THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme — Level 4
Assignment II (Test) — 2011/2012
CMU 2220 — Concepts in Chemistry

1 hour

4th November 2011 (Friday) 4.00 p.m. — 5.00 p.m.

- Answer all 25 questions (25 x 4 = 100 marks)
- Choose the most correct answer to each of the questions and mark this answer with an "X" on the answer script in the appropriate box.
- Use a **PEN** (not a PENCIL) in answering.
- Any answer with more than **one** "X" marked will be considered as an *incorrect* answer.
- Marks will be deducted for incorrect answers (0.6 per incorrect answer).
- The use of a non-programmable electronic calculator is permitted.
- Cellular phones are **not** allowed.

Gas constant (R)	=	$8.314\ JK^{-1}mol^{-1}$
Avogadro constant N_A	=	$6.023\times10^{23}\ mol^{-1}$
Faraday constant (F)	=	$96,500\ Cmol^{-1}$
Planck constant (h)	=	$6.63\times10^{-34}\ Js$
Velocity of light (c)	=	$3.0\times10^{8}\ ms^{-1}$
Standard atmospheric pressure	=	$10^{5}\ Pa\ Nm^{-2}$
$\log_e(X)$	=	$2.303\log_{10}(X)$

1. What is the total charge on 1.5 mol of PO_4^{3-} ?

   (a) −434250 C (b) −144750 C (c) −289500 C
   (d) 434250 C (e) 289500 C

2. A student electrolysed an aqueous solution of a strong electrolyte, AB_2, which dissociates as $AB_2 \rightarrow A^{4+}(aq) + 2B^{2-}(aq)$. The anode and cathode reactions were $B^{2-}(aq) \longrightarrow B(s) + 2e^-$ and $A^{4+}(aq) + 4e^- \longrightarrow A(s)$. Consider the following statements about this electrolysis process.

   (i) Electric current in the solution is carried only by the $A^{4+}(aq)$ ions since they have a positive charge.

   (ii) $A^{4+}(aq)$ ions move towards the cathode during the process.

   (iii) $B^{2-}(aq)$ ions move towards the anode during the process.

   The correct statements out of (i), (ii) and (iii) above are
   (a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
   (d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

3. A copper wire in an electric circuit carries a uniform current where 1.5×10^{-4} mol of electrons pass through a cross section in one second. What is current density through the wire if the cross sectional area of it is 2.5×10^{-2} cm^2 ?

(a) $6\ C\ s^{-1}\ m^{-2}$ (b) $6\ A\ cm^{-2}$ (c) $14.475\ A\ cm^{-2}$
(d) $14.475\ C\ s^{-1}\ m^{-2}$ (e) $579\ C\ s^{-1}\ cm^{-2}$

4. A student constructed a coulometer where the reaction, $A^{4+}(aq) + 4e^- \longrightarrow A(s)$, took place in a platinum dish. He found out that 3.5 mg of A(s) deposited in the platinum dish in an experiment involving this coulometer. What is the total charge passed through the circuit during the experiment if the relative molecular mass of A(s) is 251 ?

(a) 1345.6 C (b) 5.578×10^{-5} C (c) 5382.5 C
(d) 5.38 C (e) 6.78 C

5. The SI units of conductivity, conductance and molar conductivity, respectively are,

(a) S, Sm^{-1}, Sm^2mol^{-1}

(b) $\Omega^{-1}m^{-1}$, S, Sm^2mol^{-1}

(c) Sm^{-1}, Sm^2mol^{-1}, Ω^{-1}

(d) Sm^{-1}, S, Ωm^2mol^{-1}

(e) Sm^{-1}, Ω, Sm^2mol^{-1}

6. A current of 0.2 A flows through a 0.25 mol dm^{-3} aqueous solution of NaCl. The cross sectional area of the solution conducting the current is 1 cm^2 and the electric field strength inside the solution is 800 V m^{-1}. What is the conductivity of the solution?

(a) $10.0\ S\ m^{-1}$ (b) $0.625\ S\ m^{-1}$ (c) $2.5 \times 10^{-4}\ S\ m^{-1}$
(d) $2.5\ S\ m^{-1}$ (e) $10.0 \times 10^{-4}\ S\ m^{-1}$

7. In an experiment a student filled a conductivity cell with an aqueous solution of a strong electrolyte, X. Consider the following statements about this experiment.

