

REVIEW PACKET FOR STUDENTS ENTERING CHEMISTRY HONORS

Students entering the Chemistry Honors class will be expected to possess skills and information which have been taught in previous science classes. Class time during the year, then, can be used to enhance the skills students already have, and to apply these skills to master advanced topics. **You will be responsible for information outlined below.** The packet will serve as a review of your skills and basic knowledge. **During the second or third week of school, you will be assessed on the review material.**

A. Basic mathematics skills.

1. Conversions within the Metric system (System International, SI system)
2. Calculations using Scientific Notation (exponential notation)
3. Graphing
 - a.) Determining independent and dependent variables
 - b) Calculating slope
4. Algebraic manipulation of equations

B Skills in chemistry

1. Measuring/ calculating: length, area, volume, mass, density
2. Using standard laboratory equipment such as, balances, thermometers, Bunsen burners.
3. Knowing the names of basic equipment and glassware.
4. Using a periodic table to predict formulas for simple ionic and molecular compounds and carbon compounds.
5. Balancing equations.
6. Predicting products of equations
7. Calculations of
 - a) percent error
 - b) formula mass.
 - c) density.
 - d) mole
 - e) heat

C Topics

1. Scientific method
2. Elements, compounds, mixtures
3. Chemical and physical properties
4. Chemical and physical changes
5. Properties of solids, liquids, gases
6. Atomic structure (subatomic particles)
7. Periodic table
8. Chemical equations
9. Heat and energy.

SOME SUMMARY REVIEW NOTES

I PERCENT ERROR: When concluding an experiment, scientists like to know how accurate their results are. In order to convey this information, scientists can express the difference between their answer and the “accepted” (literature or actual) answer in either absolute terms or in relative terms. For instance, if you measure the width of a room to be 4 meters, where in reality it is 5 meters, you are off by 1 meter (absolute error), but in relative terms you are off by 1 part in 5, or 20%. If you then measure the distance from your front door to the front door of the school and obtain 15352 meters, whereas in reality it is 15353, you are still off by 1 meter (absolute error), but in relative terms you are off by 1 part in 15353, or 0.0065%. You can see therefore that both experiments give the same absolute error, but quite different relative errors. Therefore, we will express our experimental errors as a relative or percent error.

$$\text{Percent error} = \frac{(\text{actual value} - \text{experimental value})}{(\text{actual value})} \times 100$$

Percent error is always expressed as the absolute value.

II MATTER: Matter can be classified as being either element, compounds, or mixtures.

A Elements: These are the building blocks of matter. They cannot be broken down into simpler substances. There are about 114 elements known; of these 90 are naturally occurring on earth. The others do not exist naturally but are artificially produced. Each element has a one or two letter symbol. Some of the symbols are derived from Latin or Greek. Elements are made from only one kind of atom, and all atoms of a given element have identical chemical properties, but not the same mass (isotopes). About 80% of the elements are metals. Several elements are gases at room temperature. Only two are liquids at room temperature.

B Compounds: These are composed of two or more elements combined chemically in a very definite ratio (both by number of atoms and by mass of atoms). Compounds can be decomposed into simpler compounds or into elements, but this requires chemical methods such as reaction with acid, electrolysis, or the input of heat energy. A few compounds, like nitroglycerine, decompose into simpler substances quite readily without much energy input. When a compound is made from elements, the compound takes on entirely new properties than the original elements. Common salt, NaCl, is nothing like the explosive metal sodium, nor the choking, poisonous gas chlorine.

C Mixtures There are two kinds of mixtures: *homogeneous*, which means smooth, uniform, even, and *heterogeneous*, which means uneven, or having different observable properties. For most purposes, consider a mixture to be heterogeneous if you can see differences with your eyes or with a magnifying glass. Sand, however fine, would be considered heterogeneous, but air or brass is considered homogeneous. All **solutions** are homogeneous mixtures. A mixture is made by simply combining two substances together in almost any proportion. No chemical combination occurs, so the ratio among the components is not definite. Mixtures can usually be easily separated by using physical means (e.g. evaporating, filtering, and magnetism, freezing). When a mixture is made, the original substances retain their properties.

