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Assignment for B.Sc. Part II (Chem (H)

Electrochemistry

1. Standard reduction potential of $Fe^{3+} + e^- \rightarrow Fe^{2+}$ is 0.77V. What is the potential of a Pt electrode immersed in an aqueous solution containing 2.0 M Fe^{2+} and 0.2 M Fe^{3+}

   a) 0.71V b) 0.071V c) 7.1V d) 0.355 V

2. The EMF of the concentration cell $Cu(s) \mid Cu^{2+}(0.012M) \parallel Cu^{2+}(1.2M) \mid Cu(s)$ is:

   a) 0.001V b) 0.025 c) 0.059V d) 0.118V

3. A cell reaction would be spontaneous if the cell potential and and Gibb's free energy are respectively:

   a) positive and negative b) negative and negative

   c) zero and zero d) positive and zero

4. Which of the following statements is correct?

   a) Cathode is –ve terminal in both galvanic and electrolytic cells

   b) Anode is +ve terminal in both galvanic and electrolytic cells

   c) Cathode is –ve in electrolytic cell and anode is –ve in galvanic cell

   d) Cathode is +ve in electrolytic cell and anode is +ve in galvanic cell

5. The electric charge required for electrode deposition of one gram equivalent of a substance is:

   a) one ampere per second b) 96500 coulombs per second

   c) one ampere for one hour d) charge on one mole of electrons

6. How many electrons are there in one coulomb of electricity?

   a) 6.023×10^{23} b) 1.64×10^{-24} c) 6.24×10^{-24} d) 6.24×10^{18}

7. How many coulombs are provided by a current of 0.010 mA in the calculator battery that can operate for 1000 hours?

   a) 1.0 b) 10 c) 0.010 d) 36

8. An aqueous solution containing 1M each of Au^{3+}, Cu^{2+}, Ag^+, Li^+ is being electrolyzed by using inert electrodes. The value of standard potential are: $E^o_{Ag^+/Ag} = 0.80V$, $E^o_{Cu^+/Cu} = 0.34$, $E^o Au^{3+}/Au = 1.50$, $E^o_{Li^+/Li} = -3.03$, with increasing voltage, the sequence of deposition of metals on the electrode will be:

   a) Li, Cu, Ag, Au b) Cu, Ag, Au c) Au, Ag, Cu d) Au, Ag, Cu, Li

9. Total charge required for the oxidation of the two moles Mn_3O_4 into MnO_4^{2-} in presence of alkaline medium is:

   a) 5 F b) 10 F c) 20 F d) none of these

10. How many coulombs of electricity are required to give 54 Kg of aluminum? Assume following reaction $Al^{3+} + 3e^- \rightarrow Al$

    a) 17.3×10^8 b) 3.21×10^7 c) 1.82×10^4 d) 57.6×10^7

11. When a solution of $AgNO_3$ (1M) is electrolyzed using platinum anode and copper cathode. What are the product obtained at two electrodes?

    Given: $E^o_{Cu^{2+}/Cu} = +0.34V$; $E^o_{O_2,H^+/H_2O} = +1.23V$, $E^o_{H^+/H_2} = +0.0V$, $E^o_{Ag^+/Ag} = 0.8V$

    a) $Cu \rightarrow Cu^{2+}$ at anode; $Ag^+ \rightarrow Ag$ at cathode

    b) $H_2O \rightarrow O_2$ at anode; $Cu^{2+} \rightarrow Cu$ at cathode

    c) $H_2O \rightarrow O_2$ at anode; $Ag^+ \rightarrow Ag$ at cathode

    d) $NO_3^- \rightarrow NO_2$ at anode; $Ag^+ \rightarrow Ag$ at cathode

12. The function of salt bridge is to:

    a) Maintain electrical neutrality of both half cells

    b) Increase the cell potential at the positive electrode

    c) Decrease the cell potential at the negative electrode

    d) Eliminate the impurities present in the electrolyte

13. The nature of curve of E^o_{cell} vs $\log K_c$ is:

    a) Straight line b) parabola c) hyperbola d) elliptical curve

14. The standard electrode potential of SHE at 298 K is:

    a) 0.05 V b) 0.10 V c) 0.50 V d) 0.00 V

15. The cell reaction $Hg_2Cl_2(s) + Cu(s) \rightarrow Cu^{2+}(aq) + 2Cl^-(aq) + 2Hg(l)$, is best represented by:

    a) $Cu(s) \mid Cu^{2+}(aq) \parallel Hg_2Cl_2(s) \mid Hg(l)$

    b) $Cu(s) \mid Cu^{2+}(aq) \parallel Hg(l) \mid Hg_2Cl_2(s)$

    c) $Cu(s) \mid Cu^{2+}(aq) \parallel Cl^-(aq) \mid Hg_2Cl_2(s) \mid Hg(l) \mid Pt(s)$

