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ABSTRACT

This booklet is one of a set of eight designed to be used in a self-paced introductory chemistry course in conjunction with specified textbooks and computer-assisted instruction (CAI) modules. Each topic is introduced with a textbook reading assignment and additional readings are provided in the booklet. Also included are self-tests (and answers), CAI module assignments, and suggested breakpoints for student-teacher consultations. Supplementary learning materials, including filmstrips, are also suggested. Each booklet contains specific cognitive objectives to be met by completion. This booklet covers seven major topics concerning chemical reactions: equations, molecular weight, stoichiometry, percentage composition, reaction types, redox, and rates. (MH)

ILS CHEM PAC No. **5**

REACTIONS

by

William Torop

West Chester State College
West Chester, Pennsylvania

Student No. & Name ....

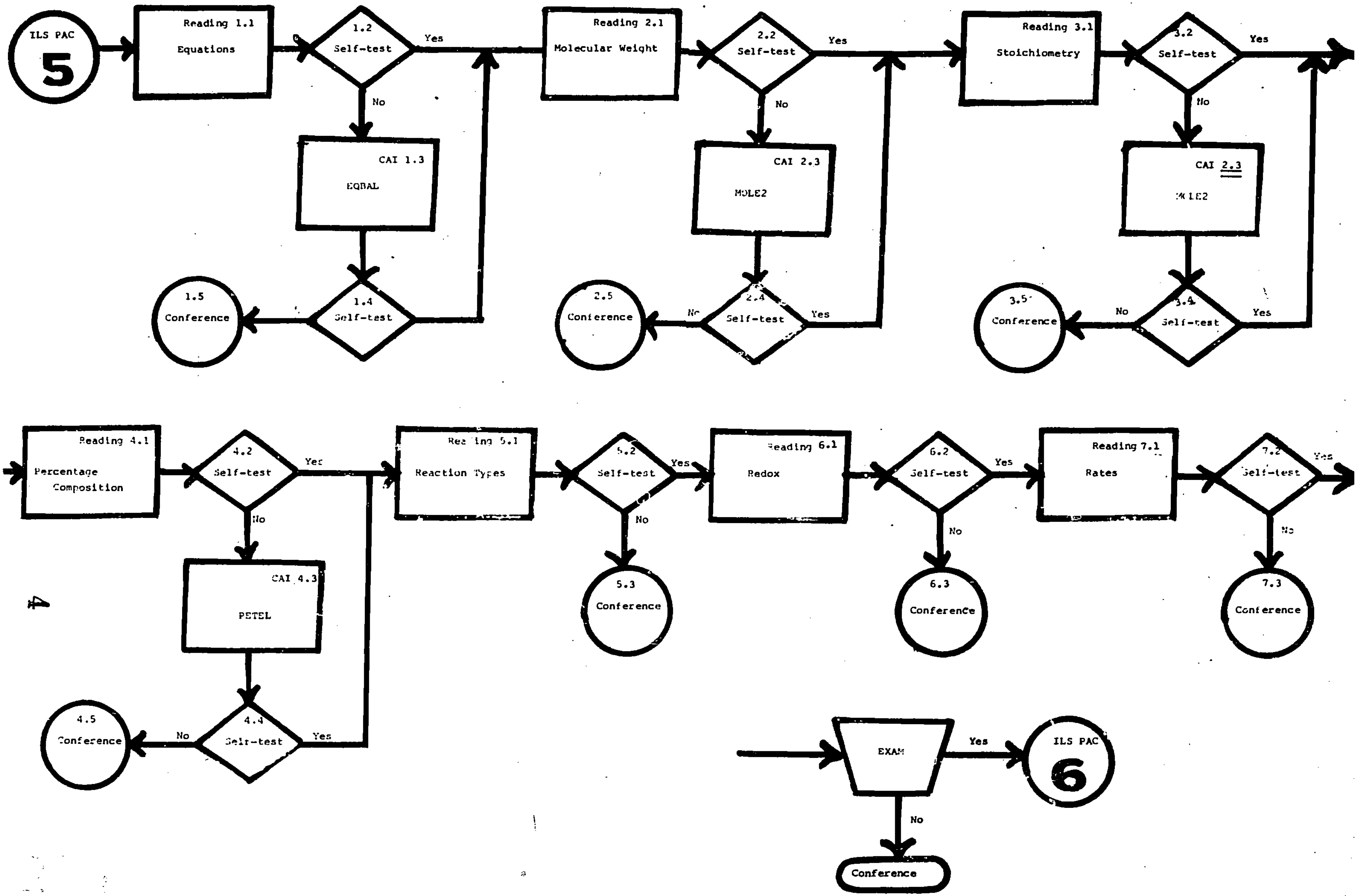
Date Started ....

