

University of Rajshahi
Department of Computer Science and Engineering
B.Sc. (Engg.) Part-I Odd Semester Examination- 2014
Course: CHEM-1111 (Physical and Inorganic Chemistry)

Full Marks: 52.5

Time: 03 hours

(Answer **SIX** questions taking any **THREE** from each group)

Part-A

1. (a) What is cell constant? How is it determined? 4.75
 (b) State and explain the principle of independent ionic migration. Explain the relation $\lambda_+^0 + \lambda_-^0 = \Lambda^0$. 4
2. (a) What is meant by transport number? Will the transport number of Cl^- ion be the same in HCl , LiCl , KCl ? If not, explain how the transport number will change and why? 5
 (b) What do you understand by the chemical equilibrium constant? Define the equilibrium constants K_p , K_c and K_x . 3.75
3. (a) What is meant by order and molecularity of a reaction? Differentiate between order and molecularity of a reaction. 4.25
 (b) Derive integrated rate equation for a second order reaction. Show that the half-life of a second order reaction is inversely proportional to the initial concentration of the reactant. 4.50
4. (a) Deduce an expression for Langmuir's monolayer adsorption isotherm. How the surface area is calculated using Langmuir's adsorption isotherm? 4.25
 (b) How do the colloidal particles acquire electrical charge? How can you prove that the colloidal particles are electrically charged? 4.50

Part-B

5. (a) Derive an expression for the radius of n th orbit of H-atom. 3.75
 (b) Calculate the radius of 1st orbit of He^+ ion. Given that the Bohr radius is $0.529 \times 10^{-10} \text{ m}$. 2
 (c) State and explain the 'Hund's rule of maximum multiplicity' with suitable example. 3
6. (a) What are quantum numbers? What is the subshell designation for each of the following cases? 2.75
 (i) $n=2, l=0$; (ii) $n=5, l=1$ and (iii) $n=4, l=3$.
 (b) Define covalent radius. Explain why the atomic radius of the elements decreases from left to right in a period whereas it increases on moving down in a group. 3
 (c) Define ionization energy. The first ionization energy of N-atom is higher than that of O-atom. Explain why. 3
7. (a) What is ionic bond? What are the conditions for the formation of ionic bonds? 2.75
 (b) Draw the MO energy level diagram for O_2 molecule and explain why it is paramagnetic. Find out its bond order. 3
 (c) Distinguish between sigma (σ) and pi (π) bonds. 3
8. (a) What is metallic bond? Discuss the electron-pool theory to explain the bonding in metals. 3.75
 (b) Explain any two of the following: 2×2.5
 (c) (i) Cu^{2+} complexes are coloured while those of Zn^{2+} are colourless.
 (ii) Transition metals are capable of forming complex compounds;
 (iii) Most of the transition metals/ions form paramagnetic compounds.

University of Rajshahi
 Department of Computer Science and Engineering
 B.Sc. Engg. Part-I Odd Semester Exam - 2015
 Course: CHEM1111 (Physical and Inorganic Chemistry)
 Full Marks: 52.5 Time: 3 Hours
 (Answer any 6 questions not taking more than 3 from each group)

Group A

- 1.(a) What is meant by molar conductance? Describe a method of determining molar conductance of an electrolyte. 1+3
- (b) Describe the calomel reference electrode and give half-cell reaction when it is coupled with a standard hydrogen electrode. 3
- (c) Calculate the EMF of the cell: $\text{Zn}|\text{Zn}^{2+}(0.001\text{M})||\text{Ag}(0.1\text{M})|\text{Ag}$. The standard potential of $\text{Ag}^+|\text{Ag}$ half-cell is 0.08 V and $\text{Zn}|\text{Zn}^{2+}$ is -0.76 V. 1.75
- 2.(a) What is meant by chemical equilibrium? Discuss briefly the various factors which influence the equilibrium constant of a reaction. 3
- (b) Deduce the relationship between K_c and K_p for reaction $a\text{A} + b\text{B} \leftrightarrow l\text{L} + m\text{M}$. 3
- (c) Explain zero order reaction with an example. A reactant is 50% consumed in 4 minutes at a given temperature. How much of the reactant will remain after one hour? 2.75
- 3.(a) Discuss the Langmuir theory of adsorption and derive expression for Langmuir monolayer adsorption isotherm. 3
- (b) Discuss the origin of charge on colloidal particles. What is meant by electric double layer? 2+1
- (c) What is meant by coagulation? Discuss how the electrolyte affects the behavior of lyophobic sols. 2.75
- 4.(a) Write down the integrated rate equation for zero and first order reaction and express graphically. 2.75
- (b) Explain why 2x3
 - i. Molar conductance increases with dilution, whereas specific conductance decreases.
 - ii. The adsorption processes are always exothermic.
 - iii. Absolute electrode potential of single electrode never is measured.