    d) $Hg_2Cl_2(s) \mid Cl^-(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

16. The cell reaction $Cr_2O_7^{2-}(aq) + 14\ H^+(aq) + 6Fe^{2+}(aq) \rightarrow 6Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$, is best represented by:

    a) $Pt(s) \mid Fe^{2+}(aq), Fe^{3+}(aq) \parallel Cr_2O_7^{2-}(aq), Cr^{3+}(aq) \mid Pt(s)$

    b) $Pt(s) \mid Cr_2O_7^{2-}(aq), Cr^{3+}(aq) \parallel Fe^{3+}(aq), Fe^{2+}(aq) \mid Pt(s)$

    c) $Fe^{2+}(aq) \mid Fe^{3+}(aq) \parallel Cr_2O_7^{2-}(aq) \mid Cr^{3+}(aq)$

    d) $Cr_2O_7^{2-}(aq) \mid Cr^{3+}(aq) \parallel Fe^{3+}(aq) \mid Fe^{3+}(aq)$

17. The standard potential at 25°C for the following half-cell reaction is given: $Zn^{2+} + 2e^- \rightarrow Zn$; $E^0 = -0.762V$ and $Mg^{2+} + 2e^- \rightarrow Mg$; $E^0 = -2.37V$, when zinc dust is added to the solution of $MgCl_2$,

a) $ZnCl_2$ is formed b) Mg is precipitated

c) Zn dissolved in the solution d) No reaction takes place

18. The standard electrode potential for the following reaction is +1.33 V. what is the potential at pH = 2.0, $Cr_2O_7^{2-}(aq, 1M) + 14\ H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq, 1M) + 7H_2O(l)$

a) +1.820 V b) +1.990 V c) +1.608 V d) +1.0542 V

19. The E^0 at 298K for the following reaction is 0.22 V, calculate the equilibrium constant at 298K: $H_2(g) + 2AgCl(s) \rightarrow 2Ag(s) + 2HCl(aq)$

a) 2.8×10^7 b) 5.2×10^8 c) 5.2×10^6 d) 5.2×10^3

20. Electrode potential of the half-cell $Pt(s) \mid Hg(l) \parallel Hg_2Cl_2(s) \mid Cl^-(aq)$ can be increased by:

a) Increasing $[Cl^-]$ b) decreasing $[Cl^-]$ c) Increasing $Hg_2Cl_2(s)$ d) decreasing Hg(l)

21. The equilibrium constant for the following general reaction is 10^{30}. Calculate E^0 for the cell at 298K, $2X_2(s) + 3Y^{2+}(aq) \rightarrow 2X_2^{3+}(aq) + 3Y(s)$

a) +0.105 V b) +0.2955 V c) +0.0985 d) −0.295

22. $Co \mid Co^{2+}(C_2) \parallel Co^{2+}(C_1) \mid Co$; for this cell, ΔG is negative if:

a) $C_2 > C_1$ b) $C_1 > C_2$ c) $C_2 = C_1$ d) none of these

23. At equilibrium for a cell reaction, the correct statement is:

a) $E^o_{cell} = 0, \Delta G^o = 0$ b) $E_{cell} = 0, \Delta G = 0$ c) both are correct d) none of these

24. The conductivity of a strong electrolyte:

a) Increases on dilution b) Decrease on dilution

c) Does not change with dilution d) Depends upon density of electrolyte

25. The increase in equivalent conductance of a weak electrolyte with dilution is due to:

a) Increase in degree of dissociation and decrease in ionic mobility

b) Decrease in degree of dissociation and decrease in ionic mobility

c) Increase in degree of dissociation and increase in ionic mobility

d) Decrease in degree of dissociation and increase in ionic mobility

26. Which of the following is arranged in increasing order of ionic mobility:

a) $I^- < Br^- < Cl^- < F^-$ b) $F^- < Cl^- < Br^- < I^-$

c) $F^- < I^- < Cl^- < Br^-$ d) $F^- < Cl^- < I^- < Br^-$

27. If the equilibrium constant for the reaction $H^+(aq) + OH^-(aq) \rightleftharpoons H_2O(l)$ is 10^{13} at certain temperature then what is the E^o for the reaction, $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$,

