



05 1.9 + 100%

Abia State University Uturu

Department of Pure and Industrial Chemistry

CHE 101 General Chemistry I TEST

First Semester 2017/2018 Academic Session (Time allowed: 1½)

Instruction: Attempt all questions

- ① In one sentence explain why BF_3 with incomplete octet structure is the preferred structure.
 - ② Which molecule is nonpolar (a) SO_3 (b) CH_2Cl_2 (c) NH_3 (d) FNO [NB: EN for S = 2.5, O = 3.5, C = 2.5, H = 2.1, Cl = 3.0, N = 3.0, F = 4.0]
 - ③ Of the following species, the one with a triple covalent bond is (a) NO_3^- ; (b) CN^- ; (c) CO_2 ; (d) AlCl_3
 - ④ The formal charges on the O atoms in the ion $[\text{ONO}]^+$ is (a) -2; (b) -1; (c) 0; (d) +1
 - ⑤ The following are state functions except (a) T (b) V (c) q (d) H
 - ⑥ The reaction $\text{A} + \text{B} + \text{C} \rightarrow \text{Products}$, is found to obey the rate Law
- Rate = $\frac{d[\text{A}]}{dt} = k[\text{A}]^2[\text{B}]^{3/2}[\text{C}]^{-1/2}$ What is the overall order of reaction?
- ⑦ List four methods for obtaining the order and rate constant for a reaction.
 - ⑧ The boiling point of a solution containing 0.20g of a substance 'x' in 20.00g of ether is 0.17K higher than that of pure ether. Calculate the molecular mass of 'x'. Boiling point constant of ether per 1kg is 2.16.
 - ⑨ State the equations for determination of molecular mass using (a) osmotic pressure (b) depression of freezing point.
 - ⑩ In one sentence each, define (a) Molarity (b) Molality.
 - ⑪ Given that 5 millilitre of 5.2 mol per litre NaCl will be used to prepare 0.026 mol per litre NaCl. Describe how you will prepare this solution.
 - ⑫ Discuss in details any case of either (i) Radioactive poisoning or (ii) nuclear accident.
 - ⑬ The label on a bottle of sodium hydroxide (NaOH) bears the following: assay is 47% and density is 1.75 g/ml. Calculate the molar concentration of this reagent. (Molar mass of NaOH = 40 g/mol).
 - ⑭ An ancient wooden artifact has a specific activity of 9.14 d/min·g, how old is the artifact? Assume the ratio of $^{12}\text{C}/^{14}\text{C}$ in a living plant has a specific activity of 15.3 d/min·g.
 - ⑮ Copy & fill the Table below. Read carefully & note the units required. Provide ONLY the needed information necessary to prepare the various concentrations of NaCl. Any value provided in a column that should be vacant nullifies the other values, even if correct. Use ONLY the atomic masses given.

	Amount of solute (mg)	No of moles of solute	weight of solvent (g)
1L of 1M NaCl			
100mL of 1M NaCl			
1L of 1m NaCl			
500mL of 1m NaCl			

Take : $\text{Na}=22.989763 \text{ g/mol}$; $\text{Cl} = 35.45 \text{ g/mol}$



ABIA STATE UNIVERSITY, UTURU
DEPARTMENT OF PURE AND INDUSTRIAL CHEMISTRY
CHE 101: General Chemistry I Examination 2016/2017 Academic Session

INSTRUCTIONS: (1) ANSWER THREE QUESTIONS, ONE QUESTION FROM EACH SECTION
 (2) ENSURE THAT YOU HAVE REGISTERED YOUR COURSES ONLINE
 (3) Time: 3 hours

SECTION A

Take the Atomic weight of the elements as follows: C=12.011; H=1.00794; O=15.9994; N=14.01

- Q1(a). A friend boiled water and made you a cup of tea. He told you that he used 0.024mol of table sugar (Sucrose, $C_{12}H_{22}O_{11}$) in the tea. What mass of sugar did he use? (5 marks)
- (b) Assuming your friend prefers an artificial sweetener such as aspartame ($C_{14}H_{18}O_{2N_2}$) in his tea. A packet of aspartame contains 40mg of sweetener (measured to two significant figures). How many moles of aspartame are in the packet? What mass of aspartame would give 0.0120 mol? How many packets is this? (10 marks)
- (c) Derive the equation below from first principle (half-life of radioactive materials)
 $t_{1/2} = 0.6932/K$ (1) (7 marks)
- (d) Mention and discuss any five (5) differences between Nuclear reactions and Chemical reactions (5 marks)
- (e) Briefly discuss any named four applications of radioisotopes. (8 marks)

- Q2. (a) You exhausted your feeding money, just like your roommates. You decided to 'smoke garri' with your 3 roommates by 'soaking' 960g of garri in a big bowl with the only remaining sugar in the room, just 60 milligrams of sugar (sucrose, $C_{12}H_{22}O_{11}$). If the garri was well mixed with the sugar before the addition of water, calculate the concentration of sugar used in ppm (weight per weight on dry weight basis). (6 marks)
- (b) An ancient wooden artifact has a specific activity of 9.14 d/min/g, how old is the artifact? Assume the ratio of $^{12}C/^{14}C$ in a living plant has a specific activity of 45.3 d/min/g. (7 marks)
- (c) Discuss the nuclear accident at Chernobyl (which country, date, what led to the accident, what are the effects then and now etc.; maximum of 2 pages) (10 marks)
- (d) A bottle of wine of volume 750ml is labeled "10.5% alcohol by volume". What is the volume of alcohol in the wine? (6 marks)
- (e) The explosive trinitrotoluene (TNT) has the composition 37.01% C, 2.22% H, 18.50% N and 42.27% O. What is the empirical formula of TNT? (6 marks)

SECTION B

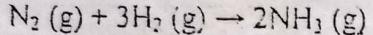
- (a) Using equations ONLY define the following: (i) Internal energy (ii) enthalpy (iii) entropy (iv) Gibbs free energy (v) Maxwell - Boltzmann's distribution law (vi) mean relative speed (vii) Mean free path (viii) root mean speed (ix) virial equation of state (x) van der waal's equation. [10 marks]
- (i) State the Octet rule (ii) give two exceptions to the Octets rule [2 marks]
- (i) Write plausible Lewis structure and evaluate the formal charges for the following (i) $COCl_2$ (ii) CH_3CHO (iii) N_2O_3 (iv) CS_2 (v) C_2 (vi) BF_3 . [12 marks]
- (i) State and define the terms in equation of state. Explain (i) the conditions under which the equation of state fails (ii) why it fails. (ii) Using equations only, state how deviations of a real gas from an ideal gas behavior can be estimated [5 marks].

- (i) Define the values of pure compounds at standard states for (i) AH° (ii) AG° (iii) AS° (iv) At high temperature how does entropy and enthalpy vary with each other? (v) Find AH , AS and AG and in one sentence for each describe the implication of these values in the reaction given: $NO + \frac{1}{2}O_2 \rightarrow NO_2$

Given change in standard heat of formation for NO, O₂ and NO₂ in kJ/mol to be 90, 0 and +34 also consider values to be 211, 205 and 240.5 respectively. [17 marks]

- (b) What type of covalent bond is formed in the following compounds (i) LiCl_(g), EN values for Li = 3.0, Cl = 3.0
 (ii) HCl_(g), EN values for H = 3.0, Cl = 2.1 (iii) Cl_{2(g)} EN value for Cl = 3.0 (iv) NH₃, EN values for N = 3.0 = 2.1 (v) ICl, EN values of I = 2.5, Cl = 3.0 (vi) FN, EN values of F = 4.0, N = 3.0 [6 marks].

(c) Predict whether there is an increase or decrease in entropy in the following reaction [2 marks]:



(d) Given $\Delta H^\circ = +177\text{kJ}$, $\Delta S^\circ = +285\text{JK}^{-1}$ for reaction $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$

Predict the feasibility of the reaction if the reaction occurs at 25°C and 500°C [10 marks]

SECTION C

Q5. (a) State (i) two mathematical expressions for Raoult's law [2 marks]. (ii) Four limitations of the elevation of boiling point method for determination of relative molecular mass [4 marks].

(iii) Predict whether or not precipitation will occur in a mixture of $10^{-2}\text{ mol dm}^{-3}$ solution of Ca²⁺ with an equal volume of a $10^{-2}\text{ mol dm}^{-3}$ solution of SO₄²⁻ ions at 25°C ($K_{sp}(CaSO_4) = 2.0 \times 10^{-5}\text{ mol}^2\text{ dm}^{-6}$ at 25°C).