Suspensions like oil and vinegar or muddy water are considered to be heterogeneous mixtures. **Colloids**, milk, smoke or fog are difficult to classify. The particles of soot in smoke or water droplets in fog are large enough to be seen but they do not settle out and appear to be homogeneous. These mixtures border between solution and suspensions.

D Physical & chemical properties: A physical property is a characteristic of matter that can be determined without changing the chemical formula of the substance. These properties include density, freezing point, or melting point (same point) boiling point, hardness, electrical conductivity, malleability, ductility, specific heat, and solubility. A chemical property is a characteristic of matter that requires a change in the chemical formula of the substance in order to be determined. Examples include combustibility, (flammability – ability to burn), reaction with acid, ability to corrode, and ability to combine with other substances. In all of these cases new substances, with new formulas, are formed.

E Physical and chemical changes: Physical changes do not alter the chemical formula of a substance. These include phase changes, warming, tearing, grinding, and dissolving. Chemical changes always alter the chemical formula of a substance. Usually chemical changes produce a color change, a gas or a precipitate. Chemical changes include burning, oxidizing, corroding, exploding, reaction with acid as well as other chemicals. Generally, chemical changes involve about 100 times more energy than do physical changes (e.g. burning wax releases about 100 times more heat than does freezing the same mass of wax.)

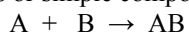
F Solids, Liquids, & Gases: These are referred to as the three common phases (states) of matter. The basic difference

among the three is the extent of the attractive forces between their particles. Gases have low attractive forces, so the kinetic energy (energy of motion) of the molecules keeps them spread apart. The warmer the particles, the farther apart they tend to be because the faster they tend to move. A gas will completely fill any container into which it is placed, hence it has neither a definite shape nor a definite volume. If the attractions become stronger, then the molecules attract each other enough so that they overcome the kinetic energy that tends to keep the particles apart. In this case, the molecules touch each other, but are still able to slide over and around each other, so a liquid is formed. A liquid has no definite shape, rather it takes the shape of its container but it does have a definite volume. In a solid, the attractions are so great that the particles are kept in rigidly fixed positions, able only to vibrate about these positions. A solid has both definite shape and definite volume.

III CHEMICAL REACTIONS AND EQUATIONS: Since there are thousands of chemical reaction that have been identified, it is useful to categorize these into groups, or types. Five of the most common are described below.

REACTANTS → PRODUCTS

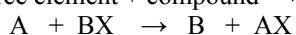
1. Synthesis: two elements or simple compounds → one compound



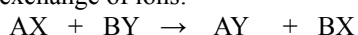
2. Decomposition: a compound decomposes into two elements or simpler compounds



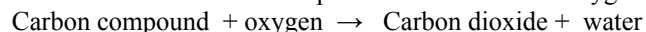
3. Single replacement: a free element + compound → new free element + new compound



4. Double replacement or exchange of ions:



5. Combustion: reaction of compound or element with oxygen



IV STRUCTURE OF THE ATOM

Complete the charts.

	electron	proton	neutron
Symbol			
Relative charge			
Relative mass (amu)			
Location in the atom			

Element	Atomic number	Mass Number	Number of protons	Number of neutrons	Number of electrons
_____	8	_____	_____	8	_____
As	_____	_____	_____	42	_____
_____	_____	_____	_____	21	20
Na	_____	23	_____	_____	_____
_____	_____	56	26	_____	_____
Ba ⁺²	_____	_____	_____	81	_____
P ³⁻	_____	31	_____	_____	_____

WRITING CHEMICAL FORMULAS

Chemical formulas can give the following information:

1. what elements are in a compound (See list of elements to be memorized.)
2. the ratio of elements (empirical formula)
3. the actual number of atoms of each element (molecular formula)
5. the arrangement of atoms in the compound (structural formula)

Some terms:

Subscripts: small numbers written to the lower right of the symbol to indicate the number of atoms of the element. One atom is understood if no number appears.

Oxidation number: an apparent charge on an atom. It may be the same as the charge. These have been determined experimentally. **Evidence shows that atoms combine in such a way that total oxidation number of a compound equals 0.**

Representative elements: elements that have only one oxidation number which can be predicted using the periodic table. These include metals in Group 1, 2, 3, 4; nonmetals in groups 5, 6, 7, & 8. (There are some exceptions including Sn and Pb.)

Ion: a charged atom.