Date Completed ....

SYMBOLS USED IN CHEMICAL REACTIONS

Symbol	Meaning	Examples
(s)	solid reactant or insoluble solid product	Cu(s) $KMnO_4$(s) H_2O(s) [ice]
(l)	liquid reactant or liquid product	H_2O(l) Hg(l) Br_2(l)
(g)	reactant in vapor state or gaseous product	H_2S(g) N_2(g) H_2O(g) [steam]
(aq)	reactants or products in water solution [aqueous]	KCl(aq) $CuSO_4$(aq) KNO_3(aq)
$\xrightarrow{\Delta}$	reactants heated	$2Mg(s) + O_2(g) \xrightarrow{\Delta} 2MgO(s)$
$\xrightarrow{MnO_2}$	manganese dioxide used as a catalyst	$2KClO_3(s) \xrightarrow{MnO_2} 2KCl(s) + 3O_2(g)$
Equation + cal (or + kcal)	exothermic reaction	$C(s) + O_2(g) = CO_2(g) + 94,100$ cal
Equation - cal (or - kcal)	endothermic reaction	$2H_2O(l) = 2H_2(g) + O_2(g) - 13.6$kcal

REACTIONS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OBJECTIVES

Upon completion of the ILS Chem Pac on Chemical Reactions the student should be able to

1. Equations

Given the formulas or names of the reactants and products, construct a balanced chemical equation using chemical symbols for 9 out of 10 given reactions.

2. Molecular Weight

With the aid of a Periodic Chart, given a formula for a substance and the number of grams in a sample of the substance, calculate the number of moles in the sample or given the number of moles or formula units, calculate the weight of the substance in grams for 9 out of 10 given calculations.

3. Stoichiometry

Given 5 balanced equations and given the amount of one substance taking part in the reaction, calculate the amount of another substance needed or produced in the reaction--in units of moles or grams--in 4 out of the 5 given reactions.

4. Percentage Composition

Given the formula of a compound, calculate the percentage composition of each element in the compound.

5. Reaction Types

Given either a balanced equation or the reactants only, identify the chemical reaction as a combination reaction, decomposition reaction, single replacement reaction, or double displacement reaction--in 9 out of 10 given reactions.

6. Redox

Given a balanced oxidation-reduction equation, identify the substances undergoing oxidation and reduction and identify the oxidizing agent and reducing agent in the redox reaction.

7. Rates

Given an equilibrium reaction (including information on the evolution or absorption of heat and the phase of each substance involved), describe the effects (direction of any shift in equilibrium) of 4 of the following:

a. increasing or decreasing pressure
b. increasing or decreasing concentration
c. increasing or decreasing temperature
d. addition of a catalyst
e. increasing or decreasing surface area

ILS Chem Pac 5 - Chemical Reactions

[or "How Does It Change"]

Reading 1.1 - Read pages 12-14 in Medeiros, and page 66 and pages 81 & 82 in Holum.
Notes:

Just as symbols represent elements and formulas represent compounds, so equations are used to represent chemical reactions. Thus, the equation $2\ H_2 + O_2 = 2\ H_2O$

has the following meaning: two molecules (or moles) of hydrogen reacted with one molecule (or mole) of oxygen to form (or yield) two molecules (or moles) of water.