(b) Write and identify half-reaction equations for the oxidation and reduction processes for the following redox reactions:

(i) When copper foil is added to concentrated trioxonitrate (V) acid, the solution becomes pale blue and brown fumes of nitrogen (IV) oxide are produced [4 marks].

(ii) Acidified potassium dichromate in solution reacts with Iron (II) sulphate to produce chromium (III) sulphate and Iron (III) sulphate [4 marks].

(iii) Obtain a balanced redox equation each for reactions (i) and (ii) above [6 marks].

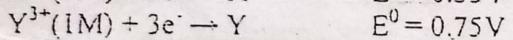
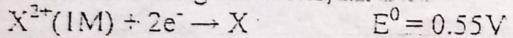
(c) Determine the order of the reaction and the value of rate constant for the hypothetical reaction A → B + C, using the data below (Don't plot any graph) [10 marks]

Time (min)	0	40	80	150	240	500	1000
Conc. [A] (mol)	0.100	0.087	0.0769	0.064	0.0526	0.0348	0.021

Q6. (a) (i) Define the term Osmotic pressure [2 marks].

(ii) The osmotic pressure of 0.2g of haemoglobin in 20.0 cm³ of solution is 383.0 Nm⁻² at 298K. Calculate the molecular weight of haemoglobin ($R = 8.314\text{ J mol}^{-1}\text{ K}^{-1}$) [5 marks].

(b) Given the following half cells;



The signs of the E° values are not specified.

(i) When each of these half cells was connected separately to a standard hydrogen electrode (SHE), electrons flowed in each case from the SHE in the external circuit. Explain which of the E° values will be positive or negative [6 marks].

(ii) If the two half cells X and Y are connected together, explain which electrode oxidation will take place and calculate the overall cell emf [6 marks].

(c) Given the reaction A(g) + B(g) + C(g) → D(g); It was discovered that:

(i) The rate at which D was formed was increased by a factor of 4 when the initial concentration of C was increased by a factor of 2; The rate at which D was formed was increased by a factor of 2 when the initial concentration of A was increased by a factor of 2; Altering the initial concentration of B, did not affect the rate at which D was formed. Considering these three statements, Write the rate law and deduce units for the rate constant if concentration is in mol dm⁻³ [8 marks].

(ii) Now if the reverse reaction was studied, and the rate equation was found to be; $\text{Rate} = K[D]^2$. Derive an equation to calculate the time it will take 50% of the initial reactant to react; If the initial concentration was doubled, how would this time (derived above) respond? [8 marks].

GOODLUCK

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SECTION A

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- Q1(a).** A friend boiled water and made you a cup of tea. He told you that he used 0.024mol of table sugar (Sucrose, $C_{12}H_{22}O_{11}$) in the tea. What mass of sugar did he use? (5 marks)
- (b) Assuming your friend prefers an artificial sweetener such as aspartame ($C_{14}H_{18}O_2N_3$) in his tea. A packet of aspartame contains 40mg of sweetener (measured to two significant figures). How many moles of aspartame are in the packet? What mass of aspartame would give 0.0120 mol? How many packets is this? (10 marks)
- (c) Derive the equation below from first principle (half-life of radioactive materials)
 $t_{1/2} = 0.6932/K \dots \dots \dots \quad (1) \quad (7 \text{ marks})$
- (d) Mention and discuss any five (5) differences between Nuclear reactions and Chemical reactions (5 marks)
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- Q2.** (a) You exhausted your feeding money, just like your roommates. You decided to 'smoke garri' with your 3 roommates by 'soaking' 960g of garri in a big bowl with the only remaining sugar in the room, just 60 milligrams of sugar (sucrose, $C_{12}H_{22}O_{11}$). If the garri was well mixed with the sugar before the addition of water, calculate the concentration of sugar used in ppm (weight per weight on dry weight basis). (6 marks)
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- (d) A bottle of wine of volume 750ml is labeled "10.5% alcohol by volume". What is the volume of alcohol in the wine? (6 marks)
- (e) The explosive trinitrotoluene (TNT) has the composition 37.01% C, 2.22%H, 18.50%N and 42.27% O. What is the empirical formula of TNT? (6 marks)

SECTION B

- Q3.** (a) Using equations ONLY define the following: (i) Internal energy (ii) enthalpy (iii) entropy (iv) Gibbs free energy (v) Maxwell - Boltzmann's distribution law (vi) mean relative speed (vii) Mean free path (viii) root mean speed (ix) viral equation of state (x) van der waal's equation. [10 marks]
- (b) (i) State the Octet rule (ii) give two exceptions to the Octet rule [2 marks]
- (c) Write plausible Lewis structure and evaluate the formal charges for the following (i) COCl_2 (ii) CH_3CHO (iii) NO^+ (iv) N_2H_5^+ (v) O_2^- (vi) BF_4^- [18 marks].
- (d) State and define the terms in equation of state. Explain (i) the conditions under which the equation of state fails (ii) why it fails. (iii) Using equations only, state how deviations of a real gas from an ideal gas behavior may be quantified. (iv) What information can one get from quantifying the deviation, and how can this information be estimated [5 marks].

- Q4.(a)** Define the values of pure compounds at standard states for (i) ΔH_f° (ii) ΔG° (iii) ΔS° (iv) At high enough temperature how does entropy and enthalpy vary with each other? (v) Find ΔH , ΔS and ΔG and in one sentence for each describe the implication of these values in the reaction given: $\text{NO} + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2$.

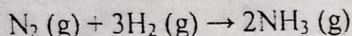
$$\bar{P} = \frac{nRT}{V-nb-a\left(\frac{n}{V}\right)^2} \quad \text{and} \quad Z = \frac{V_m}{V_m^0}$$

$$\bar{A}f = \left(\frac{m}{2\pi k_B T} \right)^{1/2} \cdot V^2 \exp \left[\frac{mv^2}{2k_B T} \right]$$

$$E = \frac{E^\circ - 2.303 RT}{nF}$$

Given change in standard heat of formation for NO , O_2 and NO_2 in kJ/mol to be 90, 0 and +34 also entropy values to be 211, 205 and 240.5 respectively. [17 marks]

- (b) What type of covalent bond is formed in the following compounds (i) $\text{LiCl}_{(\text{g})}$, EN values for Li = 3.0, Cl = 1.0
(ii) $\text{HCl}_{(\text{g})}$, EN values for H = 3.0, Cl = 2.1 (iii) $\text{Cl}_{2(\text{g})}$ EN value for Cl = 3.0 (iv) NH, EN values for N = 3.0, H = 2.1 (v) ICl, EN values of I = 2.5, Cl = 3.0 (vi) FN, EN values of F = 4.0, N = 3.0 [6 marks]
(c) Predict whether there is an increase or decrease in entropy in the following reaction [2 marks]:



- (d) Given $\Delta H^\circ = +177\text{ kJ}$, $\Delta S^\circ = +285\text{ J K}^{-1}$ for reaction $\text{NH}_4\text{Cl}(\text{S}) \rightarrow \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$
Predict the feasibility of the reaction if the reaction occurs at 25°C and 500°C [10 marks]

SECTION C

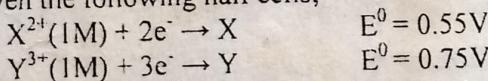
- Q5. (a) State (i) two mathematical expressions for Raoult's law [2 marks]. (ii) Four limitations of the elevation of boiling point method for determination of relative molecular mass [4 marks].
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(iii) Obtain a balanced redox equation each for reactions (i) and (ii) above [6 marks].
(c) Determine the order of the reaction and the value of rate constant for the hypothetical reaction $\text{A} \rightarrow \text{B} + \text{C}$, using the data below (Don't plot any graph) [10 marks]

Time (min)	0	40	80	150	240	500	1000
Conc. [A] (mol)	0.100	0.087	0.0769	0.064	0.0526	0.0348	0.021

- Q6. (a) (i) Define the term Osmotic pressure [2 marks].

(ii) The osmotic pressure of 0.2g of haemoglobin in 20.0 cm^3 of solution is 383.0 N m^{-2} at 298K . Calculate the molecular weight of haemoglobin ($R = 8.314\text{ J mol}^{-1}\text{ K}^{-1}$) [5 marks].

- (b) Given the following half cells;



The signs of the E° values are not specified.

