THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme — Level 4
Assignment II (Test) — 2013/2014
CMU 2220/CME4220 — Concepts in Chemistry

1 hour

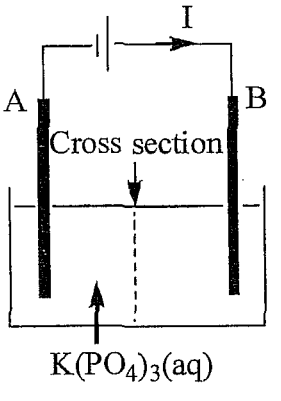
6th April 2014 (Sunday) *2.30 p.m. — 3.30 p.m.*

- 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 wrong answer).
- The use of a non-programmable electronic calculator is permitted.
- Mobile phones are **not** allowed.

- Please write your mailing address on the back of the MCQ answer sheet.

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)	=	$3.0\times10^{8}\ ms^{-1}$
Protonic charge (e)	=	$1.602\times10^{-19}\ C$
Standard atmospheric pressure	=	$10^{5}\ Pa\left(Nm^{-2}\right)$
$Log_e(X)$	=	$2.303\ Log_{10}(X)$

1. A student electrolysed an aqueous solution of $K(PO_4)_3$ using two platinum electrodes, A and B, as shown in the figure to the right using a battery. The electric current in the external circuit is I (see the figure). Consider the following statements



(i) The current carried by $K^+(aq)$ is equal to I.

(ii) In the middle of the solution (at the cross section shown in the figure) $PO_4^{3-}(aq)$ ions move towards electrode B.

(iii) In the solution, $K^+(aq)$, $PO_4^{3-}(aq)$, $H^+(aq)$ and $OH^-(aq)$ carry the electric current.

The correct statement/s 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) Only (i)

2. A student passed a current of 6.7 A through a copper wire of cross sectional area $4.0\times10^{-4}\ m^2$. What is the current density in the wire?

(a) $2.68\times10^{-3}\ A\ cm^{-2}$ (b) $1.67\times10^{4}\ A\ cm^{-2}$ (c) $1.46\times10^{4}\ A\ m^{-2}$
(d) $2.68\times10^{-3}\ A\ m^{-2}$ (e) $1.67\times10^{4}\ A\ m^{-2}$

3. A student constructed a coulometer where the reaction, $B^{3+}(aq)+3e^{-}\rightarrow B(s)$, took place in a platinum dish. In an experiment involving this coulometer he found that 15.0 mg of B(s) was deposited in the platinum dish. What was the total charge passed through the circuit during the experiment if the relative molecular mass of B(s) is 27 ?

(a) 214.4 C (b) 107.2 C (c) 145.8 C
(d) 160.8 C (e) 175.6 C

4. A current of 0.2 A flows through a $0.45\ mol\ dm^{-3}$ aqueous solution of KBr. The cross sectional area of the solution conducting the current is $2.0\ cm^2$ and the electric field strength inside the solution is $750.0\ V\ m^{-1}$. What is the conductivity of the solution?

(a) $2.96\ S\ m^{-1}$ (b) $0.60\ S\ m^{-1}$ (c) $1.33\ S\ m^{-1}$
(d) $1.55\ S\ m^{-1}$ (e) $2.33\ S\ m^{-1}$

5. Consider the following statements.
   (i) Conductivity can be defined for a solution of electrolytes as well as for a metallic conductor.
   (ii) Conductance depends on the geometry of a conductor.
   (iii) Resistivity of a metal depends on the temperature.

   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) Only (i)

6. Consider the following statements.
   (i) In measuring conductivity of a solution using a conductivity cell, you use an alternating current (AC) source to prevent any changes in composition of the solution due to electrolysis.
   (ii) In measuring conductivity of a solution, using a conductivity cell, it is desirable to keep the conductivity cell in a water bath at constant temperature since the conductivity of a solution depends on temperature.
   (iii) In a conductivity cell, the two platinum electrodes are coated with platinum black (finely divided platinum), primarily, to make the electrodes more chemically inert.

   The correct statement/s 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) Only (ii)

7. In an experiment a student filled a conductivity cell, having two platinum electrodes, 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 surface area of the platinum electrodes of the conductivity cell.

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

The correct statement/s 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) Only (i).

8. Consider an aqueous solution of a weak electrolyte, AB_2, which dissociates according to $AB_2 \rightleftharpoons A^{4+} + 2B^{2-}$. If you denote the conductivity of the ionic species, α, by κ_α, then the conductivity, κ, of the solution is given by

(a) $\kappa = \kappa_{A^{4+}} + \kappa_{B^{2-}} + \kappa_{H^+} + \kappa_{OH^-}$

(b) $\kappa = \kappa_{A^{4+}} + 2\kappa_{B^{2-}} + \kappa_{H^+} + \kappa_{OH^-}$

(c) $\kappa = \kappa_{A^{4+}} + \kappa_{B^{2-}}$

(d) $\kappa = 4\kappa_{A^{4+}} + 2\kappa_{B^{2-}} + \kappa_{H^+} + \kappa_{OH^-}$

(e) $\kappa = \kappa_{A^{4+}} + 2\kappa_{B^{2-}}$

9. Consider the following statements about a solution having only one type of anion and one type of cation.

(i) The current carried by the cation is increased when its drift speed is increased.

(ii) The current carried by the anion is decreased when the absolute numerical value of its charge number $\left(\text{i.e. } |Z|\right)$ is decreased.

(iii) The current carried by the cation is increased when its charge number is increased.

The correct statement/s 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) Only (iii)

10. Consider the following statements.

The ionic mobility of an ionic species

(i) increases with increasing concentrations of ions present in the solution.

(ii) at infinite dilution is independent of temperature.