Cation: a positive ion

Anion: a negative ion

Monatomic ion: a single atom carrying a charge.

Ex. Ca^{+2} calcium ion; Cl^- chloride ion

Polyatomic atom (PAI): a group of bonded atoms carrying a charge.

Ex. NH_4^+ ammonium; NO_3^- nitrate

(See list to be memorized)

1. IONIC COMPOUNDS – metal and nonmetal or polyatomic ion

Formulas can be predicted from charges and oxidation numbers:

Binary ionic compounds: compounds containing only 2 elements.

Ex.1 Na^+ and Cl^- = NaCl

Ex.2 Ca^{+2} and Cl^- = CaCl_2

Ex.3 Na^+ and O^{2-} = Na_2O

Ternary ionic compounds: compounds containing polyatomic ions.

Ex.1 Na^+ and NO_3^- = Na NO_3

Ex.2 Na^+ and SO_4^{2-} = Na_2SO_4

Ex.3 Ca^{2+} and ClO_3^- = $\text{Ca}(\text{ClO}_3)_2$

Ex.4 Ca^{2+} and PO_4^{3-} = $\text{Ca}_3(\text{PO}_4)_2$

Ex 5 NH_4^+ and CO_3^{2-} = $(\text{NH}_4)_2\text{CO}_3$

ACIDS: compounds containing H as the cation(positive ion) plus a nonmetal or a polyatomic ion.

1. BINARY ACIDS

Always have *hydro* in the name

The ending changes from -ide to -ic

ex. *hydrochloric* acid **HCl**

ex. *hydrosulfuric* acid **H₂S**

2. TERNARY ACIDS or OXYACIDS (contain polyatomic ions)

NEVER HAVE HYDRO IN THE NAME

The ending of the polyatomic ion changes from

-ate to -ic

or

-ite to -ous

ex. chloric acid **HClO₃**

ex. chlorous acid **HClO₂**

ex sulfuric acid **H₂SO₄**

ex. sulfurous acid **H₂SO₃**

BASES: compounds containing a metal (or cation) plus Hydroxide - OH.

sodium hydroxide **NaOH**

calcium hydroxide **Ca(OH)₂**

In compounds containing transition elements (or other elements with more than one oxidation number) the name indicates the oxidation number. This will be shown by a Roman numeral or with an ending on the name of the element.

<u>Ion</u>	<u>New name</u>	<u>Old name</u>
Cu⁺	copper (I)	cuprous
Cu²⁺	copper (II)	cupric
Fe²⁺	iron (II)	ferrous
Fe³⁺	iron (III)	ferric
Pb²⁺	lead (II)	plumbous
Pb⁴⁺	lead(IV)	plumbic
Sn²⁺	tin (II)	stannous
Sn⁴⁺	tin (IV)	stannic

Write the formulas:

- | | |
|--------------------------------|-----------------------------|
| 1. magnesium fluoride_____ | 5. aluminum sulfide_____ |
| 2. sodium nitride_____ | 6. strontium phosphide_____ |
| 3. ammonium chloride_____ | 7. barium nitrate_____ |
| 4. potassium carbonate_____ | 8. aluminum chromate_____ |
| 9. mercury (II) fluoride_____ | 15. hydrobromic acid _____ |
| 10. ferrous nitrate_____ | 16. nitric acid _____ |
| 11. iron (III) sulfate_____ | |
| 12. cobalt (II) carbonate_____ | |
| 13. Cupric chloride_____ | |
| 14. tin (II) sulfate_____ | |

2. MOLECULAR COMPOUNDS

A INORGANIC BINARY COMPOUNDS– 2 nonmetals

The name can have a Roman numeral

- Ex. 1 sulfur(IV) oxide = SO_2
Ex. 2 chlorine (III) oxide = Cl_2O_3
Ex. 3 nitrogen (V) sulfide = N_2O_5
Ex. 4 carbon (II) oxide = CO

Or the name will contain prefixes indicating the number of atoms of each element.

