ASSIGNMENT BOOKLET

Post Graduate Diploma in Analytical Chemistry (PGDAC)

Basic Analytical Chemistry	**(MCH – 001)**
Separation Methods	**(MCH – 002)**
Spectroscopic Methods	**(MCH – 003)**
Electroanalytical & Other Methods	**(MCH – 004)**

(Valid from January 1, 2023 to December 31, 2023)

It is compulsory to submit the assignments before filling in the examination form.

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2023)

Dear Learner,

This assignment booklet consists of the tutor marked assignments (TMAs) of MCH-001, MCH-002, MCH–003 and MCH–004 courses of the Post Graduate Diploma in Analytical Chemistry (PGDAC) programme.

We hope, you are familiar with the system of evaluation to be followed for this programme. You may probably like to re-read the section on assignments in the Programme Guide that was sent to you earlier. As you are aware, a weightage of 30 percent has been earmarked for continuous evaluation component. For this you have to submit the responses of the enclosed tutor marked assignments to the Study Centre Coordinator. The assignments are based on the content of all the blocks of all the courses.

Before attempting the assignment, please read the following instructions carefully.

1 On top of the first page of your assignment response, please write the details exactly in the following format; write your answers from second page onwards.

ENROLMENT NO. : ……...

NAME **:** ……

ADDRESS **:** ……...

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COURSE CODE **:** ……

COURSE TITLE **: ……..**

STUDY CENTRE **: ……..…** **DATE : ……...**

(NAME AND CODE)

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2 Use only foolscap size paper (but not of very thin variety) for writing your answers.

3 Leave about 4 cm margin on the left, top and bottom of your assignment response sheet.

4 Your answers should be precise.

5 While writing answers, clearly indicate the Question No. and part of the question being solved.

6 Though the validity of assignment is for one year, we advise you to submit the assignment response within 12 weeks after receiving it.

7 **We strongly suggest that you should retain a copy of your assignment responses.**

Wishing you good luck.

TUTOR MARKED ASSIGNMENT

MCH-001: Basic Analytical Chemistry

Course Code: MCH-001
Assignment Code: MCH -001/TMA/2023
Maximum Marks: 100

Note: Answer all the questions given below.

1	a)	Give the classification of the optical methods of analysis and the nuclear methods of analysis	(5)
	b)	How can the use of blanks minimise errors? Is it recommended to use blanks for each and every type of determination? Justify your answer.	(5)
2	a)	What is meant by significant figures? Explain with the help of suitable examples. How many significant figures are there in 0.0250?	(5)
	b)	What is a normal error curve? How can this be used to verify the laws of chance or probability?	(5)
3	a)	A replicate analysis of the blood serum of a patient for K^+ ions in mg/100 cm^3 yielded the following results. 16.20, 16.55, 16.45 and 16.30. Calculate the 90% confidence interval for the data set; you may assume the value of C_n to be = 0.63	(5)
	b)	What is the procedure of sampling and preservation of sample for bacteriological analysis?	(5)
4	a)	Discuss the possible means of chemical exposure to the human body and state the precautions to be taken to avoid them.	(5)
	b)	Give any five points to be taken as precautionary measures while handling glassware to reduce risks involved.	(5)
5	a)	What is the mechanism of enzyme catalysed reactions? Explain how can the enzyme catalysed reactions be used for the determination of substrate?.	(5)
	b)	Calculate the pH of 0.1 M aqueous solution of Na_2S. ($K_w = 1.0 \times 10^{-14}$; $K_1 = 1.6 \times 10^{-7}$ and $K_2 = 4.0 \times 10^{-13}$ for H_2S)	(5)
6	a)	Compute the pH of the solution during the course of titration of 100 cm^3 of 0.1 M HCl with a solution of NaOH having equal concentration and draw the titration curve.	(5)
	b)	Discuss the properties of buffer solutions especially when acids and bases are added. Also discuss what happens to it when it is diluted.	(5)
7	a)	Define an indicator and discuss the criteria for the selection of an acid-base indicator with the help of an example.	(5)
	b)	What are Hammet's acidity functions? Give its equation and mention what is special about it.	(5)
8	a)	Discuss the characteristics of any two common nonaqueous solvents.	(5)
	b)	With suitable chemical equations show how potassium permanganate can be used for the analysis of iron(II) and As(III). What is the advantage of using potassium dichromate over permanganate in estimating iron(II)?	(5)
9	a)	With suitable schematic precipitation titration curve explain how the iodide-chloride mixture is titrated with silver ion.	(5)
	b)	How to circumvent the problem of the cases where precipitates tend to oxidize during washing? What are the protocols to be followed during washing of precipitate in general?	(5)
10	a)	What is meant by inductively coupled plasma?	(5)
	b)	Briefly discuss the principle of the working of a colorimeter. How the modern spectrophotometers are different from these?	(5)

TUTOR MARKED ASSIGNMENT
MCH-002: Separation Methods

Course Code: MCH-002
Assignment Code: MCH -002/TMA/2023
Maximum Marks: 100

Note: Answer all the questions given below.