There must be the same number of atoms of each type on each side of the equation. To balance a simple equation by inspection:

1. Balance the metals present first.
2. Balance the non-metals except hydrogen and oxygen.
3. Balance hydrogen and oxygen.
4. Check all elements.
5. Repeat, if necessary, in the same order until all are balanced.

For example, $KClO_3 = KCl + O_2$

Rules 1 and 2 do not result in any coefficient. Rule 3 yields

$$2\ KClO_3 = KCl + 3\ O_2$$

Rule 4 indicates the K and Cl are not balanced. With rule 5 we note that there are 2 potassium and 2 chloride atoms on the left side of the equation so there must also be 2 on the right. Thus,

$$2\ KClO_3 = 2\ KCl + 3\ O_2$$

In the equation $Al + O_2 = Al_2O_3$ we see that there are two Al on the right side so we place a ...... (1) in front of the Al to give 2 Al on the left side. Next we see 3 O's on the right side and O_2 on the left. To make 3 O's from O_2, we need ...... (2) of them or $2\ Al + 1\frac{1}{2}\ O_2 = Al_2O_3$

However, the convention is to use whole numbers so we double the whole equation to remove the fraction and obtain, as coefficients ...... (3) as indicated: $4\ Al + 3\ O_2 = 2\ Al_2O_3$

The answers to Reading 1.1 are:

1. 2
2. $1\frac{1}{2}$
3. 4, 3, 2

Self-test 1.2

Balance the following equations.

1. $S + O_2 = SO_2$
2. $S + O_2 = SO_3$
3. $NaNO_3 = NaNO_2 + O_2$
4. $KI + Cl_2 = KCl + I_2$
5. $Fe_2O_3 + Al = Al_2O_3 + Fe$
6. $Al(OH)_3 + H_2SO_4 = Al_2(SO_4)_3 + H_2O$
7. $NaCl + AgNO_3 = NaNO_3 + AgCl$
8. $N_2 + O_2 = NO_2$
9. $CaCO_3 = CaO + CO_2$
10. $AgNO_3 + CuCl_2 = AgCl + Cu(NO_3)_2$

If you missed balancing more than one equation in Self-test 1.2, take the NO route (CAI 1.3).

CAI 1.3 - EQBAL - Balancing Equations

This module provides drill and practice in balancing simple chemical equations by inspection. Equations are randomly selected from a bank of equations and you are to supply the coefficients (including 1) that will balance the equation.

You may skip equations or stop at any time. The coefficients, when entered at the computer terminal, must be separated by dashes (-).

Date Completed:

Self-test 1.4

CAI 1.3 may be used for Self-test 1.4. You should correctly balance 9 out of any 10 equations presented in serial order.

Conference 1.5

If you are still having difficulty balancing chemical equations at this point, please see your instructor.

Date:

Notes:

Reading 2.1 - Read page 73 in Sackheim & Schultz, and page 79 in Holum.
Notes:

The molecular weight of a compound is the sum of the weights of all of the atoms present in the molecule. The gram molecular weight or mole is the molecular weight expressed in grams. Thus, the gram molecular weight of water (H_2O) is 18 grams/mole. This is obtained by adding 2 x 1 for the two hydrogen atoms and 1 x 16 for the one oxygen atom. A mole of a substance contains 6×10^{23} molecules of the substance. Therefore, 18 grams of water contains 6×10^{23} water molecules. 18 grams of water also contains $2 \times 6 \times 10^{23}$ (1.2×10^{24}) hydrogen atoms and 6×10^{23} oxygen atoms.

