

Rivers State University, Nkpolu-Oroworukwo Port Harcourt,  
 Department of Chemistry, 2020/2021 Academic Session, First Semester  
 Instruction: Answer all questions in Section A, 1 mark each, 1:30 hrs  
 Section B, Answer ONLY 2 questions, 10 marks for each question.  
 SET A —————— SCIENCE, & OTHERS, underline the correct answer

$C = 12$ ,  $H = 1$ ,  $O = 16$ ,  $Se = 79$ , speed of light =  $3.00 \times 10^8$  m/s  
 Avogadro's number =  $6.022 \times 10^{23}$ ,  $Mg = 24$ ,  $Al = 27$ ,  $P = 31$ ,  $Cl = 35.5$ .  
 = Atom A,  = Atom B

Surname:

Other Names:

Matric. No.:

Faculty/ Dept:

Signature:

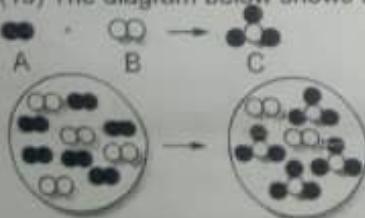
No. on attendance list:

1. Which of the following is not a mixture? gasoline steel\* air Ammonia None
2. Chemical reactions consist of reactants and ..... heat equations products\* mixture liquids
3. What is the g equivalent of 0.027 kg? 2.74 g 27.4 g 274.0 g 0.274 g 0.027 g
4. Which of the following species is a polyatomic ion?  $Zn^{2+}$   $S^{2-}$   $Ca^{2+}$   $Cl^-$   $CN^-$
5. What is the plural of the word 'quantum'? quantums quanta\* quantal quantum energy quantity
6. What the meaning of amu? atomic mass unit\* amount activity mass unit aluminium unit None
7. How many protons neutrons and electrons does  $^{37}K^+$  contain? 19, 19 & 19 18, 19 & 18 19, 18 & 18\* 20, 18 & 19 None
8. How many core electrons are in chlorine atom? 10\* 8 6 4 2
9. The percentage of hydrogen in ammonia is ...? 7.14% 82.3% 21.4% 17.6%  10.0%
10. What is the molecular mass of  $CH_3CO_2H$ ? 44 amu 60 amu\* 56 amu 30 amu 20 amu
11. What is the simplest formula of an iron ore containing 72.4% Fe (55.8) and 27.6% O (16.0)? Fe  $Fe_4O_3$   $Fe_2O_3$   $Fe_3O_4$   $FeO$ \*
12. The limiting reagent is the reactant that is? sufficient in excess not in excess agent limited\*
13. In which of the following will chlorine indicate oxidation of +5? HCl HClO HClO<sub>2</sub> HClO<sub>4</sub>\* HClO<sub>5</sub>
14. Which of the following element is not halogen? F Cl Br At Ar\*
15. Write the orbital (box) diagram of  $_{30}Zn^{2+}$
- (16) Which of the following is NOT true about mass?

It has the same value everywhere on Earth	It is independent of gravitational force	It becomes less in outer space, farther from Earth
It is a constant measure of the amount of matter	It is found in all matter	

- (17) The correct answer for  $3.71 \times 10^6$  g +  $4.62 \times 10^7$  g in the correct significant figure is  
 $4.991 \times 10^7$  g  $8.33 \times 10^{15}$  g  $4.172 \times 10^7$  g  $4.99 \times 10^7$  g  $4.17 \times 10^7$  g
- (18) What is the temperature in Kelvin that corresponds to a temperature of -12 °C?  
 -285.2 K +285.2 K 261.15 K\* 261.2 K 285.15 K

- (19) The diagram below shows the reaction of molecule A with molecule B to form molecule C.



Which equation is best?

$3A + B \rightarrow 4C$	$6A + 4B \rightarrow 4C$	$3A + B \rightarrow 2C$
$6A + 2B \rightarrow 4C$	$3A + 2B \rightarrow 2C$	

- (20) Which quantum number is shared by all the orbitals in a shell?

Principal	Spin	Angular momentum	Magnetic	None of the options
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- (21) Which type of electromagnetic radiation has the Longest Wavelength??

Microwaves	Radio/TV waves	Infrared	Ultraviolet light	Gamma rays
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- (22) The symbol for the metric unit micrometre is.....?

cm	dm	mm	Mm	μm
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Surname of student.....

Other Name.....

(23) If an equation is written for the reaction of carbon disulphide with chlorine gas to produce carbon tetrachloride and disulphur dichloride, the coefficient of chlorine gas in the equation is? 2 3 4 5 6

(24) What is the volume in  $\text{cm}^3$  of benzene left unreacted when 13  $\text{cm}^3$  of benzene is treated with 75  $\text{cm}^3$  of oxygen based on the reaction  $2\text{C}_6\text{H}_{6(\text{g})} + 15\text{O}_{2(\text{g})} \rightarrow 12\text{CO}_{2(\text{g})} + 6\text{H}_2\text{O}_{(\text{l})}$ ? 20 3 5 35 0

(25) What is the term for the inexactness of an instrumental measurement? accuracy error precision uncertainty None of the options

(26) According to the metric system, 1 g = cg  
1 x 10<sup>-3</sup> 1 x 10<sup>3</sup> 1 x 10<sup>2</sup> 1 x 10<sup>7</sup> 1 x 10<sup>1</sup>

(27) In 1.000 mol  $(\text{NH}_4)_2\text{SO}_4$ , there are 6.022 x 10<sup>23</sup> ammonium sulphate molecules 1.204 x 10<sup>22</sup> ammonium ions 1.204 x 10<sup>23</sup> ammonium ions 6.022 x 10<sup>23</sup> nitrogen atoms 24.08 x 10<sup>23</sup> hydrogen atoms

(28) Which of the following is an inexact quantity? Number of students in this exam The mass of a Kobo The number of grams in a kilogram The number of books in the library All of the above

(29) The oxidation number of the underlined elements in  $\text{NaHSO}_3$  and  $\text{Na}_2\text{O}_2$  are ... & ... respectively +6 & +2 +2 & +1 -2 & +1 +4 & +2 +4 & +1

(30) Which of these is NOT a methathesis reaction?  $2\text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$   
 $\text{NaCl}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{AgCl}(\text{s})$   $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{S}(\text{aq}) \rightarrow \text{PbS}(\text{s}) + 2\text{NaNO}_3(\text{aq})$   
 $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$   $3\text{Zn}(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + 3\text{H}_2(\text{g})$

(31) Which of the following is a physical change? \*converting iron to a steel alloy\* \*converting hydrogen to water\* \*converting nitrogen gas to ammonia\* \*converting sulphur to sulphuric acid\* \*All of the options\*

(32) The preferred name for  $\text{MnO}_3$  is? Dioxygen manganese Manganese oxide Manganese(II) oxide Manganese dioxide Manganese(IV) oxide

(33) The symbol for the ion containing 24 protons, 28 neutrons, and 21 electrons is  $^{45}_{21}\text{Sc}^{3+}$   $^{45}_{21}\text{Sc}^{-}$   $^{45}_{21}\text{Sc}$   $^{52}_{24}\text{Cr}^{3+}$   $^{52}_{24}\text{Cr}^{-}$

(34) A compound has the composition (percentage by mass): 38.37% carbon (C), 1.49% hydrogen (H), and 52.28% chlorine (Cl). The empirical formula of the compound is?  $\text{C}_2\text{HCl}$   $\text{C}_2\text{H}_3\text{Cl}_2\text{O}_2$   $\text{C}_{12}\text{H}_3\text{Cl}_3$   $\text{CH}_2\text{O}_2$   $\text{C}_{13}\text{H}_6\text{Cl}_6\text{O}_2$

(35) Oxyanions such as  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ ,  $\text{ClO}_4^-$ , and  $\text{ClO}_4^-$ , are well known in chemistry. The formulae of potassium chlorite and sodium chlorate are ... & ... respectively?  $\text{KClO}_2$ ,  $\text{NaClO}_2$   $\text{KClO}_3$ ,  $\text{NaClO}_4$   $\text{KClO}_4$ ,  $\text{NaClO}_4$

(36) What is the term for a tentative explanation of natural events? Scientific law Theory Hypothesis Experiment Observation

Use the following information to answer questions 26 - 29. Chlorine can be prepared by the reaction  $\text{MnO}_2(\text{s}) + 4\text{HCl}(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + \text{MnCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ . Assume the reaction is quantitative and the formula masses in g/mol are  $\text{MnO}_2 = 86.9$ ;  $\text{HCl} = 36.5$ ;  $\text{MnCl}_2 = 125.8$ ;  $\text{Cl}_2 = 70.9$ , and  $\text{H}_2\text{O} = 18.02$ .

(37) How many grams of  $\text{Cl}_2$  can be produced from 25.0 g of  $\text{MnO}_2$ ? If enough HCl is used to react with all of the  $\text{MnO}_2$ . 0.0326 g 10.2 g 20.4 g 30.6 g 246 g

(38) How many moles of HCl are required to react with 25.0 g of  $\text{MnO}_2$ ? 0.0326 g 10.2 g 20.4 g 30.6 g 246 g

(39) How many moles of  $\text{Cl}_2$  can be prepared from 0.57 mol  $\text{MnO}_2$ ? 2.0 mol 1.3 mol 1.0 mol 0.75 mol 0.50 mol

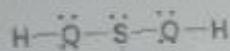
(40) If 0.75 mol  $\text{MnO}_2$  and 2.0 mol HCl are used, how many moles of the reactant will be left over? 1.3 mol HCl 0.75 mol HCl 0.25 mol  $\text{MnO}_2$  0.50 mol  $\text{MnO}_2$  None of the options

(41) A sample of white gold contains 18.0 g gold, 3.0 g silver, 2.0 g cobalt and 1.0 g platinum. What is the percentage of platinum in the sample? 12% 58% 29% 75% 50%

(42) The freezing point and boiling point of water on Celsius scale are 0 °C and 100 °C, the freezing point and boiling point of water on Fahrenheit scale are 32°F & 212°F 0°F & 100°F -32°F & 212°F 0°F & 212°F 32°F & 100°F

(43) A glass cylinder contains 4 liquids layers: mercury ( $d = 13.6 \text{ g/mL}$ ), chloroform ( $d = 1.49 \text{ g/mL}$ ),  $\text{H}_2\text{O}$  ( $d = 1.00 \text{ g/mL}$ ), ether ( $d = 0.708 \text{ g/mL}$ ). If a cork stopper ( $d = 0.50 \text{ g/mL}$ ) is put into the cylinder, where does it come to rest? \* on top of the  $\text{H}_2\text{O}$ \* \*On the bottom of the cylinder\* \*On top of the mercury\* \*On top of the ether\* \*On top of the chloroform\*

(44) In the Lewis structure for Sulphuric acid shown below, the formal charge for on sulphur is?



+2	+1	0	-1	-2
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:O:

(45) Which element below is most unlikely to form compounds with more than eight valence electrons?

sulphur

carbon

silicon

xenon

bromine

(46) How are the bonding pairs arranged in the best Lewis structure for carbon dioxide ( $\text{CO}_2$ )?

C=O=O

O-C-O

C-O-O

O=C-O

O=O=O

(47) Which pair of ions will form the ionic lattice with the highest energy?

$\text{Li}^+$  & F

$\text{Na}^+$  & Br

$\text{Li}^+$  &  $\text{O}^{2-}$

$\text{K}^+$  & F

$\text{Cs}^+$  & F

(48) Given that the ground state electron configuration of A =  $1s^2s^22p^3$ , and that of B =  $1s^22s^1$ , the formulae of the compound most likely formed by X and Y is?

$\text{BA}_3$

BA

$\text{B}_3\text{A}$

$\text{B}_5\text{A}_3$

$\text{B}_2\text{A}$

(49) The Neutron was discovered by?

J. Chadwick

J. J. Thomson

R. Millikan

E. Rutherford

J. Dalton

(50) Which of these is NOT a quantum number used in describing an electron in an atom?

Principal quantum number Spin quantum number Subsidiary quantum number electronic quantum number All

### SECTION B Attempt ONLY 2 Questions

1 (A) (i) Define the terms limiting reactant and excess reactant

(ii) which has more mass, a mole of water ( $\text{H}_2\text{O}$ ) or a mole of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ )? justify

(iii) Which contains more molecules, a mole of water or a mole of glucose? justify

①  $\text{H}_2\text{O}$   
18

1 mole  $\text{H}_2\text{O}$   
 $6 \times 6.02 \times 10^{23}$

$\text{C}_6\text{H}_{12}\text{O}_6$

180g  
1 mole glucose  
 $6 \times 6.02 \times 10^{23}$

1 (B) Several brands of antacids use  $\text{Al}(\text{OH})_3$  to react with stomach acid, which contains primarily HCl:



(a) Balance the above equation

(b) Calculate the number of grams of HCl that can react with 0.5000 g of  $\text{Al}(\text{OH})_3$

(c) Calculate the number of grams of  $\text{AlCl}_3$  and number of grams of  $\text{H}_2\text{O}$  formed when 0.5000 g of  $\text{Al}(\text{OH})_3$  reacts

**RIVERS STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
**NKPOLU-OROWORUKWO, PORT HARCOURT**  
**FIRST SEMESTER EXAMINATION**  
**CHS:101- GENERAL CHEMISTRY 1**  
**2015/2016 SESSION**

**INSTRUCTION: ATTEMPT ANY FIVE (5) QUESTION**

**UNIT:3**

**TIME ALLOWED:2HRS**

1. Ethylene glycol,  $C_2H_6O_2$ , is a liquid widely used in automobile antifreeze, it has a density of  $1.11\text{g/cm}^3$ 
  - (a) What is the mass, in grams, of  $56,000\text{cm}^3$  of ethylene glycol?
  - (b) What is the empirical formula of ethylene glycol?
  - (c) Calculate the molecular mass of ethylene glycol?
  - (d) Write Lewis dot structures of elements that make up the glycol.
  - (e) Assume you add 1.2.kg of ethylene glycol as antifreeze to 4.0 kg of water in the radiator of your car what is the weight percent of the glycol?
2. Carbonmonoxide and nitrogenmonoxide, both are serious air pollutants, are produced in large quantities in automobile engines. However, both gases can react to form carbon dioxide and nitrogen which are safer products.  
 In the equation,  $2\text{CO(g)} + 2\text{NO(g)} \rightarrow \text{N}_2\text{(g)} + 2\text{CO}_2\text{(g)}$ 
  - (a) Define rate of reaction
  - (b) Write expressions for the rate of disappearance of CO and NO, and rate of formation of  $\text{CO}_2$  and  $\text{N}_2$
  - (c) Write an expression for the general rate of the reaction.
  - (d) Considering the rate law of the reaction above is; Rate =  $k(\text{CO})(\text{NO})_2$ , what are the reaction orders for CO and NO?
  - (e) Based on the rate law what is the overall order of the reaction?
3. Given that the percentage and fractional abundance of carbon isotopes are:

Isotopes	Percent abundance	Fractional
Carbon -12	98.892%	0.98892
Carbon -13	1.108%	0.01108

- (a) Calculate the weighted average atomic mass of carbon
- (b) What are isotopes?
- (c) How many protons, neutrons and electrons are in carbon-12 and carbon-13 isotopes?
4. Give the reaction;  $\text{CO(g)} + 3\text{H}_2\text{(g)} \rightleftharpoons \text{CH}_4\text{(g)} + \text{H}_2\text{O(g)}$ 
  - (a) Write the equilibrium expression for the reaction
  - (b) With a decrease in volume, in what direction will the equilibrium shift to?
  - (c) State the LE chatelier's principle.
5. Write electron configuration for fluorine (F) using
  - i. Spdf notation ii. Orbital diagram iii. Noble-gas-core abbreviated electron configuration
  - (b) with the aid of its electron configuration, which group and period is F found in periodic table?
6. Define or explain the followings
  - (a) Atomic number (b) Avogadro's number (c) cathode ray (d) Core (inner) electrons
  - (e) hydrogen bond (f) limiting reagent (g) Molarity (h) Photon
7. Briefly describe the Rutherford's alpha-particles scattering experiment and his interpretation of the results of the experiment

# SESSION SOLUTIONS CHS 101

## 1(a) GENERAL CHEMISTRY

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

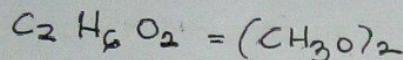
$\therefore \text{Mass} = \text{Density} \times \text{Volume}$  where:

$$\text{Density} = 1.11 \text{ g/cm}^3; \text{Volume} = 56,000 \text{ cm}^3$$

$$\text{Mass} = 1.11 \text{ g/cm}^3 \times 56,000 \text{ cm}^3 = \underline{\underline{62160 \text{ g}}}$$

1(b.) Molecular formula = Empirical formula<sub>n</sub>

$$\text{NIB: } n = 2$$



$$\therefore \text{Empirical formula} = \text{CH}_3\text{O}$$

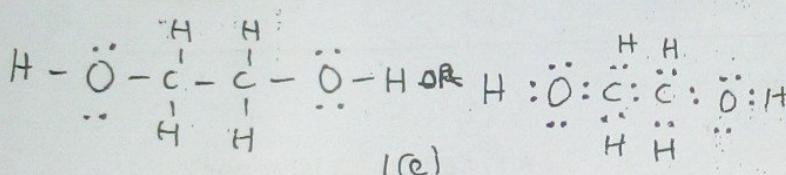
1(c.) Molecular mass of ethylene glycol.

$$\begin{aligned} \text{CH}_2\text{H}_6\text{O}_2 &= (2 \times 12.011) + (6 \times 1.008) + (2 \times 15.999) \\ &= 24.022 + 6.048 + 31.998 = \underline{\underline{62.0689}} \end{aligned}$$

d) Element that make up the glycol are

Carbon, hydrogen and oxygen.

