THE OPEN UNIVERSITY OF SRI LANKA

B.Sc Degree Programme — Level 4

Assignment II (Test) — 2015/2016

CMU 2220/CME 4220 — Concepts in Chemistry

MCQ Answer Sheet: Mark a cross $(\times)$ over the box that corresponds to the most suitable answer.

Reg. No.

1	a	b	c	d	e	2	a	b	c	d	e	3	a	b	c	d	e	4	a	b	c	d	e
5	a	b	c	d	e	6	a	b	c	d	e	7	a	b	c	d	e	8	a	b	c	d	e
9	a	b	c	d	e	10	a	b	c	d	e	11	a	b	c	d	e	12	a	b	c	d	e
13	a	b	c	d	e	14	a	b	c	d	e	15	a	b	c	d	e	16	a	b	c	d	e
17	a	b	c	d	e	18	a	b	c	d	e	19	a	b	c	d	e	20	a	b	c	d	e
21	a	b	c	d	e	22	a	b	c	d	e	23	a	b	c	d	e	24	a	b	c	d	e
25	a	b	c	d	e																			

THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme — Level 4
Assignment II (Test) — 2015/2016
CMU 2220/CME4220 — Concepts in Chemistry

1 hour

8th May 2016 (Sunday)   1.00 p.m. — 2.00 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 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)	=	$8.314 \ J K^{-1} mol^{-1}$
Avogadro constant (N_A)	=	$6.023 \times 10^{23} \ mol^{-1}$
Faraday constant (F)	=	$96,500 \ C mol^{-1}$
Planck constant (h)	=	$6.63 \times 10^{-34} \ J s$
Velocity of light (c)	=	$3.0 \times 10^{8} \ m s^{-1}$
Protonic charge (e)	=	$1.602 \times 10^{-19} \ C$
Standard atmospheric pressure	=	$10^{5} \ Pa \left(N m^{-2} \right)$
$Log_e(X)$	=	$2.303 \, Log_{10}(X)$

1. A weak electrolyte XY dissociates in aqueous solution as $XY(aq) \rightleftharpoons X^{+}(aq) + Y^{-}(aq)$. A student dissolved 1 mol of XY in water to make 1 litre of solution. The degree of dissociation of XY in this solution is 0.6. What is the total charge of $Y^{-}(aq)$ in this solution?

   (a) $-96500 \, C$ (b) $96500 \, C$ (c) $-48250 \, C$

   (d) $57900 \, C$ (e) $-57900 \, C$

2. A weak electrolyte, AB, dissociates in aqueous medium as $AB(s) \rightleftharpoons A^{2+}(aq) + B^{2-}(aq)$. The ionic mobilities $\left(\text{in units of } m^2 \, V^{-1} s^{-1} \right)$ of $A^{2+}(aq)$ and $B^{2-}(aq)$ in a $0.5 \, mol \, dm^{-3}$ solution of AB at $25°C$ are 55.0×10^{-9} and 79.1×10^{-9}, respectively. The degree of dissociation of AB in this solution is 0.4. What is the molar conductivity, in units $S \, m^2 \, mol^{-1}$, of AB in this solution?

   (a) 0.0388   (b) 0.0104   (c) 0.0259   (d) 0.0155   (e) 0.0194

3. A student studied the movement of ions in the solution phase during a conductivity experiment. A sketch of the solution phase with ions and the direction of flow of the electric current, I, is shown in the figure. Consider the following statements.

Direction of electric current

A   B
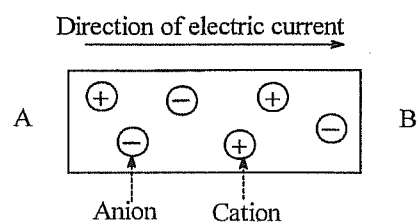
Anion   Cation

(i) Anions move from side A towards side B in the solution.

(ii) $I = I_+ - I_-$, where I_+ and I_- are the electric currents carried by the cations and anions, respectively.

(iii) Side B is at a lower electric potential than side A.

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.

Use the following data in answering questions 4, 5 and 6.

A student carried out a series of electrolysis experiments of an aqueous solution of 0.5 mol dm^{-3} copper sulphate using two copper electrodes using the apparatus shown in the figure. The left and right hand chambers are connected with glass tubes X and Y, fitted with taps so that the electric current through each of the tubes can be stopped by closing each of them. The cross sectional areas of X and Y are 0.5 cm^2 and 0.8 cm^2, respectively. The transport numbers of copper and sulphate ions in the solution were 0.6 and 0.4, respectively.