To calculate the molecular weight of sulfuric acid, H_2SO_4, we see that there are ...... (1) gram atoms of hydrogen [atomic weight ...... (2)], ... (3) gram atoms of sulfur [atomic weight ...... (4)], and ...... (5) gram atoms of oxygen [atomic weight ...... (6)]. Multiplying the number of gram atoms of each element by the respective atomic weight and adding the results, we obtain ...... (7) g/mole as the gram molecular weight of H_2SO_4

To calculate the number of moles present in a given amount of a substance, you first calculate the molecular weight as above and then divide the given mass in grams by the number of grams in one mole. For example, with 11 g of carbon dioxide (CO_2) we first find the molecular weight to be ...... (8) g/mole. Dividing the mass in grams ...... (9) by 44 g/mole we obtain ...... (10) moles.

If you are given the number of moles of a substance, you multiply that quantity by the mass of one mole to obtain the weight of the substance present in grams. For example, 0.1 mole of NaOH contains one-tenth of a mole--which is 40 g/mole or 4 grams/0.1 mole.

The answers to Reading 2.1 are:

1.	2	6.	16
2.	1	7.	98
3.	1	8.	44
4.	32	9.	11
5.	4	10.	0.25

Self-test 2.2

The gram molecular weight of $FeSO_4$ is ...... (1), $K_2Cr_2O_7$ is ...... (2), and $Pb(NO_3)_2$ is ...... (3).

The number of moles in 8 grams of NaOH is ...... (4), 196 grams of H_2SO_4 is ...... (5), and 60 grams of NaOH is ...... (6).

How many grams are there in 0.5 moles of H_2SO_4 ...... (7), 2 moles of H_2O ...... (8), 1 mole of $Pb(NO_3)_2$ ...... (9), and 0.8 moles of NaOH ...... (10)?

If you missed more than one calculation in Self-test 2.2, take the NO route (CAI 2.3).

CAI 2.3 - MOLE2 - The Mole Concept

Problem solving using the mole concept in conjunction with chemical reactions. 10 problems (parameters randomly generated) are presented each time and tutorial clues are provided.

This module may be repeated as many times as you wish.

Again due to lack of subscript capability a reaction such as

$$2\ H_2 + O_2 = 2\ H_2O$$

would appear as: 2 H2 + O2 = 2 H2O

Date Completed:

Self-test 2.4

CAI 2.3 may be used also as Self-test 2.4. Solve 9 mole concept problems correctly from any 10 such problems presented in serial order.

Conference 2.5

If you are still having difficulty with the mole concept and molecular weight calculations, please see your instructor.

Date:

Notes:

Reading 3.1 - Read pages 58-59 in Medeiros.

Notes:

Stoichiometry is the branch of chemistry which deals with the relationships involved between substances in chemical reactions. However, we must start with a balanced equation. For example, in the equation $2\ H_2 + O_2 = 2\ H_2O$ we previously noticed this indicated that 2 moles (or molecules) of H_2 combined with 1 mole (or molecule) of O_2 to form 2 moles (or molecules) of H_2O. Therefore, with our knowledge of molecular weights we also see that 4 grams of H_2 combine with 32 grams of O_2 to form 36 grams of H_2O--or any proportional amounts such as 1 gram H_2 combining with 8 grams of O_2 to form 9 grams of H_2O.

Let's apply this to a typical problem--"What weight of CO_2 will be produced by burning 6 grams of carbon?" First write the balanced equation:

.... (1)
which tells us 1 mole or gram-atom of carbon reacts with 1 mole of oxygen to produce 1 mole of carbon dioxide. 6 grams of C (atomic weight 12) represents ...... (2) gram-atoms. From the balanced equation we see that this will result in ...... (3) moles of carbon dioxide. Since CO_2 is ...... (4) g/mole, 0.5 moles is ...... (5) grams. Thus, 22 grams of CO_2 is produced by burning 6 grams of carbon.

