CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

RESIT/SPECIAL EXAMINATION

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

CHEM 102: GENERAL INORGANIC AND PHYSICAL CHEMISTRY

SREAMS: BSC (AGED, AGEC, AGRIC, FOST, ENSC, NARE, WIEM, ANSC & HORT TIME: 2 HOURS

DAY/DATE: TUESDAY 17/11/2020 5.00 P.M. – 7.00 P.M.

INSTRUCTIONS: Answer ALL questions

QUESTION ONE (30 MARKS)

a) Define the following terms (2 marks)
  i. Atomic number
  ii. Mass number

b) State the postulates of Dalton's atomic theory. (3 marks)

c) Bromine has two naturally occurring isotopes. One of them, Br-79 has a mass of 78.9183 amu and an abundance of 50.69%. Calculate the mass of the other isotope (Br-81). If the atomic mass of Br is 79.904 amu. (3 marks)

d) An organic compound contains 74.0% C, 8.60% H and 17.4% N. determine the empirical formula for the compound. (4 marks)

e) Carbon monoxide absorbs energy with a frequency of 6.5×10^{10} s^{-1}. (4 marks)
  (i) What is the wavelength (in nm) of the absorption?
  (ii) What is the energy absorbed by one photon?

f) Consider the following reaction.
  $H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$
  (i) Write the expression for the equilibrium constant (Kc) (1 mark)
  (ii) Calculate Kc using the following concentrations of each substance at equilibrium: $[H_2] = 0.95$ M; $[I_2] = 0.78$ M; $[HI] = 0.27$ M. (2 marks)

g) (i) State the Avogadro's law (1 mark)

(ii) A 4.8-L sample of helium gas contains 0.22 mol of helium. How many additional moles of helium gas must be added to the sample to obtain a volume of 6.4 L? Assume constant temperature and pressure. (3 marks)

h) Calculate the pH of a urine sample that has an H_3O^+ concentration of 1.0×10^{-5} M. and classify the solution as acidic, basic, or neutral. (3 marks)

i) Wine is produced by the fermentation of grapes. In fermentation, the carbohydrate glucose ($C_6H_{12}O_6$) is converted to ethanol and carbon dioxide according to the given balanced equation. How many grams of ethanol (C_2H_6O, molar mass 46.1 g/mol) are produced from 5.00 mol of glucose? (4 marks)

$$\underset{\text{glucose}}{C_6H_{12}O_6(aq)} \longrightarrow 2\,\underset{\text{ethanol}}{C_2H_6O(aq)} + 2\,CO_2(g)$$

QUESTION TWO (20 MARKS)

a) Consider the following species; CO_3^{2-}; PF_3; BF_3; CO_2; IF_5

(i) Write the Lewis structure of each of the species (5 marks)

(ii) Determine the molecular geometries of PF_3; BF_3 and CO_2 (3 marks)

(iii) Write the resonance forms of CO_3^{2-} (2 marks)

b) Use the half-reaction method to balance the following redox equation (5 marks)
$ClO_3^-(aq) + I^-(aq) \rightarrow I_2(s) + Cl^-(aq)$ (acidic conditions)

c) Calculate the concentration of H_3O^+ and OH^- in a beverage that has a pH of 3.15. (5 marks)

QUESTION THREE (20 MARKS)

a) State the four quantum numbers (2 marks)

b) Given the following sets of electron quantum numbers, indicate those that could not occur and justify your rationale (4 marks)

(i) (3, 0, 0, -$^1/_2$) (ii) (2, 2, 1, -$^1/_2$) (iii) (3, 2, 1, +$^1/_2$) (iv) (4, 2, -2, 0)

c) The periodic table shows the arrangement of elements according to the atomic numbers.

(i) Explain what elements in the same group have in common (2 marks)

(ii) Explain what elements in the same period have in common. (2 marks)

(iii) Explain why metals are generally electropositive while nonmetals are electronegative (2 marks)

d) Calculate the moles of gas contained in a typical human breath that takes in 0.50 L of air at 1.0 atm pressure and 37 °C (3 marks)

e) The following data were measured for the reduction of nitric oxide with hydrogen
$2NO\ (g) + 2H_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g)$

Initial concentration (mol L^{-1})		Initial rate of formation of
[NO]	[H_2]	$(CH_3)_3COOH$ (mol $L^{-1}S^{-1}$)
0.10	0.10	1.23×10^{-3}
0.10	0.20	2.46×10^{-3}
0.20	0.10	4.92×10^{-3}

Determine the rate law for the reaction (5 marks)