Group B

- 5.(a) State the postulates of Bohr's atomic theory. What are the inadequacies of Bohr's theory? 2+2
- (b) Calculate the frequency of electromagnetic radiation emitted by the hydrogen atom in the electron transition from $n=4$ to $n=3$. Given that $R_H = 1.097 \times 10^7 \text{ m}^{-1}$ and $h = 6.626 \times 10^{-34} \text{ Js}$. 2
- (c) The n quantum number of an atomic orbital is 6. What are the possible values of l ? What are the possible values of m_l if the l quantum number is 5? 1.75
- (d) State whether each of the following sets of quantum numbers is permissible for an electron in an atom. If a set is not permissible, explain why. 1
 - (i) (1, 0, +1/2, +1/2) and (ii) (3, 2, 1, 1).

- 6.(a) What is meant by disintegration rate of radioelements? What is the unit of radioactive decay constant? Give example of two radioactive elements. 2.25
- (b) State and explain Pauli's exclusion principle with suitable example. 2.5
- (c) How does atomic radius change as you move (a) from left to right across the period and (b) from top to bottom in a group? 2
- (d) What is meant by electron affinity? Arrange the following elements in order of their increasing electron affinity: F, Na, Cl, K, Br and I. 2
- 7.(a) Define covalent bond. What is hybridization of atomic orbitals? Discuss the shape of PCl_5 molecule with the help of hybridization concept. 4
- (b) What is Octet rule? Discuss deviation of this rule with example. 2.75
- (c) Explain why the melting point of p-nitrophenol is higher than that of o-nitrophenol. 2
- 8.(a) Draw the MO energy level diagram of O_2^+ and O_2^- ions. Find out the bond orders and predict the stabilities of the ions. 3
- (b) What are transition elements? Describe general characteristics of transition elements. 3
- (c) Which of the following species exhibit paramagnetic behavior? Ti^{4+} , $[\text{Ni}(\text{CN})_4]^{2-}$, Co^{3+} and Ni. 1
- (d) Describe some important use of lanthanides. 1.75

Answer six questions taking any three questions from each section

SECTION: A

- | | | |
|---|---|--------------------|
| 1 | (a) State and explain Faraday's laws of electrolysis. Describe experiments by which the first law can be verified. | 3+2 |
| | (b) State and explain the principle of independent ionic migration. | 2 |
| | (c) Equivalent conductance at infinite dilution of NaCl, HCl and CH ₃ COONa are 126.45, 426.16 and 91.0 S cm ² eq ⁻¹ , respectively. Find the equivalent conductance of acetic acid at infinite dilution. | 1.75 |
| 2 | (a) Define chemical equilibrium. Why chemical equilibrium is called a dynamic equilibrium?
(b) State and explain the law of mass action.
(c) State and explain Le Chatelier's principle. Discuss its application to the following: | 1+2
2
3.75 |
| | (i). $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -5.56 \text{ KJ}$
(ii). $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -5.78 \text{ KJ}$ | |
| 3 | (a) What do you understand by the rate of a reaction? Mention the factors that affect the rate of a reaction.
(b) What is meant by order of a reaction? Derive integrated rate equation first order reaction.
(c) What is meant by the energy of activation and how is it determined? | 1+1
1+3
2.75 |
| 4 | (a) Define physical adsorption and chemical adsorption. Distinguish between physical adsorption and chemical adsorption.
(b) Write down Langmuir assumptions of adsorption and deduce an expression for Langmuir's monolayer adsorption isotherm.
(c) Explain the terms: colloids and crystalloids. | 2+2
3.25
1.5 |