- Ex. 1 sulfur dioxide = SO_2
Ex. 2 dichlorine trioxide = Cl_2O_3
Ex. 3 dinitrogen pentoxide = N_2O_5
Ex. 4 carbon monoxide = CO

Write the formulas:

1. Carbon (IV) oxide) _____ 3. sulfur (VI) oxide _____
2. Nitrogen monoxide _____ 4. diphosphorus pentoxide _____

ORGANIC COMPOUNDS – contain carbon

Prefixes indicate the number of carbon atoms:

Meth-	hex-
Eth-	hept-
Prop-	oct-
But-	non-
Pent-	dec-

Alkanes This series of compounds contains all single bonds (called *saturated*). Compounds end in the suffix **–ane**. $\text{C}_n\text{H}_{2n+2}$

Ex. Methane CH_4 ; pentane C_5H_{12}

Alkenes This series contains double bond, and compounds end in **–ene**. C_nH_{2n} .

Ex ethene C_2H_4 ;

Alkynes This series contains triple bonds and compounds end in **–yne**. $\text{C}_n\text{H}_{2n-2}$.

Ex Propyne C_3H_4

Write the formulas:

1. Hexane _____ 2. octene _____
3. decane _____ 4. Butyne _____

Name_____

LIST OF ELEMENTS

- | | |
|---------------------|----------------------|
| 1. aluminum _____ | 30. molybdenum _____ |
| 2. antimony _____ | 31. neon _____ |
| 3. argon _____ | 32. neptunium _____ |
| 4. arsenic _____ | 33. nickel _____ |
| 5. barium _____ | 34. nitrogen _____ |
| 6. beryllium _____ | 35. oxygen _____ |
| 7. bismuth _____ | 36. phosphorus _____ |
| 8. boron _____ | 37. plutonium _____ |
| 9. bromine _____ | 38. polonium _____ |
| 10. cadmium _____ | 39. potassium _____ |
| 11. calcium _____ | 40. radium _____ |
| 12. carbon _____ | 41. radon _____ |
| 13. cesium _____ | 42. rubidium _____ |
| 14. chlorine _____ | 43. scandium _____ |
| 15. cobalt _____ | 44. selenium _____ |
| 16. chromium _____ | 45. silicon _____ |
| 17. copper _____ | 46. silver _____ |
| 18. fluorine _____ | 47. sodium _____ |
| 19. gold _____ | 48. strontium _____ |
| 20. helium _____ | 49. sulfur _____ |
| 21. hydrogen _____ | 50. tellurium _____ |
| 22. iodine _____ | 51. thorium _____ |
| 23. iron _____ | 52. tin _____ |
| 24. krypton _____ | 53. titanium _____ |
| 25. lead _____ | 54. tungsten _____ |
| 26. lithium _____ | 55. uranium _____ |
| 27. magnesium _____ | 56. vanadium _____ |
| 28. manganese _____ | 57. xenon _____ |
| 29. mercury _____ | 58. zinc _____ |

POLYATOMIC IONS

ANIONS

Name	Formula	Name	Formula	Name	Formula
acetate	$\text{C}_2\text{H}_3\text{O}_2^-$ CH_3COO^-	chromate	CrO_4^{2-}	phosphate	PO_4^{3-}
chlorate	ClO_3^-	dichromate	$\text{Cr}_2\text{O}_7^{2-}$		
cyanide	CN^-	carbonate	CO_3^{2-}		
nitrate	NO_3^-	sulfate	SO_4^{2-}		
hydroxide	OH^-				
permanganate	MnO_4^-				
bicarbonate (hydrogen carbonate)	HCO_3^-				

CATIONS

ammonium	NH_4^+
mercury (I) (mercurous)	Hg_2^{2+}

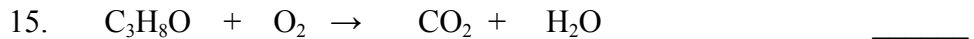
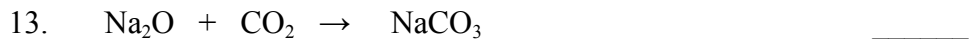
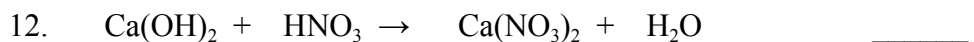
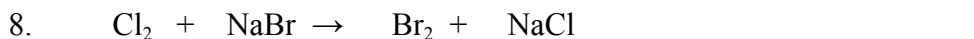
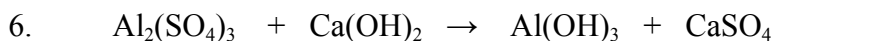
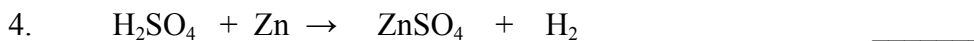
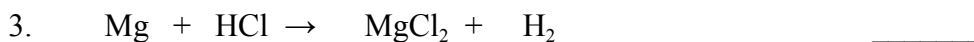
MORE POLYATOMIC IONS