- (i) When each of these half cells was connected separately to a standard hydrogen electrode (SHE), electrons flowed in each case from the SHE in the external circuit. Explain which of the E° values will be positive or negative [6 marks].

- (ii) If the two half cells X and Y are connected together, explain which electrode oxidation will take place and calculate the overall cell emf [6 marks].

- (c) Given the reaction $\text{A(g)} + \text{B(g)} + \text{C(g)} \rightarrow \text{D(g)}$; It was discovered that:

- (i) The rate at which D was formed was increased by a factor of 4 when the initial concentration of C was increased by a factor of 2; The rate at which D was formed was increased by a factor of 2 when the initial concentration of A was increased by a factor of 2; Altering the initial concentration of B, did not affect the rate at which D was formed. Considering these three statements, Write the rate law and deduce units for the rate constant if concentration is in mol dm^{-3} [8 marks].

- (ii) Now if the reverse reaction was studied, and the rate equation was found to be: Rate = $K[\text{D}]^2$. Derive an equation to calculate the time it will take 50% of the initial reactant to react. If the initial concentration was doubled, how would this time (derived above) respond? [8 marks].

GOODLUCK

FOLLOW ALL INSTRUCTIONS GIVEN IN EACH SECTION
SUBMIT YOUR EXAM ADMIT CARD (STAMPED COURSE REGISTRATION AND PASSPORT)

FINISH QUESTION FROM ONE SECTION, GIVE A BLANK SPACE BEFORE IT
QUESTION 1 OR 2

SECTION A: Answer either question 1 or 2

(Instruction: Use ONLY the following atomic weights in all calculation: H = 1.00794; O=15.9994; Ag = 107.870; N = 14.0067; C = 12.011; Ca = 40.078; Cl = 35.453)

- 107.870; N = 14.0067; C = 12.011; Ca = 40.078; O = 16.000

Q1. (a) A solution is prepared by dissolving 12.21g AgNO₃ in a 500mL volumetric flask and diluting to volume. What is the molarity of the solution (4 marks) ✓

(b) What is the name of a group of elements with atomic Nos. 58–71. Name the 1st two members (3 marks) +

(c) Sketch the Modern Periodic Table (identify the Periods and Groups) (5 marks) +

✓ (d) Differentiate between ~~concentrate~~ molarity and molality. Write the equations for calculating them. (4 marks) +

✓ (e) Calculate the ppm by mass of calcium in a 3.05g pill that contains 305mg Ca. (4 marks) PPM = ~~305 × 3:05~~

✓ (f) What is the molality of a solution prepared by mixing 302 g CaCl₂ with 721g of water? (4 marks)

✓ (g) In not more than 3 sentences define nucleosynthesis. Use equations for the bombardment of nitrogen -14 nuclei with α particles for illustration (5 marks)

✓ (h) Provide the half-life of: (i) Tritium (ii) carbon-14 (iii) carbon-15 (iv) potassium-40 (4 marks)

✓ (i) How many stable isotopes has tin (Sn)? (1 marks) [Total 34 marks]

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

- Q2.** (a) (i) What is the mass percent of each element in glucose? (ii) How many grams of oxygen is in 53.64g of glucose? (8 marks)

(b) Carbon 11, an artificial isotope, decays to a stable boron isotope. Write the equation. (2 marks)

(c) What is magic number? Write the magic numbers. (3 marks)

(d) What is the name given to elements with atomic numbers 90 – 103? Name the 1st two members (2 marks)

(e) Mention any four (4) radio-isotopes and their medical applications (and organs studied). (4 marks)

(f) Give the names of any four scientists that worked on the Periodic classification of elements (2 marks)

(h) Summarise the Dalton's Atomic Theory. State any three limitations of this theory. (7 marks)

(g) In a table outline any four (4) differences between nuclear reactions and chemical reactions (4 marks)

(h) Give the names of any four (4) members of Group 18. (2 marks) [Total 34 marks]

[Total 34 marks]

SECTION B: Answer either question 3 or 4

- Q3** a. Define the following parameters with equations only: (i) Root Mean speed (ii) Mean free path (iii) Maxwell Boltzmann distribution Law (iv) Mean relative speed (v) Charles Law (vi) Equation of State for Ideal gases (vi) Compression factor (vii) Equation of State for real gases (viii) Van der Waal's equation (ix) Change in Gibb's free energy (x) Avogadro's principle [30mks]

b. What type of chemical bonds are formed in (i) BF_3 (ii) MgCl_2 (iii) N_2H_2 (iv) Aluminium oxide [2 mks]

c. At high enough temperature how does entropy and enthalpy vary with each other [2 mks] AlO₂

10th - 1
cocktail - 1
soda -

- Q4** a. Draw resonance hybrid structures for (i) CH_3COO^- (ii) SO_2 and (iii) nitrate ion [6 mks]
b. Using equations only describe the following experimental observations in gases (i) Relationship between pressure and volume (ii) The effect of temperature on pressure and volume (iii) The effect of the amount of gas on pressure and volume. [6 mks]
c. Using equations only (i) define the compression factor. (ii) Discuss its significance and (iii) Explain how it is interpreted. [6 mks]

c. Using equations only (i) define how it is interpreted. [6 mks]

$$F(v) = \frac{1}{2\pi B T} = \frac{1}{11C}$$

AlO_2^- Ctsolt 1000kg = 1kg = 1000g 4 AK

- d. Using suitable and well defined equations outline the three (3) methods of Gibbs free energy. [3 mks each]
e. Define the values of pure compounds at standard states for (i) ΔH_f° (ii) ΔG° (iii) ΔS° [3 mks]
f. Write plausible Lewis structure for nitrosyl chloride. [10 mks]

SECTION C: Answer either question 5 or 6

Q5. (a) State two definitions of Osmotic pressure (2 marks)

- (ii) State four limitations of the depression of freezing point method (4 marks).
(b) State the equations for determination of molecular mass using (i) lowering of vapour pressure
(ii) Elevation of boiling point (2 marks).
(iii) Why are rain drops spherical? (Not more than one sentence) (1 marks)
(c) A mixture of 0.2 mole of alcohol A and 0.5 mole of alcohol B has a total vapour pressure of 40 mmHg at 298K. If the mixture obeys Raoult's law, find the pure vapour pressure of B at 298K given that the pure vapour pressure of A is 20mmHg at 298K. (3 marks)
(d) Given that 100 mL of 2.0×10^{-4} M $\text{Ca}(\text{NO}_3)_2$ was mixed with 100 mL of 2.5×10^{-4} M NaF.
(i) What is the new concentration of Ca^{2+} after mixing? (ii) What is the new concentration of F^- after mixing? (iii) Will precipitation of CaF_2 occur after mixing? (K_{sp} of CaF_2 is 1.7×10^{-10}) (6 marks)
(e) An ideal solution made up of benzene (C_6H_6) and Toluene ($\text{C}_6\text{H}_5\text{CH}_3$) has mole fraction of benzene as 0, 0.25, 0.5, 0.75 and 1.0 at various concentrations.
- 0, 0.25, 0.5, 0.75 and 1.0 at various concentrations. (Total = 34 marks)
- (i) State the equations only for the number of moles, the mole fraction and the partial vapour pressures of the species. (3 marks)
(ii) Calculate the mole fractions of Toluene. (2 marks)
(iii) Calculate the respective partial vapour pressures of benzene and Toluene given that the pure vapour pressures are 3.6×10^4 and 1.12×10^4 Nm $^{-2}$ for benzene and Toluene respectively. (5 marks)
(iv) Calculate the total vapour pressure of the solution at these concentrations. (4 marks)
(v) Sketch on one paper a fully labeled vapour pressure-composition curve for the ideal solution. (2 marks) (Total = 34 marks)

Q6. (a) In one sentence each, define (i) Molarity (ii) Molality (iii) surface tension (3 marks). (iv) State two mathematical expressions for Raoult's law (2 marks).