[Relative atomic mass of copper is 63.5]
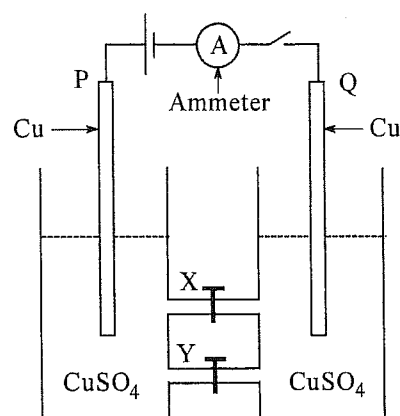
4. In one experiment the current densities in X and Y were 2000.0 A m^{-2} and 1000.0 A m^{-2}, respectively. What is the ammeter reading in this experiment?

(a) 0.36 A   (b) 0.18 A   (c) 1800.0 A   (d) 3600.0 A   (e) 0.036 A

5. In another experiment the ammeter reading was 0.20 A when the tap in tube X was opened and the tap in tube Y was closed. What is the current carried by the sulphate ions in this experiment?

(a) 0.08 A   (b) 0.16 A   (c) 0.12 A   (d) 0.15 A   (e) 0.18 A

6. In another experiment the electrolysis was carried out for 2 minutes using a constant current of 0.80 A with the tap in tube Y opened and the tap in tube X closed. What is a mass of copper deposited on the cathode?

(a) 0.32 g   (b) 0.064 g   (c) 0.64 g   (d) 0.032 g   (e) 0.316 g

7. A student prepared 1 mol dm^{-3} solution of NaCl and labelled it as A. Then he dissolved one mole of KCl in one litre of A to obtain a solution B. There was no change in volume of A when KCl was dissolved. Consider the following statements about the solutions A and B.

(i) *Conductivity* of solution A is lower than that of solution B.

(ii) *Molar conductivity* of chloride ions is higher in B than in A since the concentration of chloride ions is higher in B.

(iii) *Molar conductivity* of sodium ions is lower in B than in A due to charge asymmetry and electrophoretic effects.

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 <u>answers</u> (a), (b), (c) or (d) is correct.

8. Consider an aqueous solution of a *weak electrolyte*, AB, which dissociates according to $AB(aq) \rightleftharpoons A^{3+}(aq) + B^{3-}(aq)$ If you denote the conductivity of the ionic species, α, by κ_α, then the conductivity, κ, of the solution is given by

(a) $\kappa = \kappa_{A^{3+}} + \kappa_{B^{3-}}$

(b) $\kappa = 3\kappa_{A^{3+}} + 3\kappa_{B^{3-}}$

(c) $\kappa = 3\kappa_{A^{3+}} - 3\kappa_{B^{3-}} + \kappa_{H^+} - \kappa_{OH^-}$

(d) $\kappa = \kappa_{A^{3+}} + \kappa_{B^{3-}} + \kappa_{H^+} + \kappa_{OH^-}$

(e) $\kappa = \kappa_{A^{3+}} - \kappa_{B^{3-}} + \kappa_{H^+} - \kappa_{OH^-}$

9. In standard notation, the molar conductivity, Λ_{PQ}, of a weak electrolyte PQ, which dissociates as $PQ(aq) \rightleftharpoons P^+(aq) + Q^-(aq)$, is given by $\Lambda_{PQ} = \alpha \left(\lambda_{P^+} + \lambda_{Q^-} \right)$. Consider the following statements.

(i) $\alpha = 1$ when the concentration of PQ is 1 mol dm^{-3}.

(ii) $\lambda_{P^+} = u\,F$ where u is the ionic mobility of $P^+(aq)$ in the solution and F is the Faraday constant.

(iii) Λ_{PQ} in a solution increases with decreasing concentration of PQ in that 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 <u>answers</u> (a), (b), (c) or (d) is correct.

10. A student prepared a solution by dissolving an electrolyte XY in *alcohol*. In this solution, XY partially dissociates as $XY \rightleftharpoons X^{2+} + Y^{2-}$. Consider the following statements about phenomena taking place in this alcoholic solution of XY.