You must know the following polyatomic ions but it will not be necessary to memorize them, since they can be derived from the ones you have memorized.*

hypochlorite	ClO^-	sulfite	SO_3^{2-}	nitrite	NO_2^-
chlorite	ClO_2^-	sulfate*	SO_4^{2-}	nitrate*	NO_3^-
chlorate*	ClO_3^-				
perchlorate	ClO_4^-				

IDENTIFYING AND BALANCING CHEMICAL EQUATIONS

Identify each of the equations as synthesis (s), decomposition (d), single replacement (sr), double replacement (dr), or combustion (comb). Balance.



NAME _____

MATH SKILLS PRACTICE

SOME USEFUL FORMULAS

$D = m/v$	$Q = MC\Delta T$	mole = mass/ gram formula mass
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1. Evaluate:

$$(2.0 \times 10^{-6})(4.0 \times 10^{18}) =$$

$$(9.0 \times 10^2) \div (6.0 \times 10^{-21}) =$$

$$8.25 \times 10^{24} \div (3 \times 7.20 \times 10^{-6}) =$$

2. 32 000 g = _____ kg?

3. 53 kilometers = _____ millimeters

4. 5 L = _____ mL

5. 625 cm³ = _____ L

6. 140 cm = _____ km

7. 576 m = _____ μ m

SHOW SET-UP FOR THE FOLLOWING PROBLEMS.

6. A child is sent to a store with \$3.00 to buy donuts. If donuts cost \$0.95 per dozen, how many can be bought? Assume they can be bought individually.

7. An object is traveling at a speed of 7500 cm/s. Convert to km/hr.

8. The speed limit in a town is 35 miles/hr. What is it in km/hr (1 mile = 5280 feet; 1 ft = 30 cm)

9. In a laboratory experiment a student measures the density of a piece of iron as 7.01 g/cm³. The value given in a table of physical constants (literature value) is 7.87 g/cm³. What is the student's percent error (relative error)?

10. A certain gas under given conditions has density of 1.34 x 10⁻⁴ g/cm³. What volume will 250.0 g of this gas occupy (under the same conditions)?

11. A 5-gram sample of an alloy, composed of copper and zinc, contains 3.2 g copper. What percent of the alloy is zinc?

12. An organic substance containing chlorine was found to be 92.2% chlorine by mass. An analysis of a sample of the substance showed it to contain 52.5 g of chlorine. What was the mass of the sample analyzed?

14. Calculate the formula mass of $\text{Ca}(\text{NO}_3)_2$.

15. How many moles are in 450.0 g of $\text{Ca}(\text{NO}_3)_2$.

16. Given the equation, how many moles of $\text{Al}_2(\text{CO}_3)_3$ will be produced from 5 moles of $\text{Al}_2(\text{SO}_4)_3$?

17. What mass of water can be heated from 20.0°C to 98.0°C by the absorption of 5,425 J of heat? (Specific heat of water = $4.18 \text{ J/g} \cdot ^\circ\text{C}$)

18. A light year is the distance light can travel in one year. If the sun is 150 000 000 km away, how many light years is the sun from earth. Light travels at a speed of $3.0 \times 10^{10} \text{ cm/s}$?

GRAPHING EXERCISE

Plot a graph of the following data: Draw the best fit line.

<i>Dependent variable</i>	<i>Independent variable</i>
Mass (g)	Volume (cm ³)
0.05	0.71
2.0	2.9
3.5	5.0
4.5	6.4
5.0	7.1
6.5	9.3
7.0	10.0
8.5	12.1
10.0	14.3

1. Calculate the slope. _____
2. What is the mass of a 3.0 cm³ sample? _____
3. What would be the volume of a 45 g sample? _____
4. What type of relationship exists between mass and volume? _____
6. What physical characteristic of the substance does the slope represent? _____