- (b) State the equations for determination of molecular mass using (i) osmotic pressure (ii) Depression of freezing point. (2 marks). (iii) Calculate the total vapour pressure of a mixture of methanol (64g) and ethanol (92g) at 298K given that the pure vapour pressure of methanol is 90 mmHg and ethanol is 45 mmHg ($C = 12$, $H = 1$, $O = 16$). (4 marks).
(c) Write the solubility products constant expression for the following: (i) Silver ethanedioate (ii) Silver carbonate (iii) Lead (II) sulphate (iv) Barium sulphate. (4 marks).
(d) The solubility product of lead (II) sulphate is 1.6×10^{-8} mol 2 dm $^{-6}$. Calculate the solubility of lead (II) sulphate in: (i) Pure water (ii) 0.1M Lead (II) nitrate solution (iii) 0.01M sodium sulphate solution (8 marks).
(iv) Why is Lead (II) sulphate more soluble in (i) than in either (ii) or (iii) (2 marks).
(e) Given the reaction $\text{A(g)} + \text{B(g)} + \text{C(g)} \rightarrow \text{D(g)}$; It was discovered that:
(i) The rate at which D was formed was increased by a factor of 4 when the initial concentration of C was increased by a factor of 2; The rate at which D was formed was increased by a factor of 2 when the initial concentration of A was increased by a factor of 2; Altering the initial concentration of B, did not affect the rate at which D was formed. Considering these three statements, Write the rate law and deduce units for the rate constant if concentration is in mol dm $^{-3}$. (7 marks)
(ii) Now if the reverse reaction was studied, and the rate equation was found to be; Rate = $K[\text{D}]^2$. State the equation to calculate the time it will take 50% of D to react. If the initial concentration was doubled, how would this time respond? (2 marks) (Total = 34 marks)

GOOD LUCK

P

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retm



28 + 3 (22)

Abia State University, Uturu
Department of Industrial Chemistry
 2019/2020 Academic Session First Semester Examination
 General Chemistry I (CHE 101) (Time 2 Hours)
Instruction: Attempt ONLY ONE question from each Section

SECTION A

Q1(a). It is popularly known that $C_1V_1 = C_2V_2$ can be useful during reagent/solution preparation. Given that 8 mL of 5.2 M NaCl would be needed to prepare 0.231 M NaCl. How would the formula above be used to determine the volume of flask for the preparation? (6 marks)

1b). How many grams of the solute MgSO₄ (molar mass=120 g/mol) are required to make 65.0 mL of a solution that is 0.245 M? (6 marks)

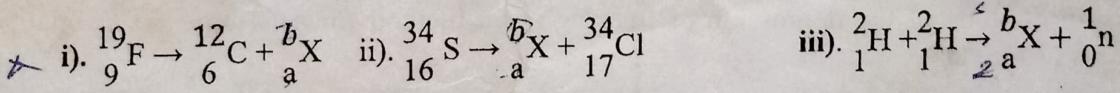
1c). Show that the same molar concentration in question (1b) above (i.e. 0.245 M) can be obtained if 0.637 g of NaOH (molar mass = 40 g/mol) is dissolved in same volume (65.0 mL) as above. (6 marks)

1d). A cobalt atom, $^{60}_{27}\text{Co}$ undergoes an alpha decay to yield $^{56}_{25}\text{Mn}$. When the manganese further undergoes two beta emissions, an isotope of cobalt is formed. Illustrate with equation the entire reaction and the isotope that is produced. (6 marks)

Q2a). John wanted to demonstrate his understanding of molality after his CHE 101 class. He placed some cubes of sugar (sucrose) weighing 110 g into 462 g of water. What would be his calculated molality (m) to 2 significant figures? Sucrose (molar mass=342 g/mol). (6 marks)

2b). Assuming he had wanted to establish the difference between molality and molarity; by formula ONLY, distinguish between molarity (M) and molality (m). (6 marks)

2c). The elements in the following nuclear reactions are among the first 20 elements in the periodic table. Identify the unknown elements or decay formed in each reaction. (6 marks)



(2d) Mention and discuss any three applications of radioisotopes. (6 marks)

SECTION B

Q3a. In one sentence explain why BF₃ with incomplete octet structure is the preferred structure. Show the structure [4mks]

3b. Which molecule is nonpolar? Show how you arrived at your answer. (a) SO₃ (b) CH₂Cl₂ (c) NH₃ (d) FNO [NB: EN for S = 2.5, O = 3.5, C = 2.5, H = 2.1, Cl = 3.0, N = 3.0, F = 4.0] [3mks]

3c. From the following species, the one with a triple covalent bond is? Draw the structure for the correct answer. (a) NO₃⁻; (b) CN⁻; (c) CO₂; (d) AlCl₃ [3mks]

3d. The formal charges on the O atoms in the ion [ONO]⁺ is? Show your workings (a) -2; (b) -1; (c) 0; (d) +1 [4mks]

3e. The following are state functions except (a) T (b) V (c) q (d) H [2mks]

3f. Identify three extensive properties and three intensive properties among the listed parameters thus; viscosity, volume, free energy, temperature, pressure, density, mass. [6mks]

3g. The physical state of a pure gas may be defined by all the following except (a) ΔG; (b) P; (c) T; (d) n (e) V. [2mks]

- Q4a.** Using equations alone with well-defined parameters, define the following (i) Pressure (ii) Dalton's law (iii) Maxwell Boltzmann distribution Law (iv) Boyles Law (v) Charles Law (vi) Equation of State for Ideal gases (vi) Compression factor (vii) Equation of State for real gases (viii) Vander Waal's equation (ix) Change in Gibb's free energy (x) Change in Enthalpy. [2mks each; Total 20 mks]

- 4b. State the sign conventions for (a) 'q' for the amount of heat added to or removed from a system. [1mks]
 And (b) 'w' for the amount of work done on or by a system. [1mks]
- 4c. What type of bonds can be used to describe the chemical bonds in BF_4^- . [1mks]
- 4c. Draw Lewis structure for two different molecules with the formula C_3H_4 and using FC show the structure with the correct arrangement [2mks]

SECTION C

- Q5.** (a) In one sentence each, define (i) Molarity (ii) Molality (2 marks)
 (b) State two mathematical expressions for Raoult's law (2 marks).
 (c) State the equations for determination of molecular mass using (i) osmotic pressure (ii) Depression of freezing point. (2 marks)

- (d) (i) In one sentence, define surface tension. (ii) What is the effect of temperature on surface tension of a liquid? (2 marks)

- (e) Find the osmotic pressure in millimetres of mercury at 15°C of a solution of Naphthalene (C_{10}H_8) in benzene containing 14g of Naphthalene per litre of solution. ($R = 0.0821 \text{ litre-atmosphere K}^{-1} \text{ mol}^{-1}$) (4 marks)

- (f) Given that 100 mL of $2.0 \times 10^{-4} \text{ M Ca}(\text{NO}_3)_2$ was mixed with 100 mL of $2.5 \times 10^{-4} \text{ M NaF}$.
 (i) What is the new concentration of Ca^{2+} after mixing? (ii) What is the new concentration of F^- after mixing? (iii) Will precipitation of CaF_2 occur after mixing? (K_{sp} of CaF_2 as 1.7×10^{-10}) (6 marks)
- (g) Given the reaction $\text{A(g)} + \text{B(g)} + \text{C(g)} \rightarrow \text{D(g)}$; It was discovered that the rate at which D was formed was increased by a factor of 4 when the initial concentration of C was increased by a factor of 2; The rate at which D was formed was increased by a factor of 2 when the initial concentration of A was increased by a factor of 2; Altering the initial concentration of B, did not affect the rate at which D was formed. Considering these three statements, (i) Write the rate law (ii) Deduce units for the rate constant if concentration is in mol dm^{-3} (6 marks) (Total = 24 marks).

- Q6.** (a) (i) In not more than two sentences, what do you understand by common ion effect? (1 mark).
 (ii) State two limitations of the depression of freezing point method for determination of relative molecular mass (2 marks).

- (b) Write the solubility products constant expression for the following: (i) Silver ethanedioate (ii) Silver carbonate (iii) Lead (II) sulphate (iv) Barium sulphate (4 marks).

- (c) The solubility product of lead (II) sulphate in water is $1.6 \times 10^{-8} \text{ mol}^2 \text{ dm}^{-6}$. Calculate the solubility of lead (II) sulphate in: (i) Pure water (ii) 0.1M Lead (II) nitrate solution (iii) 0.01M sodium sulphate solution (8 marks). (iv) Why is Lead (II) sulphate more soluble in (i) than in either (ii) or (iii) (1 mark).

- (d) (i) A mixture of 0.2 mole of alcohol A and 0.5 mole of alcohol B has a total Vapour pressure of 40 mmHg at 298K. If the mixture obeys Raoult's law, find the pure vapour pressure of B at 298K given that the pure vapour pressure of A is 20mmHg at 298K (4 marks). (ii) Given that the boiling point of water is 100°C , calculate the ebullioscopic constant for water. ($L = 2260 \text{ J g}^{-1}$; $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$) (2 marks).