Lewis dot structure of the element.



11) Weight % of the glycol =

$$\frac{\text{Mass of ethylene glycol}}{\text{Mass of water}} \times \frac{100}{1}$$

Mass of ethylene glycol +

Mass of water.

$$= \frac{1.2 \text{ kg}}{1.2 + 4.0 \text{ kg}} \times \frac{100}{1} = \frac{1.2}{5.2} \times \frac{100}{1} = \underline{\underline{23.1 \%}}$$

2a) The rate of a reaction is the number of moles of reactant converted or product formed per unit time.

$$\text{Rate of disappearance of CO} = -\frac{\Delta [\text{CO}]}{\Delta t}$$

$$\text{Rate of disappearance of NO} = -\frac{\Delta [\text{NO}]}{\Delta t}$$

$$\text{Rate of formation of CO}_2 = \frac{\Delta [\text{CO}_2]}{\Delta t}$$

$$\text{Rate of formation of N}_2 = \frac{\Delta [\text{N}_2]}{\Delta t}$$

(2c.) Expression for the general rate of the reaction.

$$\text{Rate} = k [\text{CO}]^2 [\text{NO}]^2 [\text{Reactants}]$$

$$\text{Rate} = k [\text{CO}_2]^2 [\text{N}_2] [\text{Products}]$$

$$\text{Rate} = k [\text{CO}] [\text{NO}]^2$$

Reaction order for CO = 1 (1<sup>st</sup> order)

Reaction order for NO = 2 (2<sup>nd</sup> order)

(2e.) Overall order of the reaction = 3 (3<sup>rd</sup> order.)

(3a.) Weighted average atomic mass

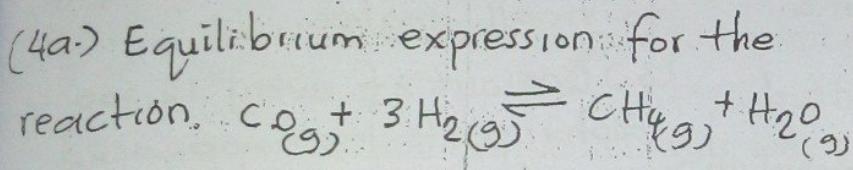
$$\begin{aligned} \text{Mass of Carbon} &= (12 \times 0.988) \\ &+ (13 \times 0.0108) \end{aligned}$$

$$= 11.86704 + 0.14404 = \underline{\underline{12.011}}$$

(3a) Isotopes are elements that have same atomic number but different mass number due to difference in the number of neutrons present in the nucleus of the atom

(3b) Isotopes are elements that have the same atomic number but different mass number due to difference in the number of neutrons present in the nucleus of the atom.

	Carbon - 12	Carbon - 13
Proton	6	6
Neutron	6	7
Electron	6	6

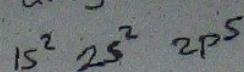


$$K_c = \frac{[\text{CH}_4][\text{H}_2\text{O}]}{[\text{CO}][\text{H}_2]^3}$$

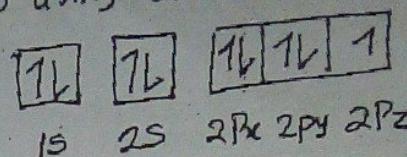
(4b.) With a decrease in volume, the equilibrium will shift to the right-hand side of the reaction i.e formation of  $\text{CH}_4$  and  $\text{H}_2\text{O}$  will be favoured.

(4c.) Le Chatelier's principle states that if an external constraint such as a change in temperature, pressure or concentration is imposed on a chemical system in equilibrium, the equilibrium will shift so as to annul or neutralize the constraint.

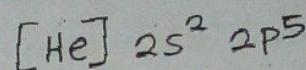
(5a) i) Using SPDF notation



(ii) Using orbital diagram.



(iii) Using noble gas core abbreviated electron configuration



(5b) Group = 7, period 2

(6a.) Atomic number is the number of protons present in the nucleus of an atom.

(6b.) Avogadro's number is the number of units in one mole of any substance and is equal to  $6.02 \times 10^{23}$

(6c.) A cathode ray is a beam of electrons in a vacuum tube travelling from the negatively charged electrode (cathode) at one end to the positively charged electrode (anode) at the other across a voltage difference between electrodes. They are also called electron beams.

(6d.) Core (inner) electrons are electrons found in the inner shells.

The hydrogen bond is an inter-molecular force which arises when hydrogen is covalently linked to elements like nitrogen, oxygen and fluorine.

(6F.) The limiting reagent is the substance that is totally consumed when the chemical reaction is complete. Limiting reagent limit the amount of product that can be formed. The reaction will stop when all of the limiting reagent is consumed.

(6g.) Molarity is unit of concentration measuring the number of moles of a solute per litre or  $\text{dm}^3$  of solution.

(6h.) The photon is the fundamental particle of visible light. It is the quantum of all forms of electromagnetic radiation.

(7.) OBJECTIVE: To demonstrate the scattering was interested in knowing how the electrons are arranged of alpha particles. Ernest Rutherford, within an atom. Rutherford designed an experiment for this. In this experiment fast moving alpha ( $\alpha$ ) particles is made to fall on a thin gold foil. He selected a gold foil because he wanted a thin layer as possible. The fast moving  $\alpha$ -particle have a considerable amount of energy.

It was expected that  $\alpha$ -particles would be deflected by the subatomic particles in the gold atoms. Since the  $\alpha$ -particles were much heavier than the protons, he did not expect to see large deflections. But the  $\alpha$ -particle scattering experiment gave totally unexpected results.

#### OBSERVATION

- (1.) Most of the fast moving  $\alpha$ -particles passed straight through the gold foil.
- (2.) Some of the  $\alpha$ -particles were deflected by the foil to small angles.
- (3.) One out of every 12000 alpha particles appeared to rebounce.

DEPARTMENT OF CHEMISTRY  
1<sup>ST</sup> SEMESTER 2016/2017 SESSION EXAMINATION/EXTRA LIKELY QUESTIONS

COURSE: CHS 101 GENERAL CHEMISTRY 1

INSTRUCTION: ANSWER ALL QUESTIONS (EXAMS & TESTS QUESTIONS  
2016/2017 - 2019 SESSION)

TIME: 1:30mins

SECTION A:

1. A local radio in RSUST broadcast a frequency of 193.7MHz. Calculate the wave length of the radio wave in meters and the energy of wave (speed of wave =  $3.00 \times 10^8$ m/s and  $h = 6.63 \times 10^{-34}$

- A. Draw the table and give the number of protons neutrons, electrons in the following species.

Atom	Proton No.	Neutron No.	Electron No.
$^{15}_{7}\text{N}$			
$^{235}_{92}\text{U}$			
$^{202}_{80}\text{Hg}$			

- B. i Write electronic configuration and Lewis dot structure for  
(a)  $\text{N}^3-$  = (b) F

- ii Give the name of the following isotopes

- (a)  $^1_1\text{H}$  (b)  $^2_1\text{H}$  (c)  $^3_1\text{H}$  (d)  $^{224}_{88}\text{Ra}$

- 3(a) How many grams of zinc iodide ( $\text{ZnI}_2$ ) are in 0.0654mol of  $\text{ZnI}_2$  ( $Z = 65$  and  $I = 127$ )

- (b)i In the periodic table, describe how electron affinity and ionization energy

- ii Vary across the second period

- iii Vary down the group 1A elements

- iv Using orbital box diagram write the electronic configuration of each of the following elements (a) Sodium and (b) Boron

- (C) Define the following:

The hydrogen bond is an inter-molecular force which arises when hydrogen is covalently linked to elements like nitrogen, oxygen and fluorine.

(5f.) The limiting reagent is the substance that is totally consumed when the chemical reaction is complete. Limiting reagent limit the amount of product that can be formed. The reaction will stop when all of the limiting reagent is consumed.

(5g.) Molarity is unit of concentration measuring the number of moles of a solute per litre or  $\text{dm}^3$  of solution.

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It was expected that  $\alpha$ -particles would be deflected by the subatomic particles in the gold atoms. Since the  $\alpha$ -particles were much heavier than the protons, he did not expect to see large deflection. But the  $\alpha$ -particle scattering experiment gave totally unexpected results.

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# CHS 107

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$Z = 32, \rho = 1, \rho_{O_2} = 1.43 \text{ g/l}, \rho_{N_2} = 1.25$   
 $\rho_{H_2} = 0.089 \text{ g/l}, \rho_{Cl_2} = 3.2 \text{ g/l}, \rho_{Ca} = 1.13 \text{ g/cm}^3$   
 $\rho_{Al} = 2.7 \text{ g/cm}^3, \rho_{Cu} = 8.9 \text{ g/cm}^3, \rho_{Ce} = 14.0 \text{ g/cm}^3$   
Avogadro's number =  $6.02 \times 10^{23}$

Signature: \_\_\_\_\_ Other Names: \_\_\_\_\_  
Matric. No. \_\_\_\_\_ Faculty/Dept. \_\_\_\_\_  
Signature: \_\_\_\_\_ No. on Attendance list: \_\_\_\_\_

SECTION A

1. Which of the following is (are) elements?

- a) CO ✓ b) Co c) C d) Cl<sub>2</sub> e) CO<sub>2</sub> Cobalt and Carbon

- a) i, iii & v b) ii, iii, & iv c) i & v d) ii & iii e) i, iii & iv

Which statement is NOT consistent with Rutherford's nuclear theory as it was originally stated?

- a) The volume of an atom is mostly empty space  
b) The nucleus of the atom is small compared to the size of the atom  
c) Nitrogen atom has seven protons in its nucleus and seven electrons outside of the nucleus  
d) A lithium atom is electrically neutral  
e) Neutral lithium atom contains more protons than neutrons ✓

Which of the following is NOT a main group (representative) element?

- a) Hydrogen b) Krypton c) Potassium d) Beryllium e) Chromium ✓

The ratio of the number of atoms in 2g hydrogen to 16g of oxygen is

- a) 1:8 b) 1:4 c) 1:2 d) 2:1 ✓ e) 1:1

Which formula represents a peroxide?

- a) K<sub>2</sub>O b) K<sub>2</sub>O<sub>2</sub> c) KO<sub>2</sub> d) CaO e) Ca<sub>2</sub>O<sub>2</sub>

The number of moles of methane (CH<sub>4</sub>) present in 6.07g of methane is?

- a) 0.379 moles b) 0.579 moles c) 0.679 moles d) 0.279 moles e) 0.479 moles

Which of the following is NOT a chemical change?

a.) A cup of household bleach changes the colour of a T-shirt from red to pink chemical

b.) Plants use carbon dioxide from air to make sugar chemical change

c.) Tin metal melting from solid to molten state at 232°C ✓ change from solid to liquid is physical

d.) Hydrogen explodes when ignited in air chemical

e.) The colourless liquid ethanol burns in air chemical

The oxidation number of the underlined element in SO<sub>4</sub><sup>2-</sup> is

- a) +6 ✓ b) +5 c) +4 d) +3 e) -6

The chemical formula of lead(II) hypochloride is

- a) Pb(ClO<sub>3</sub>)<sub>2</sub> b) Pb(ClO<sub>2</sub>)<sub>2</sub> c) Pb(ClO<sub>2</sub>)<sub>2</sub> d) Pb(ClO<sub>4</sub>)<sub>2</sub> e) PbCl<sub>3</sub>

The mass number of an element is the sum of its

- e) Protons and neutrons ✓ b) Protons and electrons c) Neutrons and electrons d) Outermost electrons e) Protons, Neutrons and electrons

a. Define the following:

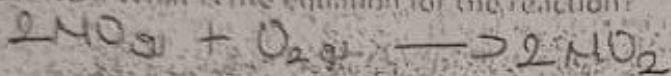
Molar Mass of a substance is determined by the position in the nucleus of an atom.

iii. Limiting reagent: It can be defined as the reactant or reagent, there is completely used up first and determines the amount of product formed in a chemical reaction.

iv. The mole: This can be defined as the amount of a substance containing a Avogadro's number of elementary entities as there are atoms in exactly 12 g of carbon-12. Isotope.

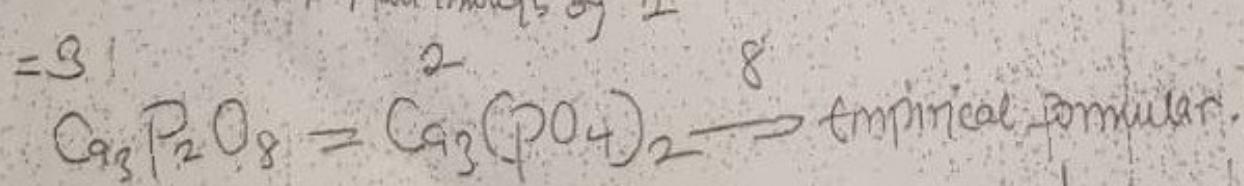
b. The following equation shows the reaction of aluminum with aqueous solution of hydrochloric acid to produce aqueous aluminum chloride and hydrogen gas:  $\text{Al}_{(s)} + \text{HCl}_{(aq)} \rightarrow \text{AlCl}_3 + \text{H}_2$ . Balance this equation.

2. 0.3g of nitrogen monoxide gas,  $\text{NO}$ , reacts with 0.16g of Oxygen gas,  $\text{O}_2$ , to give 0.56g of nitrogen dioxide gas,  $\text{NO}_2$ . What is the equation for the reaction?



• An experimental analysis of calcium phosphate shows that it contains 38.77% calcium, 19.97% phosphorus and 41.27% oxygen. What is the empirical formula of the sample?

$C_9$	P	O
$\frac{39.97}{40}$	$\frac{19.97\%}{31}$	$\frac{41.27}{16}$
$0.96925$	$0.64419$	$2.57938$
$0.64419$	$0.64419$	$0.64419$
$= 1.5$	$= 1.00$	$= 4.00$



NOW Find the volume of the gravel

Weight of gravel =

Weight of cylinder + H<sub>2</sub>O + Gravel - Wt. of H<sub>2</sub>O + Gravel

∴ Weight of gravel =

$$(175 - 165)g = 10g$$

$$\text{Density } (P) = \frac{10g}{4ml} = 2.5g/ml$$

∴ Density of gravel  
= 2.5 g/ml

(11) Given:

$$\text{Volume} = 3.14r^2h$$

$$\text{height } (h) = 16\text{cm}$$

$$\text{Diameter} = 1.6\text{cm}$$

$$\text{NOTE: Vol} = 3.14r^2h$$

$$r(\text{radius}) = \frac{\text{Diameter}}{2} = \frac{d}{2}$$

$$\therefore r^2 = \left(\frac{d}{2}\right)^2 = \frac{d^2}{4}$$

$$\therefore \text{Vol} = 3.14 \times \frac{d^2}{4} h$$
$$= 3.14 \times \frac{(1.6)^2}{4} \times 16 = 32.2 \text{ cm}^3$$

(12) Density =  $\frac{\text{mass}}{\text{volume}}$

$$\text{Given volume of H}_2\text{O} = 50\text{ml}$$

Mass of water =

$$(\text{mass of beaker} + \text{H}_2\text{O}) - (\text{mass of beaker})$$

Where mass of empty beaker  
= 95g

$$\text{New mass (beaker} + \text{H}_2\text{O}) = 145.3\text{g}$$

$$\text{Mass of H}_2\text{O} = (145.3 - 95)\text{g} = 50.3\text{g}$$

$$\text{Density} = \frac{50.3}{50} = 1.01$$

$$\text{Density of water} = 1\text{g/ml}$$

(13) Repeated readings are taken during laboratory experiment to minimize error and for the purpose of knowing the precision of the experimental result

\* Another reason is to derive an average/mean result which is believed to be more accurate.