given: $\frac{2.303RT}{F} = 0.066$

a) 1.203V b) −0.858V c) −0.80V d) −0.8274V

28. The solubility of the silver halides in water varies as,

a) AgI<AgBr< AgCl <AgF b) AgI>AgBr> AgCl >AgI

b) AgCl <AgF<AgBr<AgI d) AgCl <AgBr<AgI<AgF

29. The reduction potential values of $Cu^{2+} \mid Cu$ and $Cu^{2+} \mid Cu$ are 0.34 and 0.15V respectively. The equilibrium constant for the reaction, $Cu + Cu^{2+} \rightleftharpoons Cu^{2+}$ is:

a) 3.60×10^{-7} b) 4.95×10^{-8} c) 8.36×10^{-6} d) 3.01×10^{-12}

30. The reduction potentials of $Cr_2O_7^{2-} \mid Cr^{3+}$ and $Cr^{3+} \mid Cr$ are +1.33V and −0.74V, respectively. The reduction potential of $Cr_2O_7^{2-} \mid Cr$ is:

a) +0.295V b) +0.590V c) +0.195V d) +1.770V

31. The mean ionic activity coefficient of 0.005 mol/kg $CaCl_2$ in water at 298K is:

a) 0.98 b) 0.67 c) 0.81 d) 0.91

32. For the cell: $Cd(Hg) \mid CdSO_4,(8/3)H_2O(s) \mid CdSO_4(aq.Satd.) \mid Hg_2SO_4(s) \mid Hg$, the temperature dependence of emf in volts is given by $E = 1.0185 - 4.05\times10^{-5}(T-293) - 9.5\times10^{-7}(T-293)^2$, the change in entropy at 25°C for the cell reaction is:

a) $-253K^{-1}mol^{-1}$ b) $9.65\ JK^{-1}mol^{-1}$ c) $8.3\times10^{-4}JK^{-1}mol^{-1}$ d) Zero

33. From the data of two half cell reactions:

$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-$ $E^o = +0.22V$

$Ag^+(aq) + e^- \rightarrow Ag(s)$ $E^o = +0.80V$

The solubility product of AgCl at 298K is calculated to be

a) 1.5×10^{-10} b) 2.1×10^{-7} c) 3.0×10^{-3} d) 1.2×10^{-5}

34. The solubility product of Ag_2SO_4 at 298K is 1.0×10^{-5}. If the standard reduction potential of the half cell $Ag^+ + e^- \rightarrow Ag$ is 0.80V, the standard reduction potential of the half cell $Ag_2SO_4 + 2e^- \rightarrow 2Ag + SO_4^{2-}$ is:

a) 0.15V b) 0.22V c) 0.65V d) 0.95V

35. In the reversible chemical reaction taking place under standard condition at 298K and 1atm in a Daniel cell, $Zn \mid Zn^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu$, the heat change is:

a) equal to ΔH b) equal to TΔS c) equal to zero d) equal to ΔU

36. Given the standard potential for the following half cell reaction at 298K

$Cu^{+}(aq) + e^{-} \rightarrow Cu(s)$ $E^{0} = 0.52V$

$Cu^{2+}(aq) + e^{-} \rightarrow Cu^{+}(aq)$ $E^{o} = 0.16V$

Calculate the ΔG^{0} (kJ) for the reaction, $2Cu^{+}(aq) \rightarrow Cu(s) + Cu^{2+}$

a) −34.740 b) −65.720 c) −69.480 d) −131.440

37. Given that E^{o} ($Fe3^{+}$,Fe) = 0.04V and E^{o} (Fe^{2+}, Fe) = −0.44V, the value of E^{0} (Fe^{3+}, Fe^{2+}) is:

a) 0.76V b) −0.40V c) −0.76V d) 0.40V

38. According to the Debye-Huckel limiting law, the mean activity coefficient of 5×10^{-4} $molkg^{-1}$ aqueous solution of $CaCl_2$ at 25°C is:

a) 0.63 b) 0.72 c) 0.80 d) 0.91

39. According to Debye-Huckel limiting law, if the concentration of a dilute aqueous solution of KCl is increases 4-fold, the value of $ln\gamma_{\pm}$ will,