- (e) The reaction $\text{A} + \text{B} + \text{C} \rightarrow \text{Products}$; was found to obey the rate law: Rate = $-d[\text{A}]/dt = k[\text{A}]^0[\text{B}]^2[\text{C}]^0$. (i) What is the overall order of reaction? (1 mark). (ii) State the equation for the half-life of the overall order of reaction (1 mark) (Total = 24 marks).

GOODLUCK

$$A_1 = \frac{W_1 k_F W_2}{M_2 W_1}$$

$$k_F$$

$$\frac{P_1}{P_2} = \frac{n_1}{n_2} = \frac{P_1}{P_2} \cdot \frac{M_2}{M_1}$$

$$\Delta V = \frac{M}{M} \cdot \frac{R T}{P} \cdot \frac{V_2 - V_1}{V_1}$$

$$\Delta H = \Delta U + P \Delta V$$

INSTRUCTIONS: (1) ANSWER ONE QUESTION IN EACH SECTION
(2) ENSURE THAT YOU HAVE REGISTERED YOUR COURSES ONLINE
(3) Time: 3 hours

Section A {Attempt all question under this section}

(1a) Using equations alone define the following; (i) Internal energy (ii) enthalpy (iii) entropy (iv) The two laws of thermodynamics that deal with entropy. (v) Entropy change of universe (vi). State the sign conventions for (a) Q, for the amount of heat added to or removed from a system and (b) W, for the amount of work done on or by a system (ix) Define the values of pure compounds at standard states for (a) ΔH° (b) ΔG° (c) S° (x) At high enough temperature how does entropy and enthalpy vary with each other? (xi) Find ΔH , ΔS and ΔG and in one sentence for each describe the implication of these values in the reaction given: $\text{NO} + \frac{1}{2}\text{O}_2 \rightarrow \text{NO}_2$. Given change in standard heat of formation for NO, O₂ and NO₂ in kJ/mol to be 90, 0 and -34 also entropy values to be 211, 205 and 240.5 respectively. [16 marks].

(1b) What type of bond can be used to describe the chemical bonds in (i) BF_3^- (ii) MgCl_2 (iii) N_2H_2 (iv) Aluminium oxide (v) NH_3 (vi) In which group of the periodic table are the elements most likely to use multiple bonds? (vii) Write plausible lewis structure for nitrosyl chloride (NOCl). [10 marks]

(1c) Using equations only describe the following experimental observations in gases (i) Relationship between pressure and volume (ii) The effect of temperature on pressure and volume (iii) The effect of the amount of gas on pressure and volume. (iv) Using equation only define the compression factor, (a) its significance and (b) how it is interpreted. (v) Using equations only define the following: (a) root mean speed (b) Mean free path (c) mean speed (d) Maxwell Boltzmann's distribution law (e) mean relative speed [8 marks]

Section B attempt either questions 3 or 4

Instruction: Use ONLY the following atomic weights in all calculation: H= 1.00794; O= 15.9994; P= 30.9738; S = 32.066; Ag= 107.870; N= 14.0067; C = 12.011; Ca= 40.078; Na=22.9898; Cl=35.453

(a) A solution is prepared by dissolving 2.22g AgNO_3 in a 500mL volumetric flask and diluting to volume. Calculate the molarity of the solution. How many millimoles of AgNO_3 were dissolved? (8 marks)(b) Methane is a principal component of natural gas. How many mole of methane are present in 8.72g of methane? (5 marks)

(c) A 1.0g sample of carbon made from wood found in an archeological site gave 7990 carbon -14 disintegrations in a 20-h period. In the same period (20-h) 1.0g of carbon from a modern source underwent 14,880 disintegrations. Calculate the age of the sample. (10 marks)

(d) Mention any five (5) radio-isotopes and their medical applications (and organs studied). (5 marks) (e) calculate the ppm by mass of calcium in a 3.05g pill that contains 45.6mg Ca. What is the full meaning of ppm? Give the unit. (6marks) [Total 34 marks]

(a) Glucose is the most important nutrient in the cell for generating chemical potential energy. (i) What is the mass percent of each element in glucose? (ii) How many grams of carbon is in 15.65g of glucose? What is the unit of molecular weight? (10 marks)

(b) Phosphoric acid is used in the manufacture of detergents, fertilizers, toothpastes and carbonated drinks. Calculate the percent composition by mass of the elements in this compound. (6 marks) (c) The approximate date of an earthquake in Mexico is to be determined by measuring the ^{14}C activity (take $t_{1/2} = 5700$ years) of parts of a tree that was uprooted during the earthquake. The tree parts have an activity of 10.9d/min.g, and a living tree has 15.3d/min.g.

What was the date of the earthquake? (12marks)(d) Derive the rate law equation $t^{1/2} = \frac{0.693}{k}$ (6 marks)

[Total 34 marks]



Abia State University, Uturu, Department of Pure and Industrial Chemistry
General Chemistry I (CHE 101) Examination 2015/2016 Academic Session
Instruction: Attempt only three (3) questions, one (1) question from each section

INSTRUCTIONS: (1) ANSWER ONE QUESTION IN EACH SECTION
(2) ENSURE THAT YOU HAVE REGISTERED YOUR COURSES ONLINE.
(3) Time: 3 hours

Section A (Attempt all question under this section)

- (1a) Using equations alone define the following; (i) Internal energy (ii) enthalpy (iii) entropy (iv) The two laws of thermodynamics that deal with entropy. (v) Entropy change of universe (vi). State the sign conventions for (a) Q, for the amount of heat added to or removed from a system and (b) W, for the amount of work done on or by a system. (ix) Define the values of pure compounds at standard states for (a) ΔH_f° (b) ΔG_f° (c) S° (x) At high enough temperature how does entropy and enthalpy vary with each other? (xi) Find ΔH , ΔS and ΔG and in one sentence for each describe the implication of these values in the reaction given: $\text{NO} + \frac{1}{2}\text{O}_2 \rightarrow \text{NO}_2$. Given change in standard heat of formation for NO , O_2 and NO_2 in kJ mol⁻¹ to be 90, 0 and -34 also entropy values to be 211, 205 and 210 J K⁻¹ respectively. [16 marks]
- (1b) What type of bond can be used to describe the chemical bond, in (i) BF_3 (ii) MgCl_2 (iii) NaH (iv) Aluminum oxide (v) NH_3 (vi) In which group of the periodic table are the elements most likely to use multiple bonds? (vii) Write plausible lewis structure for nitrosyl chloride (NOCl). [10 marks]
- (1c) Using equations only describe the following experimental observations in gases (i) Relationship between pressure and volume (ii) The effect of temperature on pressure and volume (iii) The effect of the amount of gas on pressure and volume. (iv) Using equation only define the compression factor, (a) its significance and (b) how it is interpreted. (v) Using equations only define the following: (a) root mean speed (b) Mean free path (c) mean speed (d) Maxwell Boltzmann's distribution law (e) mean relative speed [8 marks]

Section B attempt either questions 3 or 4

- (Instruction: Use ONLY the following atomic weights in all calculation: H= 1.00794; O= 15.9994; P= 30.9738; S = 32.066; Ag= 107.870; N= 14.0067; C = 12.011; Ca= 40.078; Na = 22.9898; Cl = 35.453)
- 3 (a) A solution is prepared by dissolving 2.22g AgNO_3 in a 500ml. volumetric flask and diluting to volume. Calculate the molarity of the solution. How many millimoles of AgNO_3 were dissolved? (8 marks)(b) Methane is a principal component of natural gas. How many mole of methane are present in 8.72g of methane? (5 marks)
(c) A 1.0g sample of carbon made from wood found in an archeological site gave 7990 carbon-14 disintegrations in a 20-h period. In the same period (20-h) 1.0g of carbon from a modern source underwent 14,880 disintegrations. Calculate the age of the sample. (10 marks)
- (d) Mention any five (5) radio-isotopes and their medical applications (and organs studied). (5 marks) (e) Calculate the ppm by mass of calcium in a 3.05g pill that contains 45.6mg Ca. What is the full meaning of ppm? Give the unit. (6marks) [Total 34 marks]

- 4(a) Glucose is the most important nutrient in the cell for generating chemical potential energy. (i) What is the mass percent of each element in glucose? (ii) How many grams of carbon is in 15.65g of glucose? What is the unit of molecular weight? (10 marks)
- (b) Phosphoric acid is used in the manufacture of detergents, fertilizers, toothpastes and carbonated drinks. Calculate the percent composition by mass of the elements in this compound. (6 marks) (c) The approximate date of an earthquake in Mexico is to be determined by measuring the ^{14}C activity (take $t_{\frac{1}{2}} = 5700$ years) of parts of a tree that was uprooted during the earthquake. The tree parts have an activity of 10.9 d/min.g, and a living tree has 15.3 d/min.g. What was the date of the earthquake? (12marks)(d) Derive the rate law equation $t_{\frac{1}{2}} = \frac{0.693}{k}$ (6 marks)
- [Total 34 marks]

(ii) State one reason for the occurrence of methanol (CH_3OH) explosion.

