B i) Explain the evidences in favour of Arrhenius theory. (6 marks)

ii) Determine the mean activity coefficient and mean activity of a 0.004 molal of $Ba(HCO_3)_2$ . (4 marks)

22. A Evaluate the thermodynamic treatment of electrified interfaces leading to the derivation of the Lippmann equation.

**OR**

B With a neat sketch explain the various models of the electrical double layer.

23. A Determine the kinetics of single step one e- transfer electrode reaction and examine the Butler-Volmer equation for i) high over voltage , ii) Low over voltage values.

**OR**

B i) Determine the application of overvoltage for the elctrodeposition of metals in aqueous solution with example. (5 marks)

ii) The transfer coefficient of an electrode in contact with $M^{3+}$ / $M^{2+}$ aqueous solution at 25°C is 0.39. The current density is found to be 55mA/cm$^2$ when the overpotential is 125mV. What is the overpotential required for current density of 75 mA/cm$^2$? (5 marks)

24. A With a neat Pourbiax diagram explain the effect of pH on the electrochemical reaction.

**OR**

B Evaluate the kinetics of a two-electron transfer process.

25. A Classify different types of fuel cells with examples.

**OR**

B Sketch a cyclic voltammogram of a hypothetical reversible redox-couple: $A^{n+} + n e^- \rightarrow A$ and explain the theory behind it.

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**END SEMESTER EXAMINATION NOV/DEC-2023**

**First Semester**

**M Sc CHEMISTRY**

**ELECTIVE – II ELECTROCHEMISTRY**

Time: Three Hours                                    Maximum: 75 marks

**SECTION A – (15 x 1 = 15 marks)**
**ANSWER ALL QUESTIONS**

1. What is the ionic strength of 1M solution of $Na_3PO_4$ ?

   A  1                         B  3

   C  6                         D  12

2. The Debye-Huckel limiting law correlates _____.

   A  activity of electrolyte with ionic strength

   B  mean ionic activity coefficient of electrolyte with ionic strength

   C  molality of electrolyte with ionic strength

   D  mean molality of electrolyte with ionic strength

3. At high frequencies the variation of conductance with frequency is referred as _____.

   A  Dispersion of conductance

   B  Wien effect

   C  Polarization

   D  Dissociation field effect

4. The phenomenon of back emf due to accumulation of products at the electrodes is called _____.

   A  Over voltage

   B  Electroplating

   C  Decomposition potential

   D  Polarization

5. What is the symbol of overvoltage?

    A  Alpha ($\alpha$)          B  Beta ($\beta$)

    C  Eta ($\eta$)            D  Delta ($\Delta$)

6. The electrical double layer model among the following that consists of both fixed and diffuse layers is _____.

    A  Debye-Huckel      B  Helmoltz

    C  Gouy             D  Stern

7. The deposition of zinc occurs along with the liberation of hydrogen due to _____.

    A  High over voltage of hydrogen      B  low over voltage of hydrogen

    C  High oxiation potential for Zinc      D  High Reduction potential for hydrogen

8. The electrolyte with the smallest Debye length at 298K is _____.

    A  NaCl           B  KCl

    C  $CuCl_2$          D  $LaCl_3$

9. The relative movement of a solid and a liquid with respect to one another is due to the presence of a potential difference at the interface of the two phases. This potential is called _____.

    A  Streaming potential      B  Oxidation potential

    C  Sedimentation potential      D  Zeta potential

10. For most of the metals the value of constant 'b' in Tafel equation is _____.

    A  0.10 v         B  0.12 v

    C  0.14 v         D  0.16 v

11. Tafel equation is _____.

    A  $\ln(-i) = \ln i - \alpha\eta F/RT$      B  $\ln(-i) = \ln i - \alpha\eta/FRT$

    C  $\ln(-i) = \ln i - \alpha F/RT$      D  $\ln(-i) = \ln i - \eta F/RT$

12. The fuel cell is considered a battery in which _____ is continuously replaced.

    A  fuel only          B  both fuel and oxidizer

    C  oxidizer          D  none of the mentioned

13. The diffusion current in the polarography depends on all of the following, except _____.

    A  Charge of the electrolyte      B  Capillary diameter

    C  Life time of mercury drop      D  Temperature

14. In cyclic voltammetry, potential is the

    A  dependent variable      B  independent variable

    C  constant parameter      D  Changeable variable

15. The emf of $H_2$-$O_2$ cell is

    A  1.0 v         B  1.13 V

    C  1.23 V        D  1.33 V

## SECTION B – (2 x 5 = 10 marks)

### ANSWER ANY TWO QUESTIONS

16. Determine the significance of the constants A and B in Debye Huckel equation.

17. Explain electro-endosmosis and electrophoresis.

18. Explain the nature of a polarizable and non-polarizable electrode with the help of Tafel plot.

19. Discuss the calculation of transfer coefficients from Tafel Plot.

20. What is a capacitor? How does a capacitor work in storing energy?

## SECTION C – (5 x 10 = 50 marks)

### ANSWER ALL QUESTIONS

21. A  Discuss the assumptions of Debye-Huckel Onsager theory and derive the electrical potential equation for strong electrolytes.

                **OR**