The answers to Reading 3.1 are:

1. $C + O_2 = CO_2$
2. 0.5
3. 0.5
4. 44
5. 22

Self-test 3.2

How many grams of $KClO_3$ will have to be heated to produce 96 grams of O_2 ...... (1)? How much KCl will also be produced ...... (2)? $2\ KClO_3 = 2\ KCl + 3\ O_2$

How much SO_2 will be formed when 64 grams of sulfur are burned in air ...... (3) ? $S + O_2 = SO_2$

How much H_2 can combine with 16 grams of O_2 to form H_2O ...... (4) ? How much water will be formed ...... (5)?
$2\ H_2 + O_2 = 2\ H_2O$

How many grams of N_2 will have to combine with 32 grams of O_2 to form NO_2 ...... (6) ? How much NO_2 is produced in this reaction ...... (7) ? $N_2 + 2\ O_2 = 2\ NO_2$

How many moles of oxygen can be produced by the thermal decomposition of one mole of $NaNO_3$ ...... (8) ? How many grams of oxygen is this ...... (9) ? How many moles of $NaNO_2$ is produced at the same time ...... (10) ?
$2\ NaNO_3 = 2\ NaNO_2 + O_2$

If you missed more than one problem in Self-test 3.2, take the NO route (CAI 2.3). Please note that this is the same NO route as the previous objective.

CAI 2.3 - MOLE2 - The Mole Concept

(see page 5 for description)

Self-test 3.4

CAI 2.3 may also be used as Self-test 3.4 as well as Self-test 2.4. Solve 9 problems correctly from any 10 such problems presented in serial order.

Conference 3.5

If you are still having difficulty with the concept of stoichiometry, please see your instructor.

Date:

Notes:

Reading 4.1 - Read pages 63-65 in Medeiros, page 74 in Sackheim & Schultz, and page 77 in Holum.
Notes:

A percentage or fraction is a part of the whole. Percent represents the parts per hundred. Percentage is 100 times the fraction of the substance present per unit of weight. The percentage composition of each element in the compound water is obtained as follows. First the molecular weight of water, ... (1) g/mole, is calculated. The percent of hydrogen is equal to the amount of hydrogen present, ... (2) grams, divided by the weight of water, 18 grams, times 100 and has the value of 11%. The percent of oxygen is obtained by dividing the amount of oxygen present, 16 grams, by the weight of water, 18 grams, times 100 and has the value of ...... (3) %. These two values, 11% plus 89%, must equal the whole or ...... (4) %.

The answers to Reading 4.1 are:

1. 18
2. 2
3. 89
4. 100

Self-test 4.2

To determine the percentage composition of SO_2, we obtain the molecular weight first which is ...... (1) g/mole. The percent of S is obtained by dividing ...... (2) grams by 80 g/mole x 100 which equals ...... (3) %. The percent of O is obtained by dividing ...... (4) grams by ...... (5) gram/mole times 100 which equals ...... (6) %. These two percentages should equal the whole or 100%.

The percentage composition of $KClO_3$ is ...... (7) % K, ... (8) % Cl, and ...... (9) % O; while the percentage composition of HF is ...... (10) %H and ...... (11) % F.

If you made any mistakes, other than arithmetic, in Self-test 4.2, take the NO route (CAI 4.3). Please note, however, that CAI 4.3 is NOT identical to Reading 4.1

CAI 4.3 - PETEL - Percentage Calculations

This module involves the calculation of the percentage weight loss derived from a series of theoretical crucible weights.

Following a second incorrect response, the coreect expression format and answer are provided for each incorrect response. All values are randomly generated.

Again only the numerical answer and no units are input to the computer. The calculations are based on the following general subtraction problem:

Weight of substance + container	= A
Weight of container (empty)	= B
Weight of substance	= A - B

Self-test 4.4

CAI 4.3 may also be used as Self-test 4.4.

Conference (4.5)

If you are still having difficulty with percentage composition, please see your instructor.

Date:

Notes:

Reading 5.1 - Read pages 12-14 in Medeiros, pages 77-79 in Sackheim & Schultz, and pages 151 & 152 in Holum.
Notes:

There are several ways to classify chemical reactions. One way is to divide chemical reactions, especially in a beginning chemistry course, into combination, decomposition, single replacement, and double displacement reactions.

