2024

CHEMISTRY — HONOURS

Paper : SEC-1

(Quantitative Analysis and Basic Laboratory Practices)

Full Marks : 75

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question nos.*** **1, 2, 3, 4** and ***any four*** from ***question nos.*** **5** to **10**.

1. Answer ***any ten*** questions : *2×10*

(a) What is the median of the following data set?

38, 64, 56, 23, 49, 34, 60, 43, 69, 52.

(b) Name a chemical compound that can be used as a primary standard substance both in an acid-base titration as well as in redox titration. What is its acidimetric equivalent mass?

(c) Mention the reason behind hardness of water.

(d) The data obtained from two sets of experiments A and B have following characteristics :

Experiment	A	B
Mean	50	100
Standard deviation	2 units	2 units

Between A and B which one is more precise?

(e) Write the expression for colour-change interval of an acid-base indicator.

(f) Define COD of a water sample.

(g) The mass and volume of a body are 4.237g and 2.5 cm^3, respectively. Find the density of the body in correct significant figure.

(h) In neutral medium, potassium permanganate reacts with a reducing agent and brown manganese dioxide is precipitated. If the strength of the potassium permanganate solution is 0.3 (N), determine its strength in molarity.

(i) What is the role of activated carbon in purification of water?

(j) A loss of 0.4 mg of Zn occurs in the course of analysis. Calculate the percentage of relative error due to this loss if the weight of the Zn in the sample is 400 mg.

(k) Arrange the metal ligand complexes according to their stability order in alkaline pH medium : Ca-EDTA, Ca-EBT, Mg-EDTA, Mg-EBT.

(l) When diluting concentrated H_2SO_4, should we add water to concentrated H_2SO_4 or the reverse? Justify your answer.

2. The following results were obtained in the replicate analysis of a blood sample for its lead content : 0.752, 0.756, 0.753, 0.751, 0.760 (ppm of Pb). Calculate the mean, standard deviation, variance, range and relative standard deviation of this set of data. 5

Or,

You are required to find a linear fit of the type $y = mx + c$ for a set of data (x_i, y_i). For this purpose, find the sum of squared residuals and hence using the proper condition, find slope (m) and intercept (c) of the linear fit. 5

3. (a) Describe the method of gravimetric estimation of Ni^{2+} ion using an organic reagent. 5

Or,

(b) Write a short note on titrimetric method of estimation of chloride ion in a sample by Mohr's Method mentioning the titrant, indicator used, colour change during the course of the titration, pH of the solution. 5

4. (a) Mention the standard parameters to be maintained for water to be used for

(i) industrial purpose, and

(ii) agricultural purpose. 5

Or,

(b) Mention ten basic laboratory practices that we have to follow in a chemical laboratory. 5

5. (a) What is determinate error? Name three types of determinate error and state how they are detected.

(b) 50 mL 0.1 (N) Mohr's salt solution is titrated against 0.1 (N) $KMnO_4$ solution in 1(M) H_2SO_4 medium. Calculate potential of the solution of the following stages of $KMnO_4$ solution added

(i) 30.0 mL (ii) 50.0 mL, where $E^o_{Fe^{3+}/Fe^{2+}} = 0.77$ V and $E^o_{MnO_4^-/Mn^{2+}} = 1.51$ V.

(c) Why groundwater is less susceptible to bacterial pollution than surface water? Does this mean that the groundwater is always fit to drink? Justify your answer. (1+3)+3+(1½+1½)

6. (a) What volume of (M/50) Na_2H_2EDTA solution is to be required to titrate a solution containing 100 mg $CaCO_3$? [Molar Mass of $CaCO_3$ = 100.08 g/mol]

(b) Discuss about any three methods of primary treatment of industrial effluent.

(c) Analysis of three rare earth ores indicates 4.987 $\pm$ 0.003%, 3.897 $\pm$ 0.004% and 4.829 $\pm$ 0.003% rare earth content respectively. Find the average rare earth content of the ores. 4+3+3

7. (a) Discuss the steps of Municipal waste water treatment for drinking purpose.

(b) Find the significant figures in 5.0030 g, 0.0030 g and 02.550 g.

(c) Briefly discuss the advantages of using organic reagents over inorganic reagents in gravimetric analysis of metal ions. 4+3+3

8. (a) What do you mean by method validation in analytical technique? Discuss how linearity, accuracy and precision are related with method validation.

(b) What are the limitations of precipitation titration?

(c) How would you calibrate :

(i) 10 mL pipette,

(ii) 50 mL burette, and

(iii) 250 mL volumetric flask? 4+3+3

9. (a) Balance the following redox reactions by ion-electron method :

(i) $KMnO_4 + H_2C_2O_4 + H_2SO_4 \rightarrow MnSO_4 + CO_2 + K_2SO_4 + H_2O$

(ii) $Zn + NaNO_3 + NaOH \rightarrow Na_2ZnO_2 + NH_3 + H_2O$.

(b) Mention the precautions necessary for preventing fire accidents in laboratories.

(c) Write a short note on random error. 4+3+3

10. (a) Why sampling or sample preparation is essential prior to its analysis? Illustrate with examples.

(b) The limit of detection (LOD) of copper using three different analytical techniques are :

(i) 0.015 mg / mL

(ii) 0.00175 mg / mL

(iii) 0.0098 mg / mL.

Identify the most 'sensitive' method. Considering 5% error in each analysis, identify the method with highest accuracy.

(c) Find out the mole fraction of sodium acetate in its aqueous solution consisting of 3.4 moles of sodium acetate in 119 mL of water. 4+3+3
