Name ______________________ Section ________ Date ________

Chapter 7: Basic Review Worksheet

1. What kind of visual evidence indicates that a chemical reaction has occurred? Give a reaction that illustrates each type of evidence you have mentioned.

2. What are the substances indicated to the left of the arrow called in a chemical equation? To the right of the arrow?

3. How are the physical states of reactants and products indicated when writing chemical equations?

4. What does it mean to "balance" an equation?

5. What do the *coefficients* in a balanced chemical equation represent? What do the *subscripts* in a balanced chemical equation represent? Which can be changed when balancing a chemical equation?

6. Balance the following chemical equations.
   a. $FeCl_3(aq) + KOH(aq) \rightarrow Fe(OH)_3(s) + KCl(aq)$
   b. $AgC_2H_3O_2(aq) + HCl(aq) \rightarrow AgCl(s) + HC_2H_3O_2(aq)$
   c. $SnO(s) + C(s) \rightarrow Sn(s) + CO_2(g)$
   d. $K_2O(s) + H_2O(l) \rightarrow KOH(aq)$

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Chapter 7: Review Worksheet

1. Do all reactions produce visual evidence that they have taken place? If yes, explain why; if no, provide examples of reactions that do not provide visual evidence.

2. What, in general terms, does a chemical equation indicate?

3. Why is it so important that the equations be balanced? What does it mean to say that atoms must be *conserved* in a balanced chemical equation?

4. When balancing a chemical equation, why is it acceptable to adjust a substance's coefficient but not permissible to adjust the subscripts within the substance's formula? What would changing the subscripts within a formula do?

5. Balance the following chemical equations.
   a. $Na_2O_2(s) + H_2O(l) \rightarrow NaOH(aq) + O_2(g)$
   b. $Fe(s) + Br_2(l) \rightarrow FeBr_3(s)$
   c. $Na_2S(s) + HCl(aq) \rightarrow NaCl(aq) + H_2S(g)$
   d. $H_2SO_4(aq) + NaCl(s) \rightarrow Na_2SO_4(aq) + HCl(aq)$
   e. $N_2(g) + I_2(s) \rightarrow NI_3(s)$

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Chapter 7: Challenge Review Worksheet

1. The text emphasizes balancing a chemical equation so that all of the coefficients are lowest multiple whole numbers. This is called standard form. Although it is not standard, coefficients in a balanced equation can be fractions. However, subscripts can never be fractions. Explain why each of these statements is true.

2. Determine the sum of the coefficients for each of the following chemical equations when they are balanced in standard form.
   a. $NaBH_4 + BF_3 \rightarrow NaBF_4 + B_2H_6$
   b. $NO + H_2 \rightarrow N_2 + H_2O$
   c. $Fe_2O_3 + CO \rightarrow Fe + CO_2$

3. Potassium and sodium are highly reactive metals. Write balanced chemical equations (standard form) for the reaction of each of these metals with the following substances, to give the indicated products.
   a. With water, producing aqueous sodium hydroxide or potassium hydroxide, and hydrogen gas.
   b. With chlorine gas, producing sodium chloride or potassium chloride.
   c. With phosphorus, producing sodium phosphide or potassium phosphide.
   d. With nitrogen gas, producing sodium nitride or potassium nitride.
   e. With hydrogen gas, producing sodium hydride or potassium hydride.

4. You wish to make baking soda (sodium hydrogen carbonate). To do so you bubble carbon dioxide into cold water that contains dissolved ammonia and sodium chloride. The other product is ammonium chloride, which remains dissolved in the water. The baking soda is not soluble, so you can collect it by filtration. Write a balanced chemical equation (standard form) for this reaction.

$$\text{millimol O} = 55.15 \text{ mg} \times \frac{1 \text{ millimol}}{16.00 \text{ g}} = 3.477 \text{ millimol O}$$

Dividing each of these numbers of millimols by the smallest number of millimols (3.447 millimol O) gives the empirical formula as C_2H_4O.

8. $$3.66 \text{ g } CO_2 \times \frac{12.01 \text{ g C}}{44.01 \text{ g } CO_2} = 0.999 \text{ g C}$$

$$1.50 \text{ g } H_2O \times \frac{2.016 \text{ g H}}{18.016 \text{ g } H_2O} = 0.168 \text{ g H}$$

$$2.500 \text{ g} - 0.999 \text{ g} - 0.168 \text{ g} = 1.333 \text{ g O}$$

$$0.999 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 0.0833 \text{ mol C}$$

$$0.168 \text{ g C} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 0.167 \text{ mol H}$$

$$1.332 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 0.08331 \text{ mol O}$$

Since 0.0833:0.167:0.08331 = 1:2:1, the empirical formula is CH_2O.