(b) Calculate the total vapour pressure of a mixture of methanol is 90 mmHg and ethanol is 90 mmHg at 298K given that the pure vapour pressure:



(c) Given the reaction $\text{A(g)} + \text{B(g)} \rightarrow \text{C(g)} + \text{D(g)}$: It was discovered that when the initial rate at which D was formed was increased by a factor of 2, the rate at which C was increased by a factor of 2. The rate at which D was increased by a factor of 2; The rate at which A was increased by a factor of 2 when the initial concentration of A was increased by a factor of 2. Derive an equation to calculate the rate at which D was formed.

(d) Altering the initial concentrations. Write the rate law and deduce units for the rate constant.

Considering these three statements. Write the rate law (10 marks).

If concentration is in mol dm⁻³, and the rate equation was studied, and the rate equation was studied.

(e) Now if the reverse reaction was studied, how would this time (derived above), respond? (6 marks)



(f) Balance the following redox reaction: Fe²⁺ + MnO₄⁻ → Mn²⁺ + H₂O + Fe³⁺ (5 marks)

(g) Balance the following redox reaction: (4 marks).

Q5. (a)(i) State two mathematical expressions for the following: (i) Silver

(ii) Write the solubility products constant expressions for the following: (ii) Barium sulphate (4 Marks).

(iii) Lead (II) sulphate (iv) Barium carbonate (iii) Lead (II) sulphate in water is 1.6×10^{-5} mol² dm⁻⁶; calculate the

(b)- The solubility product of lead (II) sulphate solution: (iii) 0.1 M lead nitrate solution; (ii) 0.1 M lead

sulphate of lead (II) sulphate in (i) pure water; (ii) 0.1 M lead nitrate solution. Comment on your results (10 Marks).

(c) Find the rate law expression and calculate the rate constant for the sodium sulphate solution. Comment on your results below (5 marks).

(d) Given the following half cells: (5 marks)

	[A] mol/dm ³	[B] mol/dm ³	[C] mol/dm ³	Initial Rate mol dm ⁻³ s ⁻¹
Expt.				0.0015
1	1.2	2.0	1.0	0.0030
2	2.4	2.0	1.0	0.0030
3	3.6	4.0	1.0	0.0120
4	2.4	4.0	2.0	

- (e) Given the following half cells:
- (i) $\text{X}_2^-(1\text{M}) + 2\text{e}^- \rightarrow \text{X}$ 0.55V
 - (ii) $\text{Y}_3^-(1\text{M}) + 3\text{e}^- \rightarrow \text{Y}$ 0.75V

ABIA STATE UNIVERSITY UTURU
DEPARTMENT OF PURE AND INDUSTRIAL CHEMISTRY
FIRST SEMESTER EXAMINATIONS 2014/2015 SESSION
CHE 101: GENERAL CHEMISTRY 1

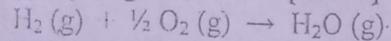
Instructions: Answer Two Questions from Each Section

Time: 3 Hrs

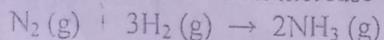
SECTION A

Q1. Using equations only define the laws of thermodynamics [3 mks]

(b) Given that the standard molar entropies of hydrogen, oxygen, and gaseous water are 131.0, 205.0 and 189.0 JK⁻¹ respectively, calculate the standard molar entropy change for the complete combustion of one mole of gaseous hydrogen at 25 °C. [4 mks]



(c) Predict whether there is an increase or decrease in entropy in the following reaction [2 mks]:



(d) An old magicube camera flash bulb that uses Mg metal sealed in bulb with oxygen. Determine the feasibility of the reaction [8 mks];

Mg	+	$\frac{1}{2} O_2$	\rightarrow	MgO
S°	32.7	205.0		26.9 J/molK
ΔH_f	0	0		-601.2 kJ/mol

Q2. In a tabular form compare and contrast between properties of Ionic, covalent and metallic compounds

(b) Fill the table below [1½ mks]

Electronegativity difference	Type of Bond
greater than or equal to 1.7	
between 1.7 and 0.3	
less than or equal to 0.3	

(c) State the Octets rule (ii) give two exception to the Octets rule [1½ mks]

(d) Write plausible Lewis structure and evaluate the formal charges for the following (i) COCl₂ (ii) CH₃CHO (iii) NO⁺ (iv) N₂H₅⁺ (v) O₂⁻ (vi) BF₄⁻ [14 mks]

Q3. Using equations only state the following terminologies and define each terms in them; (i) Maxwell – Boltzmann distribution equation (ii) mean speed (iii) mean relative speed (iv) mean free path (v) most probable speed (vi) root mean speed. [6 mks]

(b) State and define the terms in equation of state. Explain (i) the conditions under which the equation of state fails (ii) why it fails. (iii) Using equations only, state how deviations of a real gas from an ideal gas behavior may be quantified. (vi) what information can one get from quantifying the deviation, and how can this information be estimated. [8 mks]

(c) Using equations only, state the viral equation of state and define each term in it. (b) state the van der waal's equation, define each term, and show how the equation expressed in terms of molar volume can be obtain. [3 mks]

SECTION B

4(a) Transfer the Table below into your answer booklet and fill the vacant spaces (8 marks)

Type of decay	Emission	Typical balanced equation	Change in		
			A	Z	N
β^- decay					
α decay					
Positron decay					
Electron capture					

(b) Gaseous SO₂ is created by combustion of sulfur-containing fuels, especially coal. Explain how SO₂ in the atmosphere makes acidic rain. Propose reaction equations. (3 marks)

(c) An ancient wooden artifact has a specific activity of 5.24 d/min·g, how old is the artifact? Assume the ratio of ¹⁴C/¹²C in a living plant has a specific activity of 15.3 d/min·g. (4 marks)

(d) The stability of a nuclide is determined by two factors. Name them. (2 marks) [Total 17 marks]

$$\begin{aligned} C_0 &= D_0 e^{-\lambda t} \\ D_n &= D_0 e^{-\lambda t} = D_0 \times K_t \\ D_n &= D_0 \times K_t = (5.24) \times 0.613 \quad t_{1/2} = 5720 \quad K_t = 2.23 \end{aligned}$$

- CH_3OH $\text{CH}_3\text{C}_2\text{H}_5\text{OH}$ 146
- (a) Typical seawater contains 2.7 g of salt (sodium chloride, NaCl) per 100 mL ($= 100 \times 10^{-3}$ L). What is the molarity of NaCl in the ocean? (4 marks)
- (b) Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is the most important nutrient in the cell for generating chemical potential energy. (i) Calculate the mass percent of each element in glucose. (ii) How many grams of carbon are in 16.56g of glucose? (5 marks)
- (c) Name any six (6) isotopes and give their half lives: (3 marks)
- (d) Briefly discuss the topic 'artificial disintegration' and use any four (4) equations for illustration. (5 marks) [Total 17 marks]

- 6(a) Briefly discuss the following (Use an equation each for illustration): (i) spontaneous nuclear fission (ii) induced nuclear fission. (6 marks)
- (b) MgCl_2 has a concentration of 0.054 M in the ocean. How many grams of MgCl_2 are present in 25 mL of seawater? (4 marks)
- (c) Derive the equation $0.6932 = kt_{1/2}$ (or $t_{1/2} = 0.6932/k$) (5 marks)
- (d) What numbers are referred to as Magic Numbers? (2 marks) [Total 17 marks]