Using  $M_1V_1 = M_2V_2$  because H and Cl are in the ratio of 1:1 in HCl

where  $M_1 = 12.4\text{M}$ ;  $V_1 = ?$ ;  $M_2 = 0.25\text{M}$ ;  $V_2 = 1.50\text{L}$

$$\therefore 12.4 \times V_1 = 0.25 \times 1.50$$

$$\therefore V_1 = \frac{0.25 \times 1.50}{12.4} = 0.031$$

NOTE:  $V_1$  = volume of the commercial HCl while  $V_2$  is the volume of diluted HCl

(15) Using  $M_1V_1 = M_2V_2$

where  $M_1 = 0.12\text{M}$ ;  $V_1 1.00\text{L}$

$$M_1 = 15.8\text{M}; V_2 = ?$$

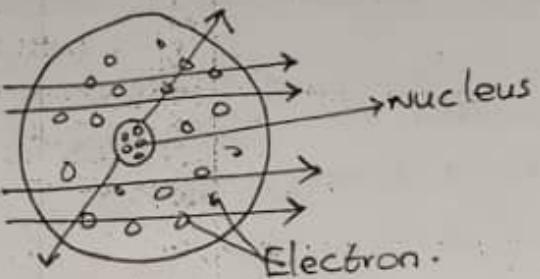
$$\therefore 0.12 \times 1.00\text{L} = 15.8 \times V_2$$

$$\therefore V_2 = \frac{0.12 \times 1.00\text{L}}{15.8} = 0.00761$$

$$\therefore 0.0076 \times 1000 = 7.6\text{ml}$$

## CONCLUSION OF RUTHERFORD'S SCATTERING EXPERIMENT

- (i) Most of the space inside the atom is empty because most of the  $\alpha$ - particles passed through the gold foil without getting deflected.
- (ii) Very few particles were deflected from their path indicating that the positive charge of the atom occupies very little space.
- (iii) A very small fraction of  $\alpha$ - particles were deflected by a very large angle indicating that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.



Representation of the scattering of alpha particle by gold foil.

ELITE MEDIA

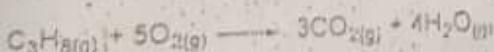
$$\begin{aligned} &C = 12, H = 1, O = 16, N = 14, F = 19 \\ &Na = 23, Cl = 35.5, Al = 27, Cu = 64 \\ &\text{Avogadro's number} = 6.02 \times 10^{23} \\ &\text{GMV} = 22.4 \text{ dm}^3 \text{ at } 1 \text{ atm} \end{aligned}$$

- (1) Which of the following is a property of cathode rays? The travel from the cathode to anode. They are negatively charged.  
 (a) They travel in all directions (b) They flow from the anode to the cathode (c) They are uncharged  
 (d) They are deflected by magnetic fields (e) none of the above
- (2) The reaction represented by:  $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$   
 (a) Is a neutralization reaction (b) Is a displacement reaction (c) Is a redox reaction  
 (d) Is a metathesis reaction (e) Double decomposition
- (3) Which formula represents a peroxide?  
 (a)  $K_2O$  (b)  $K_2O_3$  (c)  $KO_2$  (d)  $CaO$  (e)  $Ca_2O_3$
- (4) A sample of an ionic compound containing iron and chlorine is analysed and found to have a molar mass of 177 g/mol. The charge (combining power) of the iron in the compound is?  $Si = 14$   
 (a) +1 (b) +2 (c) +3 (d) +4 (e) +5
- (5) A silicon atom in its ground state orbital diagram has ..... Number of unpaired electron(s).  $Si = 14$   
 (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
- (6) The number of moles of methane ( $CH_4$ ) present in 6.07 g of methane is?  $\frac{16g}{60.07g} = 0.339 \text{ mol}$   
 (a) 0.279 moles (b) 0.379 moles (c) 0.479 moles (d) 0.579 moles (e) 0.679 moles
- (7) Which is true of the  $^{24}_{15}Am^+$  ion? If P = protons, E = electrons, and N = neutrons.  
 NOTE: It has lost 32 - 15 = 17 electrons.  $P = 24 - 17 = 7$ ,  $E = 15 - 7 = 8$ ,  $N = 24 - 7 = 17$ .  $P + N = 24$ .  $P + E = 24$ .  $P + N + E = 24$ .  
 (a) 95 P, 92 F, 243 N (b) 95 P, 90 E, 143 N (c) 95 P, 95 E, 148 N (d) 95 P, 92 E, 148 N (e) 92 P, 95 E, 148 N
- (8) Which of the following oxyanions is NOT correctly named?  
 (a) Chlorate (b)  $ClO_4^-$ , chlorate (c)  $SeO_4^{2-}$ , selenate (d)  $IO_4^-$ , periodate (e)  $SO_3^{2-}$ , sulphite (f)  $IO_3^-$ , iodate

- (9) Which of the following is a chemical change?

- (a) Water vapour exhaled in your breath condenses in the air on a cold day  
 (b) The melting of butter when placed under the sun. (c) The evaporation of a solution of NaCl to dryness  
 (d) The burning of lamp oil (e) Forming of dew on a cold night

- (10) How many moles of propane will be left unreacted when 20 moles of propane are treated with 30 moles of oxygen based on the reaction?



- (a) 20 moles (b) 10 moles (c) 14 moles (d) 30 moles

$$\begin{aligned} &5 \text{ moles of } O_2 \rightarrow 1 \text{ mole of } C_3H_8 \\ &30 \text{ moles of } O_2 \rightarrow 6 \text{ moles of } C_3H_8 \\ &\text{Given: mole reacted} - \text{mole unreacted} = \text{mole lost} \\ &20 - 6 = 14 \text{ moles} \end{aligned}$$

Rivers State University, Nkpolu-Oroworko Port-Harcourt,  
 Department of Chemistry  
 2019/2020 Academic Session, Port-Harcourt  
 1st Semester  
 CHM 103 (General Chemistry 1) (GENERAL)  
 Time Allowed: 40 minutes  
 Instruction: Answer all questions. Section A, 1 Mark for each question, Section B, 10 marks for each question

$\text{C}=12$ ,  $\text{H}=1$ ,  $\text{O}=16$ ,  $\text{Se}=79$ ,  $\text{Fe}=56$ ,  $\text{S}=32$ ,  $\text{Ca}=40$ ,  $\text{P}=31$   
 Avogadro's number =  $6.02 \times 10^{23}$

Surname: \_\_\_\_\_

Other Names: \_\_\_\_\_

Matric. No. \_\_\_\_\_

Faculty/Dept: \_\_\_\_\_

Signature: \_\_\_\_\_

No. on Attendance list: \_\_\_\_\_

SECTION A

1. The number of moles of methane ( $\text{CH}_4$ ) present in 6.07g of methane is?
  - a) 0.279 moles
  - b) 0.379 moles
  - c) 0.479 moles
  - d) 0.579 moles
  - e) 0.679 moles
2. A 7.83g sample of HCN is found to contain 0.29g of H and 4.06g of N. the mass of carbon in a sample of with a mass of 3.37g is?
  - a) 1.50
  - b) 2.50
  - c) 3.50
  - d) 2.48
  - e) 3.18
3. The oxidation number of the underlined element in  $\underline{\text{S}}\text{O}_4^{2-}$  is?
  - a) +6
  - b) +5
  - c) +4
  - d) +3
  - e) -6
4. Which of the following is NOT a main group (representative) element?
  - a) Hydrogen
  - b) Krypton
  - c) Potassium
  - d) Beryllium
  - e) Chromium it is a transition element
5. Which statement is NOT consistent with Rutherford's nuclear theory as it was originally stated?
  - a) The volume of an atom is mostly empty space
  - b) The nucleus of the atom is small compared to the size of the atom
  - c) Nitrogen atom has seven protons in its nucleus and seven electrons outside of the nucleus
  - d) A lithium atom is electrically neutral
  - e) Neutral lithium atom contains more protons than neutrons
6. The ratio of the number of atoms in 2g hydrogen to 16g of oxygen is?
  - a) 1:8
  - b) 1:4
  - c) 1:2
  - d) 2:1
  - e) 1:1
7. The chemical formula of lead(II) hypochloride is?
  - a)  $\text{Pb}(\text{ClO}_3)_2$
  - b)  $\text{Pb}(\text{ClO})_2$
  - c)  $\text{Pb}(\text{ClO}_4)_2$
  - d)  $\text{Pb}(\text{ClO}_2)_2$
  - e)  $\text{PbCl}_2$
8. Which of the following is NOT an element?
  - a) Chromium
  - b) Ammonium it is a compound and not an element
  - c) Sodium
  - d) Vanadium
  - e) Aluminum
9. The reaction represented by  $2\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{MgO}_{(s)}$ 
  - a) Is a neutralization reaction
  - b) Is a displacement reaction
  - c) Is a redox reaction
  - d) Is a metathesis reaction
10. 23.0g of Sodium contains  $6.02 \times 10^{23}$  protons, how many protons are there in 32g of Sulphur?
  - a)  $6.58 \times 10^{23}$
  - b)  $6.02 \times 10^{24}$
  - c)  $6.15 \times 10^{23}$
  - d)  $0.6 \times 10^{24}$
  - e)  $6.432 \times 10^{23}$

$$32\text{g of S} \longrightarrow 6.02 \times 10^{23} \text{ protons}$$

$$3.5\text{g of S} \longrightarrow x = 6.02 \times 10^{23} \times \frac{3.5}{32} \text{ protons}$$

$$\text{Mg} - 2 = 0$$

$$\text{Mg} = +2$$

$$x = 6.58 \times 10^{22} \text{ protons}$$

ELITE MEDIA  
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..... is placed in a flask and allowed to come to equilibrium at a specified temperature according to the reaction  $\text{H}_2\text{N}(\text{g}) + \text{NH}_3(\text{g}) = 2\text{NH}_2(\text{g})$ , analysis of the equilibrium mixture shows it contains 3.00 atm  $\text{NH}_2$ , 3.00 atm  $\text{H}_2\text{N}$  and  $\text{NH}_3$ . The value of the equilibrium constant ( $K_p$ ) at constant pressure is?

- (a) 0.500 (b) 3.00 (c) 0.250 (d) 0.333 (e) 27.00

Overall step of a reaction mechanism is called the:

- (a) catalytic step (b) inhibitor step (c) elementary step (d) rate law step (e) rate determining step

When the volume of hexane left unreacted when 7 cm<sup>3</sup> of hexane is treated with 38 cm<sup>3</sup> of oxygen based on the reaction



- (a) 3 cm<sup>3</sup> (b) 5 cm<sup>3</sup> (c) 31 cm<sup>3</sup> (d) 31 cm<sup>3</sup> (e) 6 cm<sup>3</sup>

The density of mercury (līq, a liquid metal) at 25 °C is 13.534 g/cm<sup>3</sup>. How many moles are in 32.0 cm<sup>3</sup> of mercury?

- (a) 0.54 mol (b) 0.56 mol (c) 2.56 mol (d) 1.56 mol (e) 3.56 mol

Ratio of the number of atoms in 2 g of hydrogen molecule and 32 g of oxygen molecule is?

- (a) 1:8 (b) 1:4 (c) 1:2 (d) 2:1 (e) 1:1

How many moles of electrons are lost when lead (II) ion ionizes to lead (IV) ion?

- (a) 1.2 mol (b) 1 mol (c) 4 mol (d) 3 mol (e) 5 mol

Which of the following is NOT a redox reaction?

- (a)  $\text{Fe}_2\text{O}_3(\text{aq}) + 3\text{CO}(\text{g}) \longrightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$  (b)  $\text{PCl}_3(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \longrightarrow 3\text{HCl}(\text{aq}) + \text{H}_3\text{PO}_4(\text{aq})$   
 (c)  $\text{HgCl}_2 + 2\text{Na}(\text{aq}) \longrightarrow \text{Hg}(\text{s}) + \text{KCl}_2(\text{aq})$  (d)  $4\text{NH}_3(\text{g}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$   
 (e)  $\text{CaCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \longrightarrow \text{Ca}(\text{NO}_3)_2(\text{aq}) + \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

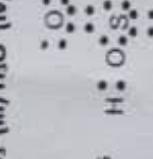
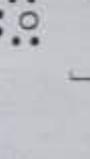
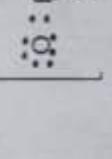
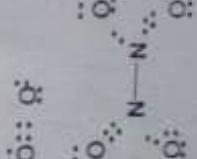
ANSWER ONLY 2 questions 10 MARKS FOR 25 MARKS

(a) When metal carbonates are heated, they decompose to give solid metal oxides and gaseous carbon dioxide. Write a balanced chemical equation to show what happens when solid magnesium carbonate is heated. (2 mks)

Solution

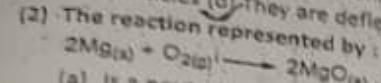


(ii) (i) Write Lewis Dot structures for (i)  $\text{H}_2\text{O}$ ; (ii)  $\text{BrO}_3$ ; (iii)  $\text{H}_3\text{O}^+$ ; (iv)  $\text{O}_2$ ; (v)  $\text{N}_2\text{O}_4$

- (i)  $\text{H}_2\text{O} = 1 \times 2 + 6 \times 1 + 6 \times 4 = 32$  valence electrons   
 Or 
- (ii)  $\text{BrO}_3 = 7 \times 1 + 6 \times 3 + 1 = 26$  valence electrons 
- (iii)  $\text{H}_3\text{O}^+ = 1 \times 3 + 6 \times 1 - 1 = 8$  valence electrons 
- (iv)  $\text{O}_2 = 6 \times 2 = 12$  valence electrons 
- (v)  $\text{N}_2\text{O}_4 = 5 \times 2 + 6 \times 4 = 34$  valence electrons 

(1) Which of the following is a property of cathode rays?

- (a) They travel in all directions (b) They flow from the anode to the cathode (c) They are uncharged particles (d) They are deflected by magnetic fields (e) none of the above



- (2) The reaction represented by:
- (a) Is a neutralization reaction (b) Is a displacement reaction (c) Is a redox reaction
  - (d) Is a metathesis reaction (e) Double decomposition

- (3) Which formula represents a peroxide?

- (a)  $\text{K}_2\text{O}$
- (b)  $\text{K}_2\text{O}_2$
- (c)  $\text{KO}_2$
- (d)  $\text{CaO}$
- (e)  $\text{Ca}_2\text{O}_2$

- (4) A sample of an ionic compound containing iron and chlorine is analysed and found to have a molar mass of 127 g/mol. The charge (combining power) of the iron in the compound is?  $\text{FeCl}_2 = 56 + 2(35.5) = 56 + 71 = 127$
- (a) +1
  - (b) +2
  - (c) +3
  - (d) +4
  - (e) +5

- (5) A silicon atom in its ground state orbital diagram has ..... Number of unpaired electron(s)

- (a) 1
- (b) 2
- (c) 3
- (d) 4
- (e) 5

- (6) The number of moles of methane ( $\text{CH}_4$ ) present in 6.07 g of methane is? Methane ( $\text{CH}_4$ ) =  $12 + 4(\text{C}) = 12 + 4 = 16$

- (a) 0.279 moles
- (b) 0.379 moles
- (c) 0.479 moles
- (d) 0.579 moles
- (e) 0.679 moles

- (7) Which is true of the  $^{243}\text{Am}^{3+}$  ion? If P = protons, E = Electrons, and N = neutrons

- (a) 95 P, 92 E, 243 N
- (b) 95 P, 98 E, 243 N
- (c) 95 P, 95 E, 148 N
- (d) 95 P, 92 E, 148 N
- (e) 92 P, 95 E, 148 N

- (8) Which of the following oxyanions is NOT correctly named? ~~no excitation state, the name will end with~~ ~~normal~~ ~~higher~~ ~~lowest~~

- (a)  $\text{ClO}_2^-$ , chlorate
- (b)  $\text{SeO}_4^{2-}$ , selenate
- (c)  $\text{IO}_4^-$ , periodate
- (d)  $\text{SO}_3^{2-}$ , sulphite
- (e)  $\text{IO}_3^-$ , iodate

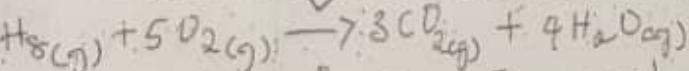
- (9) Which of the following is a chemical change?