SECTION: B

- | | | |
|---|--|---------------------|
| 5 | (a) Derive an expression for the radius of nth orbit of H-atom.
(b) Find out the frequency in terms of wave numbers ($\bar{\nu}$) for the 2 nd spectral line of Lyman series. Given that $R_H = 1.097 \times 10^7 \text{ m}^{-1}$.
(c) State and explain the 'Hund's rule of maximum multiplicity' with suitable example.
(d) What are quantum numbers? What is the subshell designation for each of the following cases?
(i) $n=2, l=0$; (ii) $n=5, l=1$ and (iii) $n=4, l=3$. | 3
2
2
1.75 |
| 6 | (a) What are s and p block elements? Mention the main characteristics of s and p block elements?
(b) Define ionization energy. The first ionization energy of nitrogen is higher than that of oxygen-explain.
(c) What is ionic bond? What are the conditions for the formation of ionic bonds? | 3
3
2.75 |
| 7 | (a) What is 'octet rule'? Draw the Lewis (or electron-dot) structure of the following molecules/ion: PH ₃ , SiCl ₄ , NO, SO ₄ ²⁻ .
(b) Draw the MO energy level diagram for O ₂ molecule and explain why it is paramagnetic? Find out its bond order.
(c) Explain why H ₂ O is liquid whereas H ₂ S is gas at NTP.
(d) Deduce the shape of BeCl ₂ and PF ₅ molecules with the help of hybridization concept. | 1.75
3
2
2 |
| 8 | (a) What are lanthanides? Discuss their position in the periodic table?
(b) Write the ground state electronic configuration of the following metals/ions: Cr(24), Cu(29), Co ²⁺ (27), Ni ²⁺ (28).
(c) Explain any two of the following: | 1.75
2
5 |
| | (i). Cu ²⁺ complexes are colored while those of Zn ²⁺ are colorless;
(ii). Transition metals show variable oxidation states;
(iii). Fe ³⁺ is more stable than Fe ²⁺ . | |

University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg. Part-I Odd Semester, Examination-2017
Course: CHEM1111 (Physical and Inorganic Chemistry)
[Answer SIX (06) questions taking at least THREE (03) from each Section.] Full Marks: 52.5

Time: 3 Hrs.

Section A

1. (a) Define the terms with their units: 1.5
(i) Electromotive Force, (ii) Specific Conductance, and (iii) Cell Constant.
- (b) What current strength in amperes will be required to liberate 30 g of iodine from potassium iodide solution in one hour? 2.25
- (c) Describe the calomel reference electrode and give half-cell reaction when it is coupled with a standard hydrogen electrode. 3
- (d) The specific conductance of weak electrolytes decrease rapidly with increase in concentration – explain. 2
2. (a) What is meant by equilibrium constant? Explain the various factors which influence the equilibrium constant of a reaction. 3
- (b) Derive the relation between K_p and K_c . The value of K_p at 25°C for the reaction
 $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{NOCl}(\text{g})$
is $1.9 \times 10^3 \text{ atm}^{-1}$. Calculate the value of K_c at the same temperature. 2.75
- (c) State Le chatelier's principle. 1
- (d) Show that for first order reactions the half-life period is independent of the initial concentration. 2
3. (a) Explain zero order reaction with an example. Obtain integrated rate equation for first order reaction. 4
- (b) Discuss graphical method for the determination of the order of a reaction. 2.5
- (c) Describe briefly the transition state theory of reaction rates. 2.25
4. (a) Define the terms 'absorption' and 'adsorption'. 1
- (b) What is adsorption isotherm? Critically discuss the Freundlich adsorption isotherm. 2.5
- (c) How do the colligative particles acquire electrical charge? How can you prove that the colloidal particles are electrically charged? 3.25
- (d) Colloidal solutions show Tyndall effect, whereas true solutions do not – explain. 2

Section B

5. (a) Derive an expression for the radius of an electron in the n^{th} orbit of H-atom. 3.5
- (b) State and explain the Pauli exclusion principle. 2.5
- (c) Write down the significance of $(n+l)$ rule. 1
- (d) Find out the four quantum numbers for the 15^{th} electron of Cl-atom. 1.75
6. (a) Classify the elements on the basis of the electronic configuration of their atoms. 3
- (b) Explain the following: 4.5
i) First ionization energy of Al is lower than that of Mg.
ii) Chlorine has the largest value of electron affinity.
iii) Cations are smaller than their parent atoms.
- (c) Find out the effective nuclear charge acting on one of the 4s electrons of $\text{V}_{(23)}$. 1.25
7. (a) Discuss the shape of ClF_3 and CO_3^{2-} with the help of hybridization concept. 3
- (b) Arrange the following compounds according to their increasing order of thermal stability and explain the trend: BeCO_3 , CaCO_3 , MgCO_3 , SrCO_3 and BaCO_3 1.25
- (c) Explain the following: 4.5
i) O_2 is paramagnetic but N_2 is diamagnetic.
ii) Boiling point of H_2O is greater than that of HF .
iii) AgF is more soluble in water than AgCl .
8. (a) What are transition elements? Write down the general characteristics of transition elements. 3
- (b) Which one of the following has the maximum magnetic moment: Fe^{2+} , Mn^{2+} and Cr^{2+} 1.25
- (c) Explain the following: 4.5
i) Transition elements show variable oxidation states.
ii) Zn, Cd and Hg have low melting points unlike other d-block elements.
iii) Transition elements exhibit good catalytic properties.