Combination reactions take place when two or more substances combine to form a more complex substance. The general equation is A + B = AB where A and B are the reactants that combine to form the product AB. An example of such a reaction is that between hydrogen and oxygen to form water: $2\ H_2 + O_2 = 2\ H_2O$.

A decomposition reaction is the breakdown of a compound into two or more simpler substances. The general equation is AB = A + B where AB is now the reactant (starting material) and A and B are now the products. An example of such a reaction is the decomposition of water by an electric current to yield hydrogen and oxygen: $2\ H_2O = 2\ H_2 + O_2$

Single replacement reactions occur when one element in a compound is replaced by another element. One general equation is A + BC = AB + C. For example zinc replacing the copper in $CuSO_4$ and producing the element Cu: $Zn + CuSO_4 = ZnSO_4 + Cu$. The same type of reaction occurs with non-metals. The general equation D + EF = ED + F is also a single replacement reaction. For example: $Cl_2 + 2\ NaBr = 2\ NaCl + Br_2$

Double displacement reactions occur when substances in two different compounds displace each other. The general equation is AB + CD = AD + CB where A has taken the place of C and likewise C has taken the place of A in their corresponding compounds. For example: $AgNO_3 + NaCl = AgCl + NaNO_3$

Self-test 5.2

Identify the following reactions as one of these four types: combination, decomposition, single replacement, or double replacement.

1. $H_2SO_3 = H_2O + SO_2$
2. $FeS + 2\ HCl = FeCl_2 + H_2S$
3. $C + O_2 = CO_2$
4. $Mg + 2\ HCl = MgCl_2 + H_2$
5. $S + O_2 = SO_2$
6. $H_2O_2 = H_2O + O_2$
7. $MgCl_2 + NaOH = Mg(OH)_2 + NaCl$
8. $Al + CuSO_4 = Al_2(SO_4)_3 + Cu$
9. $KI + Cl_2 = KCl + I_2$
10. $CaCO_3 + HCl = CaCl_2 + H_2CO_3$

Conference 5.3

If you are still having trouble classifying chemical reactions, please see your instructor.

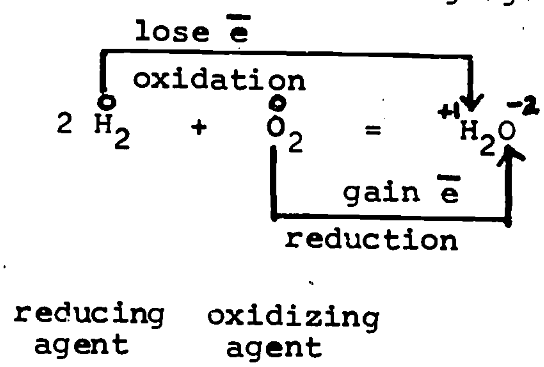
Date:

Notes:

Reading 6.1 - Read pages 60-62 in Medeiros, pages 106-110 in Sackheim & Schultz, and page 46 in Holum.
Notes:

Another way to classify chemical reactions is oxidation-reduction (redox) reactions and non-oxidative reactions. Oxidation is defined as the loss of electrons. Reduction is then the gain of electrons. A substance which undergoes oxidation is a reducing agent and a substance which undergoes reduction is itself an oxidizing agent. Oxidation and reduction occur simultaneously. Free, uncombined elements are always assigned an oxidation state of zero. Look at the reaction: $2\ H_2 + O_2 = 2\ H_2O$

Hydrogen as a free element on the left has an oxidation number of zero but on the right in water it is +1. Likewise, oxygen's oxidation number as a free element is zero but on the right in water it is -2. Since the H is going from 0 to +1 it must have lost an electron. Thus, hydrogen undergoes oxidation and hydrogen is a reducing agent. Since the O goes from 0 to -2, it must have gained 2 electrons. Thus, oxygen undergoes reduction and oxygen is an oxidizing agent.