- (a) Water vapour exhaled in your breath condenses in the air on a cold day
- (b) The melting of butter when placed under the sun
- (c) The evaporation of a solution of  $\text{NaCl}$  to dryness
- (d) The burning of lamp oil
- (e) Forming of dews on a cold night

- (10) How many moles of propane will be left unreacted when 20 moles of propane are treated with 30 moles of oxygen based on the reaction?



- (a) 20 moles
- (b) 10 moles
- (c) 14 moles
- (d) 30 moles



$$1 \text{ mol} : 5 \text{ mol} : 3 \text{ mol} : 4 \text{ mol}$$

$$30 \text{ mol} : 150 \text{ mol}$$

~~Cross multiply~~

$$x \text{ mol} = \frac{30}{150} \times 1 = 6 \text{ mol C}_3\text{H}_8$$

$$\$1$$

$$\begin{aligned} \text{C} &= 12, \text{H} = 1, \text{O} = 16, \text{N} = 14 \\ \text{Ar} &= 32, \text{Fe} = 56, \text{Cl} = 35.5, \text{F} = 19 \\ \text{Avogadro's number} &= 6.02 \times 10^{23} \\ \text{GMV} &= 22.4 \text{ dm}^3 \text{ at } \text{S.T.P} \end{aligned}$$

ELITE MEMBER  
Okwudili Emmanuel  
08164824019

Rivers State University, Nkpolu-Oroworukwo Port Harcourt,

Department of Chemistry

2019/2020 Academic Session, First Semester. (17/11/2020)

CHM 101 (General Chemistry 1) Examination. Time allowed: 1:45

Instruction: Answer all questions in Section A, 1 mark each,

Section B, Answer ONLY 2 questions, 15 marks for each question.

**SET A —— SCIENCE AND OTHERS**

Surname: **BULL** Other Names **OKPARA SERGEANT**

Matric. No: **COURSE COORDINATOR** Faculty/ Dept: **SCIENCE/CHEMISTRY**

Signature: \_\_\_\_\_ No. on attendance list: \_\_\_\_\_

**SECTION A**

(1) Which statement is true

- (a) An atom is smallest indivisible particle of an element
- (b) Ionic compounds are usually soluble in non-aqueous solvents,
- (c) The molecular formula of dinitrogenpentoxide is  $N_2O_5$
- (d) The mass number is always equal to the atomic number
- (e) All ionic compounds have at least one metal

(2) Magnesium nitride reacts with water to form ammonia and magnesium hydroxide, the chemical formulae that describe this statement is?

- (a)  $Mg(NO_3)_2$ ,  $NH_4^+$ , and  $Mg(OH)_2$
- (b)  $Mg_3N_2$ ,  $NH_3$ , and  $MgOH$
- (c)  $Mg(NO_3)_2$ ,  $NH_4^+$ , and  $Mg(OH)_2$
- (d)  $Mg_3(N)_2$ ,  $NH_3$ , and  $Mg(OH)_2$
- (e)  $Mg(NO_3)_2$ ,  $NH_4^+$ , and  $Mg(OH)_2$

(3) The most likely general formula for an alkaline earth metal hydride is? Where M = metal

- (a)  $M_2H$
- (b)  $MH_2$
- (c)  $M(OH)_2$
- (d)  $MOH$
- (e)  $MH$

(4) If 23.0 gram of sodium contains  $6.02 \times 10^{23}$  protons, how many protons are there in 3.5 g of sulphur?

- (a)  $6.58 \times 10^{22}$
- (b)  $6.02 \times 10^{23}$
- (c)  $6.85 \times 10^{23}$
- (d)  $5.06 \times 10^{23}$
- (e)  $6.02 \times 10^{22}$

(5) Which quantity must always be the same on both sides of a balanced ordinary chemical equation?

- (a) Number of molecules of each kind
- (b) Number of outermost Electrons
- (c) Atomic number and mass number
- (d) Number of moles of each kind of molecule
- (e) Number of atoms of each kind

(6) Which is a collection of ONLY covalent Compounds?

- (a)  $NO$ ,  $KOH$ ,  $PCl_3$ ,  $HBr$
- (b)  $SF_4$ ,  $NH_3$ ,  $MgO$ ,  $PCl_5$
- (c)  $H_2O$ ,  $CaO$ ,  $CO_2$ ,  $CO$
- (d)  $CS_2$ ,  $SF_4$ ,  $NO_2$ ,  $CCl_4$
- (e)  $CCl_4$ ,  $NaNO_3$ ,  $CS_2$ ,  $CuS$

(7) Which of the following is NOT an element

- (a) germanium
- (b) ammonium
- (c) scandium
- (d) vanadium
- (e) aluminium

(8) If the chemical formula of copper (II) sulphate is  $CuSO_4$ , the formula of copper (II) selenite is?

- (a)  $Cu_2SeO_4$
- (b)  $CuSeO_4$
- (c)  $Cu_2SeO_3$
- (d)  $CuSeO_2$
- (e) CuSeO<sub>3</sub>

(9) Which of these is NOT a quantum number used in describing an electron in an atom?

- (a) Principal quantum number
- (b) electronic quantum number
- (c) Magnetic quantum number
- (d) Spin quantum number
- (e) Subsidiary quantum number

(10) The oxidation number of the underlined elements in  $\underline{S}O_4^{2-}$ , and  $H_2\underline{O}_2$  are respectively

- (a) +6 and -2
- (b) +6 and +1
- (c) +4 and +2
- (d) +8 and -1
- (e) +6 and -1

(11) Which statement is consistent with Dalton's atomic theory as it was originally stated?

- (a) Phosphorus and Sulphur have the same atomic number
- (b) all gold atoms are identical
- (c) The formation of  $NaNO_3$  involves the combination of two elements
- (d) An oxygen atom combines with 1.5 hydrogen atoms to form water
- (e) Silver atom can be converted to gold

(12) The Neutron was discovered by?

- (a) R. Millikan
- (b) J. J. Thomson
- (c) E. Rutherford
- (c) J. Chadwick
- (d) J. Dalton
- (e) M. Faraday

(13) An element Y has two isotopes ( $^{20}X$  and  $^{22}X$ ), for which the isotopes are present in the ratio 3:1 respectively, this means that the relative atomic mass of Y is?

- (a) 20.5
- (b) 21.5
- (c) 22.0
- (d) 22.5
- (e) 21.0

(14) Which of the following types of electromagnetic radiation has the longest wavelength?

- (a) Infra-red
- (b) gamma rays
- (c) microwave
- (d) radio waves
- (e) ultraviolet

$_6C = 12$	$_1H = 1$	$_8O = 16$	$_15P = 31$	$_1S = 32$
$_35Se = 79$	$_35Br = 79.904$	$_80Hg = 200.6$	$_35Cl = 35.5$	
Avogadro's number = $6.02 \times 10^{23}$				
GMV = $22.4 \text{ dm}^3$ at s.t.p				
Speed of light = $3.00 \times 10^8 \text{ m/s}$				

SOLUTION TO CHS107  
PRACTICAL CHEMISTRY

SECTION A

1 D 2 A 3 + TRUE & B

NOTE:

- (i) Phenolphthalein - strong acid & strong base
- (ii) Methyl orange - strong acid and weak base
- (iii) NO suitable indicator - weak acid and weak base
- (iv) Phenolphthalein - weak acid and strong base

SECTION B

(6) Percentage Error

$$\frac{\text{Error} - \text{Actual}}{\text{Actual}} \times 100$$

where Error = 276;  
Actual = 250

$$\therefore \% \text{ Error} = \frac{276 - 250}{250} \times 100 = \frac{26}{250} \times 100 = \frac{52}{5} = 10\%$$

(7) Density =  $\frac{\text{mass}}{\text{volume}}$

where density of water =  $1g/ml$

Mass of water =

Weight of Cylinder &  $H_2O$

- Weight of empty cylinder

Where  
Weight of cylinder filled  
with water = 183g  
Weight of empty cylinder  
= 134g

$$\therefore \text{Mass of } H_2O = (183 - 134)g = 49g$$

$$\therefore 1g/ml = \frac{49g}{x}. \text{ Find } x[\text{volume}]$$

$$\therefore x = 49g \times \frac{1ml}{g} = 49ml$$

$$(8) \text{ Mean}(X) = \frac{\sum fx}{\sum f} = \frac{\sum x}{n}$$

$$\frac{78+64+68+74}{4} = \frac{284}{4} = 71$$

(9) To convert 67cm to meter;

$$67\text{cm} \times \frac{1m}{100\text{cm}} = 0.67m$$

(10) Density of the gravel (P)

=  $\frac{\text{Mass}}{\text{Volume}}$  Let's solve for  
the mass & volume  
of the gravel

\* The mass of the gravel

$$\text{vol. of } H_2O = 50ml$$

Weight of  $H_2O$  and cylinder

$$= 165g$$

Weight of cylinder +  $H_2O$  +

gravel = 175g

New vol. ( $H_2O + \text{gravel}$ )

$$= 54ml$$

$\therefore$  vol. of gravel

$$= \text{vol of } H_2O + \text{gravel} - \text{vol of } H_2O$$

$$\text{vol of gravel } (54 - 50)g$$

$$= 4ml$$

$eC = 12, eHe = 1, eO = 16, eNa = 11, eFe = 56, eSi = 14$   
Avogadro's number =  $6.02 \times 10^{23}$   
GMV =  $22.4 \text{ dm}^3 \text{ at } 1.0 \text{ bar}$

E:

C NO:

Signature:

SECTION A

(1) Which of the following is (are) elements?

- (i) CO (ii) co (iii) C (iv) Cl<sub>2</sub> (v) CO<sub>2</sub>  
(a) i, iii & v (b) ii, iii & iv (c) i & v (d) ii & iii (e) i, iii, & iv

(2) Which statement is NOT consistent with Rutherford's nuclear theory as it was originally stated?

- (a) The volume of an atom is mostly empty space  
(b) The nucleus of an atom is small compared to the size of the atom  
(c) Nitrogen atom has seven protons in its nucleus and seven electrons outside of the nucleus  
(d) A lithium atom is electrically neutral  
(e) Neutral lithium atom contains more protons than electrons

(3) Which of the following is NOT a main Group (representative) element?

- (a) Hydrogen (b) krypton (c) potassium (d) beryllium (e) chromium

A sample of an ionic compound containing iron and chlorine is analysed and found to have a molar mass of 127 g/mol. The Charge (combining power) of the iron in the compound is?

- (a) +1 (b) +2 (c) +3 (d) +4 (e) +5

(5) In an oxygen atom, the number of unpaired electron(s) in its ground state is?

- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5

$O - 2 \quad 4$   
 $1s^2 \quad 2s^2 \quad 2p^2$

$1L = 1dm^3 \quad 1mol = 1dm^3$

(6) The amount (n) of ammonia (NH<sub>3</sub>) present in 4.60 L, 2.30 M of ammonia is?  $0.006 \text{ mol} / (\text{dm}^3) = \text{mole} = \frac{\text{litre}}{\text{dm}^3} \times \text{Molarity}$

- (a) 8.58 moles (b) 7.58 moles (c) 0.5 moles (d) 2 moles (e) none of the above

(7) Among the elements, B, Ca, F, He, Al and P, which two elements exhibit the greatest similarity in chemical properties?

- (a) B & Ca (b) Ca & Al (c) B & Al (d) I<sup>-</sup> & P (e) He & F

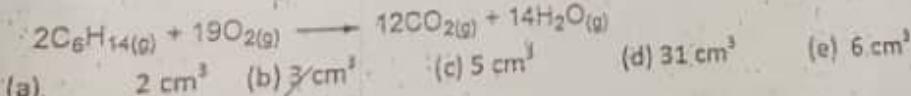
(8) Which of the following is NOT a known diagonal relationship associated with elements in the Periodic Table?

- (a) Li → Mg (b) Cu → Au (c) Be → Al (d) B → Si (e) None  
~~Li → Be → B → Si~~  
~~Cu → Au~~  
~~Be → Al~~  
~~B → Si~~  
~~Li → Cu → B → Si~~

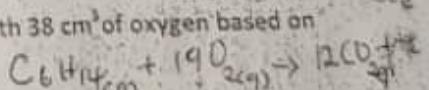
(9) According to ..... no two electrons in the same atom have identical sets of all four quantum numbers

- (a) J. J. Thompson (b) Pauli's exclusion principle (c) Heisenberg's uncertainty principle (d) Aufbau principle (e) Hund's rule

(10) What is the volume of hexane left unreacted when 7 cm<sup>3</sup> of hexane is treated with 38 cm<sup>3</sup> of oxygen based on the reaction:



- (a) 2 cm<sup>3</sup> (b) 3 cm<sup>3</sup> (c) 5 cm<sup>3</sup> (d) 31 cm<sup>3</sup> (e) 6 cm<sup>3</sup>



$$2\text{mol} \quad 19\text{mol} \quad 12\text{mol} \quad 14\text{mol}$$

$$2\text{Vol} \quad 19\text{Vol} \quad 12\text{Vol} \quad 14\text{Vol}$$

$$X\text{Vol} \quad 3\text{Vol}$$

$$X\text{Vol} = \frac{2 \times 3\text{Vol}}{19\text{Vol}} = \frac{6\text{Vol}}{19\text{Vol}} = \frac{6}{19} \text{ Vol}$$

$$7 - 4 = 3$$

Page 1 of 2

$\begin{matrix} 2 & 2 \\ 1s & 2s & 2p & 3s & 3p & 4s \end{matrix}$

2cm<sup>3</sup>  
2 mol =

ELITE MEDIA

## SECTION B

1.

## Group 6

(a) If Sulphur and selenium are on the same group on the Periodic Table, if the chemical formula of the sulphate ion is  $\text{SO}_4^{2-}$ , then what is the formula of the selenite ion?  $\text{SeO}_3^{2-} - \text{Se}^{4+}\text{O}_4^{2-}$

(ii) Write orbital diagram for sulphur

(iii) Determine the number of paired electron(s) in sulphur

(b) Define the following: 7 paired shell electrons

(i) An Atom:

(ii) A molecule

is the smallest group of atoms that can maintain its chemical properties

Xylene is an organic compound that is a major component of many gasoline blends, and is made up of only carbon and hydrogen atoms. A complete combustion of 17.12 mg sample of xylene, gave 56.77 mg of  $\text{CO}_2$  and 14.53 mg of  $\text{H}_2\text{O}$ .