Time: 3 Hours

Full Marks: 52.5

[Answer six questions taking any three questions from each section]

SECTION: A

- 1 (a) Balance following equations by Ion-Electron method: 3
 - (i). $MnO_4^- + Fe^{2+} + \dots \leftrightarrow Mn^{2+} + \dots + H_2O$
 - (ii). $Cr_2O_7^{2-} + Fe^{2+} + \dots \leftrightarrow Cr^{2+} + \dots + H_2O$
- (b) Differentiate 'Electrochemical' and 'Electrolyte' cell. 2
- (c) What happens when a copper rod is dipped in a zinc sulfate solution? 1.75
- (d) The galvanic cell represented as 2

$$Mg(s) | Mg^{2+} (1 \text{ mol. dm}^{-3}) || H^+ (1 \text{ mol. dm}^{-3}) | H_2(g) | Pt(s)$$

And the reading found on the voltmeter is 2.36 V.
Calculate the standard reduction potential of the magnesium half-cell. Show all of your working. And write down the balanced NET (overall) cell reaction that takes place in this cell. No spectator ions are required.
- 2 (a) Consider the following gaseous, reversible, exothermic reaction: $A = B + C + D$ 1.25
What could be done to increase the equilibrium concentration of species D? Give your explanation in short.
- (b) What is the correct equilibrium expression of the following chemical reaction? Give the explanation in favor of your answer. 3

$$NH_4NO_3(s) \leftrightarrow N_2O(g) + 2H_2O(g)$$
- (c) A chemical reaction $A + 3B = 2C + 2D$ is at equilibrium. You have measured the concentration of A and C to be $[A] = 1.20M$ and $[C] = 0.5M$, respectively. What would be the equilibrium constant, K? Show your calculations. 1.5
- (d) A chemical reaction at equilibrium releases 25 Kilo Joules of heat energy at $37^\circ C$. What is the entropy change for this same reaction? Hint: Consider $\Delta G = \Delta H - T\Delta S$. 3
- 3 (a) What do you mean by rate of chemical reaction? Give a chemical reaction to show the reaction of first order. 2
- (b) Differentiate between molecularity and order of chemical reactions. 2
- (c) Write the possible rate law equations of the following second order reactions: 1.75
 $P + Q \rightarrow \text{Product}$.
- (d) Calculate the order of a reaction, which has the rate expression is $rate = k[X]^{1/2}[Y]^{1/4}$. 1
- (e) How does a catalyst increase the rate of chemical/ biochemical reactions? 2
- 4 (a) What do you understand by the term adsorption? Give four points of differences between physical adsorption and chemical adsorption. 3
- (b) What is an adsorption isotherm? Deduce Langmuir's adsorption isotherm. 4
- (c) Discuss the origin of charge on colloidal particles. 1.75

SECTION: B

- 5 (a) Draw the periodic table for first 36 elements with their correct symbols. You should also label the number of groups and periods of that segmented table. 5
- (b) Give the electronic configuration of Chromium and Technetium. 2
- (c) Discuss the basic properties of transition elements. 1.75
- 6 (a) Discuss the drawbacks of Rutherford's model for atomic structure. 1.5
- (b) States the limitations of Bohr atomic model. 1.5
- (c) The equation for the reaction is shown below: 1
- $${}^{131}_{53}\text{I} \rightarrow {}^Z_A\text{Xe} + {}^0_{-1}\beta$$
- Write down the atomic number (A) and the mass number (Z) for the xenon.
- (d) Describe what each of alpha, beta and gamma radiations is, and discuss what happens inside a nucleus when it produces each of three types of radiation. In your answer, you will need to state what happens to the atomic number and mass number. 3
- (e) The half-life of ${}^{99\text{m}}\text{Tc}$ is 6.0 hours. 12 milligram of Technetium ${}^{99\text{m}}\text{Tc}$ is injected in a patient and starts to decay into Technetium 99. Calculate the amount of Technetium 99 present in the patient after 24 hours. [NB. Technetium ${}^{99\text{m}}\text{Tc}$ means meta-stable Technetium 99]. 1.75
- 7 (a) Explain with examples Hund's rule of maximum multiplicity. How does this rule help in determining the electronic configuration of elements? 2.75
- (b) Explain the following giving appropriate reasons: 6
- Fluorine is more electronegative than chlorine.
 - Na^+ is smaller than Na-atom but Cl^- is larger than Cl-atom.
 - The first ionization energy of N is more than that of O.
 - The electron affinity of noble gases is zero.
- 8 (a) Discuss sp^2 type of hybridization by giving one example. 2.75
- (b) Draw the molecular orbital energy diagram for F_2 molecule. Label all of the orbitals specifically. Determine the bond order of molecule. Indicate whether the molecule is paramagnetic or diamagnetic. Compare the relative stabilities of molecular species F_2^- and F_2^+ based on their bond orders. 4
- (c) According to the molecular orbital theory show (by ticking in the boxes), whether the following chemical species can be existed or not: 2