1	Explain the following:	
	i) Fractional distillation	(5)
	ii) Flash distillation	(5)
	iii) Vacuum distillation	(5)
	iv) Steam distillation	(5)
	v) Azeotropic distillation	(5)
2	What is electromigration? What are the techniques included in it?	(5)
3	Explain distribution ratio. Discuss the distribution of benzoic acid between benzene and water.	(5)
4	Describe important features of extraction using crown ethers.	(5)
5	What are modifiers? Explain their use with the help of suitable examples.	(5)
6	What are masking agents? How does their presence affect the extraction.	(5)
7	List the criteria for the choice of the organic phase is solvent extraction	(5)
8	Discuss the concept of theoretical plates.	(5)
9	What are the requirements of an ideal support material for liquid - liquid partition chromatography?	(5)
10	What is R_f? What factors influence the R_f value in paper chromatography?	(5)
11	Briefly discuss the applications of TLC.	(5)
12	Write van Deemter equation. Which conclusions of the rate theory help to improve the column efficiency?	(5)
13	List various advantages of HPLC.	(5)
14	Give a brief account of natural ion exchangers.	(5)
15	Explain the separation of actinide elements using ion-exchange chromatography.	(5)
16	Discuss the important features of sephadex gels.	(5)
17	What are the unique features of size exclusion chromatography?	(5)
18	What is reverse osmosis? Discuss its applications.	(5)
19	What are liquid membrane processes? Describe.	(5)
20	Briefly explain the important features of SDS-PAGE Gel electrophoresis.	(5)

TUTOR MARKED ASSIGNMENT

MCH-003: Spectroscopic Methods

Course Code: MCH-003
Assignment Code: MCH-003/TMA/2023
Maximum Marks: 100

Note: Answer all the questions given below.

1. a) What is electromagnetic radiation according to the quantum mechanical model? (2)

   b) Molecular spectra are band spectra whereas the atomic spectra are line spectra. Explain. (3)

   c) An iron complex has a λ_{max} of 508 nm. If the molar absorptivity of the complex is 1.10×10^4, calculate the absorbance of its 2.63×10^{-5} M solution taken in a cuvette of 2 cm path length. (5)

2. a) Explain the origin of colour in charge transfer complexes on the basis of energy level diagram. (5)

   b) State Lambert-Beer's law and discuss the factors responsible for deviations from the law. (5)

3. a) What is a monochromator? Explain the principle of grating monochromator. (5)

   b) The absorbance values of a mixture of $K_2Cr_2O_7$ and $KMnO_4$ at 440 nm and 545 nm using a cell of 1 cm path length were found to be 0.319 and 0.623 respectively. The absorbance values of pure solutions of $K_2Cr_2O_7$ (0.001 M) and $KMnO_4$ (0.0002 M) in similar conditions were as follows:

   A (Cr,440 nm) = 0.374, A (Cr, 545 nm) = 0.009

   A (Mn, 440nm) = 0.019, A (Mn, 545 nm) = 0.475

   Using the given data determine the concentration of chromium and manganese ions in the mixture. (5)

4. a) What is meant by the degrees of freedom? Calculate the vibrational degrees of freedom for a bent molecule having molecular formula as AB_2 (4)

   b) How can IR spectrum be used to check the authenticity of an organic compound? (2)

   c) What is meant by polarizability of a molecule? (2)

   d) What is the requirement for the vibrational mode of a molecule to be Raman active? (2)

5. a) What is photoluminescence? Discuss its dependence on structure of the molecules. (5)

   b) Fluorescence can be used for qualitative as well as quantitative determination of the analyte. Discuss the factors affecting the quantitative applications of fluorescence. (5)

6. a) What is a flame? Briefly describe the structure of flame clearly indicating the significance of each region. (5)

   b) Outline the merits and limitations of atomic fluorescence spectrometry. (5)

7. a) Explain the principle of standard addition method for quantitative determinations using atomic absorption spectrometry. Under what conditions this methodology does becomes important? (5)

   b) Enlist at least five characteristics of an ideal atomization-excitation source to be used in atomic spectroscopy. (5)

8. a) Define nebulisation and list different types of nebulisers used in ICP-AES. Describe the working of any one of them. (5)

b) Compare and contrast atomic absorption spectrophotometry and atomic emission spectrometry. (5)

9. a) What is plasma? What makes argon a good choice for the plasma gas? (5)

b) Explain McLafferty rearrangement with the help of a suitable example. (3)

c) FT-NMR is better than CW-NMR. Comment on the statement. (2)

10. a) Define chemical shift and discuss the factors affecting it. (5)

b) The important spectral details of an organic molecule having a molecular formula $C_5H_{10}O$ are as follows:

Mass: (Prominent peaks at m/z 41, 43 (base peak); and 86 (M+)

IR : (2937 cm^{-1} (medium); 1718 cm^{-1} (strong); 1428 cm^{-1} (medium); and 1254 cm^{-1} (medium))

NMR: (δ= 1.11 (6H, doublet); δ = 2.14 (3H, singlet) and δ = 2.58 (1H, multiplet)

Determine the structure of the organic molecule. (5)

TUTOR MARKED ASSIGNMENT

MCH-004: Electroanalytical and Other Methods

Course Code: MCH-004
Assignment Code: MCH-004/TMA/2023
Maximum Marks: 100

Note: Answer all the questions given below.