(i) Determine the empirical formula of xylene.  $1000 \text{ mg} = 1 \text{ g}$

$$56.77 \text{ mg } \text{CO}_2 = \frac{56.77}{1000} = 0.05677 \text{ g } \text{CO}_2 \quad \text{Amount of hydrogen in } \text{H}_2\text{O} = \frac{2}{18} \text{ g}$$

$$14.53 \text{ mg } \text{H}_2\text{O} = \frac{14.53}{1000} = 0.01453 \text{ g } \text{H}_2\text{O}$$

$$\text{Mr of } \text{CO}_2 = 12 + 2(16) = 44 \text{ g/mol } \text{CO}_2 \quad C : H = 0.05677$$

$$\text{Mr of } \text{H}_2\text{O} = 1 + 2(16) = 18 \text{ g/mol } \text{H}_2\text{O} \quad \frac{0.01453}{18 \text{ mol}} : \frac{0.01629}{1 \text{ g/mol}}$$

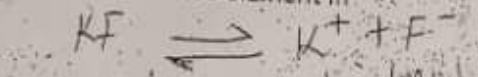
$$\text{Amount of C in } \text{CO}_2 = \frac{12}{44} \times 0.05677 \quad \text{binded by the smallest mole}$$

$$= 0.0155 \text{ g } \text{C}_2 \quad \frac{0.00129}{0.00129} : \frac{0.01629}{0.01629}$$

$$= C_1 H_{12.5} \approx \text{CH}_3$$

(b) The number of atoms of each underlined element in

(i) 0.52 moles of KF

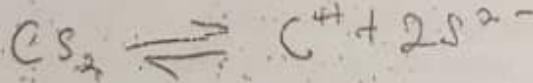


$$1 \text{ mol} \quad 1 \text{ mol} \quad 1 \text{ mol}$$

$$0.52 \text{ mol} : 0.52 \text{ mol} : 0.52 \text{ mol}$$

$$\therefore \text{KF} = 0.52 \times 6.02 \times 10^{23}$$

(ii) 12.8 moles of  $\text{CS}_2$



$$1 \text{ mol} \quad 1 \text{ mol} : 2 \text{ mol}$$

$$12.8 \text{ mol} : 12.8 \text{ mol} : 2(12.8 \text{ mol})$$

$$2\text{S}^{2-} = 2(12.8 \text{ mol}) \times 6.02 \times 10^{23}$$

**ELITE MEDIA**

is formed when hydrogen gas reacts with nitrogen gas. If equal number of moles of nitrogen and hydrogen are combined, the maximum number of moles of ammonia that could be formed will be equal to:  
 (a) twice the number of moles of nitrogen (b) twice the number of moles of hydrogen (c) twice the number of moles of nitrogen and twice the number of moles of hydrogen (d) the number of moles of hydrogen  
 (e) the number of moles of hydrogen

number of electrons in the ground state of a  $^{63}\text{Cu}$  atom with quantum number  $n = 3, l = 2$  is?

- (a) 18 (b) 2 (c) 2 (d) 6 (e) 8

The mineral chromite ( $\text{FeCr}_2\text{O}_4$ ) is a mixture of only iron (II) oxide ( $\text{FeO}$ ) and chromium (III) oxide ( $\text{Cr}_2\text{O}_3$ ). This implies that the most likely ratio of iron (II) oxide, and chromium (III) oxide in chromite is?

- (a) 2:1 (b) 2:3 (c) 1:2 (d) 1:1 (e) none of the above

Bromine has just two isotopes ( $^{75}\text{Br}$  and  $^{77}\text{Br}$ ) given it an atomic number mass 79.904 amu. Based on this piece of information, the statement that can explain the atomic mass value of bromine is?

- (a)  $^{75}\text{Br}$  is about twice as abundant than  $^{77}\text{Br}$  (b) the two isotopes have 45 and 46 neutrons (c)  $^{75}\text{Br}$  is more abundant than  $^{77}\text{Br}$  (d) the isotope,  $^{75}\text{Br}$ , is more common than  $^{77}\text{Br}$   
(e)  $^{75}\text{Br}$  and  $^{77}\text{Br}$  exist in about the same equal proportion

Which formula represents a peroxide?

- (a)  $\text{Na}_2\text{O}_2$  (b)  $\text{LiOH}$  (c)  $\text{Na}_2\text{O}_2$  (d)  $\text{K}_2\text{O}$  (e)  $\text{Ca}_2\text{O}_2$

The empirical formula of pyrogallol is  $\text{C}_2\text{H}_2\text{O}$  and its molar mass is 126. This implies that the molecular formula of pyrogallol is? (a)  $\text{C}_6\text{H}_6\text{O}_2$  (b)  $\text{C}_4\text{H}_4\text{O}_2$  (c)  $\text{C}_8\text{H}_8\text{O}_4$  (d)  $\text{C}_6\text{H}_6\text{O}_3$  (e)  $\text{C}_2\text{H}_2\text{O}_6$

The wavelength (nm) of the red light emitted by barcode scanner which possess a frequency of  $4.62 \times 10^{14} \text{ s}^{-1}$  is?

- (a) 0.401 nm (b) 64.9 nm (c) 0.649 nm (d) 649 nm (e) 500 nm

Given that the ground state electron configuration of: X =  $1s^2s^22p^3$ , and that of Y =  $1s^22s^1$ , the formulae of the compound most likely formed by X and Y is?

- (a)  $\text{Y}_3$  (b)  $\text{Y}_2\text{X}$  (c)  $\text{YX}_3$  (d)  $\text{Y}_2\text{X}$  (e)  $\text{Y}_5\text{X}_3$

The wavelength of electromagnetic radiation is longer when:

- (a) its energy and frequency are small (b) its energy is large and its amplitude is high (c) its energy is small and its frequency is large (d) its energy is high and its frequency is small (e) its energy is large & its frequency is large

Which list of elements is arranged in order of increasing atomic size?

- (a) Ba, Sr, Ca, Mg, Be (b) Ba, Sr, Ca, Be, Mg (c) Ba, Sr, Be, Mg, Ca (d) Be, Mg, Ca, Ba, Sr (e) Be, Mg, Ca, Sr, Ba

Which atom in the ground state is paramagnetic (hint, paramagnetic refers to atoms which have one or more unpaired electrons): (a)  $^{20}\text{Ca}$  (b)  $^{12}\text{Mg}$  (c)  $^2\text{He}$  (d)  $^{14}\text{Si}$  (e)  $^{10}\text{Ne}$

Which is NOT true about non-metals?

- (a) Most tend to lose electron(s) readily (b) many are gases at room temperature (c) They are poor conductors of heat (d) most of their oxides are acidic (e) they are poor conductors of electricity

Which pair of atoms will likely form the most polar bond?

- (a) S and N (b) C and O (c) F and B (d) F and O (e) N and F

Which pair of ions will form the ionic lattice with the highest energy?

- (a)  $\text{Na}^+$  and  $\text{Br}^-$  (b)  $\text{Cs}^+$  and  $\text{F}^-$  (c)  $\text{K}^+$  and  $\text{F}^-$  (d)  $\text{Li}^+$  and  $\text{O}^{2-}$  (e)  $\text{Li}^+$  and F

Which of the following factors does NOT affect equilibrium?

- (a) Changes in concentration (b) Changes in amount of catalyst (c) Changes in volume  
 (d) Changes in temperature (e) Changes in pressure

How are the bonding pairs arranged in the best Lewis structure for carbon dioxide ( $\text{CO}_2$ )?

- (a)  $\text{O}=\text{C}=\text{O}$  (b)  $\text{O}=\text{C}-\text{O}$  (c)  $\text{C}=\text{O}=\text{O}$  (d)  $\text{O}-\text{C}-\text{O}$  (e)  $\text{C}-\text{O}-\text{O}$

The Lewis Structure  $\text{H}_2\text{O}$  has a total of

- (a) 2 bonding pairs and zero nonbonding pair (b) 1 bonding pair and 2 nonbonding pair (c) 3 bonding pairs and 2 nonbonding pairs (d) 2 bonding pairs and 1 nonbonding pair (e) 2 bonding pairs and 2 nonbonding pairs

$\text{SO}_4^{2-}$  is called the sulphate ion, while  $\text{S}^{2-}$  is the sulphide ion. Based on the differences in oxidation number of sulphur in  $\text{SO}_4^{2-}$  and  $\text{S}^{2-}$ , number of electron(s) needed to convert one sulphate ion into one sulphide ion is?

- (a) 1 (b) 6 (c) 8 (d) 4 (e) 2

$\text{NH}_3(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_2(\text{g}) \Delta H = -92.2 \text{ kJ}$ , the number of moles  $\text{H}_2(\text{g})$  are decreased by:

- (a) Adding  $\text{NH}_3$  (b) Increase in pressure (c) Removing  $\text{N}_2$  (d) Increasing temperature (e) adding catalyst

- (ii) In each (b) above, (i-v), determine the number of bonding and nonbonding pairs of electron(s)
- Solution:**

Bonding pairs are electron pair(s) involved in actual bonding in a given molecule, whereas non-bonding pairs are the electron pair(s) in the molecule that are alone (i.e. not involved in bonding). Thus from the Lewis dot structures above, we therefore have:

$$\text{TOTAL} = 15 \text{ PAIRS}$$

Molecules	Bonding pairs	Non-bonding pairs
(i) $\text{H}_2\text{SO}_4$	8	8
(ii) $\text{BrO}_3$	3	10
(iii) $\text{H}_2\text{O}^-$	3	1
(iv) $\text{O}_2$	2	4
(v) $\text{N}_2\text{O}_4$	7	10

2. Two stable isotopes of chlorine are  $^{35}\text{Cl}$  and  $^{37}\text{Cl}$  with masses of 34.969 amu, and 36.966 amu respectively. If the relative atomic mass of chlorine in the Periodic Table is 35.4527 amu.

- (a) What is the % abundance of each isotope?

**Solution:**

Let  $x$  = % abundance of  $^{35}\text{Cl}$  (1 MIC)  
 and  $y$  = % abundance of  $^{37}\text{Cl}$  (1 MIC)  
 $x + y = 1$  .....(1) (1 MIC)  
 $34.969x + 36.966y = 35.4527$  .....(2) (1 MIC)  
 From equation 1,  $x = (1-y)$  (1 MIC).  
 Substituting the value of  $x$  into equation 2, gives  
 $34.969(1-y) + 36.966y = 35.4527$  (1 MIC)  
 $34.969 - 34.969y + 36.966y = 35.4527$  (1 MIC)  
 $2.027y = 35.4527 - 34.969$  (1 MIC)  
 $2.027y = 0.4837$  (1 MIC)  
 $y = 0.4837/2.027 = 0.2386 = 23.86\%$ ,  
 therefore  $^{37}\text{Cl}$  % abundance = 23.86% (1 MIC)  
 $x = 1 - 0.2386 = 0.7614 = 76.14\%$ ,  
 and  $^{35}\text{Cl}$  = 76.14% abundance (1 MIC)

OR

The sum of the fraction abundance of the two isotopes = 1, and let  $^{35}\text{Cl} = y$  (1 MIC)  
 therefore  $^{37}\text{Cl} = 1-y$  (1 MIC)  
 Atomic mass = Mass of isotope 1 x fraction abundance of 1 + Mass of isotope 2 x fraction abundance of 2 (1 MIC)  
 $35.4527 = 34.969y + 36.966(1-y)$  (1 MIC)  
 $35.4527 = 34.969y + 36.966 - 36.966y$  (1 MIC)  
 $36.966y - 34.969y = 36.966 - 35.4527$  (1 MIC)  
 $2.027y = 1.5433$  (1 MIC)  
 $y = 0.7614 = 76.14\%$  (1 MIC)  
 $^{35}\text{Cl}$  % abundance = 76.14% (1 MIC)  
 $^{37}\text{Cl} = 1 - 0.7614 = 0.2386$  (1 MIC)  
 $^{37}\text{Cl}$  % abundance = 23.86% (1 MIC)

- (b) (i) One of the active ingredients in disinfectants is  $\text{ClO}^-$ , what is its common name? (1 marks)

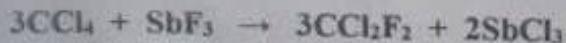
Hypochlorite (1 MIC)

- (ii) Give the common names of  $\text{NO}_2$  Nitrite and  $\text{H}_2\text{PO}_4^-$  Dihydrogen phosphate (1 mark each)

(1 MIC)

$$\text{TOTAL} = 15 \text{ MICS}$$

- (13) 3 (a) Freon-12, ( $3\text{CCl}_2\text{F}_2$ ) is a gas used as a refrigerant, and its preparation is carried out in accordance with the reaction scheme:



If 1.05 kg of Freon-12 (98% pure) is obtained for every 1.68 kg of  $\text{CCl}_4$  used. Calculate

- (i) The theoretical yield

- (ii) The actual yield

- (iii) Percentage yield

(a) If Sulphur and Selenium are on the same group on the Periodic Table, if the chemical formula of the sulphite is  $\text{SO}_3^{2-}$ , then what is the formula of the selenite ion?  $\text{SeO}_4^{2-}$

(ii) write orbital diagram for sulphur  $S^{+}$

10) Determine the number of paired electron(s) in sulphur.

(b) Define the following:

(b) Define the following:  
i) An Atom: is defined as the smallest particle of an element that can take part in a chemical reaction.

(ii) Atom: Is the smallest part of an element that can stand alone and still retain all the properties of the elements.

Xylene is an organic compound that is a major component of many gasoline blends, and is made up of only carbon and hydrogen atoms. A complete combustion of 17.12 mg sample of xylene, gave 56.77 mg of  $\text{CO}_2$ , and 14.53 mg of  $\text{H}_2\text{O}$ .

(ii) Determine the empirical formula of xylene.

$$\text{Molar mass of } \text{CO}_2 = \frac{56.07 \text{ g}}{1000} = 0.056077 \text{ g}$$

$$m_{CO_2} + C_{in CO_2} = \frac{1000}{44} \times 0.0569772$$

$$\text{Mass of H}_2\text{O} = \frac{14.5 \text{ g}}{1000} = 0.0145 \text{ g}$$

$$\text{mass of H}_2 \text{ in H}_2\text{O} = \frac{2}{18} \times 0.014532 \\ = 0.007614444444444444 \text{ g}$$

$$\begin{array}{r}
 \begin{array}{c} C \\ \hline 0.001548272 \\ \times 12 \\ \hline 0.001290226 \end{array}
 \end{array}
 \quad
 \begin{array}{r}
 \begin{array}{c} H \\ \hline 0.0016144444 \\ \times 1 \\ \hline 0.0016144444 \end{array}
 \end{array}$$

Empirical formula = C<sub>4</sub>H<sub>10</sub>

The number of atoms of each underlined element is

$$0.52 \text{ moles of } KF \rightarrow K^+ + F^-$$

mole ratio: 1 mole : 1 mole : 1 mole

$$0.52 \text{ m}^2 \text{ Pa} = 0.52 \text{ m}^2 \text{ Pa} \times 10^6 \frac{\text{N}}{\text{m}^2} = 0.52 \text{ m}^2 \text{ N/m} = 0.52 \text{ kN/m}$$

$$\text{iii) 12.8 moles of } \text{CS}_2 \rightarrow \text{CS}_2 \rightarrow \text{C}_{\text{out}}^{+} \text{ and } \text{S}_{\text{out}}^{2-}$$

more than 1mW : 1mW, 2mW

12-8m | ~~50~~

$$JC = \frac{12.8 \text{ miles} \times 2 \text{ minutes}}{1 \text{ minute}} = 25.6 \text{ miles}$$

$$\begin{aligned} & \text{width } x \text{ dm} \\ & \text{Major one } x 16.1 \text{ m} \\ & = 4.64 \times 2.5 \text{ m} \\ & = 10.58 \text{ m} \end{aligned}$$

(i) The package of a fluorescent bulb for table lamp list output in terms of lumen, lm. Which of the seven SI unit would you expect to be part of the definition of a lumen? Justify your line of reasoning. *Solution* The lumen (lm) is the international unit of luminous flux. It is defined in terms of candela steradians (i.e Cd multiplied by Sr) one lumen is the amount of light emitted in a solid angle of 1 Sr, from a source that radiates to an equal extent in all directions and whose intensity is 1 Cd. Thus the answer is candela (Cd). *1M1*

(ii) A particular atom of chromium has a mass of 52.94 amu, whereas the atomic mass of chromium is given as 51.99 amu. Explain the difference in the two masses: *1M1*

Any single atom of chromium must be one of the isotopes of that element. The isotope mentioned has a mass of 52.94 amu (g/mol) and is probably  $^{53}\text{Cr}$ . The atomic mass of differs from the mass of any particular atom because it is the average atomic mass of the naturally occurring isotopes of chromium. *1M1*

(iii) When Na and S undergo combination reaction, what is the chemical formula of the product? Justify. *The chemical formula of the product formed is  $\text{Na}_2\text{S}$ . It is an ionic compound, sodium is a group 1 metal and thus  $\text{Na}^+$ , while sulphur is a group (6) or 16 non-metal ( $\text{S}^{2-}$ ). The product is a transfer of valence electron by Na and gain of electron by S.* *1M1*

3 (B) An unscrupulous student plans to steal a gold sphere with a radius of 28.9 cm from RSU Chemistry Department Laboratory. If the gold has a density of  $19.3 \text{ g/cm}^3$ .

