Roll No: ……..

Name of the Course : B Sc (Prog.) L.Sc/P.Sc/Analytical Chemistry/Industrial Chemistry

Semester II

Name of the Paper : C-II Chemical Energetics, Equilibria & Functional Group OrganicChemistry I

Unique Paper Code : (42171205_OC)

Duration: 3 hours **Maximum Marks: 75**

Instructions for candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Attempt 2 questions from SECTION A and 2 questions from SECTION B.**
3. Use separate sheets for section A and section B and indicate the section you are attempting by putting a heading.
4. The questions should be numbered in accordance to the number in the question paper.

Section A

Q.1 (a) Explain the following:

i) The enthalpy of neutralization of any strong acid with a strong base is always a constant.

ii) Salts of strong acids and strong bases do not undergo hydrolysis.

iii) Difference between integral enthalpy of solution and integral enthalpy of dilution.

(1.5, 1.5, 3.25)

(b) Prove that pH of the salt solution of weak acid and strong base is

$$pH = -1/2 [\log K_w + \log K_a - \log c]$$

where: K_w is the Ionic product of water

K_a is the dissociation constant of weak acid

and c is the original concentration of the salt solution in moles L^{-1}

(6.25)

(c) Define Bond enthalpy. Calculate the bond enthalpy of C-H bond using the following data at 298K.

Enthalpy of combustion of methane $\Delta H = -890.36$ kJ mol^{-1}

Enthalpy of Combustion of C(graphite) $\Delta H = -393.51$ kJ mol^{-1}

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -285.85$ kJ mol^{-1}

Enthalpy of dissociation of $H_2(g)$ $\Delta H = 435.93$ kJ mol^{-1}

Enthalpy of sublimation of C(graphite) $\Delta H = 716.68$ kJ mol^{-1}

(6.25)

Q.2 a) What is a buffer solution? Give an example of acidic buffer.

Also derive the Henderson-Hasselbalch equation

$pH = pK_a + \log [salt]/[acid]$

for the acidic buffer mixture. **(4.75)**

b) Consider the equilibrium

$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ $\Delta H = -92.38$kJ mol^{-1}

Explain the effect of temperature and pressure on the above equilibrium. **(4.75)**

c) Define the enthalpy of combustion. Calculate the enthalpy change of the following reaction:

$3C_2H_2(g) \rightarrow C_6H_6(g)$

Given that Enthalpy of Combustion of $C_2H_2(g)$ $\Delta H = -1.30$ MJ mol^{-1}

and Enthalpy of Combustion of $C_6H_6(g)$ $\Delta H = -3.302$ MJ mol^{-1}

(4.75)

d) At 25℃, will a precipitate of $Mg(OH)_2$ form in a 0.0001M solution of $Mg(NO_3)_2$ if pH of the solution is adjusted to 9.0 ? Ksp of $Mg(OH)_2 = 8.9 \times 10^{-12}$ M^3 **(4.5)**

Q.3 a) Prove that

$\Delta G^\circ = -RT \ln K_p$ **(4.5)**

b) The value of C_P is always greater than C_V. Explain. Also show thermodynamically that for an ideal gas $C_P - Cv = R$ **(4.5)**

c) (i) Calculate the pH of $1x10^{-7}$ M solution of HCl at 25℃. Given that K_w at 25℃ is $1x10^{-14}$ mol^2 dm^{-6}

(ii) What is the pH at 25˚C of a solution which is twice as alkaline as pure water?

(2, 2.75)

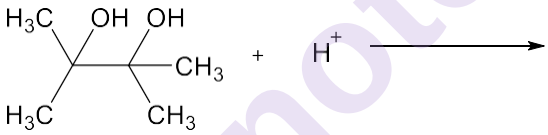
d) (i) The equilibrium constant of a reaction doubles on raising the temperature from 25˚C to 35˚C. Calculate ΔH˚ for the reaction.

(ii) Calculate the solubility in grams per litre of $Al(OH)_3$ in water at 25˚C if Ksp is $8.5x10^{-32}$ M^4 **(2, 3)**

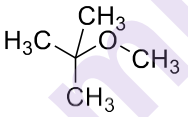
Section B

Q.1 (i) (+) 2-Butanol when treating with $SOCl_2$ gives (+) 2-chlorobutane. Explain the reaction with mechanism. **(3.75x5 M)**

(ii) Gives the product and explain the reaction with mechanism.



(iii) The following can be prepared by which method? Explain with mechanism.

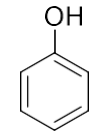


(iv) Chlorobenzene on treatment with $NaNH_2$ gives aniline. Explain with mechanism.

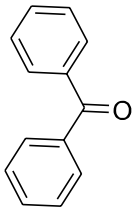
(v) Arrange the following in increasing order of reactivity towards nucleophilic substitution, CH_2=CH-Cl, Ph-Cl. Ph-CH_2-Cl

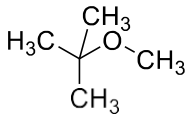
Q.2 A. Complete the following and give the name of the reaction.

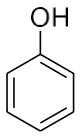
(3x6 M)

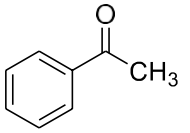
(i)  + PhCOCl $\xrightarrow{NaOH}$ **A**

(ii) C_2H_5Cl $\xrightarrow{KNO_3}$ **B**, $\xrightarrow{AgNO_3}$ **C**

(iii)  + PPh_3Cl + CH_3Cl $\xrightarrow{base}$ **D**

(iv)  + HI $\xrightarrow{base}$ **E** + **F**

(v)  + CH_3Cl $\xrightarrow{Na/NH_3}$ **G**

(vi)  + Zn/HCl $\xrightarrow{base}$ **H**

B. Write one method of preparation of benzaldehyde from benzoyl chloride.

(0.75M)

Q.3 Write a short note on following with mechanism (any three).

(6.25x3 M)

(i) Benzoin condensation

(ii) Gattermann Koch reaction

(iii) Friedel-Crafts alkylation

(iv) Preparation of phenol from cumene.

(v) Houben-Hoesch condensation