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)
   i. Isotopes
   ii. 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 34ºC. If the gas is compressed to a volume of 108 mL and heated to a temperature of 85ºC, calculate its final pressure in millimeters of mercury. (3 marks)

d) Consider the following species; Na; Ni; F^-
   i. Write the ground state electronic configuration for each of the species (3 marks)
   ii. 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 CO_2 and 1.007 g of H_2O 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 $[OH^-] = 3.5 \times 10^{-3}$ M. (3 marks)

QUESTION TWO (20 MARKS)

a) The reaction N_2O_4 (g) ⇌ $2NO_2$ (g) is endothermic, with ΔH = +56.9 KJ. Explain how the amount of NO_2 at equilibrium will be affected by; (4 marks)

(i) By adding N_2O_4
(ii) Lowering the pressure by increasing the volume of the container.
(iii) Raising the temperature
(iv) Adding a catalyst to the system

b) For the reaction CO (g) + H_2O (g) ⇌ CO_2 (g) + H_2 (g), the equilibrium constant (Kc) at 800K is 4.24. Calculate the equilibrium concentrations of CO_2, H_2, CO and H_2O at 800 K, if only CO and H_2O 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)
HI (g) + NH_3 (g) ⇌ NH_4^+(aq) + I^-(aq)

d) Given that $K_W = 1.0 \times 10^{-14}$, calculate at 25°C;

i. the $[H^+]$ and pH of a tap water sample in which $[OH^-] = 2.0 \times 10^{-7}$ (3 marks)
ii. the $[H^+]$ and $[OH^-]$ of human blood at pH 7.40. (3 marks)
iii. 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) H_2S (ii) SO_3 (iii) CO_2 (iv) BF_3 (v) NO_3^- (5 marks)

(ii) Determine the molecular geometry of (i) CO_2 (ii) H_2S (iii) BF_3 (3 marks)

(iii) Draw the resonance structures for NO_3^- (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 = 1.097×10^{-2} 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)

i. Atomic radius
ii. Ionization energy
iii. 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 L atm $mol^{-1}K^{-1}$} (3 marks)

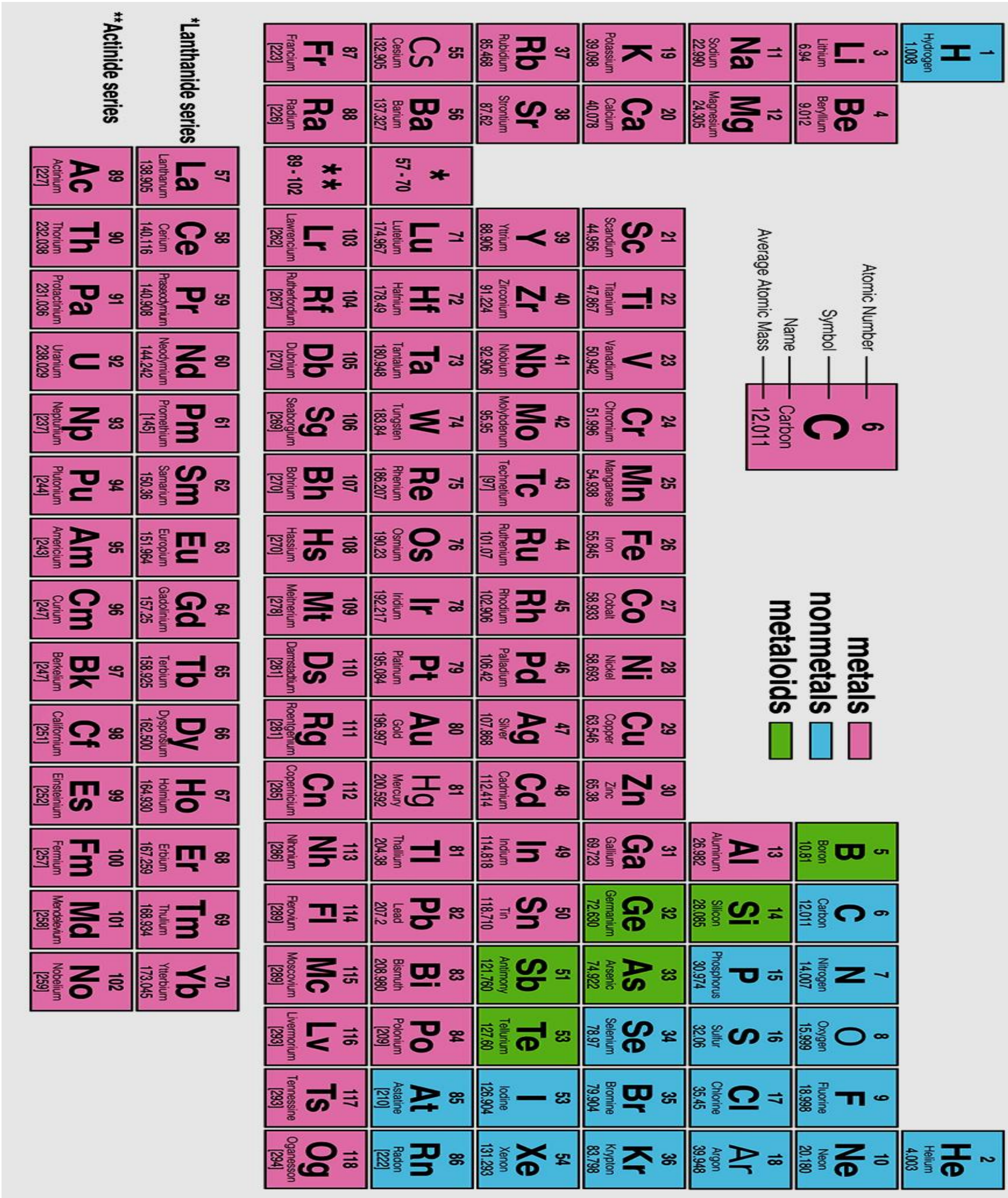
c) Explain how the real gases deviate from the ideal gasses in obeying the ideal gas law. (4 marks)

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 $Pb(NO_3)_2$ 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, Ka = 1.8×10^{-5} (4 marks)


Atomic Number
Symbol
Name
Average Atomic Mass
6
C
Carbon
12.011
metals
nonmetals
metaloids
*Lanthanide series
**Actinide series