(i) The resistance between the two electrodes of the cell increases with increasing concentration of X.

(ii) The conductance between the two electrodes of the cell depends on the temperature of the solution.

(iii) The resistance between the two electrodes of the cell is proportional to the conductivity of the solution of X.

The correct statements out of (i), (ii) and (iii) above are
(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

8. Following resistances were observed at 30°C in a conductivity cell filled with various solutions: 411.82 Ω for a KCl solution; 10.875 kΩ for a solution of $MgCl_2$. The conductivity of the KCl solution is known to be 1.2856 S m^{-1} at 30°C. What is the conductivity of $MgCl_2$ solution at 30°C.

(a) 3.78×10^{-2} S m^{-1} (b) 1.43×10^{-2} S m^{-1} (c) 4.87×10^{-2} S m^{-1}
(d) 3.25×10^{-3} S m^{-1} (e) 5.67×10^{-2} S m^{-1}

9. Consider an aqueous solution of a strong electrolyte, Y. The conductivity of this solution

(i) is maximum at infinite dilution.

(ii) increases with increasing concentration of Y.

(iii) increases when you dissolve another strong electrolyte X (which does not react with Y) keeping the concentration of Y constant.

The correct statements out of (i), (ii) and (iii) above are
(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

10. Consider an aqueous solution of a weak electrolyte, AB, which dissociates according to $AB \rightleftharpoons A^{2+} + B^{2-}$. If you denote the conductivity of the ionic species, α, by κ_α, then the conductivity, κ, of the solution is given by

(a) $\kappa = \kappa_{A^{2+}} + \kappa_{B^{2-}}$

(b) $\kappa = 2\kappa_{A^{2+}} + 2\kappa_{B^{2-}}$

(c) $\kappa = 2\kappa_{A^{2+}} + \kappa_{H^+}$

(d) $\kappa = 2\kappa_{A^{2+}} + 2\kappa_{B^{2-}} + \kappa_{H^+} + \kappa_{OH^-}$

(e) $\kappa = \kappa_{A^{2+}} + \kappa_{B^{2-}} + \kappa_{H^+} + \kappa_{OH^-}$

11. An electric current is passed through a dilute solution of electrolytes. The density of the current carried by a particular ionic species in it is proportional to the

(i) molar charge

(ii) drift speed

(iii) molar concentration

of that ionic species in the solution.

The correct statements out of (i), (ii) and (iii) above are
(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

12. Ionic mobility of an ionic species in a solution at a particular temperature

(i) is defined as the drift speed per unit electric field strength.

(ii) has the unit m^2Vs^{-1}.

(iii) depends on the solvent.

The correct statements out of (i), (ii) and (iii) above are

(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

13. Consider the following statements.

(i) The ionic mobility of an ionic species in an aqueous solution (at a particular temperature) has its largest value at infinite dilution.

(ii) The electrophoretic effect becomes larger with increasing concentration of electrolytes in the solution.

(iii) The charge asymmetry effect becomes larger with decreasing concentration of electrolytes in the solution.

The correct statements out of (i), (ii) and (iii) above are

(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

14. What is the most probable relationship if the limiting ionic mobility of an ionic species B in aqueous medium at 25°C is denoted by by u_B^0 ?

(a) $u_{H^+}^0 > u_{CH_3COO^-}^0 > u_{OH^-}^0$ (b) $u_{CH_3COO^-}^0 > u_{H^+}^0 > u_{OH^-}^0$

(c) $u_{OH^-}^0 > u_{CH_3COO^-}^0 > u_{H^+}^0$ (d) $u_{OH^-}^0 > u_{H^+}^0 > u_{CH_3COO^-}^0$

(e) $u_{H^+}^0 > u_{OH^-}^0 > u_{CH_3COO^-}^0$

15. The transport number, t_B, of an ionic species, B, in a solution

(i) is defined as the current carried by that ionic species in that solution.

(ii) may be given by $t_B = \frac{j_B}{j}$ where j and j_B are the total current density and the current density carried by the ionic species B.