Species	Existed	Not	Species	Existed	Not	Species	Existed	Not
He_2			He_2^{2+}			H_2^-		
He_2^+			H_2^{2+}			H_2^{2-}		

Section-A

- 1.a) What is meant by the equivalent conductance of an electrolyte? Explain why the equivalent conductance of a solution of a strong electrolyte gradually increases. 3
- b) A first order reaction is 25% complete in 20 minutes. How long will it take to be 70% complete? 2
- c) Make a clear distinction between an electrolytic cell and a galvanic cell. Write the cell reactions for the following electrochemical cells: 3
- (i) $\text{Zn}|\text{Zn}^{2+}||\text{Cu}^{2+}|\text{Cu}$; (ii) $\text{Cd}|\text{Cd}^{2+}||\text{Hg}_2\text{Cl}_2|\text{Hg}$;
- d) What is transference number? ¾
- 2.a) What is ionic mobility? State and explain the 'Kohlrausch's Law' of independent migration of ions. 3
- b) Define the following terms: liquid junction potential, electrode potential, standard electrode potential and concentration cell. 3
- c) Calculate the EMF of the following cell: $\text{Zn}|\text{Zn}^{2+}(0.001\text{M})||\text{Ag}^+(0.01)|\text{Ag}$ 2¾
- Given that $E_{\text{Ag}^+/\text{Ag}}^\circ = 0.80\text{V}$ and $E_{\text{Zn}^{2+}/\text{Zn}}^\circ = -0.76\text{V}$.
- 3.a) What is meant by chemical equilibrium? Derive a relation between the equilibrium constants K_p and K_c . 3
- b) What is rate constant of a reaction? Derive the integrated law for a first order reaction. 3
- c) From the following data for decomposition of N_2O_5 and CCl_4 at 48°C , show that the reaction is of the first order: 2¾

t (min)	10	15	20	∞
Vol. of O_2 evolved (mL)	6.30	8.95	11.40	34.75

- 4.a) Distinguish between adsorption and absorption. Define the terms adsorbent and adsorbate giving suitable examples. 2
- b) Explain the 'Freundlich adsorption isotherm'. How can you test the validity of this isotherm? 3¾
- c) What are sols and emulsions? Give four important points of differences between lyophilic and lyophobic sols. 3

Section-B

- 5.a) Derive an expression for the radius of nth orbit of H-atom. 3¾
- b) Calculate the radius of 2nd orbit of He^+ ion. Given that the Bohr radius is $0.529 \times 10^{-10}\text{m}$. 1½
- c) Find out the frequency in terms of wavenumbers ($\bar{\nu}$) for the 2nd spectral line of Lyman series. Given that $R_H = 1.097 \times 10^7\text{m}^{-1}$ 1½
- d) State and explain the Pauli exclusion principal. 2
- 6.a) What are s and p block elements? Mention the main characteristics of s and p block elements. 3
- b) Define electron affinity. The electron affinity of chlorine is higher than that of fluorine – explain why. 2¾
- c) What is ionic bond? What are the conditions for the formation of ionic bonds? 3
- 7.a) Define covalent bond with example. What are the characteristics of covalent compounds? 2
- b) Draw the MO energy level diagram of O_2^+ and O_2^- ions. Find out the bond orders and predict the stabilities of the ions. 3
- c) What is hybridization of atomic orbitals? Mention the shapes of the following species: XeF_4 , NH_3 , SO_4^{2-} and PCl_5 2
- d) Discuss important application of lanthanides in automobile and electronic industries. 1¾

8.a) Write the ground state electronic configuration of the following metals/ions:
Cr (24), Cu(29), Co^{2+} (27) and Ni^{2+} (28).

b) Explain the following (**Any Three**)

- i) The melting point of MgO is much higher than that of NaF;
- ii) Cu^{2+} complexes are colored while those of Zn^{2+} are colorless;
- iii) Transition metals show variable oxidation states
- iv) Fe^{3+} is more stable than Fe^{2+} .

2 x