SECTION C

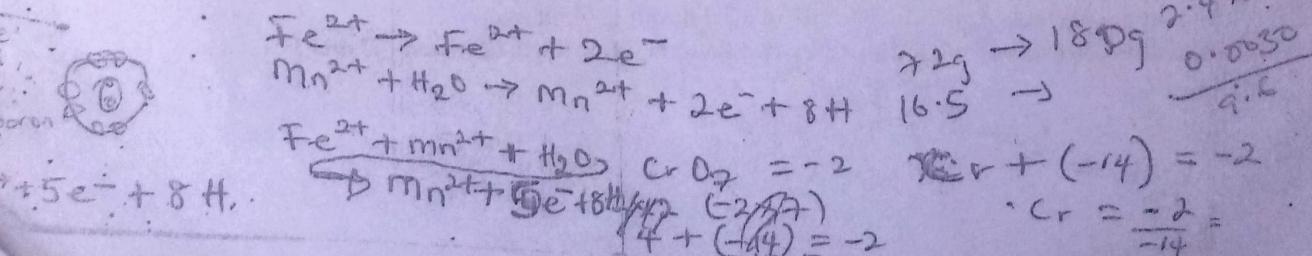
- Q7. (a) (i) State two definitions of Osmotic pressure (2 marks)
- (ii) In not more than 10 sentences, what do you understand by common ion effect? (2 marks)
- (b) (i) Balance the following redox reaction.
- $$\text{Fe}^{2+} + \text{MnO}_4^- \rightarrow \text{Mn}^{2+} + \text{H}_2\text{O} + \text{Fe}^{3+}$$
- (4 Marks)
- (ii) A mixture of 0.2 mole of alcohol A and 0.5 mole of alcohol B has a total Vapour pressure of 40 mmHg at 298K. If the mixture obeys Raoult's law, find the pure vapour pressure of B at 298K given that the pure vapour pressure of A is 20 mmHg at 298K (4 marks).
- (c) Given that the rate law for the reaction $\text{D(g)} \rightarrow \text{A(g)} + \text{B(g)} + \text{C(g)}$ is Rate = $K[\text{D}]^2$. Derive an equation from first principle to calculate the time it will take 50% of the initial reactant to react. If the initial concentration was doubled, how would this time (derived above) respond? (6 marks).

- Q8. (a) (i) Define surface tension and state one reason for its occurrence in liquids (2 marks).
- (ii) Given that the boiling point of water is 100°C , calculate the ebullioscopic constant for water: ($L = 2260 \frac{\text{J}}{\text{g}}$; $R = 8.314 \frac{\text{Jmol}^{-1}\text{K}^{-1}}$).
- (b) (i) What is the change in oxidation number of chromium from $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} (2 marks).
- (ii) An aqueous solution contains 1.00 g/L of a derivative of the detergent Lauryl alcohol. The osmotic pressure of this solution at 25°C is $2.0 \times 10^2 \text{ Nm}^{-2}$. What is the molar mass of the detergent ($R = 8.314 \frac{\text{Jmol}^{-1}\text{K}^{-1}}$) (5 marks).
- (c) Find the rate law expression and calculate the rate constant for the data below (5 marks).

Expt	[A] mol/dm ³	[B] mol/dm ³	[C] mol/dm ³	Initial Rate mol dm ⁻³ s ⁻¹
1	1.2	2.0	1.0	0.0015
2	2.4	2.0	1.0	0.0030
3	2.4	4.0	1.0	0.0030
4	2.4	4.0	2.0	0.0120

- Q9 (a) State (i) two mathematical expressions for Raoult's law (2 marks).
- (ii) four limitations of the depression of freezing point method for determination of relative molecular mass (4 marks).
- (b) (i) Calculate the oxidation number of sulphur in $\text{Na}_2\text{S}_4\text{O}_6$ (2 marks)
- (ii) Calculate the total vapour pressure of a mixture of methanol (64g) and ethanol (92g) at 298K given that the pure vapour pressure of methanol is 90 mmHg and ethanol is 45 mmHg ($C = 12$, $H = 1$, $O = 16$) (4 marks).
- (c) Determine the order of the reaction and the value of the rate constant for the reaction $\text{A} \rightarrow \text{B} + \text{C}$ using the data below (Don't plot any graph) (6 marks).

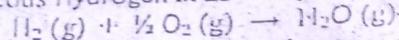
Time (min)	0	40	80	150	240	500	1000	$\frac{0.0030}{(2.4)(20)}$
Cone [A] (mol)	0.100	0.087	0.0769	0.064	0.0526	0.0348	0.021	



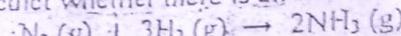
Instructions: Answer Two Questions from Each Section

SECTION A

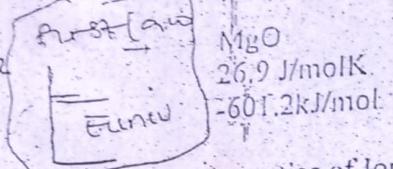
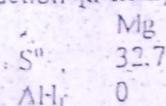
Using equations only define the laws of thermodynamics [3 mks] \rightarrow 1st law = $\Delta U = q + w$
 Given that the standard molar entropies of hydrogen, oxygen, and gaseous water are 131.0, 205.0 and 167.0 $J K^{-1}$ respectively, calculate the standard molar entropy change for the complete combustion of one mole of gaseous hydrogen at 25 °C. [4 mks]



(c) Predict whether there is an increase or decrease in entropy in the following reaction [2 mks]:



(d) An old magicube camera flash bulb that uses Mg metal sealed in bulb with oxygen. Determine the feasibility of the reaction [8 mks];



1st law \rightarrow Entropy of reaction

2nd law \rightarrow Entropy of system

Q2. In a tabular form compare and contrast between properties of ionic, covalent and metallic bonds [2 mks]

(b) Fill the table below [1½ mks]

Electronegativity difference

greater than or equal to 1.7

Type of Bond

Ionic

between 1.7 and 0.3

Covalent

less than or equal to 0.3

Polar Covalent

non-polar Covalent

(c) State the Octet rule (ii) give two exception to the Octet rule [1½ mks]

(d) Write plausible Lewis structure and evaluate the formal charges for the following (i) COCl₃ (ii) CH₃NO₂ (iv) N₂H₅⁺ (v) O₂ (vi) BP₃ [14 mks]

(e) Using equations only state the following terminologies and define each terms in them (i) Maxwell-Boltzmann distribution equation (ii) mean speed (iii) mean relative speed (iv) mean free path (v) most probable speed (vi) mean speed [6 mks]

(b) State and define the terms in equation of state. Explain (i) the conditions under which the equation of state fails, (ii) why it fails, (iii) Using equations only, state how deviations of a real gas from an ideal gas behavior may be quantified. (vi) what information can one get from quantifying the deviation, and how can this information be estimated. [8 mks]

(c) Using equations only, state the virial equation of state, and define each term in it. (b) state the van der Waals equation, define each term, and show how the equation expressed in terms of molar volume can be obtained [3 mks]

SECTION B

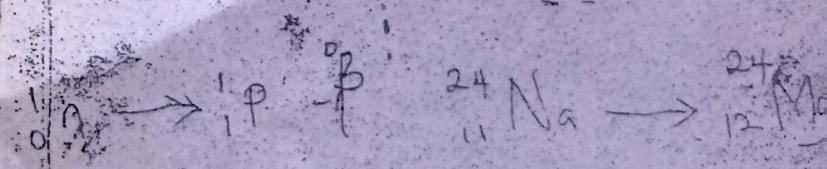
4(a) Transfer the Table below into your answer booklet and fill the vacant spaces (8 marks)

Type of decay	Emission	Typical balanced equation	Change in A	Change in Z
β^- -decay	${}^{37}_{17}Cl \rightarrow {}^{37}_{18}Ar + {}^{0}_{-1}e$	${}^{37}_{17}Cl \rightarrow {}^{37}_{18}Ar + {}^{0}_{-1}e$	-1	+1
α -decay	${}^{238}_{90}U \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$	${}^{238}_{90}U \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$	-2	+2
Positron decay				
Electron capture				

(b) Gaseous SO₂ is created by combustion of sulfur-containing fuels, especially coal. Explain how SO₂ in the atmosphere makes acidic rain. Propose reaction equations. (3 mks)

(c) An ancient wooden artifact has a specific activity of 5.24 d/min/g, how old is the artifact? Assume the ratio of ¹⁴C/¹²C in a living plant has a specific activity of 15.3 d/min/g. (4 marks)

(d) The stability of a nuclide is determined by three factors. Name them. (2 marks) [Total 12 marks]



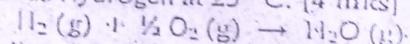
ABIA STATE UNIVERSITY UTURU
DEPARTMENT OF PURE AND INDUSTRIAL CHEMISTRY
FIRST SEMESTER EXAMINATIONS 2014/2015 SESSION
CHE 101: GENERAL CHEMISTRY I