(i) What is the mass of sphere in pound:

Solution

Density = mass/volume, but volume of a sphere is  $4/3\pi r^3$ ,

$r = 28.9 \text{ cm}$ , therefore the volume of the spherical gold =  $4/3 \times 3.143 \times (28.9 \text{ cm})^3 =$   
therefore mass of the gold sphere = Density of gold  $\times$  volume of the gold sphere =  $19.3 \text{ g/cm}^3 \times 101,152.5058 \text{ cm}^3$

Mass of the gold sphere = 1952, 243.3619 g *1M1*

Recall, 1 pound = 453.59237 g

Therefore,  $1952,243.3619 \text{ g} = \frac{1,952,243.3619 \text{ g}}{453.59237 \text{ g}} \times 1 \text{ pound} = 4,304.95988 \text{ pound}$  *1M1*

(ii) Is the unscrupulous student likely to be able to walk off the laboratory with the gold unassisted?

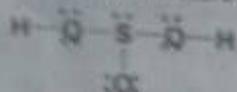
Explain your line of reasoning (Hint: Volume of a sphere =  $4/3 \times 3.143 \times r^3$ , 1 pound (lb) = 453.59237 g)

*The unscrupulous student is NOT likely to walk off the laboratory with the gold unassisted. The mass of the gold sphere is imagine a bag of cement which weigh 50 kg. The sphere can be said to weigh about 39 times a bag of cement.* *1M1*

TOTAL = 10 MKS

- (143) A glass cylinder contains 4 liquids layers: mercury ( $d = 13.6 \text{ g/mL}$ ), chloroform ( $d = 1.49 \text{ g/mL}$ ),  $\text{H}_2\text{O}$  ( $d = 1.00 \text{ g/mL}$ ), ether ( $d = 0.708 \text{ g/mL}$ ). If a cork stopper ( $d = 0.50 \text{ g/mL}$ ) is put into the cylinder, where does it come to rest? \* on top of the  $\text{H}_2\text{O}$ \* "On the bottom of the cylinder" \*On top of the mercury\* \*On top of the ether\* \*On top of the chloroform\*

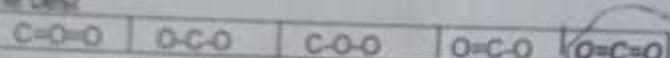
- (144) In the Lewis structure for Sulphuric acid shown below, the formal charge for on sulphur is?



+2	+1	0	-1	-2
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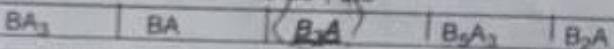
- (145) Which element below is most unlikely to form compounds with more than eight valence electrons  
 sulphur      carbon      silicon      xenon      bromine

- (146) How are the bonding pairs arranged in the best Lewis structure for carbon dioxide ( $\text{CO}_2$ )?



- (147) Which pair of ions will form the ionic lattice with the highest energy  $\text{Li}^+ & \text{F}^-$   $\text{Na}^+ & \text{Br}^-$   $\text{Li}^+ & \text{O}^{2-}$   $\text{K}^+ & \text{F}^-$   $\text{Cs}^+ & \text{F}^-$

- (148) Given that the ground state electron configuration of A =  $1s^2 2s^2 2p^3$ , and that of B =  $1s^2 2s^2$ , the formulae of the compound most likely formed by X and Y is?



- (149) The Neutron was discovered by? J. Chadwick J. J. Thomson R. Millikan E. Rutherford J. Dalton

- (150) Which of these is NOT a quantum number used in describing an electron in an atom?  
 Principal quantum number   Spin quantum number   Subsidiary quantum number (electronic quantum number) All

TOTAL = 50 MKs

SECTION B: Attempt ONLY 2 Questions

- 1 (A) (i) Define the terms limiting reactant: This is (or limiting reagent) is the reactant present in the smallest stoichiometric quantity in a mixture of reactants; It limits the extent of the reaction by its complete consumption and thereby determines the amount of product that can be formed. 1 MK

- Excess reactant: This is (or excess reagent) is the portion of all the other reactant(s) leftover after the stoichiometric reaction has come to a stop, as a result of the complete consumption of the limiting reactant. 1 MK

- (ii) which has more mass, a mole of water ( $\text{H}_2\text{O}$ ) or a mole of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ )? A mole of glucose has more mass. By inspecting their molecular formulae, We can find that in glucose there are more atoms of hydrogen, and oxygen than there are in water. Furthermore, in a mole of glucose contains 6 carbon atoms whereas in water there is none. Thus, a mole of glucose has a greater mass than a mole of water. 1 MK

- (iii) Which contains more molecules, a mole of water or a mole of glucose? They both contain the same number of molecules: this is because a mole each substance contains  $6.02 \times 10^{23}$  molecules. 1 MK

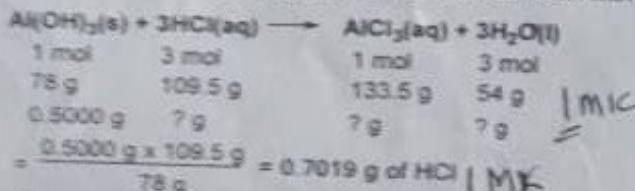
- 1 (B) Several brands of antacids use  $\text{Al(OH)}_3$  to react with stomach acid, which contains primarily HCl:



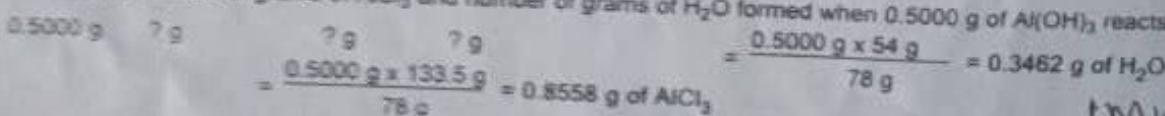
- (a) Balance the above equation



- (b) Calculate the number of grams of HCl that can react with 0.5000 g of  $\text{Al(OH)}_3$



- (c) Calculate the number of grams of  $\text{AlCl}_3$  and number of grams of  $\text{H}_2\text{O}$  formed when 0.5000 g of  $\text{Al(OH)}_3$  reacts



Signature of student

Other Name \_\_\_\_\_

TOTAL = 10 MKs

DEPARTMENT OF CHEMISTRY  
 1<sup>ST</sup> SEMESTER 2016/2017 SESSION EXAMINATION/EXTRA LIKELY  
 QUESTIONS

ELITE MEDIA

COURSE: CHS 101 GENERAL CHEMISTRY 1 TIME: 1:30mins

INSTRUCTION: ANSWER ALL QUESTIONS ( EXAMS & TESTS QUESTIONS  
 SECTION A: 2016/2017 - 2019 SESSION )

1. A local radio in RSUST broadcast a frequency of 193.7MHz. Calculate the wave length of the radio wave in meters and the energy of wave (speed of wave =  $3.00 \times 10^8$ m/s and  $h = 6.63 \times 10^{-34}$

- A. Draw the table and give the number of protons neutrons, electrons in the following species.

Atom	Proton No.	Neutron No.	Electron No.
$^{15}_{7}\text{N}$			
$^{235}_{92}\text{U}$			
$^{202}_{80}\text{Hg}$			

- B. i Write electronic configuration and Lewis dot structure for  
 (a).  $\text{N}^3-$       (b) F

- ii. Give the name of the following isotopes

- (a)  $^{1}_1\text{H}$     (b)  $^{2}_1\text{H}$     (c)  $^{3}_1\text{H}$     (d)  $^{224}_{88}\text{Ra}$

- 3(a) How many grams of zinc iodide ( $\text{ZnI}_2$ ) are in 0.0654mol of  $\text{ZnI}_2$  ( $Z = 65$  and  $I = 127$ )

- (b)i In the periodic table, describe how electron affinity and ionization energy

- ii. Vary across the second period

- iii. Vary down the group 1A elements

- iv Using orbital box diagram write the electronic configuration of each of the following elements (a) Sodium and (b) Boron

- (C) Define the following:

FIRST CLASS IS POSSIBLE !!!

Q. 2  
1) Sulphur and selenium are in the same group of the Periodic Table. If the chemical formula of the sulphate ion is  $\text{SO}_4^{2-}$ , then, what is the formula of the selenate ion?  
Define:

(i) Homogeneous mixture:

(ii) A reaction stoichiometry: It is a relationship between the amount of reactant and product in a chemical reaction - thereby reactants and products are balanced.

(iii) Molar Mass of a substance:

Stoichiometry is a chemical equation.  
It is expressed in g/mol + it is the sum of relative atomic mass in a chemical reaction is expressed in g/mol!

2. The combustion of a 34.8 mg sample of benzaldehyde, which contains only carbon, hydrogen, and oxygen, produced 20.2 mg of  $\text{CO}_2$  and 17.7 mg of  $\text{H}_2\text{O}$ .

(a) What were the masses of carbon, and hydrogen in the sample?

$$\text{Mass of O} = \text{Total sample mass} - (\text{mass of C} + \text{mass of H})$$

$$0.0348 - (0.02895)$$

(b) What was the mass of oxygen in the sample?

(c) What is the percentage by mass of oxygen in the sample?

(d) What is the empirical formula of the benzaldehyde?  $\text{C}_7\text{H}_6\text{O}$  (molecular formula =  $n(\text{C}_7\text{H}_6\text{O})$ )

$$n = 1$$

(e) Benzaldehyde has a molar mass of 106 g/mol. what is the molecular formula?

$$\text{Molecular formula} = n(\text{C}_7\text{H}_6\text{O})$$

$$(106)$$

$$n = 1$$

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11. Which of the following is NOT an element?

- a) Chromium b) Ammonium c) Sodium d) Vanadium e) Aluminum

12. What is the name of this process? ~~which process?~~

- a) Sublimation b) Condensation c) Decomposition d) Evaporation e) Melting

13. Two moles of glycine ( $\text{H}_2\text{NCH}_2\text{COOH}$ ) contains:

$$\begin{cases} 1 \text{ mole} \rightarrow 3.0 \text{ g of O} \\ 2 \text{ mole} \rightarrow 6 \text{ g} \end{cases} \quad 6 \text{ g} + 3.0 \times 2 = 6.0 \text{ g of O}$$

$$= 20.0 \text{ g of H}_2\text{O}$$

$$= 20.0 \text{ g of O} / 6.02 \times 10^{23} \text{ atoms of H}_2\text{O}$$

$$= 3.33 \times 10^{22} \text{ atoms of H}_2\text{O}$$

14. Which of the following is NOT a main group (representative) element?

- a) Hydrogen b) Krypton c) Potassium d) Beryllium e) Chromium

15. The amount (n) of ammonia ( $\text{NH}_3$ ) present in 4.80L, 2.30M of ammonia is:

- a) 8.56 moles b) 7.58 moles c) 0.5 moles d) 2 moles e) none of the above

16. The reaction represented by  $2\text{Mg}_{(\text{s})} + \text{O}_{2(\text{g})} \rightarrow 2\text{MgO}_{(\text{s})}$

- a) Is a redox reaction b) Is a displacement reaction c) Is a neutralization reaction d) Is a metathesis reaction e) Is a double decomposition

17. The electron was discovered by?

- a) R. Millikan b) J.J. Thompson c) E. Rutherford d) J. Chadwick e) J. Dalton

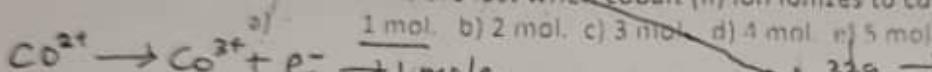
18. A sample of an ionic compound containing iron and chlorine is analyzed and found to have a molar mass of 127 g/mol. The charge (combining power) of the iron in the compound is?

$$\begin{array}{lllll} \text{a)} & +1 & \text{b)} & +2 & \text{c)} & +3 & \text{d)} & +4 & \text{e)} & +5 \end{array} \quad (\text{FeCl}_2)_n = 127 \rightarrow (56+7)n = 127$$

19. If 23.0g of Sodium contains  $6.02 \times 10^{23}$  protons, how many protons are there in 3.5g of Sulphur?

- a)  $5.85 \times 10^{23}$  b)  $6.02 \times 10^{23}$  c)  $6.58 \times 10^{23}$  d)  $6.02 \times 10^{22}$  e)  $5.06 \times 10^{23}$

20. How many moles of electrons are lost when cobalt (II) ion ionizes to cobalt (III) ion?



$$\begin{aligned} 32.9 &\rightarrow 6.02 \times 10^{23} \\ 3.59 &\rightarrow x = \frac{6.02 \times 10^{23}}{32.9} \times 3.5 = 6.56 \text{ moles} \end{aligned}$$

### SECTION B (ANSWER TWO QUESTIONS ONLY)

1.

- a) List any three visual changes that may happen to indicate that a chemical reaction has taken place.

i. color change

ii. Formation of a precipitate

iii. Formation of gas

iv. odour change

v. temperature change

b) The empirical formula of garnet (a gemstone) is  $\text{Fe}_2\text{Al}_2\text{Si}_3\text{O}_{12}$ . Calculate the percentage by mass of silicon in garnet?

$$\text{Fe}_2 = 56 \times 2 = 112, \text{Al}_2 = 27 \times 2 = 54, 29 \times 3 = 87; \text{Si} = 28, \text{O} = 16 \times 12 = 192$$

$$\text{Fe}_2\text{Al}_2\text{Si}_3\text{O}_{12} = 445 \text{ g/mol}$$

$$\% \text{ by mass of Si} = \frac{87}{445} \times 100\% = \underline{\underline{19.55\%}}$$

c) Calculate the % composition of the mass of the elements present in sugarcane,  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ , = 342 g/mol.

$$\text{C}_{12} = 12 \times 12 = 144, \text{H}_{22} = 22 \times 1 = 22, \text{O}_{11} = 16 \times 11 = 176$$

$$\% \text{ composition of mass of C} = \frac{144}{342} \times 100\% = 42.12\% \quad \left. \sum \text{ up} = 99.995 \right\}$$

$$\text{H} = \frac{22}{342} \times 100\% = 6.43\%$$

$$\text{O} = \frac{176}{342} \times 100\% = 51.46\%$$

$\approx 100\%$

- 14) A Chemist wants to prepare 0.25M HCl. Concentration of Commercial hydrochloric acid is 12.4M. How many milliliters of the commercial acid does the Chemist require to make up 1.50L of the dilute acid?
- 15) You wish to prepare 0.12M HNO<sub>3</sub> from a stock solution of nitric acid that is 15.8M. How many milliliters of the stock solution do you require to make up 1.00L of 0.12M HNO<sub>3</sub>?
- 16) A 50.0mL volume of AgNO<sub>3</sub> solution contains 0.0285mol AgNO<sub>3</sub> (Silver Nitrate). What is the molarity of the solution?
- 17) A sample of 0.0341mol of iron (II) Chloride was dissolved in water to give 25mL of solution. What is the concentration of FeCl<sub>3</sub> in g/dm<sup>3</sup>? (Fe = 55.85g/mol, Cl = 35.45g/mol)
- 18) Sample X has the following characteristics
- Visual Test: White Powder
  - Solubility in water: Soluble
  - Sample X + Nitric Acid: Soluble/ Colorless solution
  - Sample X + Barium Nitrate: White precipitate
  - Sample X + NaOH: Formed a white precipitate, dissolved in excess NaOH
  - Sample X + Ammonia Solution: Formed a white precipitate then dissolved in excess NH<sub>3</sub> Solution.
- What is Salt X?
- 19) You are provided with a 1.10g of anhydrous Na<sub>2</sub>CO<sub>3</sub> and asked to transfer it into a 250mL volumetric flask then dilute with distilled water to the 250mL mark. Using the relationship: Concentration (g/dm<sup>3</sup>) = Molarity (mol/dm<sup>3</sup>) x Molar mass Calculate the molarity of anhydrous Na<sub>2</sub>CO<sub>3</sub> prepared. (Na = 22.99g/mol, C = 12.0g/mol, O = 16g/mol)

TEST	OBSERVATION
Sample Y + Distilled Water	Blue Solution
Sample Y + NaOH	Blue ppt soluble in excess NaOH
Sample Y + NH <sub>3</sub> Solution	Blue ppt soluble in excess
Sample Y + Ba(NO <sub>3</sub> ) <sub>2</sub>	Dense Blue ppt formed

Mention cations and anions you suspect will be present in sample Y.

