Registration Number:

Date & session:

ST JOSEPH'S UNIVERSITY, BENGALURU - 27

B.Sc. CHEMISTRY: 2nd SEMESTER

SEMESTER EXAMINATION: APRIL 2024

(Examination conducted in May / June 2024)

CH 222: CHEMISTRY- II

(For current batch students only)

Time: 2 Hours **Max Marks: 60**

This paper contains 4 printed pages and 3 parts.

PART-A

Answer any SEVEN of the following questions. **[7x2=14]**

1. Draw the structure of a metal-EDTA complex.
2. Differentiate between limit of detection and limit of quantification.
3. What are the conditions for a gas to typically exhibit ideal behaviour according to its compressibility factor?
4. Write the electrophile in (i) Friedel-Crafts alkylation and (ii) bromination of benzene.
5. List any two physical methods to determine the end point of argentometric titrations.
6. Among CH_3O^- and CH_3OH, which is a stronger nucleophile? Why?
7. How does high fever affect the viscosity of blood?
8. Mention any two differences between Frenkel and Schottky defects.
9. What is coprecipitation in gravimetry? How can it be minimized?

PART-B

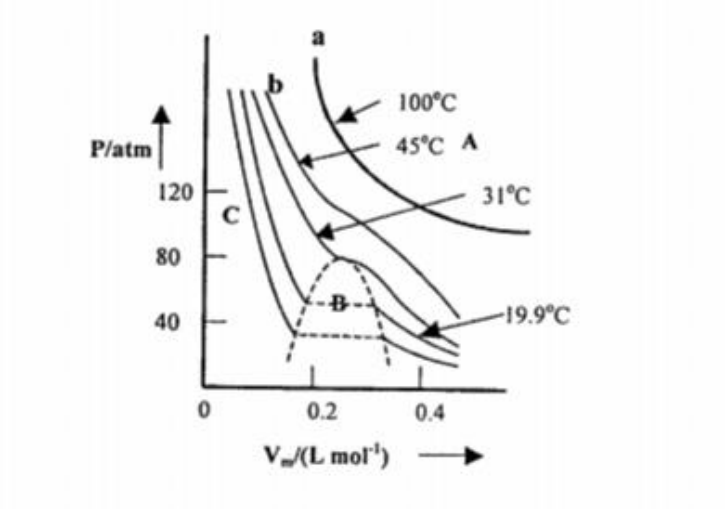
Answer any SIX of the following questions. **[6x6=36]**

10. (a) Derive the general formula to calculate the amount of solute left unextracted after 'n' number of extractions.
    (b) When 2.1035 g of a nonvolatile solute is dissolved in 70 g of water, the boiling point increased by 0.23 ℃. Calculate the molar mass of the solute. K_b= 0.5 K kg mol^{-1}. (3+3)
11. (a) What are the advantages of organic precipitating agents over inorganic precipitating agents in gravimetry?
    (b) The lattice constant for a unit cell of aluminium is 4.031 Å. Calculate the interplanar space of (2 1 1) plane. Based on the hkl values, comment on the type of unit cell that aluminium could belong to. (3+3)
12. (a) List the titration methods involving EDTA and describe one of them.
    (b) Mention the assumptions of least square analysis. Write the equation used to generate the least square line. (3+3)

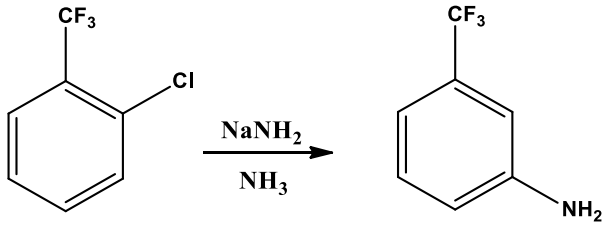
13. (a) Draw the unit cells for a body centred lattice and a face centred lattice. How many atoms are present per unit cell in these arrangements?
(b) A gas with a critical temperature (T_c) of 250 K and a critical pressure (P_c) of 50 atm is compared to another gas with a T_c of 150 K and a P_c of 30 atm. If both the gases are at a temperature of 200 K and a pressure of 20 atm, determine whether they exhibit similar behaviour according to the Law of Corresponding States. (3+3)

14. How does the $–NO_2$ group in nitrobenzene influence the reactivity of the aromatic ring towards electrophilic substitution? Based on the stability of arenium ions, explain how this group in nitrobenzene influences the orientation of the incoming electrophile.