a) Decrease by a factor of 2 b) Increases by a factor of 2

c) Decreases by a factor of 4 d) increases by a factor of 4

40. Given the standard cell potential as below: $AgCl + e^{-} \rightarrow Ag + Cl^{-}$ $E^{o} = 0.2223V$

$Ag^{+} + e^{-} \rightarrow Ag$ $E^{0} = 0.799V$, The solubility product for the reaction, $AgCl \rightarrow Ag^{+} + Cl^{-}$ is:

a) 2.80×10^{-10} b) 0.80×10^{-10} c) 28.0×10^{-10} d) 1.80×10^{-10}

41. The velocity of Li^{+} ion in water is 2×10^{-2}cm/sec. when 100V is applied between two electrode is separated by 2 cm. The mobility of Li^{+} ion in water is,

a) $4\times10^{-4}cm^{2}s^{-1}V^{-1}$ b) $1\times10^{-4}cm^{2}s^{-1}V^{-1}$ c) $4\ cm^{2}s^{-1}$ d) $2.5\times10^{-5}cm^{2}sV$

42. The ionic strength of a solution containing 0.1 molal each of $CuSO_4$ and $Al_2(SO_4)_3$ is:

a) 0.2 m b) 0.7 m c) 1.9 m d) 1.0 m

43. At 20°C the standard EMF of a certain cell is +0.2699 V and at 30°C it is +0.2669 V. What can you say about the standard entropy of this reaction? Assume that the standard ΔH^{0} and ΔS^{0} are independent of temperature.

a) $\Delta S^{o} = 0$ b) ΔS^{o} = +ve c) $\Delta S^{0} = -Ve$ d) none of these

44. The ionic strength of 0.01M K_2SO_4 is:

a) 0.01 b) 0.02 c) 0.03 d) 0.04

45. In the mixture obtained by mixing 25.0 ml of 1.2×10^{-3} M $MnCl_2$ and 35.0 ml of 6.0×10^{-4}MKCl solution, the concentration of Mn^{2+}, K^{+} and Cl^{-} ions respectively are

a) 6.0×10^{-4}, 3.0×10^{-4}, 1.5×10^{-3} b) 6.0×10^{-4}, 3.0×10^{-4}, 9×10^{-4}

c) 5.0×10^{-4}, 3.5×10^{-4}, 1.35×10^{-3} d) 5.0×10^{-4}, 3.5×10^{-4}, 8.5×10^{-4}

46. Faraday's law of electrolysis is related to the:

a) atomic number of cation b) atomic number of the anion

c) equivalent weight of the electrolyte d) speed of the cation

47. For an aqueous solution at 25°C, the Debye-Huckel limiting law is given by

a) $\ln\gamma_{\pm} = 0.509 \left| Z_+ Z_- \right| \sqrt{\square}$ b) $\ln\gamma_{\pm} = 0.509 \left| Z_+ Z_- \right| \mu$

c) $\ln\gamma_{\pm} = -0.509 \left| Z_+ Z_- \right| \sqrt{\square}$ d) $\ln\gamma_{\pm} = 0.509 \left| Z_+ Z_- \right| \mu^2$

48. If the ratio of composition of oxidized and reduced species in electrochemical cell, is given as $\frac{[O]}{[R]} = e^2$, the correct potential difference will be

a) $E - E^0 = +\frac{2RT}{nF}$ b) $E - E^0 = -\frac{2RT}{nF}$

b) $E - E^0 = +\frac{RT}{nF}$ d) $E - E^0 = -\frac{RT}{nF}$

49. For the following reaction $2MnO_4^{2-} + 5H_2C_2H_4 + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

$E^o\ (MnO_4^- \mid Mn^{2+}) = +1.51V$ and $E^o\ (CO_2 \mid H_2C_2O_4) = -0.49V$, at 298 K, the equilibrium constant is:

a) 10^{500} b) 10^{338} c) 10^{38} d) 10^{833}

50. For a potentiometric titration, in the curve of emf vs volume of the titrant added, the equivalence point is indicated by

a) $\left|\frac{dE}{dV}\right| = 0, \left|\frac{d^2E}{dV^2}\right| = 0$ b) $\left|\frac{dE}{dV}\right| = 0, \left|\frac{d^2E}{dV^2}\right| > 0$

c) $\left|\frac{dE}{dV}\right| > 0, \left|\frac{d^2E}{dV^2}\right| = 0$ d) $\left|\frac{dE}{dV}\right| > 0, \left|\frac{d^2E}{dV^2}\right| > 0$