Elite media  
02164824018

i) The following equation shows the reaction of aluminum with aqueous solution of hydrochloric acid to form aluminum chloride and hydrogen gas.  $Al + 6HCl \rightarrow AlCl_3 + 3H_2$



ii) An experimental analysis of calcium phosphate shows that it contains 38.77% calcium, 19.77% phosphorus and 41.27% oxygen. What is the empirical formula of the sample?

$\frac{Ca}{38.77}$	$\frac{P}{19.77}$	$\frac{O}{41.27}$	Multiply through by 2
$= 0.96925$	$= 0.64419$	$= \frac{2.57438}{0.64419}$	$Ca = 3, P = 2, O = 8; Ca_2P_2O_8$
$= 1.5$	$= 1$	$= 4$	Empirical formula = $Ca_2(P_2O_8)$

iii) Copper (II) sulphate crystals,  $CuSO_4 \cdot 5H_2O$  were dissolved in  $100\text{cm}^3$  of solution. What is the concentration of the solution?

$$\begin{aligned} & CuSO_4 \cdot 5H_2O \\ & = 64 + 32 + 64 + 10 + 80 \\ & = 250 \text{ g/mol} \end{aligned}$$

$$5g \rightarrow 100\text{cm}^3$$

$$x \rightarrow 1000\text{cm}^3$$

$$x = \frac{5000}{100} = 50 \text{ g/dm}^3$$

$$\text{Molar Conc.} = \frac{\text{Mass Conc.}}{\text{molar mass}} = \frac{50 \text{ g/dm}^3}{250 \text{ g/mol}} = 0.2 \text{ mol/dm}^3$$

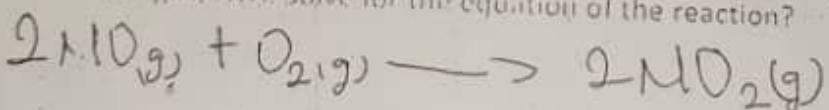
q. Define the following:

Molar Mass of a Substance: This is defined as the total number of protons in the nucleus of an atom.

ii. Limiting reagent is defined as the reagent / substance that will be used up in the reaction.

iii. The mole is defined as the amount of a substance containing as elementary entities as there are atoms in exactly 12g of Carbon

b. 0.8g of nitrogen monoxide gas,  $NO$ , reacts with 0.16g of Oxygen gas,  $O_2$ , to give 0.46g of nitrogen dioxide gas,  $NO_2$ . Solve for the equation of the reaction?



c. Cesium is often used as "electron eyes" for automatic doors in an application of the photoelectric effect the amount of energy required to ionize (remove an electron from) a cesium atom is 1.6810<sup>-19</sup>J. Show by calculation whether a beam of yellow light with wavelength 5830 Å can ionize a cesium atom. ( $h = 6.63 \times 10^{-34}$ ,  $c = 3.00 \times 10^8 \text{ m/s}$ ) Don't see the values well.

**ELITE MEDIA**  
Okwudili Emmanuel  
081614824013

# 2016 SESSION SOLUTIONS CHS 101

## GENERAL CHEMISTRY

(a) Density =  $\frac{\text{Mass}}{\text{Volume}}$

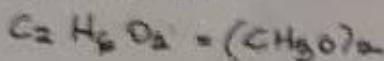
$\therefore \text{Mass} = \text{Density} \times \text{Volume}$  where:

$$\text{Density} = 1.11 \text{ g/cm}^3; \text{Volume} = 560 \text{ cm}^3$$

$$\text{Mass} = 1.11 \text{ g/cm}^3 \times 560 \text{ cm}^3 = \underline{\underline{616.0}}$$

(b) molecular formula = empirical formula<sub>n</sub>

$$\text{NMR: } n = 2$$



$$\therefore \text{Empirical formula} = \text{CH}_3\text{O}$$

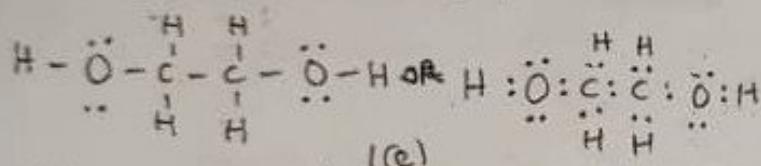
(c) Molecular mass of ethylene glycol.

$$\text{CH}_2\text{H}_6\text{O}_2 = (2 \times 12.011) + (6 \times 1.008) + (2 \times 15.991)$$

$$= 24.022 + 6.048 + 31.998 = \underline{\underline{62.0689}}$$

(d) Element that make up the glycol are carbon, hydrogen and oxygen.

Lewis dot structure of the element.



(e) Weight % of the glycol =

$$\frac{\text{Mass of ethylene glycol} \times 100}{\text{Mass of ethylene glycol} + \text{Mass of water}}$$

$$= \frac{1.2 \text{ kg}}{1.2 + 4.0 \text{ kg}} \times \frac{100}{1} = \frac{1.2}{5.2} \times \frac{100}{1} = \underline{\underline{23.1\%}}$$

(f) The rate of a reaction is the number of moles of reactant converted or product formed per unit time.

$$\text{Rate of disappearance of CO} = \frac{-\Delta [\text{CO}]}{\Delta t}$$

$$\text{Rate of disappearance of NO} = \frac{-\Delta [\text{NO}]}{\Delta t}$$

$$\text{Rate of formation of CO}_2 = \frac{\Delta [\text{CO}_2]}{\Delta t}$$

$$\text{Rate of formation of N}_2 = \frac{\Delta [\text{N}_2]}{\Delta t}$$

(g) Expression for the general rate of the reaction.

$$\text{Rate} = k [\text{CO}]^2 [\text{NO}]^2 \text{ [Reactants]}$$

$$\text{Rate} = k [\text{CO}]^2 [\text{N}_2] \text{ [Products]}$$

$$\text{Rate} = k [\text{CO}] [\text{NO}]^2$$

Reaction order for CO = 1 (1<sup>st</sup> order)

Reaction order for NO = 2 (2<sup>nd</sup> order)

(h) Overall order of the reaction = 3 (3<sup>rd</sup> order.)

(i) Weighted average atomic mass of carbon =

$$(12 \times 0.9889) + (13 \times 0.0108) = 11.86704 + 0.14404 = \underline{\underline{12.01108}}$$

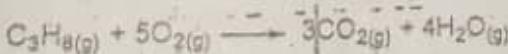
SECTION A

- (1) Which of the following is a property of cathode rays?  
 (a) They travel in all directions (b) They flow from the atoms to the cathode (c) They are deflected by magnetic fields (d) They are uncharged particles (e) none of the above
- (2) The reaction represented by:  

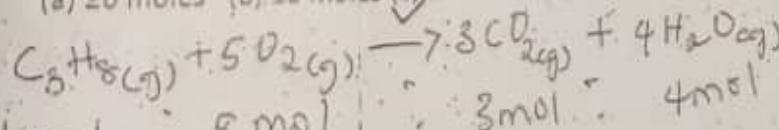
$$2\text{Mg}_{(s)} + \text{O}_{2(g)} \longrightarrow 2\text{MgO}_{(s)}$$
  
 (a) Is a neutralization reaction (b) Is a displacement reaction (c) Is a redox reaction (d) Is a metathesis reaction (e) Double decomposition
- (3) Which formula represents a peroxide?  
 (a)  $\text{K}_2\text{O}$       (b)  $\text{K}_2\text{O}_3$       (c)  $\text{KO}_2$       (d)  $\text{CaO}$       (e)  $\text{Ca}_2\text{O}_2$
- (4) A sample of an ionic compound containing iron and chlorine is analysed and found to have a molar mass of 127 g/mol. The charge (combining power) of the iron in the compound is?  $\text{FeCl}_x = 56 + 2(35-x) = 56 + 7x = 127$   
 (a) +1      (b) +2      (c) +3      (d) +4      (e) +5
- (5) A silicon atom in its ground state orbital diagram has ..... Number of unpaired electron(s)  
 (a) 1      (b) 2      (c) 3      (d) 4      (e) 5
- (6) The number of moles of methane ( $\text{CH}_4$ ) present in 6.07 g of methane is?  $\text{methane} = (\text{CH}_4) = 12+4(\text{C}) = 12+4 = 16$   
 (a) 0.279 moles (b) 0.379 moles (c) 0.479 moles (d) 0.579 moles (e) 0.679 moles  $\text{mole} = \frac{\text{mass}}{\text{molar mass}} = \frac{6.07}{16} = 0.38$
- (7) Which is true of the  $\text{Am}^{3+}$  ion? If P = protons, E = Electrons, and N = neutrons  

$$\frac{243}{95} = P+N$$
  
 (a) 95 P, 92 E, 243 N (b) 95 P, 98 E, 243 N (c) 95 P, 95 E, 148 N (d) 95 P, 92 E, 148 N (e) 92 P, 95 E, 148 N
- (8) Which of the following oxyanions is NOT correctly named?  
 (a) sulphate (b)  $\text{ClO}_4^-$ , chlorate (c)  $\text{SeO}_4^{2-}$ , selenate (d)  $\text{IO}_4^-$ , periodate (e)  $\text{SO}_3^{2-}$ , sulphite (f)  $\text{IO}_3^-$ , iodate
- (9) Which of the following is a chemical change?  
 (a) Water vapour exhaled in your breath condenses in the air on a cold day  
 (b) The melting of butter when placed under the sun (c) The evaporation of a solution of  $\text{NaCl}$  to dryness  
 (d) The burning of lamp oil (e) Forming of dews on a cold night

- (10) How many moles of propane will be left unreacted when 20 moles of propane are treated with 30 moles of oxygen based on the reaction?



- (a) 20 moles (b) 10 moles (c) 14 moles (d) 30 moles



$$\begin{aligned} & \cancel{3\text{mol}} \quad \cancel{30\text{mol}} \\ & \text{cross multiply} \\ & x\text{mol} = \frac{6}{30} \times 1 = 6\text{ mol C}_3\text{H}_8 \end{aligned}$$

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Okwudili Emmanuel  
08164821101

(1) Isotopes are elements that have same atomic number but different mass number due to difference in the number of neutrons present in the nucleus of the atom.

(b) Isotopes are elements that have the same atomic number but different mass number due to difference in the number of neutrons present in the nucleus of the atom.

	Carbon-12	Carbon-13
Proton	6	6
Neutron	6	7
Electron	6	6

(4a.) Equilibrium expression for the reaction,  $\text{CO}_{(g)} + 3\text{H}_2_{(g)} \rightleftharpoons \text{CH}_4_{(g)} + \text{H}_2\text{O}_{(g)}$

$$K_c = \frac{[\text{CH}_4][\text{H}_2\text{O}]}{[\text{CO}][\text{H}_2]^3}$$

(4b.) With a decrease in volume, the equilibrium will shift to the right-hand side of the reaction i.e. formation of  $\text{CH}_4$  and  $\text{H}_2\text{O}$  will be favoured.

(4c.) Le Chatelier's principle states that if an external constraint such as a change in temperature, pressure or concentration is imposed on a chemical system in equilibrium, the equilibrium will shift so as to annul or neutralize the constraint.

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(iii) Using shell notation

1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>5</sup>

(iv) Using orbital diagram

[1s] [1s] [1s] 1s 1s 1s

1s 2s 2p<sub>x</sub> 2p<sub>y</sub> 2p<sub>z</sub>

(v) Using noble gas core abbreviated electron configuration

[He] 2s<sup>2</sup> 2p<sup>5</sup>

(5b) Group = 7, period 2

(6a.) Atomic number is the number of protons present in the nucleus of an atom.

(6b.) Avogadro's number is the number of units in one mole of any substance and is equal to  $6.02 \times 10^{23}$

(6c.) A cathode ray is a beam of electrons in a vacuum tube travelling from the negatively charged electrode (cathode) at one end to the positively charged electrode (anode) at the other across a voltage difference between electrodes. They are also called electron beams.

(6d.) Core (inner) electrons are electrons found in the inner shells.

Rivers State University, Nkpolu-Oronosukwu Port Harcourt,  
 Department of Chemistry, 2020/2021 Academic Session, First Semester  
 Instruction: Answer all questions in Section A, 1 mark each, 1:30 hrs  
 Section B, Answer ONLY 2 questions, 10 marks for each question.  
 SET A ————— SCIENCE, & OTHERS, underline the correct answer

$Z_C = 12, Z_H = 1, Z_O = 16, Z_N = 14, Z_Fe = 56$   
 $Z_{Se} = 79, \text{ speed of light} = 3.00 \times 10^8 \text{ m/s}$   
 $Z_{Avogadro's number} = 6.022 \times 10^{23}$   
 $Z_Mg = 12, Z_{Al} = 13, Z_P = 15, Z_Cl = 17.5.$

= Atom A, = Atom B

Surname: compiled by Dr Bull

Other Names: Course Coordinator

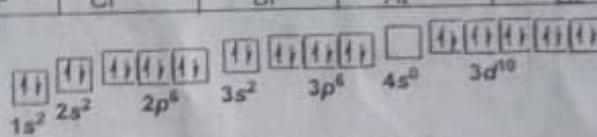
Matric. No:

Faculty/ Dept:

Signature:

No. on attendance list:

1. Which of the following is NOT a mixture?  gasoline  steel  air  Ammonia  None
2. Chemical reactions consist of reactants and  heat  equations  products  mixture  liquids
3. What is the g equivalent of 0.027 kg?  2.74 g  27.4 g  274.0 g  0.274 g  0.027 g
4. Which of the following species is a polyatomic ion?   $Zn^{2+}$    $S^{2-}$    $Ca^{2+}$    $Cl^-$    $CN^-$
5. What is the plural of the word 'quantum'?  quanta  quantal  quantum energy  quantity
6. What is the meaning of amu?  atomic mass unit  amount  activity mass unit  aluminium unit  None
7. How many protons neutrons and electrons does  $^{37}K^+$  contain?  19, 19 & 19  18, 19 & 18  19, 18 & 18  20, 18 & 19  None
8. How many core electrons are in chlorine atom?  10  8  6  4  2
9. The percentage of hydrogen in ammonia is ...?  7.14%  82.3%  21.4%  17.6%  10.0%
10. What is the molecular mass of  $CH_3CO_2H$ ?  44 amu  60 amu  56 amu  30 amu  20 amu
11. What is the simplest formula of an iron ore containing 72.4% Fe (55.8) and 27.6% O (16.0)?  Fe   $Fe_4O_3$    $Fe_2O_3$    $Fe_3O_4$   FeO
12. The limiting reagent is the reactant that is?  sufficient  in excess  not in excess  agent  limited
13. In which of the following will chlorine indicate oxidation of +5?  HCl   $HClO$    $HClO_2$    $HClO_4$    $HClO_2$
14. Which of the following element is not halogen?  F  Cl  Br  At  Ar



15. Write the orbital (box) diagram of  $^{30}Zn^{2+}$

- (16) Which of the following is NOT true about mass?

It has the same value everywhere on Earth	It is independent of gravitational force	<u>It becomes less in outer space, farther from Earth</u>
It is a constant measure of the amount of matter	It is found in all matter	

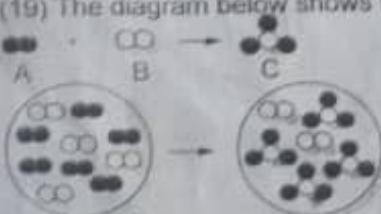
- (17) The correct answer for  $3.71 \times 10^8 \text{ g} + 4.62 \times 10^7 \text{ g}$  in the correct significant figure is

$4.991 \times 10^7 \text{ g}$    $8.33 \times 10^{15} \text{ g}$    $4.172 \times 10^8 \text{ g}$    $4.99 \times 10^7 \text{ g}$    $4.17 \times 10^7 \text{ g}$

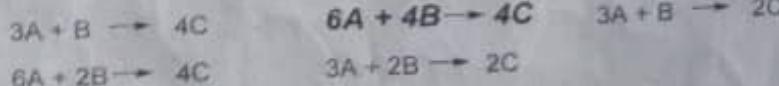
- (18) What is the temperature in Kelvin that corresponds to a temperature of -12 °C?

-285.2 K  +285.2 K  261.15 K  261.2 K  285.15 K

- (19) The diagram below shows the reaction of molecule A with molecule B to form molecule C.



Which equation is best?



- (20) Which quantum number is shared by all the orbitals in a shell?