An example of a nonoxidative reaction is:

$AgNO_3 + NaCl = AgCl + NaNO_3$

Self-test 6.2

Examine the reaction $2\ Na + Cl_2 = 2\ NaCl$. The oxidation number of sodium on the left is ...... (1) and on the right in NaCl it is ...... (2). The oxidation number of chlorine on the left is ...... (3) and on the right in NaCl it is ...... (4). Thus sodium ...... (5) an electron which is called ...... (6). Sodium is a(n) ...... (7) agent. Chlorine, in contrast, ... (8) an electron which is called ...... (9). Chlorine is a(n) ...... (10) agent. Note that elements other than oxygen can be oxidizing agents.

In the equation $Fe + CuSO_4 = FeSO_4 + Cu$ what is oxidized? ...... (11) What undergoes reduction? ...... (12) What is the oxidizing agent? ...... (13) What is the reducing agent? ...... (14) Note that the SO_4^{2-} remains essentially unchanged in solution on both sides of the equation.

Conference (6.3)

If you are still having trouble with oxidation and reduction equations, please see your instructor.

Date:

Notes:

Reading 7.1 - Read pages 79-84 in Sackheim & Schultz, and pages 93-96 in Holum.
Notes:

Many times when reactants unite to form products, these products themselves unite to re-form the original reactants. These reversible reactions are indicated by double arrows $\rightleftharpoons$ as shown:

$$N_2 + 3\ H_2 \rightleftharpoons 2\ NH_3$$

When the rates of formation and decomposition become equal, a chemical equilibrium exists--a dynamic equilibrium because the reaction has not stopped. The rates are equal so that the composition remains constant.

The speed or rate of a chemical reaction depends on several factors. One is the nature of the reacting substances. Paper burns quickly while iron rusts very slowly. Second is temperature. Generally, as the temperature rises, the speed of a chemical reaction increases. Third is the concentration of a reactant--amount present in a given unit of volume. Greater concentration leads to faster reactions because there are more molecules that can react. Likewise is the amount of surface area. The more surface area available, the more molecules that can react. Fifth is the presence--or absence--of a catalyst. A catalyst is a substance that affects the speed of a reaction and can be recovered unchanged at the conclusion of the reaction.

For an equilibrium reaction one can apply Le Chatelier's principle: If a stress is applied to a reaction at equilibrium, the equilibrium will be displaced in such a direction as to relieve the stress. Consider the general equation

$$A + B \rightleftharpoons C + D$$

If we add more of substance A to the mixture at equilibrium, we will cause a stress which the reaction will tend to oppose by using up more A and so shifting the equilibrium to the right. In a similar manner the addition of more D will cause a stress which the reaction will tend to oppose by using up more D and so shift the equilibrium to the left. Predict the shift in equilibrium when more B is added ... and more C is added ...

Adding more D, the equilibrium will shift to the right and adding more B the shift is to the left.

Self-test 7.2

Predict the effect upon the equilibrium of the following reactions at equilibrium if

a. the temperature is increased
b. a catalyst is added
c. the concentration of a reactant is increased
d. the concentration of a reactant is decreased
e. the concentration of a product is increased
f. the concentration of a product is decreased

1. $A + B \rightleftharpoons AB + q$ calories

2. $2\ H_2(g) + O_2(g) \rightleftharpoons 2\ H_2O(g) + 116{,}000$ calories

Conference 7.3

If you are still having difficulty predicting the effect of the various parameters on the rate of a reaction, please see your instructor.

Date:

Notes:

EXAM

ILS Pac 5 Exam will consist of 10 questions.

Objective 1 - Equations - 2 questions

Objective 2 - Molecular Weight - 2 questions

Objective 3 - Stoichiometry - conference and/or MOLE2

Objective 4 - Percentage Composition - 2 questions

Objective 5 - Types of Reactions - 1 question

Objective 6 - Redox - 2 questions

Objective 7 - Rates - 1 question

See ILS Pac 0 (Student Directions) for Grading System Equivalents. Please remember that although the Exam is necessary for a grade it may not be sufficient. You may also be asked to have a final conference with your instructor.