51. The equilibrium constant for a cell reaction $2Cu^{2+}(aq) \rightarrow Cu(s) + Cu^{2+}(aq)$ at 25^0 C. given half cell reaction, $Cu^+(aq) + e^- \rightarrow Cu(s)$ $E^0 = +0.52V$ and $Cu^{2+}(aq) + e^- \rightarrow Cu^+$ $E^0 = +0.16V$, is

a) 1.2×10^8 b) 1.2×10^6 c) 3.2×10^8 d) 4.0×10^6

52. The standard reduction potential at 298K for single electrodes are given below

Electrode Electrodepotential(Volt)

Mg^{2+}/Mg	−2.34
Zn^{2+}/Zn	−0.76
Fe^{2+}/Fe	−0.44, from this data we can infer that

a) Zn can reduce both Mg^{2+} and Fe^{2+} b) Fe can reduce both Mg^{2+} and Zn^{2+}

c) Mg can reduce both Zn^{2+} and Fe^{2+} d) Mg can reduce Zn^{2+} but not Fe^{2+}

53. Given, $Ag^+ + e^- \rightarrow Ag$, $E^0 = 0.50V$ and $Cu^{2+} + 2e^- \rightarrow Cu$, $E^0 = 0.34V$, a 100 ml solution is 1080 mg with respect to Ag^+ and 635 mg with respect to Cu^{2+}. If 0.1 mg Ag^+ left in the solution is considered to be the complete deposition of Ag^+, the cathode potential , so that no copper is deposited during the process is:

a) 0.16 V b) 0.84 V c) 0.31 V d) −0.16 V

54. The correct Nernst equation for the concentration cell:

Pt | $H_2(P)$ | $HCl(a\pm)_1$ | AgCl(s) | Ag and | AgCl(s) | Ag | $HCl(a\pm)_2$ $H_2(p)$ | Pt, without junction potential would be

a) $E = \frac{2RT}{F} \ln \frac{(a\pm)1}{(a\pm)2}$ b) $E = \frac{RT}{F} \ln \frac{(a\pm)2}{(a\pm)1}$

c) $E = \frac{2RT}{F} \ln \frac{(a\pm)2}{(a\pm)1}$ d) $E = \frac{RT}{2F} \ln \frac{(a\pm)2}{(a\pm)1}$

55. The specific conductance of a solution is0.176 $\Omega^{-1}cm^{-1}$. If the cell constant is 0.255 cm^{-1}, the conductance (Ω^{-1}) of that solution is

a) 1.449 b) 0.690 c) 0.045 d) 0.431

56. The electrochemical cell potential (E), after the reactants and products reach equilibrium, is (E^o is the standard cell potential and n is the number of electrons involved)

a) $E = E^o + \frac{nF}{RT}$ b) $E = E^0 - \frac{nF}{RT}$

c) $E = E^o$ d) E = 0

57. Given, (i) $Zn + 4NH_3 \rightarrow Zn(NH_3)_4^{2+} + 2e$, $E^o = 1.03$ V

(ii) $Zn \rightarrow Zn^{2+} + 2e$, $E^o = 0.763$ V, The formation constant of the complex $Zn(NH_3)_4^{2+}$ is approximately $\left(\frac{2.303RT}{F} = 0.0591\right)$

a) 1×10^5 b) 1×10^7 c) 1×10^9 d) 1×10^{12}

58. The ionic mobilities of NH_4^+ and HCO_3^- are 6×10^{-4} $V^{-1}s^{-1}$ and 5×10^{-4} $V^{-1}s^{-1}$, respectively. The transport numbers of NH_4^+ and HCO_3^- are, respectively

a) 0.545 and 0.455 b) 0.455 and 0.545

c) 0.090 and 0.910 d) 0.910 and 0.090

59. The ionic strength of a solution containing 0.008 M $AlCl_3$ and 0.005 M KCl is

a) 0.134 M b) 0.053 M c) 0.106 M d) 0.086 M

60. The standard EMF of the cell Pt,$H_2(g)$ | HCl(soln.) | AgCl(s), Ag(s)

a) Increases with T

b) Decreases with T

c) Remains unchanged with T

d) Decreases with [HCl]