<u>Principal</u>	<u>Spin</u>	<u>Angular momentum</u>	<u>Magnetic</u>	<u>None of the options</u>
------------------	-------------	-------------------------	-----------------	----------------------------

- (21) Which type of electromagnetic radiation has the Longest Wavelength??

Other Name.....

Surname of student.....

INSTRUCTION: ATTEMPT ANY FIVE (5) QUESTION

ELITE MEDIA

UNIT:3 08164824018  
 070353A4061

TIME ALLOWED:2HRS

- Ethylene glycol,  $C_2H_6O_2$ , is a liquid widely used in automobile antifreeze. It has a density of 1.11g/cm $^3$ .
  - What is the mass, in grams, of 56.000cm $^3$  of ethylene glycol?
  - Calculate the empirical formula of ethylene glycol?
  - Write Lewis dot structures of elements that make up the glycol.
  - Assume you add 1.2 kg of ethylene glycol as antifreeze to 4.0 kg of water in the radiator of your car what is the weight percent of the glycol?
- Carbonmonoxide and nitrogenmonoxide, both are serious air pollutants, are produced in large quantities in automobile engines. However, both gases can react to form carbon dioxide and nitrogen which are safer products.
  - Define rate of reaction
  - Write expressions for the rate of disappearance of CO and NO, and rate of formation of  $CO_2$  and  $N_2$
  - Write an expression for the general rate of the reaction.
  - Considering the rate law of the reaction above is, Rate =  $k(CO)(NO)_2$ , what are the reaction orders for CO and NO?
  - Based on the rate law what is the overall order of the reaction?
- Given that the percentage and fractional abundance of carbon isotopes are:

Isotopes	Percent abundance	Fractional
Carbon -12	98.892%	0.98892
Carbon -13	1.108%	0.01108

- Calculate the weighted average atomic mass of carbon
- What are isotopes?
- How many protons, neutrons and electrons are in carbon-12 and carbon-13 isotopes?
- Give the reaction;  $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ 
  - Write the equilibrium expression for the reaction
  - With a decrease in volume, in what direction will the equilibrium shift to?
  - State the LE chateller's principle.
- Write electron configuration for fluorine (F) using
  - Spdf notation
  - Orbital diagram
  - Noble-gas-core abbreviated electron configuration
  - with the aid of its electron configuration, which group and period is F found in periodic table?
- Define or explain the followings
  - Atomic number
  - Avogadro's number
  - cathode ray
  - Core (inner) electrons
  - hydrogen bond
  - limiting reagent
  - Molarity
  - Photon
- Briefly describe the Rutherford's alpha-particles scattering experiment and his interpretation of the results of the experiment

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## CHM 101

### Introduction to Chemistry

\* Chemistry can be defined as the branch of science that describes matter; its properties, composition and changes they undergo.

\* Scientific methods are set patterns which scientists use to search for answers or solutions to problems. The set patterns comprises of Observations, hypothesis, experiments, scientific laws & Theory.

\* Observations are things that can be witnessed and can be quantitative or qualitative.

\* Quantitative observations deals with on how much species of matter is present, from its definition.

It comprises of a number and a unit.

\* Qualitative observation deals on the properties which helps in the identification of a substance rather than how much.

\* Hypothesis is an uncertain explanation of an observation which may or may not be correct.

\* Experiments are systematic observations carried out under controlled conditions to test the validity of a hypothesis.

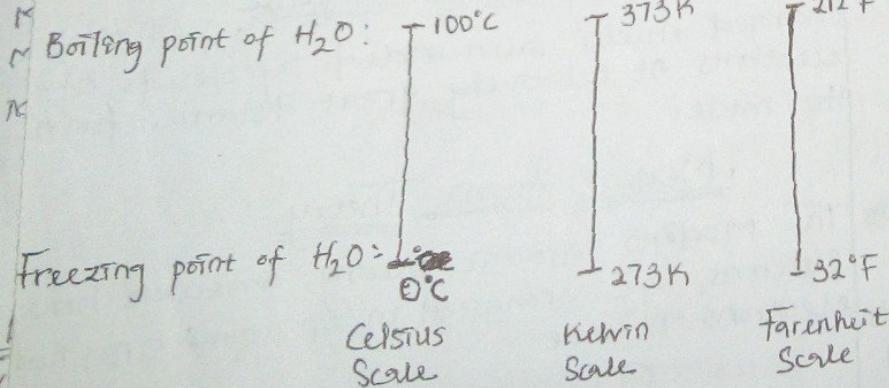
\* Scientific Laws are concise, verbal statements or mathematical expressions that summarizes a broad variety of observations and experiments.

\* A theory is an explanation of a general principle or certain phenomena with considerable evidence or facts to support it. It explains what and why something happened.

$$v K = ^\circ C + 273.15$$

$$v ^\circ F = \frac{9}{5} (^\circ C + 32)$$

$$v ^\circ C = \frac{5}{9} (^\circ F - 32)$$



### Volume

$$1 \text{ Litre} = 1000 \text{ millimetre (mL)} = 1000 \text{ cm}^3 = 1 \text{ dm}^3$$

$$1 \text{ dm}^3 = 1000 \text{ cm}^3 = 1 \text{ Litre} = 1000$$

### Density

Density is defined as mass per unit volume

$$\rho = \frac{m}{V}$$

Unit of density =  $\text{kg/m}^3$  or  $\text{g/cm}^3$  or  $\text{g/mL}$ .

### Precision and Accuracy

\* Precision refers to how closely two or more related measurements of the same quantity agree with each other.

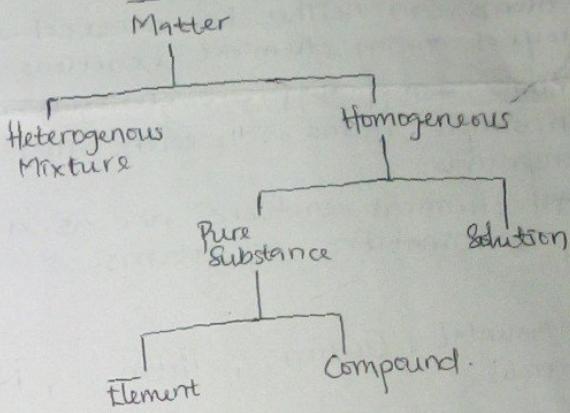
\* Accuracy tells us closely how a measurement is to the value of a quantity that is being measured.

### Properties of matter

\* Physical properties: This is a kind of change that affects the physical properties of a substance. E.g Melting, Boiling, Condensation, etc. No physical changes are reversible and no new substances are formed.

\* Chemical changes: This is a type of change that results in the formation of new substances.

### Classification of Matter



Atomic StructureDalton's Atomic Theory ①

- i) An element is composed of small indivisible particles called atoms.
- ii) Atoms of the same elements are the same in size and structure and differs from atoms of other elements.
- iii) Atoms cannot be created, destroyed or transformed into atoms of other elements.
- iv) Atoms of different elements combine with each other in simple ratios to form compounds.
- v) The relative number and sizes of atoms are constant in a given compound.

Dalton's Atomic Theory ②

1. All elements are composed of small indivisible particles called atoms.
2. Atoms of the same elements are alike in all aspects and differs from atoms of other elements.
3. Atoms can neither be created nor destroyed during chemical reactions.
4. Atoms of different elements combine in simple ratios with each other to form compounds.
5. All chemical reactions are as a result of combinations of atoms.

Fundamental Particles: Electron, Proton, Neutron

Charge: -1 +1 None

Mass:  $\frac{1}{1836}$  1 1

Discovery of Electrons (Cathode Rays)

\* Electrons were discovered by J.J. Thompson in 1897, during his cathode ray experiment. In his experiment, he sealed two electrodes in a glass tube at very low temperature and applied high voltage. Current flowed and rays were given off from the negative electrode and it travelled in straight lines towards the positive electrode, this caused the wall of the tube to glow. An obstacle placed in its way cast a shadow upon the Zinc Sulphide screen. These

Characteristics of Cathode rays

- i) They are negatively charged.
- ii) Their rays travel in straight lines towards the positive electrode.
- iii) An obstacle placed on the path of the cathode rays casts a shadow on a Zinc Sulphide screen.
- iv) They are deflected by both electric and magnetic fields in directions expected for negatively charged particles.
- v) Cathode rays have mass as they can turn a small paddle wheel in their path.

Discovery of Protons (Canal Rays)

\* Protons (canal rays) were discovered by Ernest Rutherford in 1886

Characteristics of Canal Rays

1. They are positively charged.
2. They travel in directions opposite of the cathode rays in magnetic and electric fields.
3. Electron per mass ( $e/m$ ) ratio is smaller due to their greater mass.

Discovery of neutrons

\* Neutrons were discovered by James Chadwick in 1932.

ATOMIC MODELS

1. J.J. Thompson's atomic model was described as "plum in the pudding model". He described the atom as having the positive charge distributed evenly throughout the atom. The negative charges were seen as being embedded in the atoms like 'plums in the pudding'.

2. Rutherford's Model of the atom:- "Atoms consists of very small, very dense, positively charged nuclei surrounded by clouds of electrons at relatively great distance from the nuclei".

Modern Atomic Theory

The Modern atomic theory answers how electrons are arranged in an atom and how electrons behave.

Quantum Numbers

Quantum number is

Atomic orbital is a region of space in which electron is found with high probability.

Pure substances, chemical species and nomenclature

- Matter can be defined as anything that has mass and occupies space.
- A substance is a kind of matter that has a definite composition and distinct properties.
- Elements are substances that cannot be split in simpler units by ordinary chemical processes.
- A compound is a substance composed of two or more elements chemically combined together.

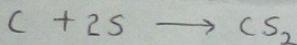
Laws of chemical combination

- Law of conservation of matter: It states that matter can neither be created nor destroyed in a reaction, but can be changed from one form to another.

$$\text{Mass of reactants} = \text{Mass of products}$$

Law of definite proportion:

Eg: A mixture of 12g of Carbon and 64g of Sulphur is heated until reaction is complete and none of the reactant is left over. What mass of the compound, Carbon (II) Sulphide is formed?

Solution

$$\text{Mass of } C = 12\text{ g}$$

$$\text{Mass of } S = 64\text{ g}$$

By law of conservation of mass:

$$\text{Mass of reactant} = \text{Mass of products}$$

$$\therefore 12\text{ g} + 64\text{ g} = 76\text{ g}$$

Eg 2: 12.3g of iron (II) tetroxosulphate (VI) crystals when heated gave 6.0g of the anhydrous salt. If only its water of crystallization is lost as a result of heating, calculate the percentage mass of the water of crystallization.

Solution

$$\text{Mass of } Fe_2S_4O_8 = 12.3\text{ g}$$

$$\text{Mass of Anh. Salt} = 6.0\text{ g}$$

$$\text{Mass of water of crystallization} = 12.3 - 6.0 = 6.3\text{ g}$$

$$\therefore \% \text{ of water} = \frac{6.3}{12.3} \times 100\% = 51.2\%$$

2) Law of constant composition / Proportion:

It states that the same chemical compound always contains the same elements in the same proportion by mass. Or All pure samples of a particular compound contains similar elements combined in the same proportion by mass.

- If two elements

Law of Multiple proportion: If two elements combine to form more than one compound, the different masses of one which combines with a fixed mass of the other are in a simple whole number ratio.

Difference between Physical & chemical changesPhysical change

- It is easily reversible
- No new substances are formed
- No change in mass is involved

Chemical change

- It is not easily reversible
- New substances are formed.
- Change in mass is involved

Oxidation Number

Oxidation number of an element in a molecule or ion is the charge it appears to have determined by a set of rules

The set of rules that determine oxidation numbers of elements includes:

- The oxidation of all elements in free state is zero
- The oxidation number of a single ion has the same size and charge of the ion.
- When the ion consists of more than one element, its oxidation number is the algebraic sum of all the oxidation number of the element in the ion.
- The algebraic sum of all elements in a compound is zero. The oxidation no. of oxygen is -2, except in oxides peroxides where it is -1.

Eg:  $KMnO_4$ , find the oxidation no. of Mn

$$+1 + Mn + 4(-2) = 0$$

$$Mn = 8 - 1 = +7$$

$CaCO_3$ , find the oxidation no. of Carbon  
 $+2 + C + 3 \times (-2)$

$$C = 6 - 2 = +4$$

$H_2SO_4$ , find the oxidation no. of Sulphur  
 $2(1) + S + 4(-2) = 0$

$$S = 8 - 2 = +6$$

$SO_3$  in  $SO_2$   
 $SO_2 + 2(-2) = 0$   
 $SO_2 + S = +4$

## Quantum Numbers

Max Planck gave the name quantum to the smallest quantity of energy that can be emitted or absorbed in the form of electromagnetic radiation. Quantum numbers describes the ~~rest~~ energy of electrons in an atom derived from quantum mechanical treatment.

1. Principal Quantum number (n): This describes the main energy level or shell an electron occupies. It may be any positive integer  $n = 1, 2, 3, 4, \dots$ . The maximum electron capacity on the main shell is given as  $2n^2$ , where  $n$  is number of main shells.

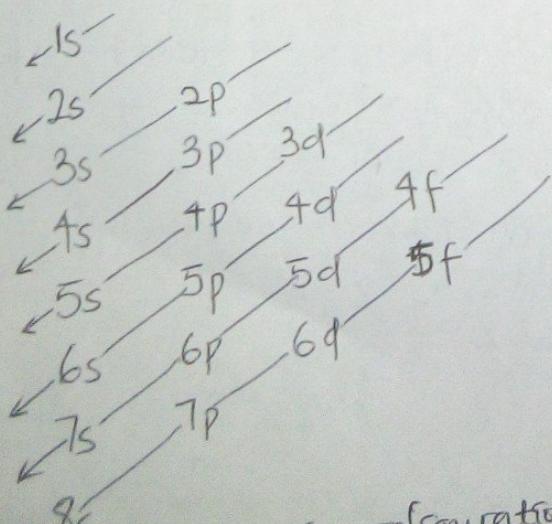
2. The angular momentum quantum numbers (L): This designates the shape of the region in space ~~that~~ an electron occupies. The maximum value of  $L = n-1$ . Each letter corresponds to a different sublevel -  $L = 0, 1, 2, 3, \dots, (n-1)$ . They are s, p, d & f.

3) Magnetic Quantum number ( $M_L$ ): This designates the ~~orbi~~ specified orbital within a sub-shell. The maximum value of  $M_L$  depends on the value of L. Electron capacity of subshell =  $4L+2$ . The Electron capacity of main shell =  $2n^2$ .

4) Spin Quantum Number ( $M_S$ ): This refers to the spin of an electron and the orientation of the magnetic field produced by spin.

## Electronic Configuration

Electronic configuration is the specific distribution of electrons in the atomic orbitals of an atom or ion.



Electronic configuration key

## CHM 101

### Behaviour of Gases and the Kinetic Model

#### Properties of gases

1. Gases have no definite shape and volume. They take the shape of the container they occupy
2. Gases are compressible
3. Gases are soluble in each other
4. Gases exhibit random motion.

In general, the behaviour of gases is largely controlled by ① Pressure ② Volume ③ Temperature ④ No. of moles of gases.

$$1 \text{ Pa} = 1 \text{ Nm}^{-2} = \text{Kg} \frac{\text{m}}{\text{s}^2} \text{ m}^{-2} = \text{Kgs}^{-2} \text{ m}^{-1}$$

$$1 \text{ atm} = 760 \text{ mmHg}$$

Charles Law  $V \propto T$

$$\frac{V}{T} = \frac{K}{T} \quad \therefore K = \frac{V}{T}$$

$$\therefore \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Boyle's Law:  $P \propto \frac{1}{V}$

$$P = \frac{K}{V}$$

$$K = PV \quad \therefore P_1 V_1 = P_2 V_2$$

$$PV = nRT \quad (\text{Ideal gas Law})$$

\* A fluid is a kind of matter that exhibits brownian movement, viscous flow, thermal conductivity, and diffusion, and isotropic properties

## Kinetic Theory of Gases

\* The gas molecules move randomly in straight lines, therefore colliding with one another and the walls of its container.

\* The collisions of the gas molecules are elastic.

\* The volume gases occupy are negligible, as gases tend to fill the container which they are in.

\* The force of cohesion between gas molecules are negligible.

\* The temperature of the gas is a measure of the average kinetic energy of the gas particles.