BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. in Environmental, Water Resources, and Coastal Engineering , Term Final (Sprin) Examination 2023: Jul-Sep 2023

Student Group: 0 <Earned Credit Hours ≤ 36

Subject:CHEM-101, Fundamentals of Chemistry

Time: 3.00 hours **Full Marks: 180**

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. **Question-1** in **Section-A** and **Question-5** in **Section-B** are compulsory
c. Answer any other **TWO** questions out of **THREE** from each section.
d. Figures in the margin indicate full **marks**.
e. Assume reasonable data if necessary.
f. **Symbols** and **abbreviations** used have their usual meanings.

SECTION-A

Question 1 (Compulsory)

a. Define α-particles. Discuss how can we get the idea of nucleus in an atom from α-particle scattering experiment. **2+8 = 10**

b. Derive the equation used to calculate the radius of an orbit in an atom. Calculate the first Bohr radius using the derived equation. (Given h = 6.625×10^{-27} erg sec, m = 9.109×10^{-28} g, e = 4.8×10^{-10} esu) **8+2 = 10**

c. State Heisenberg uncertainty principle. Explain, 'Pauli's exclusion principle is of immense value in telling the maximum number of electrons accommodate in any shell'. **2+8 = 10**

Question 2

a. Explain the LCAO (Liner combination of atomic orbital) method used in molecular orbital theory (MOT). Define bond order and discuss the significances of bond order according to MOT with an example. **4+2+3 = 09**

b. Define hybridization. Identify the hybridization of the central atom of the following molecules and discuss about the shapes of the molecules using appropriate theories involved. **1+5×2 = 11**

i) $CH_2=CH_2$ ii) H_2O

c. Explain that O_2^+ is paramagnetic in nature where as O_2^- is diamagnetic based on MOT. **10**

Question 3

a. Define buffer solution. Discuss the types of buffer solution. **2+4 = 06**

b. Discuss how an acidic buffer resist the change of pH of a solution upon addition of a small amount of HCl and NaOH. **10**

c. Define pH. Describe how can we measure the pH of a solution using a pH meter. **10**

d. Sketch a pH titration curve of a weak base and strong acid. Indicate the end point in the curve. **04**

Question 4

a. State the modern periodic law. Classify elements in the periodic table based on their electronic configuration. 2+8 = 10

b. Discuss the mechanism of free radical substitution reaction with suitable example. 05

c. Explain ,"Though carbonyl group (=C=O) is electron rich it gives nucleophilic addition reaction." 05

d. Complete the following reaction with proper explanation. 04

$$CH_3 - CH = CH_2 + HBr \rightarrow A\ (80\%) + B\ (20\%)$$

e. Discuss the factor effects on the S_N reaction mechanism. 06

SECTION-B

Question 5 (Compulsory)

a. Define colligative properties and why are they called so? From Raoult's law show that $\frac{Po-Ps}{Po} = \frac{n}{n+N}$; where the symbols have their usual meaning. 2+8 = 10

b. Explain freezing point depression with an appropriate diagram. 10

c. 0.440 g of a substance dissolved in 22.2 g of benzene lowered the freezing point of benzene by 0.567 ^{0}C. Calculate the molar mass of the substance. ($K_f = 5.12\ ^0C\ mol^{-1}$). 05

d. Define solubility curves. Explain why are some of the solubility curves discontinues. 2.5+2.5 = 05

Question 6

a. Define order, molecularity and half-life of a reaction. Justify that half-life of a first order reaction is independent of initial concentration. 6+4 = 10

b. Deduce integrated form of rate equation for a second order reaction, when the reactant concentration is same. 06

c. A second order reaction is 25% completed in 1200 s. Calculate the time required for the reaction for 75% completion. 05

d. State and explain the collision theory of reaction rate. Mention some important limitations of the theory. 6+3 = 09

Question 7

a. Write down the salient features of chemical equilibrium. Correlate with Kp and Kc. 4+5 = 09

b. Define Gibb's free energy. Derive the equation $\frac{\delta(lnKp)}{\delta T} = -\frac{\Delta H_0}{RT^2}$ + constant, from the relationship between free energy of a reaction in the standard (ΔG^0) state and equilibrium constant (Kp) at constant pressure. 2+8 = 10

c. The equilibrium constant, Kp for the reaction 05

$$C_2H_4\,(g) + H_2 \rightleftharpoons C_2H_6\,(g)$$

is $6.04 \times 10^{-17}\ atm^{-1}$ at 25^{0}C. Calculate ΔG^0 for this reaction.

d. State and explain the law of mass of action. 06

Question 8

a. State and explain Faraday's laws of electrolysis. Write down the mechanism of electrolysis. **5+5 = 10**

b. "On progressive dilution, Specific conductance of an electrolyte-decreases but molar conductance increases"- Justify the statement. **06**

c. The heat of combustion of ethyl alcohol is -330 kCal. If the heat of formation of $CO_2(g)$ and H_2O (g) be -94.3 kCal and -68.5 kCal, respectively then calculate the heat of formation of ethyl alcohol. **06**

d. Explain the following term – **4×2 = 08**

i) Enthalpy of reaction
ii) Standard heat of formation
iii) Heat of neutralization.
iv) Heat combustion.