Instructions: Answer Two Questions from Each Section

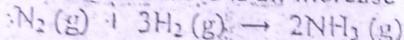
Time: 3 Hrs

SECTION A ✓

1. Using equations only define the laws of thermodynamics [3 mks] → $\Delta U = q + w$
 2. Given that the standard molar entropies of hydrogen, oxygen, and gaseous water are 131.0, 205.0 and 188.9 $J K^{-1}$ respectively, calculate the standard molar entropy change for the complete combustion of one mole of gaseous hydrogen at 25°C. [4 mks]

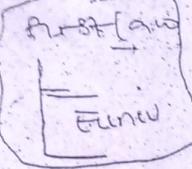


- c) Predict whether there is an increase or decrease in entropy in the following reaction [2 mks]:



- d) An old magicube camera flash bulb that uses Mg metal sealed in bulb with oxygen. Determine the feasibility of the reaction [8 mks]:

Mg	+	$\frac{1}{2} O_2$	<i>Reactants</i>	MgO	<i>Products</i>
S°	32.7	205.0		26.9 J/mol.K	
ΔH°f	0	0		-601.2 kJ/mol	



1st law $\Delta U = q + w$
2nd law $\Delta S = \frac{\Delta H - \Delta U}{T}$

1st law $\Delta S = \frac{\Delta H - \Delta U}{T}$
2nd law $\Delta S = \frac{\Delta H - \Delta U}{T}$

- Q2. In a tabular form compare and contrast between properties of ionic, covalent and metallic compounds.

- b) Fill the table below [1½ mks]

Electronegativity difference

	Type of Bond
greater than or equal to 1.7	Ionic
between 1.7 and 0.3	Polar Covalent
less than or equal to 0.3	Covalent Non Polar Covalent

- c) State the Octet rule (ii) give two exception to the Octet rule [1½ mks]

- d) Write plausible Lewis structure and evaluate the formal charges for the following (i) $COCl_3$ (ii) CH_3^+ (iii) NO^- (iv) $N_2H_5^+$ (v) O_2^- (vi) BP_3^- [14 mks]

- e) Using equations only state the following terminologies and define each terms in them (i) Maxwell-Boltzmann distribution equation (ii) mean speed (iii) mean relative speed (iv) mean free path (v) most probable speed and mean speed [6 mks]

- f) State and define the terms in equation of state. Explain (i) the conditions under which the equation of state fails. (ii) why it fails. (iii) Using equations only, state how deviations of a real gas from an ideal gas behavior may be quantified. (iv) what information can one get from quantifying the deviation, and how can this information be estimated. [8 mks]

- g) Using equations only, state the van der Waals equation of state and define each term in it. (b) state the van der Waals equation, define each term, and show how the equation expressed in terms of molar volume can be obtained. [5 mks]

SECTION B ✓

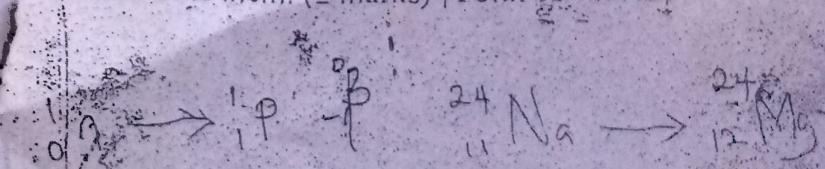
- 4(a) Transfer the Table below into your answer booklet and fill the vacant spaces (8 marks)

Type of decay	Emission	Typical balanced equation	Change in		
			A	Z	N
β^- decay	$^{37}Cl \rightarrow ^{37}Ar + e^-$	$^{37}Cl \rightarrow ^{37}Ar + e^-$	+1	-1	
α -decay	$^{238}U \rightarrow ^{234}Th + ^{4}He$	$^{238}U \rightarrow ^{234}Th + ^{4}He$	-2	-2	
Positron decay					
Electron capture					

- (b) Gaseous SO_2 is created by combustion of sulfur-containing fuels, especially coal. Explain how SO_2 in the atmosphere makes acidic rain. Propose reaction equations. (3 mks)

- (c) An ancient wooden artifact has a specific activity of 5.24 d/min/g, how old is the artifact? Assume the ratio $^{14}C/^{12}C$ in a living plant has a specific activity of 15.3 d/min/g. (4 marks)

- (d) The stability of a nuclide is determined by factors. Name them. (2 marks) [Total 12 marks]



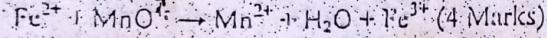
- (d) (i) Whether the following form...
 (ii) ...specie...
 (iii) ...form...
 (iv) ...specie...
- (b) Glucose ($C_6H_{12}O_6$) is the most important nutrient in the cell for generating chemical potential energy. Calculate the mass percent of each element in glucose. (4 marks)
- (c) Name any six (6) isotopes and give their half-lives. (3 marks)
- (d) Briefly discuss the topic 'artificial disintegration' and use any four (4) equations for illustration. (5 marks)
 [Total: 17 marks]

- Q6. (a) Briefly discuss the following (Use an equation each for illustration): (i) spontaneous nuclear fission (ii) nuclear fission. (6 marks)
- (b) $MgCl_2$ has a concentration of 0.054 M in the ocean. How many grams of $MgCl_2$ are present in 25 mL of seawater? (4 marks)
- (c) Derive the equation $0.6932 = kt_1/2$ (or $t_{1/2} = 0.6932/k$). (5 marks)
- (d) What numbers are referred to as Magic Numbers? (2 marks) [Total: 17 marks]

SECTION C

- Q7. (a) (i) State two definitions of Osmotic pressure (2 marks)
 (ii) In not more than 10 sentences, what do you understand by common ion effect? (2 marks).

- (b) (i) Balance the following redox reaction.



- (ii) A mixture of 0.2 mole of alcohol A and 0.5 mole of alcohol B has a total vapour pressure of 40 mmHg at 298K. If the mixture obeys Raoult's law, find the pure vapour pressure of B at 298K given that the pure vapour pressure of A is 20 mmHg at 298K. (4 marks).
- (c) Given that the rate law for the reaction $D(g) \rightarrow A(g) + B(g) + C(g)$ is $\text{Rate} = k[D]^2$. Derive an equation from first principle to calculate the time it will take 50% of the initial reactant to react. If the initial concentration was doubled, how would this time (derived above) respond? (6 marks).

- Q8. (a) Define surface tension and state one reason for its occurrence in liquids (2 marks).

- (b) Given that the boiling point of water is 100°C , calculate the ebullioscopic constant for water. ($L = 2260 \text{ J/g}$, $8.314 \text{ J mol}^{-1}\text{K}^{-1}$).

- (b) (i) What is the change in oxidation number of chromium from $Cr_2O_7^{2-}$ to Cr^{3+} ? (2 marks).
 (ii) An aqueous solution contains 1.00 g/L of a derivative of the detergent lauryl alcohol. The osmotic pressure of this solution at 25°C is $2.0 \times 10^4 \text{ N m}^{-2}$. What is the molar mass of the detergent ($R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$)? (5 marks)
- (c) Find the rate law expression and calculate the rate constant for the data below (5 marks).

Expl	[A] mol/dm ³	[B] mol/dm ³	[C] mol/dm ³	Initial Rate mol dm ⁻³ s ⁻¹
1	1.2	2.0	1.0	0.0015
2	2.4	2.0	1.0	0.0030
3	2.4	4.0	1.0	0.0030
4	2.4	4.0	2.0	0.0120

- Q9. (a) State (i) two mathematical expressions for Raoult's law (2 marks).

- (ii) Four limitations of the depression of freezing point method for determination of relative molecular mass (4 marks).

- (b) (i) Calculate the oxidation number of sulphur in $Na_2S_4O_6$ (2 marks).
 (ii) Calculate the total vapour pressure of a mixture of methanol (64g) and ethanol (92g) at 298K given that the vapour pressure of methanol is 90 mmHg and ethanol is 45 mmHg ($C = 12$, $H = 1$, $O = 16$) (4 marks).
 (c) Determine the order of the reaction and the value of the rate constant for the reaction $A \rightarrow B + C$ using the data below (Don't plot any graph) (6 marks).

Time (min)	0	40	80	150	240	500	1000
Cone [A] (mol)	0.100	0.087	0.0769	0.064	0.0526	0.0348	0.021

states that element gain or lose electron

attain electronic configuration of next noble gas