1 a) Find the cell Potential of a galvanic cell based on the following half-cell reaction at 25^{o} C. (5)

$Cd^{2+} + 2e$ Cd $E_o = -0.403$V

$Pb^{2+} + 2e$ Pb $E_o = -0.126$V

Where $[Cd^{2+}] = 0.020$ M and $[Pb^{2+}] = 0.200$ M

b) Derive the following expression: (5)

$$\log K = \frac{nE^{o}_{cell}}{0.0591}$$

Calculate the equilibrium constant for the galvanic cell given in question 1(a).

2 a) Derive an expression for the operational definition of pH. (5)

b) Calculate the pH during the titration of 25.00 cm_3 of 0.025 M acetic acid with 0.5 M NaOH on addition of 2.50 cm^3 of this solution. (5)

3 a) Drive following expression: (5)

$K = G\,k_{cell}$

Discuss the variation of molar conductivities for the strong and weak electrolytes with change in their concentrations.

b) From the following data, calculate the molar conductivity of KBr in aqueous solution: (5)
Conductivity of 2.5×10^{-4} mol dm^3 KBr = 3.72×10^{-3} S m^{-1},

Conductivity of the water=0.6×10^{-3} S m^{-1}.

4 a) Discuss the advantages of coulometric titration. (5)

b) A 25.0 cm^3 sample of solution containing phenol was treated with 5.0 cm^3 of 1 M KBr and 10.0 cm^3 of 1.0 M HCl. A platinum electrode was made anodic so that the bromide ion was oxidised to Br_2. A constant current of 8.00 mA was passed through the electrolysis cell for 2 min. and 38 s in order to reach the end-point for the titration. The reaction is (5)

Phenol + 3 $Br_2 \longrightarrow$ Phenol $(Br)_3$ + 3HBr

How many mg of phenol were present in the original sample?

5 a) What is the major advantage of sampling the current in 'Sampled DC polarography'? (2)

b) In DPP, why do not we use amplitudes greater than 100 mV? (2)

c) Name some solid electrode, which are used in cyclic voltammetry. (1)

d) In which cases are cathodic stripping voltammetry used? (2)

e) Give a labelled diagram for a typical polarogram. (3)

6 a) What are the responsibilities of the residual current? (2)

b) What is meant by capillary characteristics with reference to the ILKOVIC equation? (3)

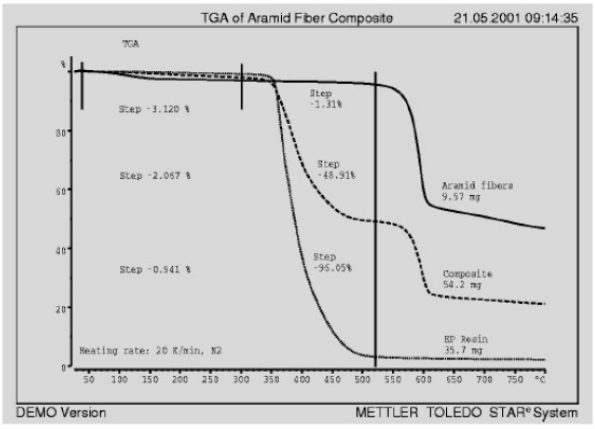
c) Derive the expression for the electrode potential in case of complexation of metal ion with the complexing agent? (5)

7 a) Why is the catalytic current so useful to trace analysis of number of transition metals? (2)

b) Give the equation used for calculating adsorption wave and explain the terms. (3)

c) Explain how cyclic voltammetry is used to diagnose coupled chemical reactions. (5)

8 a) Interpretate the TGA Curves given in figure below. Determine the resin and fibre content in composite material using following this figure. (5)



TGA of an epoxy resin aramid fibre composite (middle): above pure aramid fibre, and below pure resin.

b) Discuss the principle of thermometric titration. What way thermometric titrations are different from classical titration? Explain. (5)

9 a) Discuss the various types of detectors used to measure radioactivity. (5)

b) A protein hydrolysate is to be assayed for aspartic acid. Exactly 5.0 mg of aspartic acid, having specific activity of 0.46 μCi/mg is added to the hydrolysate. From the hydrolysate, 0.21 mg of highly purified aspartic acid, having specific activity of 0.01 μCi/mg can be isolated. How much aspartic acid is present in the original hydrolysate? (5)

10 Write short notes on: (10)

a) Radiochromatography

b) NAA

c) DSC

d) Polarisation