Score ____ / 100 pts.

Name ___________________________

Class _____ Date ________________

In a chemical reaction new substances are formed as atoms and molecules are rearranged. The concept of atoms explains the conservation of matter, since the number of atoms stays the same in a chemical reaction no matter how they are rearranged; the total mass stays the same. Although energy can be absorbed or released in a chemical reaction, the total amount of energy and matter in it remains constant. Many reactions attain a state of equilibrium. Many ordinary activities, such as baking, involve chemical reactions.

STANDARD IV: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.

Objective 1 Identify evidence of chemical reactions and demonstrate how chemical equations are used to describe them.

1. What happens during a chemical reaction? Bonds of reactant compounds break and atoms rearrange to form new compounds. What is the difference between a physical change and a chemical change? Physical changes result in no formation of new compounds. Chemical changes result in the formation of new substances. How can you tell that a chemical change has happened? The formation of new compounds usually result in one or more of the following: Color change, formation of a gas, formation of a precipitate, a new odor, or changes in temperature.

1. Do products have the same properties as the reactants they came from? No Why or why not? The bonding in the products is different. Electron configurations are different. New properties result.

2. Name three things from every day life that involve chemical reactions. Wow, chemical reactions happen everywhere. Your body is full of chemical reactions occurring at the cellular level. Food cooking involves bonds breaking and new substances forming. Breathing, plants growing, etc.

3. Balance the following reactions AND write them in sentence form:

   a. _2_ Fe + _3__CO $_2$ → ___ Fe $_2$ O $_3$ + _3__ CO
   Iron reacts with carbon dioxide to form iron (III) oxide and carbon monoxide.

   b. ___ N $_2$ + ___3_H $_2$ → _2__ NH $_3$
   Nitrogen reacts with hydrogen to form ammonia.

   c. ___ C_3H_8 + _5_ O $_2$ → _3_ CO $_2$ + 4 H $_2$ O (use simple name for this reaction)
   Propane combusts. Or, propane reacts with oxygen to form water and carbon dioxide.

4. Write (and balance) the following reaction: sulfur reacts with oxygen to produce sulfur trioxide
   $S_8 + 12O_2 \rightarrow 8SO_3$

5. Which atoms are never found by themselves in chemical reactions?
   $Br_2I_2N_2Cl_2H_2O_2F_2$ as well as P_4 and S_8

Objective 2 Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions.

6. The number (and identity) of __atoms___ stays the same during a chemical reaction. The atoms are just _____rearranged_______. This can be used to explain the law of _conservation of mass_.

7. The total mass before and after a reaction are always __equal____. If it appears that mass has been "lost", what has probably happened? The lost mass was converted into a gas, or it was left in a beaker, etc.

8. How could you design a lab to test the law of conservation of mass? Take a glow stick and weigh it. Snap the stick and start the reaction, weigh it while it is glowing. The chemical reaction taking place changed the composition of the chemicals in the glow stick. The stick was sealed so none of the atoms inside should have been able to escape. The mass after the reaction should be the same as the mass before the reaction.

9. Bob decomposes hydrogen peroxide in the lab according to the following reaction:
$2\ H_2O_2 \rightarrow 2H_2O + O_2$ He collects the water and the oxygen produced and weighs them.
He started with 15 grams of hydrogen peroxide. At the end of the lab he has 8 grams of water and 7 grams of oxygen. Does this support the conservation of mass? Explain. Yes, the mass at the beginning was 15 grams, The total mass of the products is still 15 grams (7+8). Mass was conserved.

10. Use the following equation to answer the following questions: $3NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$
    a. If I have 5 moles of water, how many moles of NO can I produce? The ratio of water to NO in the reaction is 1 to 1. So 5 moles of water should produce 5 moles of NO

    b. If I want to produce 10 moles of HNO_3, how many moles of NO_2 do I need? The ratio of HNO_3 to NO_2 in the reaction is 2 to 3. so to produce 10 moles of HNO_2 you will need 15 moles of NO_2.

    c. What do the numbers in front of the chemicals tell us? The coefficients relate the number of moles required to balance the reaction and produce products. The reaction must always be balanced in order to reflect the conservation of mass.

11. The following reacts to completion: $BCl_3 + 3H_2O \rightarrow H_3BO + 3HCl$
If I use 25 grams of water, how many grams of HCl will I end up with? Use the molar mass of water to calculate the number of moles of water, 25 grams water divided by 18 grams per mole, is approximately 1.4 moles of water. The ratio of water to HCl is 1 to 1 so you will produce 1.4 moles of HCl. Use the molar mass of HCl, 36.5 grams per mole, to calculate the mass of HCl produced. 1.4 moles times 36.5 grams per mole results in approximately 50.7 grams of HCl.

