

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

**FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF
SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION**

CHEM 102: GENERAL INORGANIC AND PHYSICAL CHEMISTRY**STREAMS: BSC****TIME: 2 HOURS****DAY/DATE: WEDNESDAY 16/12/2020****8.30 A.M. – 10.30 A.M.****INSTRUCTIONS**

- Answer question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- a) Define the following terms (2 marks)
- Isotopes
 - Mass number
- b) Copper is made of two isotopes. Copper-63 is 69.17% abundant and it has a mass of 62.9296 amu. Copper-65 is 30.83% abundant and it has a mass of 64.9278 amu. Calculate the weighted average mass of the two isotopes. (2 marks)
- c) A sample of gas has an initial volume of 158 mL at a pressure of 735 mm Hg and a temperature of 34°C. If the gas is compressed to a volume of 108 mL and heated to a temperature of 85°C, calculate its final pressure in millimeters of mercury. (3 marks)
- d) Consider the following species; Na; Ni; F⁻
- Write the ground state electronic configuration for each of the species (3 marks)
 - Write the orbital diagram for Na and Ni (2 marks)
- e) State the four quantum numbers and describe their significance. (4 marks)

- f) Nitrogen dioxide (NO) is a component of urban smog that forms from gases in car exhaust. Determine the number of molecules present in 8.92 g of nitrogen dioxide. (3 marks)
- g) Anabolic steroids are sometimes used illegally by athletes to increase muscle strength. A forensic chemist analyzes some tablets suspected of being a popular steroid. He determines that the substance in the tablets contains only C, H, and O and has a molar mass of 300.42 g/mol. When a 1.200-g sample is studied by combustion analysis, 3.516 g of CO₂ and 1.007 g of H₂O are collected. Determine the empirical and molecular formulae of the substance in the tablets. (6 marks)
- h) Briefly discuss the covalent bonding. (2 marks)
- i) Calculate the pH of sodium hydroxide solution in which [OH⁻] = 3.5 × 10⁻³ M. (3 marks)

QUESTION TWO (20 MARKS)

- a) The reaction N₂O₄ (g) ⇌ 2NO₂ (g) is endothermic, with ΔH = +56.9 KJ. Explain how the amount of NO₂ at equilibrium will be affected by; (4 marks)
- By adding N₂O₄
 - Lowering the pressure by increasing the volume of the container.
 - Raising the temperature
 - Adding a catalyst to the system
- b) For the reaction CO (g) + H₂O (g) ⇌ CO₂ (g) + H₂ (g), the equilibrium constant (K_c) at 800K is 4.24. Calculate the equilibrium concentrations of CO₂, H₂, CO and H₂O at 800 K, if only CO and H₂O are present initially at concentrations of 0.10 M each. (5 marks)
- c) Identify the acid, base, conjugate acid and the conjugate base in the following reaction. (2 marks)
- $$\text{HI (g)} + \text{NH}_3 \text{ (g)} \rightleftharpoons \text{NH}_4^+ \text{ (aq)} + \text{I}^- \text{ (aq)}$$
- d) Given that K_w = 1.0 × 10⁻¹⁴, calculate at 25°C;
- the [H⁺] and pH of a tap water sample in which [OH⁻] = 2.0 × 10⁻⁷ (3 marks)
 - the [H⁺] and [OH⁻] of human blood at pH 7.40. (3 marks)
 - the pOH of a solution in which [H⁺] = (5.0)[OH⁻]. (3 marks)

QUESTION THREE (20 MARKS)

- a(i) Draw Lewis structures of the following molecules/ions (i) H₂S (ii) SO₃ (iii) CO₂ (iv) BF₃ (v) NO₃⁻ (5 marks)
- (ii) Determine the molecular geometry of (i) CO₂ (ii) H₂S (iii) BF₃ (3 marks)
- (iii) Draw the resonance structures for NO₃⁻ (1 mark)
- b) State the postulates of Bohr's model of an atom. (3 marks)

- c) Calculate the wavelength in nanometers of a transition in a hydrogen atom from $n=5$ to $n=2$ ($R_H = 1.097 \times 10^{-2} \text{ nm}^{-1}$) (2 marks)
- d) Explain briefly how the following properties of the elements vary across a period and down a group in the periodic table (6 marks)
- Atomic radius
 - Ionization energy
 - Electronegativity

QUESTION FOUR (20 MARKS)

- a) Derive the ideal gas law, explaining each term as used in the equation. (3 marks)
- b) A student collected a sample of a gas in a 220 ml gas bulb until its pressure reached 575 torr at a temperature of 25.0°C . Its mass was found to be 0.299g. What is the molecular mass of the gas? {1atm=760 torr, 1ml= 10^{-3} L, $R=0.0821 \text{ L atm mol}^{-1}\text{K}^{-1}$ } (3 marks)
- c) Explain how the real gases deviate from the ideal gasses in obeying the ideal gas law. (4 marks)
- d) (i) Differentiate between molarity and molality (2 marks)
- (ii) Calculate the concentration of a solution formed by diluting 0.850 L of a 5.0 M glucose solution to 1.80L. (2 marks)
- (iii) If 0.025 gram of $\text{Pb}(\text{NO}_3)_2$ is dissolved in 100 grams of H_2O , calculate the concentration of the resulting solution, in parts per million (2 marks)
- e) Calculate the pH of 0.10 M acetic acid (CH_3COOH which can be simplified to HAc). Given that the dissociation constant for acetic acid is, $K_a = 1.8 \times 10^{-5}$ (4 marks)
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1 H Hydrogen 1.008	2 He Helium 4.003	<p>Atomic Number — 6 Symbol — C Name — Carbon Average Atomic Mass — 12.011</p> <p>metals — nonmetals — metalloids — </p>																																																																																							
3 Li Lithium 6.94	4 Be Beryllium 9.012	5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	11 Na Sodium 22.990	12 Mg Magnesium 24.305	13 Al Aluminum 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948	19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.97	35 Br Bromine 79.904	36 Kr Krypton 83.798	37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.904	54 Xe Xenon 131.298	55 Cs Cesium 132.905	56 Ba Barium 137.327	57-70 *	71 Lu Lutetium 174.967	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]	87 Fr Francium [223]	88 Ra Radium [226]	89-102 **	103 Lr Lawrencium [262]	104 Rf Rutherfordium [261]	105 Db Dubnium [270]	106 Sg Seaborgium [289]	107 Bh Bohrium [270]	108 Hs Hassium [270]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [281]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [293]	118 Og Oganesson [294]
*lanthanide series		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.045																																																																										
** Actinide series		89 Ac Actinium [227]	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]																																																																										