

BACHELOR OF METALLURGICAL AND MATERIALS ENGG. EXAMINATION, 2023

(2nd Year, 1st Semester, Supplementary)

CHEMISTRY II

Time: 3 Hours

Ful Marks: 100

(Use separate answer script for each Part)

PART I (40 Marks)

Attempt any **Four** Questions

1. Tick (\checkmark) the correct answer(s) :

2 x 5 = 10

(i) The magnetic properties of $[\text{NiCl}_4]^{2-}$ show 2 unpaired electrons and $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic. Identify the hybridization of the central metal ion:

- (a) sp^3 and sp^2 respectively
- (b) sp^2d and sp^3d^2 respectively
- (c) sp^3 and dsp^2 respectively
- (d) sp^3d^2 and dsp^2 respectively

(ii) In the formation of ML_6 complex of transition metal ions the valence d orbitals of M split, which orbitals appear in lower energy ?

- (a) d_{xy} and $d_{x^2-y^2}$
- (b) d_{xy} , d_{xz} and d_{yz}
- (c) d_{xz} and d_{yz}
- (d) $d_{x^2-y^2}$ and d_{z^2}

(iii) What is the reason behind the yellow colour of smog?

- (a) Nitrogen dioxide
- (b) Sulphur dioxide
- (c) Sulphate ions
- (d) Nitrate ions

(iv) Which is correct to the temperature profile of Atmosphere

- (a) Upper troposphere and lower Mesosphere are hot
- (b) Upper troposphere and lower Mesosphere are hot
- (c) Lower stratosphere and lower Troposphere are cold
- (d) Upper troposphere and lower Stratosphere are cold

(v) Who is paramagnetic in the following compounds?

[Turn over

- (a) $[\text{CoF}_6]^{3-}$
- (b) $[\text{MnO}_4]^-$
- (c) $[\text{TiCl}_4(\text{Py})]$
- (d) $[\text{Cu}(\text{bpy})_2]^+$

2. (a) Write down all possible isomers of $[\text{M}(\text{LL})_2\text{X}_2]$ (where LL= symmetric bidentate ligand; X = monodentate ligand). If you use unsymmetric LL' ligand then identify the number of isomers.

(b) Write four Principles of Green Chemistry and give short explanation to each point.

6+4=10

3. Write a Note on Quality of Drinking Water. How do you measure DO (Dissolved Oxygen) in water? Write chemical reactions.

4+4+2 = 10

4. Explain the followings :

2.5 x4 = 10

(a) Increase in atmospheric temperature with increasing CO_2 Concentration.

(b) Ozone layer depletion is related to radical concentration in upper atmosphere.

(c) What are the effects of Arsenic (As) toxicity? Out of As(III) and As(V) who is more Toxic and why?

(d) Explain the mechanism of Pb pollution.

5. Answer the following questions:

2x5 = 10

a) What are the effects of halo compounds to the environment?

b) What are the reasons for toxicity of F^- in water?

c) Why $[\text{CoCl}_4]^{2-}$ is intensely blue?

d) What is the effect of increase in SO_2 concentration in air to the plant health?

e) Write IUPAC name of $[\text{CoCl}(\text{NO}_2)(\text{NH}_3)_4]^+$.

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PART II (60 Marks)**1. Answer any ten questions from the following.**

10 x 1

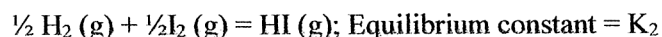
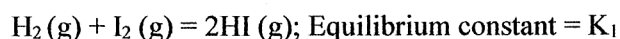
- (a) What is the unit of pre-exponential factor in Arrhenius equation for a second order chemical reaction?
- (b) What is the relation between K_p and K_c ?
- (c) In which direction does a reversible reaction move when the magnitude of reaction quotient is lower than that of equilibrium constant?
- (d) The rate constant of a certain chemical reaction is $13.6 \text{ L}^3\text{mol}^{-3}\text{s}^{-1}$. What is the order of the reaction?
- (e) What do you mean by molecularity of a chemical reaction?
- (f) For the adsorption of the gas on a solid surface, what should be the sign of entropy change?
- (g) What is the relation between rate constant and half-life of a first order chemical reaction?
- (h) What is the nature of the curve of $\ln k$ vs $1/T$?
- (i) At which temperature condition chemisorption is favoured?
- (j) Which kind of reaction doesnot undergo completion?
- (k) What is the unit of activation energy (E_a) of a chemical reaction?
- (l) For the adsorption of HI on gold surface, state the name of adsorbate and adsorbent.
- (m) Give an example of fraction order chemical reaction.

Answer any five questions from the following.

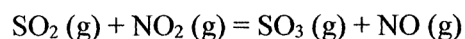
5 x 10

2. (a) Establish the relation between K_p and K_x .

(b) Consider the following reactions

Establish the relation between K_1 and K_2 .

(c) Consider the following reaction,



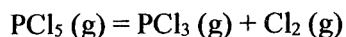
The equilibrium constant, K_c is found to be 16 at a particular temperature. If we take two moles of each species at the beginning in a 1 Litre container, what would be the concentration of the reactants and products at equilibrium?

3+3+4

3. (a) "Chemical equilibrium is dynamic in nature"– explain.

(b) Consider the following dissociation reaction of PCl_5 -

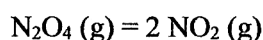
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Initially, 3 moles of $\text{PCl}_5 (\text{g})$ are kept in a 1L closed reaction vessel and allowed to attain equilibrium at 380 K. The equilibrium constant, K_C is found to be 1.8. Calculate the number of moles of each species at equilibrium.

(c) For a certain chemical reaction, the magnitude of equilibrium constant, K_P is found to be 1.64×10^4 and 1.44×10^{-5} at 673K and 773K temperature respectively. Calculate the value of standard molar enthalpy change of the reaction. 3+4+3

4. (a) Derive the expression for equilibrium constant, K_P for the following dissociation reaction of N_2O_4 in terms of the degree of dissociation and total pressure



(b) Deduce the expression of integrated form of rate equation for second order chemical reaction.

(c) Show that for a first order chemical reaction, the time required for the 99 % completion is almost 6.64 times of the half-life of the reaction. 4+3+3

5. (a) Consider the following reaction



Express the rate of the reaction in terms of rate of change of concentrations of each species (reactant and products).

(b) Show that for a second order chemical reaction, the half-life of the reaction is inversely proportional to the initial concentration of the reactant.

(c) Rate constants of the decomposition of certain hydrocarbon is $2.41 \times 10^{-5} \text{ s}^{-1}$ at 546 K. If the activation energy of the reaction is $179.9 \text{ KJ mol}^{-1}$, what will be the value of pre-exponential factor? 3+3+4

6. (a) 'Adsorption is generally an exothermic process' - explain.

(b) Derive the expression for fraction of surface covered (θ) for the adsorption of a gas on solid surface according to Langmuir isotherm.

(c) How can you determine the value of K and n graphically for Freundlich adsorption isotherm. 3+4+3

7. (a) Write down the differences between physisorption and chemisorption.

(b) At 273 K and 1atm pressure, only 0.2 fraction of the solid surface is covered by the CO gas. Calculate the equilibrium constant for the adsorption process according to Langmuir adsorption isotherm.

(c) How can you obtain Freundlich isotherm starting from expression of Langmuir adsorption isotherm applying high-pressure and low-pressure condition. 3+3+4