   (i) The value of ionic mobility of X^{2+} in this solution is smaller than its value at infinite dilution in alcohol (at the same temperature).

   (ii) The <u>electrophoretic effect</u> on Y^{2-} becomes larger with decreasing concentration of XY in the solution.

   (iii) The <u>charge asymmetry effect</u> on X^{2+} becomes larger with increasing concentration of XY in the solution.

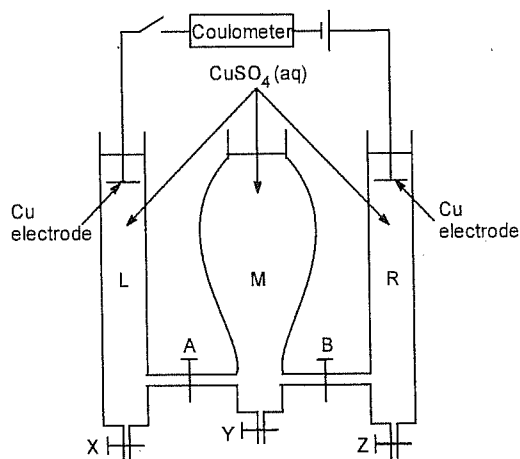   The correct statements out of (i), (ii) and (iii) above are
   (a) Only (i) and (ii).   (b) Only (i) and (iii).   (c) Only (ii) and (iii).
   (d) All (i), (ii) and (iii)   (e) None of the <u>answers</u> (a), (b), (c) or (d) is correct.

11. The limiting molar conductivities, in units of $S\,cm^2\,mol^{-1}$, of the electrolytes AB_2, AQ_2 and PB in aqueous medium at $25°C$ are, 91, 426 and 1265, respectively. The electrolytes dissociate as $AB_2 \rightarrow A^{2+} + 2B^-$, $AQ_2 \rightarrow A^{2+} + 2Q^-$ and $PB \rightarrow P^+ + B^-$. What is the limiting molar conductivity of the binary electrolyte PQ in aqueous medium at $25°C$ in the same units?

   (a) 1600   (b) 930   (c) 595.5
   (d) 748   (e) 1432.5

12. A student used the apparatus shown in the diagram (to the right) in measuring the transport number of $Cu^{2+}(aq)$ using Hittorf method. Consider the following statements about his experiment.

   (i) The *amount* of $Cu^{2+}(aq)$ in the right (R) compartment will decrease during the experiment.

   (ii) He can use the apparatus shown in the diagram in determining the transport number of $Cu^{2+}(aq)$ using Hittorf method even though the solution in the middle compartment does <u>not</u> have the same volume as the solutions in the left and right compartments.

   (iii) During the experiment the *amount* of $Cu^{2+}(aq)$ in the left (L) compartment decreases with increasing time.

   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).

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13. Ionic mobilities of H_3O^+, OH^- and Cu^{2+} at $30°C$ in aqueous medium at infinite dilution are denoted by $u^0_{H_3O^+}$, $u^0_{OH^-}$ and $u^0_{Cu^{2+}}$ respectively. Consider the following relationships.

(i) $u^0_{H_3O^+} > u^0_{OH^-}$

(ii) $u^0_{Cu^{2+}} < u^0_{OH^-}$

(iii) $u^0_{H_3O^+} > u^0_{Cu^{2+}}$

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 <u>answers</u> (a), (b), (c) or (d) is correct.

14. A student *correctly* determined the ionic mobility of an ion using the moving boundary method. The apparatus he used is shown in the diagram (to the right). The two solutions he used are marked as X and Y. (The solution X is placed in the upper compartment.) During the experiment the boundary moved upwards a distance *a*. Consider the following statements.

(i) The *following solution* is X.

(ii) He has determined the ionic mobility of a positive ion.

(iii) The density of Y is greater than that of X.
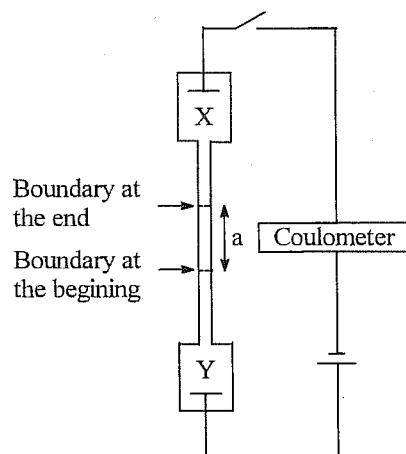
Boundary at the end
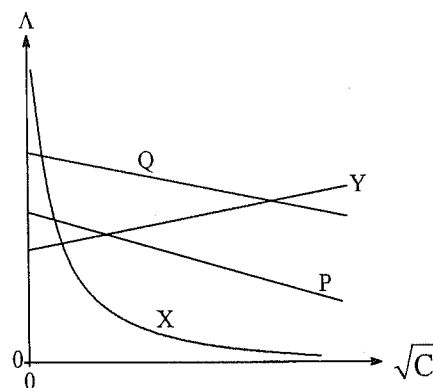
Boundary at the begining