CONFERENCE

Date:

Notes:

SUPPLEMENTARY MATERIAL

Objective 2 - Molecular Weight

Filmstrip-Tape #831: Atomic Weights, Molecular Weights and Mole Concept

Objective 3 - Stoichiometry

Program Tape #5: Calculations From Chemical Equations

Filmstrip-Tape #834: Calculations Involving Equations

Objective 5 - Reaction Rates

Audio-Tape B1: Introduction to Chemical Equilibrium

Objective 6 - Redox

Audio-Tape B3: Balancing Oxidation-Reduction Equations

Objective 7 - Rates

Audio-Tape A3: Rates of Chemical Reactions

ANSWERS

Self-test 1.2

1. already balanced
2. 2, 3, 2
3. 2, 2, 1
4. 2, 1, 2, 1
5. 1, 2, 1, 2
6. 2, 3, 1, 6
7. already balanced
8. 1, 2, 2
9. already balanced
10. 2, 1, 2, 1

Self-test 2.2

1. 152
2. 294
3. 331
4. 0.2
5. 2
6. 1.5
7. 49
8. 36
9. 331
10. 32

Self-test 3.2

1. 245
2. 149
3. 128
4. 2
5. 18
6. 14
7. 46
8. ½
9. 16
10. one

Self-test 4.2

1. 80
2. 32
3. 40
4. 48
5. 80
6. 60
7. 31.9
8. 28.9
9. 39.2
10. 5
11. 95

Self-test 5.2

1. decomposition
2. double displacement
3. combination
4. single replacement
5. combination
6. decomposition
7. double displacement
8. single replacement
9. single replacement
10. double displacement

Self-test 6.2

1. zero
2. +1
3. zero
4. -1
5. loses
6. oxidation
7. reducing
8. gains
9. reduction
10. oxidizing
11. Fe
12. Cu^{+2}
13. Cu^{+2}
14. Fe

Self-test 7.2

1 & 2 a. rate increases but equilibrium shifts to left
b. effects rate but not equilibrium
c. equilibrium shifts to right
d. equilibrium shifts to left
e. equilibrium shifts to left
f. equilibrium shifts to right

Decomposition Reactions

$HgO \rightarrow Hg + O_2$

$KClO_3 \rightarrow KCl + O_2$

$NaNO_3 \rightarrow NaNO_2 + O_2$

$H_2O_2 \rightarrow H_2O + O_2$

$CaCO_3 \rightarrow CaO + CO_2$

Combination Reactions

$S + O_2 \rightarrow SO_2$

$S + O_2 \rightarrow SO_3$

$P + O_2 \rightarrow P_2O_5$

$Mg + N_2 \rightarrow Mg_3N_2$

$N_2 + O_2 \rightarrow NO_2$

Activity Series of Metals

Li
K
Ca
Na
Mg
Al
Mn
Zn
Cr
Fe
Ni
Sn
Pb
H
Cu
Hg
Ag
Pt
Au

Single Replacement Reactions

$Zn + NaOH \rightarrow Na_2ZnO_2 + H_2$

$Na + H_2O \rightarrow NaOH + H_2$

$Zn + HCl \rightarrow ZnCl_2 + H_2$

$Al + CuSO_4 \rightarrow Al_2(SO_4)_3 + Cu$

$KI + Cl_2 \rightarrow KCl + I_2$

Double Replacement Reactions

$Fe(OH)_3 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2O$

$AgNO_3 + CuCl_2 \rightarrow AgCl + Cu(NO_3)_2$

$MgCl_2 + NaOH \rightarrow Mg(OH)_2 + NaCl$

$CaCO_3 + HCl \rightarrow CaCl_2 + H_2CO_3$

$BaCl_2 + (NH_4)_2CO_3 \rightarrow BaCO_3 + NH_4Cl$