmentally friendly than a method that used bromomethane, CH_3Br. However, bromomethane was more effective than ozone because CH_3Br killed immature insects as well as adult insects.

Adapted From: *The Sunday Gazette* (Schenectady, NY) 3/9/03

28. Determine the total number of moles of CH3Br in 19 grams of CH3Br (gram-formula mass = 95 grams/mol). [1]

29. Given the balanced equation for producing bromomethane:

$$Br_2 + CH_4 \rightarrow CH_3Br + HBr$$

Identify the type of organic reaction shown. [1] _____

30. Based on the information in the passage, state *one* advantage of using ozone instead of bromomethane for insect control in grain storage bins. [1]

A hydrate is a compound that has water molecules within its crystal structure. The formula for the hydrate $CuSO_4 \cdot 5H_2O(s)$ shows that there are five moles of water for every one mole of $CuSO_4(s)$. When $CuSO_4 \cdot 5H_2O(s)$ is heated, the water within the crystals is released, as represented by the balanced equation below.

$$CuSO_4 \cdot 5H_2O(s) \rightarrow CuSO_4(s) + 5H_2O(g)$$

A student first masses an empty crucible (a heat-resistant container). The student then masses the crucible containing a sample of $CuSO_4 \cdot 5H_2O(s)$. The student repeatedly heats and masses the crucible and its contents until the mass is constant. The student's recorded experimental data and calculations are shown below.

Data and calculation before heating:

mass of $CuSO_4 \cdot 5H_2O(s)$ and crucible	21.37 g
– mass of crucible	19.24 g
mass of $CuSO_4 \cdot 5H_2O(s)$	2.13 g

Data and calculation after heating to a constant mass:

mass of $CuSO_4(s)$ and crucible	20.61 g
– mass of crucible	19.24 g
mass of $CuSO_4(s)$	1.37 g

Calculation to determine the mass of water:

mass of $CuSO_4 \cdot 5H_2O(s)$	2.13 g
– mass of $CuSO_4(s)$	1.37 g
mass of $H_2O(g)$	0.76 g

31. Identify the total number of significant figures recorded in the calculated mass of $CuSO_4 \cdot 5H_2O(s)$. [1]

32. In the space below, use the student's data to show a correct numerical setup for calculating the percent composition by mass of water in the hydrate. [1]

33. Explain why the sample in the crucible must be heated until the constant mass is reached. [1]