(iii) may be given by $t_B = \frac{\kappa_B}{\kappa}$ where κ and κ_B are the conductivity of the solution and the conductivity due to the ionic species B.

The correct statements out of (i), (ii) and (iii) above are

(a) Only (i) and (ii). (b) Only (i) and (iii). (c) Only (ii) and (iii).
(d) All (i), (ii) and (iii) (e) None of the answers (a), (b), (c) or (d) is correct.

16. The limiting molar conductivities, in units of $S\ cm^2\ mol^{-1}$, of the binary electrolytes AB, AQ and PB in aqueous medium at 25°C are 91, 426 and 1265, respectively. The electrolytes dissociate as $AB \rightarrow A^+ + B^-$, $AQ \rightarrow A^+ + Q^-$ and $PB \rightarrow P^+ + B^-$. What is the limiting molar conductivity of the binary electrolyte PQ in the same units?

(a) 1600 (b) 930 (c) 1782
(d) 748 (e) 1509

17. In general, spontaneous reactions are driven by,

(a) Low enthalpy values and high entropy values
(b) Low enthalpy values and low entropy values.
(c) High enthalpy values and low entropy values.
(d) High enthalpy values and high entropy values.
(e) High temperatures and low pressures.

18. The Gibbs free energy for a reaction having $\Delta H = 31400\ cal\ mol^{-1}$ and $\Delta S = 32\ cal\ K^{-1}\ mol^{-1}$ at 1000°C, in units of $cal\ mol^{-1}$, is

(a) +9336 (b) −9336 (c) −7386
(d) −1936 (e) zero

19. Which one of the following is referred to as a fundamental thermodynamic equation?

(a) $H = U + PV$ (b) $G = H - TS$ (c) $dA = -PdV - SdT$
(d) $PV = nRT$ (e) $dU = Dq - Dw$

20. Write down the Maxwell Relationship that you can deduce from the equation $dU = TdS - PdV$

(a) $\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$ (b) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$
(c) $\left(\frac{\partial T}{\partial P}\right)_S = -\left(\frac{\partial P}{\partial T}\right)_V$ (d) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$
(e) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$

21. The equation $\frac{dP}{dT} = \frac{\Delta H}{T\,\Delta V}$ is applicable for

(a) a reversible isothermal expansion. (b) a reversible adiabatic expansion.
(c) a univariant phase transformation. (d) adiabatic reversible process.
(e) None of the answers (a), (b), (c) or (d) is correct.

22. ΔG^{o} for melting of three moles of water at $0^{o}C$ is

(a) one (b) positive (c) negative

(d) zero (e) None of the answers (a), (b), (c) or (d) is correct.

23. The equation $\Delta S = nC_V \ln\left(\frac{T_2}{T_1}\right) + nR \ln\left(\frac{V_2}{V_1}\right)$ will apply for the change from state A (V_1, T_1) to a state B (V_2, T_2) for

(a) any homogeneous system at constant pressure.

(b) any homogeneous system at constant volume.

(c) any homogeneous system under all conditions.

(d) an ideal gas at constant pressure.

(e) an ideal gas under all conditions.

24. The volume and temperature coefficients of Helmholtz Free Energy are,

(a) $\left(\frac{\partial A}{\partial V}\right)_T = -P$ and $\left(\frac{\partial A}{\partial T}\right)_V = -S$ (b) $\left(\frac{\partial A}{\partial V}\right)_T = -P$ and $\left(\frac{\partial G}{\partial P}\right)_T = V$

(c) $\left(\frac{\partial G}{\partial P}\right)_T = V$ and $\left(\frac{\partial G}{\partial P}\right)_T = V$ (d) $\left(\frac{\partial A}{\partial T}\right)_V = -S$ and $\left(\frac{\partial G}{\partial P}\right)_T = V$

(e) $\left(\frac{\partial G}{\partial T}\right)_V = -S$ and $\left(\frac{\partial A}{\partial V}\right)_T = -P$

25. An endothermic gaseous reaction proceeds spontaneously at $30^{o}C$ when all substances are at one standard atmospheric pressure. What is true at $30^{o}C$ for this reaction?

(a) $\Delta A < 0$ (b) $\Delta S < 0$ (c) $\Delta G < 0$

(d) $\Delta S > 0$ (e) $\Delta H < 0$