9. The molar mass of CH_2O is about 30 g/mol. This is half of the molar mass of the compound. Thus the molecular formula is $C_2H_4O_2$.

Chapter 7: Basic Review Worksheet

1. There are numerous ways we can recognize that a chemical reaction has taken place.

In some reactions there may be a *color change*. For example, the ions of many of the transition metals are brightly colored in aqueous solution. If one of these ions undergoes a reaction in which the oxidation state changes, however, the characteristic color of the ion *may* be changed. For example, when a piece of zinc is added to an aqueous copper (II) ion solution (which is bright blue), the Cu^{2+} ions are reduced to copper metal, and the blue color of the solution fades as the reaction takes place.

$$Zn\ (s) + \underset{\text{blue solution}}{Cu^{2+}\ (aq)} \rightarrow Zn^{2}\ (aq) + \underset{\text{red/black solid}}{Cu\ (s)}$$

In many reactions of ionic solutes, a solid precipitate forms when the ions are combined. For example, when a clear, colorless aqueous solution of sodium chloride is added to a clear, colorless solution of silver nitrate, a white solid of silver chloride forms and settles out of the mixture.

$$AgNO_3\,(aq) + NaCl\,(aq) \rightarrow NaNO_3\,(aq) + AgCl\,(s)$$

In some reactions, particularly in the combustion of organic chemical substances with oxygen gas, heat, and light (a flame) may be produced. For example, when methane (natural gas) is burned in oxygen, a luminous flame is produced and heat energy is released:

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g) + \text{energy}$$

2. The substances to the left of the arrow in a chemical equation are called the reactants; those to the right of the arrow are referred to as the products.

3. The physical states are indicated by using letters in parentheses after the formula: (s), (l), (g), or (aq).

4. When we "balance" a chemical equation, we adjust the *coefficients* of the reactants and products in the equation so that the same total numbers of atoms of each element are present both before and after the reaction has taken place.

5. Coefficients in a balanced chemical equation represent the relative numbers of each type of molecule involved in the reaction. Subscripts represent the numbers of each type of atom in a particular molecule. When we balance a chemical equation, it is permitted only to adjust the coefficients of a formula, since changing a coefficient merely changes the number of molecules of a substance being used in the reaction, without changing the identity of the substance.

6. a. $FeCl_3\,(aq) + 3KOH\,(s) \rightarrow Fe(OH)_3\,(s) + 3KCl\,(aq)$
   b. $AgC_2H_3O_2\,(aq) + HCl\,(aq) \rightarrow AgCl\,(s) + HC_2H_3O_2\,(aq)$
   c. $2SnO\,(s) + C\,(s) \rightarrow 2Sn\,(s) + CO_2\,(g)$
   d. $K_2O\,(s) + H_2O\,(l) \rightarrow 2KOH\,(aq)$

Chapter 7: Review Worksheet

1. All chemical reactions do produce some evidence that the reaction has occurred, but sometimes this evidence may *not* be visual, and may not be very obvious. For example, when very dilute aqueous solutions of acids and bases are mixed, the neutralization reaction

$$H^+\,(aq) + OH^-\,(aq) \rightarrow H_2O\,(l)$$

takes place. However, the only evidence for this reaction is the release of heat energy, which should be evident as a temperature change for the mixture. Since water has a relatively high specific heat capacity, however, if the acid and base solutions are very dilute, the temperature may only change by a fraction of a degree and may not be noticed.

2. A chemical equation indicates the substances necessary for a chemical reaction to take place, as well as what is produced by that chemical reaction. In addition, if a chemical equation has been balanced then the equation indicates the relative proportions in which the reactant molecules combine to form the product molecules.

3. Balancing chemical equations is so important because a balanced chemical equation shows us not only the identities of the reactants and products, but also the relative numbers of each involved in the process. This information is necessary if we are to do any sort of calculation involving the amounts of reactants required for a process or are to calculate the yield expected from a process. When we say that atoms must be conserved when writing balanced chemical equations, we mean that the number of atoms of each element must be the same after the reaction as before the reaction. Atoms are not created or destroyed during a chemical reaction, they are just arranged into new products

4. It is never permissible to change the subscripts of a formula when balancing a chemical equation. Changing the subscripts changes the identity of a substance from one chemical to another. For example, consider the unbalanced chemical equation

$$H_2(g) + O_2(g) \rightarrow H_2O(l)$$

If you changed the *formula* of the product form $H_2O(l)$ to $H_2O_2(l)$, the equation would appear to be "balanced". However, H_2O is water, whereas H_2O_2 is hydrogen peroxide—a completely different chemical substance (which is not prepared by reaction of the elements hydrogen and oxygen).