(iii) at infinite dilution depends on the solvent used in preparing the solution.

The correct statement/s 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) Only (iii)

11. Consider the following mathematical relationships with respect to a dilute aqueous solution of the strong electrolyte, $AlCl_3$. (All the symbols have their usual meanings).

(i) $\lambda_{AlCl_3} = \lambda_{Al^{3+}} + 3\lambda_{Cl^-}$

(ii) $\kappa_{Al^{3+}} = u_{Al^{3+}} c_{Al^{3+}} F$

(iii) $\kappa_{AlCl_3} = \kappa_{Al^{3+}} + \kappa_{Cl^-}$

The correct relationships 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. Consider the following statements about the moving boundary method for the determination of ionic mobility of an ionic species in a solution A.

(i) The density of the following solution must always be greater than that of solution A.

(ii) Always solution A must be kept in the compartment above the compartment having the following solution.

(iii) One cannot use a colourless following solution if solution A is also colourless.

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. A student was given an aqueous solution of KBr at 30^0C, labelled as A. He determined the conductivity of solution A to be $1.250\,Sm^{-1}$ at 30^0C. Then he dissolved some NaCl in it to obtain a solution B. The conductivity of solution B was determined to be $3.450\,Sm^{-1}$ at 30^0C. The conductivity of the water used to prepare the solution A was determined to be $0.007\,Sm^{-1}$ at the same temperature. Approximately, what is the conductivity of NaCl in B?

(a) $1.831\,Sm^{-1}$ (b) $2.200\,Sm^{-1}$ (c) $4.693\,Sm^{-1}$

(d) $4.200\,Sm^{-1}$ (e) $3.443\,Sm^{-1}$

14. 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 $m^2 V s^{-1}$.

(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.

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 $t_B = j_B/j$ where j and j_B are the total current density and the current density carried by the ionic species B, respectively.

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

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 molar conductivities (in units of $S\,m^2\,mol^{-1}$) of calcium and thiocyanate ions, in a solution of $Ca(CNS)_2$ at 25^0C and at 1 atm, are 1.2×10^{-2} and 6.2×10^{-3} respectively. Calculate the molar conductivity of calcium thiocyanate in this solution (in units of $S\,m^2\,mol^{-1}$) if it behaves as a weak electrolyte with a degree of dissociation, $\alpha = 0.7$.

(a) 0.023 (b) 0.056 (c) 0.017
(d) 0.0034 (e) 0.078

17. If a chemical reaction has a positive change in entropy, ΔS, then

(a) the disorder of the system increases during reaction.
(b) the reaction is spontaneous.
(c) the reaction is exothermic.
(d) the Gibbs free energy of the reaction is negative
(e) heat is released from the system to the surrounding during reaction.

18. Which of the following gives the correct relationship for an endothermic and spontaneous process in a closed system at constant pressure?

(a) $\Delta G > 0$ and $\Delta H < 0$ (b) $\Delta G < 0$ and $\Delta H > 0$ (c) $\Delta G < 0$ and $\Delta S > 0$
(d) $\Delta H < 0$ and $\Delta S > 0$ (e) $\Delta H > 0$ and $\Delta S < 0$

19. The equation $\frac{dP}{dT} = \frac{\Delta H_{fusion}}{T\,\Delta V}$ describes which of the following?

(a) The change in pressure with respect to temperature when a solid is converted into liquid.

(b) The change in pressure with respect to temperature when a liquid is converted into solid.

(c) The change in pressure with respect to temperature when a liquid and solid are in equilibrium.

(d) The change in pressure with respect to temperature when a liquid is heated.

(e) The change in pressure with respect to temperature when a solid is heated.

20. For an ideal gas the pressure coefficient of isobaric thermal capacity at constant temperature

(i) is independent of pressure and temperature.

(ii) depends only on temperature.

(iii) is zero.

The correct statement/s is/are,

(a) Only (i). (b) Only (ii). (c) Only (iii).
(d) Only (i) and (ii) (e) Only (ii) and (iii).

21. All of the following relationships are true EXCEPT

(a) $\Delta G^0_{sys} = \Delta H^0_{sys} - T\,\Delta S^0_{sys}$

(b) $\Delta G^0 = -RT\ln(K)$

(c) $\Delta S^0_{univ} = \Delta S^0_{sys} + \Delta S^0_{surr}$

(d) $\Delta H = \Delta H^0_{sys} + RT\ln(K)$

(e) $G - A = H - U$

22. The equation $\Delta S = \Delta H/T$ is applicable for a

(a) reversible, isothermal and isobaric process

(b) irreversible, isobaric and isochoric process

(c) reversible, isobaric and isochoric process

(d) irreversible, isobaric and isothermal process

(e) adiabatic, reversible and ideal gas system

23. Which of the following define the two free energy functions?

(a) $G = H - TS$ and $H = U + PV$

(b) $G = H - TS$ and $A = U + TS$

(c) $H = U + PV$ and $A = U - TS$

(d) $G = H - TS$ and $A = U - TS$

(e) $G - A = U - TS$ and $G = H + TS$

24. For a reversible process in a closed system at constant pressure and temperature the Gibbs free energy change is equal to

(a) $\Delta A - T\Delta S$ (b) $\Delta U - T\Delta S$ (c) zero (d) one (e) $\Delta U + P\Delta V$

25. Consider the following statements about a process that takes place in a closed system at constant volume and constant temperature.

(i) Process is spontaneous if $dA_{V,T} > 0$

(ii) Process is reversible if $dA_{V,T} = 0$

(iii) Process is spontaneous if $dA_{V,T} < 0$

The correct expression/s is/are

(a) Only (i). (b) Only (ii). (c) Only (i) and (ii)
(d) Only (iii) (e) Only (ii) and (iii).