a Coulometer

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 <u>answers</u> (a), (b), (c) or (d) is correct.

15. A student experimentally determined the molar conductivity of four binary electrolytes, P, Q, X and Y, in aqueous medium at a series of different concentrations, C, close to $0.0001 \, mol \, dm^{-3}$. His results are schematically represented in the figure (to the right). Consider the following statements.

(i) X is a weak electrolyte.

(ii) P and Q are a strong electrolytes.

(iii) The molar conductivity values determined for Y by the student are <u>not</u> correct.

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 <u>answers</u> (a), (b), (c) or (d) is correct.

16. 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) to make the electrical contact between the solution and platinum electrodes more effective.

    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)

17. In which of the following processes does entropy of the system *decreases*?
    (a) Dissolution of solid KCl in water
    (b) Freezing of water to form ice
    (c) Melting of ice to form water
    (d) Boiling water to form steam
    (e) Mixing of two gases in a container

18. Which of the following is always positive when a spontaneous process occurs?
    (a) ΔH_{univ} (b) ΔH_{surr} (c) ΔS_{surr} (d) ΔS_{univ} (e) ΔS_{sys}

19. The entropy change, in units of JK^{-1}, that occurs when 10 mol of an ideal gas $\left(C_{p,m} = 30.0\ JK^{-1}\,mol^{-1} \right)$ is heated from $27°C$ to $2727°C$ at standard atmospheric pressure is approximately equal to
    (a) 690   (b) – 690   (c) 345   (d) 300   (e) – 345

20. The SI unit of Ebullioscopy constant is,
    (a) $kg\,mol^{-1}$ (b) $K\,kg\,mol^{-1}$ (c) $kg\,K^{-1}$ (d) $J\,mol^{-1}\,K^{-1}$ (e) $K\,g\,mol^{-1}$

21. Helmholtz free energy criterion is applicable only for,
    (i) spontaneous processes.
    (ii) processes at constant volume.
    (iii) processes which does no PV-work.

    The correct statement/s out of (i), (ii) and (iii) above are
    (a) Only (i) and (ii)   (b) Only (i)   (c) Only (ii)
    (d) Only (iii)   (e) Only (ii) and (iii)

22. A process where Clausius-Clapeyron equation is applicable should,
    (i) be reversible.
    (ii) have one gaseous phase which is ideal.
    (iii) be adiabatic.

    The correct statement/s out of (i), (ii) and (iii) above are
    (a) Only (i) and (ii)   (b) Only (i)   (c) Only (ii)
    (d) Only (iii)   (e) Only (ii) and (iii)

23. When the concentration of a solute in a solution increases what effect does it have on the freezing point and vapour pressure respectively?
    (a) Decreases the freezing point; increases the vapour pressure
    (b) Decreases the freezing point; decreases the vapour pressure
    (c) Increases the freezing point; decreases the vapour pressure
    (d) Decreases the freezing point; unaffected the vapour pressure
    (e) Increases the freezing point; increases the vapour pressure

24. The **incorrect** statement regarding Colligative properties of solutions is,
    (a) a depression of vapour pressure on addition of a solute to a solvent.
    (b) an elevation of the boiling point of a solution on addition of a solute to a solvent.
    (c) an increase of reaction rates with increase in temperature.
    (d) a depression of freezing point of a solution on addition of a solute to a solvent.
    (e) an increase in osmotic pressure of a solution on addition of a solute.

25. Consider the following statements.
    (i) Entropy change of a process can be zero at a given temperature.
    (ii) $\Delta G_{sys} = -T \Delta S_{universe}$
    (iii) The universe is becoming less ordered because $\Delta S_{universe}$ is always negative.

    Which of the above statement/s regarding the second law of thermodynamics is/are true?

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