#### Moles/Stoichiometry Review

#### Compounds

- A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion.
- A chemical compound can be broken down by chemical means.
- A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.

### Particle Diagrams

- There is usually one particle diagram question on each exam.
- Black and white circles are used to represent elements.
- They are used to distinguish elements from compounds and simulate chemical reactions.
  Look at your copies of regents exams for examples.

#### 13 A substance is classified as either an element or a

- (1) compound
- (2) solution
- (3) heterogeneous mixture
- (4) homogeneous mixture

- 20 Which sample of matter is classified as a substance?
  - (1) air (2) ammonia (3) milk (4) seawater

#### 43 Given the diagrams X, Y, and Z below:



Which diagram or diagrams represent a mixture of elements A and B?

1) X, only	(3) $X$ and $Y$	
2) Z, only	(4) $X$ and $Z$	

8 Which diagram represents a mixture of two different molecular forms of the same element?







Base your answers to questions 54 through 57 on the particle diagrams below. Samples A, B, and C contain molecules at STP.



- 54 Explain why the average kinetic energy of sample B is equal to the average kinetic energy of sample C. [1]
- 55 Explain, in terms of the composition, why sample A represents a pure substance. [1]
- 56 Explain why sample C could represent a mixture of fluorine and hydrogen chloride. [1]
- 57 Contrast sample A and sample B, in terms of compounds and mixtures. Include both sample A and sample B in your answer. [1]

## Naming Compounds

- There is always one naming question on each exam.
- They often use polyvalent metals (Fe, Pb, Cu, Sn, etc) in ionic compounds.
- The non-metal oxidation number (always the top one on the periodic table) will allow you to determine the charge on the metal.
- Beware of endings on the anion: -ide endings generally mean binary ionic compounds; -ate or -ite endings indicate polyatomic ions (Table E)

A chemical formula can be represented as an empirical formula, a structural formula, or a molecular formula.

- *Structural formulas* are for organic compounds only.
- They are needed because of the existence of isomers for larger molecules.
- Remember, a dash represents a pair of shared electrons.

#### **Empirical Formulas**

- The empirical formula of a compound is the simplest whole-number ratio of atoms of the elements in a compound.
- It may be different than the molecular formula, which is the actual ratio of atoms in a molecule of that compound.

The molecular formula is a wholenumber multiple of the empirical formula.

- Sometimes they will give you molar mass of a compound and its empirical formula.
- You must find the "empirical formula mass" and divide the molar mass by the efm.

# In all reactions there is a conservation of mass, energy, and charge.

- They can ask questions like "Which equation does/does not show conservation of mass?"
- This can mean balanced or unbalanced chemical equations, half-reactions or faulty half-reactions, net ionic equations (usually in electrochemistry), which require you to balance electrons.

A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in a reaction.

 It is a certainty that you will have to balance an equation in at least one question on the exam.

- 10 Which quantities must be conserved in all chemical reactions?
  - (1) mass, charge, density
  - (2) mass, charge, energy
  - (3) charge, volume, density
  - (4) charge, volume, energy

35 Given the incomplete equation representing a reaction:

 $2C_6H_{14} + \underline{\qquad} O_2 \rightarrow 12CO_2 + 14H_2O$ 

What is the coefficient of  $O_2$  when the equation is completely balanced using the smallest whole-number coefficients?

Given the unbalanced equation:

 $\_C_6H_{12}O_6 \xrightarrow{\text{enzyme}} C_2H_5OH + \_CO_2$ 

- 54 Balance the equation provided in your answer booklet, using the lowest whole-number coefficients. [1]
- 55 Identify the type of reaction represented. [1]

39 Given the balanced equation:

 $2 \operatorname{C_4H_{10}(g)} + 13 \operatorname{O_2(g)} \rightarrow 8 \operatorname{CO_2(g)} + 10 \operatorname{H_2O(g)}$ 

What is the total number of moles of  $O_2(g)$  that must react completely with 5.00 moles of  $C_4H_{10}(g)$ ?

- (1) 10.0 (3) 26.5
- (2) 20.0 (4) 32.5

The formula mass of a substance is the sum of the masses of its atoms. The gram-formula mass of the substance equals 1 mole of that substance.

- Remember, the atomic mass of everything in a parenthesis in a chemical formula must be multiplied by its subscript when calculating its gram formula mass.
- Coefficients in chemical reactions are not included in molar mass calculations!
- Table T (back page) has the formula for mole calculations.

- 61 What is the gram-formula mass of  $(NH_4)_2CO_3$ ? Use atomic masses rounded to the nearest whole number. [1]
- 62 In the space provided in your answer booklet, show a correct numerical setup for calculating the number of moles of  $CO_2$  (gram-formula mass = 44 g/mol) present in 11 grams of  $CO_2$ . [1]

#### 37 What is the gram-formula mass of $(NH_4)_3PO_4$ ?

(1) 112 g/mol (2) 121 g/mol (3) 149 g/mol (4) 242 g/mol

#### % Composition

- The percent composition by mass of each element in a compound can be calculated mathematically.
- Table T has this formula also
- Note that all compounds with the same molecular formula have the same % composition.

34 Which compound has the *smallest* percent composition by mass of chlorine?

(1)	HCl	(3)	LiCl
(2)	KCl	(4)	NaCl

## **Types of Chemical Reactions**

• There are many types of chemical reactions, e.g., synthesis, decomposition, single replacement, and double replacement.

 All of these reactions except double replacement (and acid-base neutralization) are redox reactions.

- 6 In which type of chemical reaction do two or more reactants combine to form one product, only?
  - (1) synthesis
  - (2) decomposition
  - (3) single replacement
  - (4) double replacement

33 Given the balanced equations representing two chemical reactions:

 $Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$ 

 $2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2$ 

Which types of chemical reactions are represented by these equations?

- (1) single replacement and decomposition
- (2) single replacement and double replacement
- (3) synthesis and decomposition
- (4) synthesis and double replacement

## **Organic Reactions**

There are also a number of **organic reactions** you must know how to recognize:

- **substitution** (by halogens) of saturated hydrocarbons
- addition (by hydrogen and halogens) of unsaturated hydrocarbons
- esterification (condensation): alcohol + organic acid ester + H<sub>2</sub>O
- **combustion**: organic compound +  $O_2$   $CO_2 + H_2O$
- fermentation:  $C_6H_{12}O_6$  2CH<sub>3</sub>CH<sub>2</sub>OH + 2CO<sub>2</sub>
- **saponification**: fatty acids + base soap + glycerol
- There is also addition polymerization and condensation polymerization.

Base your answers to questions 75 through 78 on the information below.

Vitamin C, also known as ascorbic acid, is water soluble and cannot be produced by the human body. Each day, a person's diet should include a source of vitamin C, such as orange juice. Ascorbic acid has a molecular formula of  $C_6H_8O_6$  and a gram-formula mass of 176 grams per mole.

- 75 What is the color of the indicator thymol blue after it is added to an aqueous solution of vitamin C? [1]
- 76 Determine the number of moles of vitamin C in an orange that contains 0.071 gram of vitamin C. [1]
- 77 In the space in your answer booklet, show a numerical setup for calculating the percent composition by mass of oxygen in ascorbic acid. [1]
- 78 Write the empirical formula for ascorbic acid. [1]