15. (a) Two flasks 'A' and 'B' have equal volume. Flask 'A' contains H_2 and is maintained at 300 K while flask 'B' contains an equal mass of CH_4 gas and is maintained at 600 K. Compare the speed of molecules in terms of root mean square speed and identify the flask in which molecules move faster.
(Given: R=8.314 J K^{-1} mol^{-1}; Atomic weights of C = 12 g mol^{-1} and Hydrogen = 1 g mol^{-1}).
(b) The figure below shows isotherms for CO_2 at various temperatures.
i) Identify the isotherm in which CO_2 behaves as a perfect gas.
ii) Identify the isotherm in which CO_2 behaves as a real gas.
iii) State the phase which exists at point 'B'. (3+3)

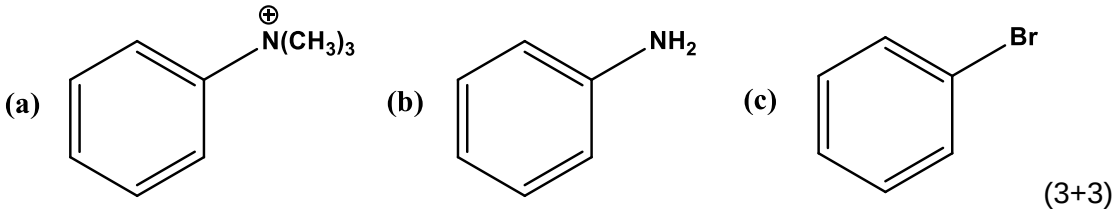


16. (a) Outline the mechanism for the reaction given below.



(b) Explain the effect of solute on the surface tension of liquids. (3+3)

17. (a) The decreasing order of stability for the following carbocations is
$(CH_3)_3C^+ > CH_3CH_2^+ > CH_3^+$. Justify the reason for this trend.
(b) Label each of the following aromatic rings as activated or deactivated based on the substituent attached and state whether the group is ortho/para or meta directing.



(3+3)

Part-C

Answer any TWO of the following questions. [**2x5=10]**

18. (a) What mass of KIO_3 is needed to convert the copper in 0.2750 g of $CuSO_4 \cdot 5H_2O$ to $Cu(IO_3)_2$? (Molar mass of : $CuSO_4.5H_2O$ is 249.67 g mol^{-1} ; KIO_3 = 214 g mol^{-1} ; $Cu(IO_3)_2$ = 413.351 g mol^{-1}).
(b) Identify the crystal systems from the following data:
(i) a = 4.2 Å, b = 4.0 Å, c= 3.8 Å; α = γ = 90°, β ≠ 90°
(ii) a = 6.1 Å, b = 7.1 Å, c = 5.6 Å; α ≠ β ≠ γ ≠ 90° (3+2)

19. (a) A certain crystal has lattice parameters of 4.24 Å, 10.00 Å and 3.66 Å on X, Y, Z axes, respectively. Determine the Miller indices of a plane having intercepts of 2.12 Å, 10.00 Å and 1.83 Å on the X, Y and Z axes, respectively.
(b) The inversion temperature of a gas is -80 ℃. Among the temperatures given: 173 K, 193 K, 273 K and 298 K, identify the temperature at which the cooling occurs under Joule-Thomson effect? Justify your choice. (3+2)

20. (a) A capillary tube is dipped inside a beaker containing water at 25 °C. Calculate the radius of this capillary tube in meters if the height of water raised inside the capillary tube was 10 cm. The surface tension of water is 0.0728 Nm^{-1}.
[density of water = 0.997 kg/m^3 and acceleration due to gravity (g) = 9.81 m/s^2]

(b) The relative rates of the reaction of the following primary alkyl halides in ethanol towards nucleophilic substitution reaction are as follows:

Primary alkyl halides	Relative rate
CH_3CH_2I	1.95
$CH_3CH_2\,CH_2I$	0.21
$(CH_3)_2CHCH_2I$	0.037
$(CH_3)_3CCH_2I$	0.00000000000123

i. Identify if the above reactions are likely to be S_N1 or S_N2.

ii. Would you expect the rate to increase or decrease if solvent is changed to acetone? (3+2)