5. a. $2Na_2O_2\ (s) + 2H_2O\ (l) \rightarrow 4NaOH\ (aq) + O_2\ (g)$
   b. $2Fe\ (s) + 3Br_2\ (l) \rightarrow 2FeBr_3\ (s)$
   c. $Na_2S\ (s) + 2HCl\ (aq) \rightarrow 2NaCl\ (aq) + H_2S\ (g)$
   d. $H_2SO_4\ (aq) + 2NaCl\ (s) \rightarrow Na_2SO_4\ (aq) + 2HCl\ (aq)$
   e. $N_2\ (g) + 3I_2\ (s) \rightarrow 2NI_3\ (s)$

Chapter 7: Challenge Review Worksheet

1. The coefficients represent the relative numbers of molecules involved in the reaction. They can also represent the relative numbers of moles of molecules (in fact, this is the most convenient way of thinking about coefficients). Since we can have fractions of moles, the coefficients can be fractions. Subscripts represent numbers of each type of atom in a molecule. Since we cannot have fractions of atoms, the subscripts cannot be fractions.

2. The balance equations are given as follows
   a. $3NaBH_4 + 4BF_3 \rightarrow 3NaBF_4 + 2B_2H_6$ — sum of coefficients = 12
   b. $2NO + 2H_2 \rightarrow N_2 + 2H_2O$ — sum of coefficients = 7
   c. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ — sum of coefficients = 9

3. a. $2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$
   $2K\ (s) + 2H_2O\ (l) \rightarrow 2KOH\ (aq) + H_2\ (g)$
   b. $2Na\ (s) + Cl_2\ (g) \rightarrow 2NaCl\ (s)$
   $2K\ (s) + Cl_2\ (g) \rightarrow 2KCl\ (s)$

c. $3Na\ (s) + P\ (s) \rightarrow Na_3P\ (s)$

$3K\ (s) + P\ (s) \rightarrow K_3P\ (s)$

d. $6Na\ (s) + N_2\ (g) \rightarrow 2Na_3N\ (s)$

$6K\ (s) + N_2\ (g) \rightarrow 2K_3N\ (s)$

e. $2Na\ (s) + H_2\ (g) \rightarrow 2NaH\ (s)$

$2K\ (s) + H_2\ (g) \rightarrow 2KH\ (s)$

4. $CO_2\ (g) + H_2O(l) + NH_3\ (aq) + NaCl\ (aq) \rightarrow NaHCO_3\ (s) + NH_4Cl\ (aq)$

Chapter 8: Basic Review Worksheet

1. The concept of a "driving force" for chemical reactions, at this point, is a rather nebulous idea. Clearly there must be some reason why certain substances react when combined, and why other substances can be combined without anything happening. Because there are driving forces, we can use some generalizations about what sorts of events tend to make a reaction take place.

2. A precipitation reaction is one in which a *solid* forms when the reactants are combined: the solid is called a precipitate. An example is $Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow PbI_2\ (s) + 2NaNO_3(aq)$

3. A strong electrolyte is one that completely dissociates into ions when dissolved in water. That is, each unit of the substance that dissolves in water produces separated, free ions. For example, NaCl (sodium chloride), KNO_3 (potassium nitrate), and NaOH (sodium hydroxide) are strong electrolytes.

4. In summary, nearly all compounds containing the nitrate, sodium, potassium, and ammonium ions are soluble in water. Most salts containing the chloride and sulfate ions are soluble in water, with specific exceptions (see Table 8.1 for these exceptions). Most compounds containing the hydroxide, sulfide, carbonate, and phosphate ions are not soluble in water, unless the compound also contains one of the cations mentioned above (Na^+, K^+, NH_4^+).

5. The spectator ions in a precipitation reaction are the ions in the solution that do *not* precipitate.

6. Acids (such as the citric acid found in citrus fruits and the acetic acid found in vinegar) were first noted primarily because of their sour taste. The first bases noted were characterized by their bitter taste and slippery feel on the skin. Acids and bases chemically react with (neutralize) each other forming water. The net ionic equation is

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

   The strong acids and bases are those that fully ionize when they dissolve in water: since these substances fully ionize, they are strong electrolytes.

7. A salt can be thought of as any ionic compound that contains ions other than H^+ and OH^- (compounds containing these ions are called acids and bases, respectively). In particular, a salt is formed in the neutralization reaction between an acid and a base. Examples will vary, but could include NaCl (sodium chloride), KNO_3 (potassium nitrate), and Na_2SO_4 (sodium sulfate).