12. The following reacts to completion: $CaCO_3 + 2\ NH_3 \rightarrow Ca(CN)_2 + 3\ H_2O$
If I want to produce 56 grams of $Ca(CN)_2$, then how much NH_3 will I need? Use the molar mass of $Ca(CN)_2$, 92.24 grams per mole, to calculate the moles of $Ca(CN)_2$. 56 grams divided by 92.24 grams per mole results in .607 moles of calcium cyanide. The ratio of ammonia to calcium cyanide is 2 to 1, so for every one mole of calcium cyanide 2 moles of ammonia are required. .607 moles of calcium cyanide will require twice as much ammonia, 1.214 moles of ammonia. The molar mass of ammonia is 17 grams per mole so 1.214 moles times 17 grams per mole will require approximately 20.64 grams of ammonia.

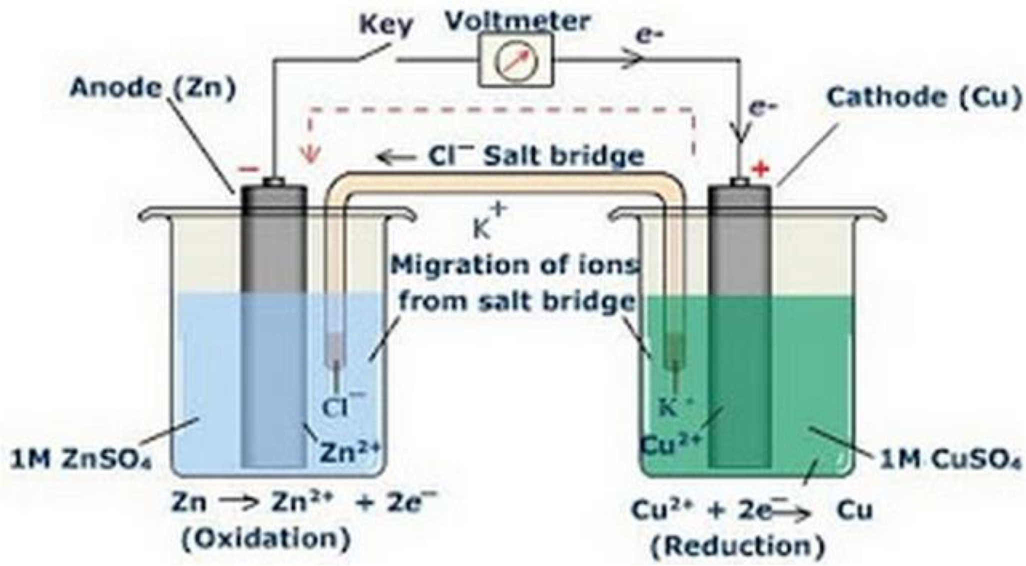
13. In addition to mass, what else is always conserved in a chemical reaction? The energy present in the process is always conserved.

14. Reactions that absorb energy (pull it in from the environment) are called _endothermic__ and feel _cold to the observer__. Where does that energy go? Energy flows from the surroundings into the new bonds formed in the products of the reaction.

15. Reactions that release energy (push it out into the environment) are called _exothermic_ and feel __warm to the observer_. Where does that energy come from? The new bonds formed require less energy than the bonds that broke, so the excess energy is released from breaking the old bonds.

16. How do we know when energy is released or produced by a chemical reaction? As energy is released we will observe the surroundings increasing in temperature. If the temperature drops, the reaction was _endothermic_ and energy was _absorbed_. If the temperature rises, the reaction was _exothermic__ and energy was _released_.

17. What is a redox reaction? What is a half reaction? Draw a picture of a simple electrochemical cell (battery) and explain how it works. A redox reaction is where electrons are transferred from one element to another during chemical changes. A half reaction isolates one of the elements involved in the transfer and shows how many electrons leave and how the charge changes.



18. You have 100 grams of water that is currently 25 ^{o}C. You add a powder to the water and stir. The temperature drops to 20 ^{o}C. How much heat was involved during the reaction between the powder and the water? The heat is calculate by multiplying the mass of the water by the specific heat of water by the change in temperature. The mass of the water was 100 grams times the specific heat which was 4.184 joules per gram per degree Celsius times the change in temperature which was a drop of 5 degrees Celsius. Heat absorbed was 2092 joules. Was this energy "gained" or "lost" by the water? The energy is taken from the water and used in the new bonds formed in the process. (Use 4.18 for the specific heat of water even though it is contaminated.)