THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme — Level 4

Assignment III (Test) — 2014/2015

CMU 2220/CME4220 — Concepts in Chemistry

1 hour

2nd August 2015 (Sunday) 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 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. Consider the following statements.

   (i) Composition is one of the variables associated with a one component system.

   (ii) Extensive variables are those that are dependent on the size of the system.

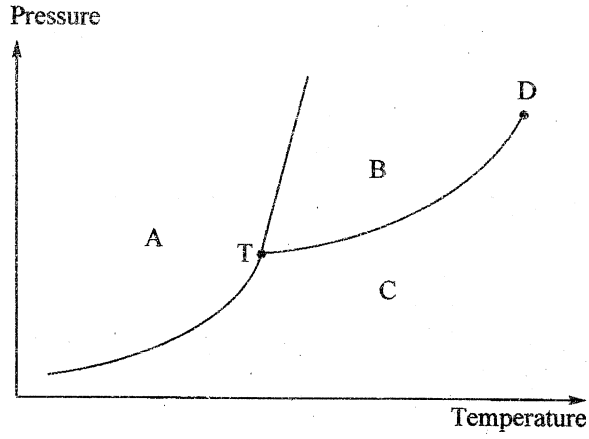
   (iii) Number of Phases and Components in a mixture of Oxygen and Nitrogen is the same.

   (iv) Temperature of a system is an example of an Intensive Variable.

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

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

Answers to questions (2) and (3) are based on the following phase diagram of a one-component system.



2. Consider the following statements.

   (i) The regions A, B, C correspond to solid, liquid and gas phases, respectively.

   (ii) The number of degrees of freedom at T is zero.

   (iii) The number of phases corresponding to any point along the curve TD is one.

   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 statements (i), (ii) or (iii) is correct.

3. Consider the following statements.

   (i) The value of temperature at T is unique for a given system.

   (ii) The point T is called the triple point.

   (iii) The number of phases at the triple point is three.

   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 statements (i), (ii) or (iii) is correct.

4. Molality is defined as the number of moles of solute per kilogram of solvent. If the molality of an aqueous solution of an acid is 5.5 mol kg^{-1}, the mole fraction of the solvent is (Relative atomic masses: C = 12.0 ; O = 16.0 ; H = 1.0)

   (a) 5.5×10^{-3} (b) 9.1×10^{-1} (c) 9.1×10^{-2}
   (d) 1.0×10^{-1} (e) 2.7×10^{-2}

5. A solution is made by mixing 90.0 g of water and Y cm^3 of methanol. If the mole fraction of water in this solution is 2/3, the value of Y is [Relative atomic masses: C = 12.0 ; O = 16.0 ; H = 1.0. Assume density of methanol = 0.80 g cm^{-3}]

   (a) 400 (b) 10 (c) 40
   (d) 50 (e) 100

6. Consider the following statements.

(i) According to Raoults Law, the vapour pressure due to component A in an ideal binary system is equal to the product of its mole fraction in solution and its pure vapour pressure.

(ii) Mathematically, Raoults Law can be expressed as $P_A x_A = P_A^o$ (where the symbols used have their usual meanings).

(iii) The correct representation of a combination of Raoults and Daltons Law, with respect to an ideal binary system is $P = x_B\left(P_B^o - P_A^o\right) + P_A^o$.

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 statements (i), (ii) or (iii) is correct.

7. Consider the following statements.

(i) An Azeotropic mixture is formed ONLY by systems that shows negative deviation from Raoults Law.

(ii) A binary mixture that shows negative deviation from Raoults Law would show a boiling point maxima in the temperature vs composition phase diagram.

(iii) Fractional distillation can be used to separate A and B only if A and B form an ideal binary mixture.

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 statements (i), (ii) or (iii) is correct.

Answers to questions (8) to (10) are based on the following information.

A and B are two liquids that are miscible at all compositions and forming an ideal solution. Vapour pressures of pure A (relative molar mass = 50) and pure B (relative molar mass = 100) are, 1.0×10^5 Pa and 5.0×10^4 Pa, respectively, at 75°C. A mixture is formed by mixing 25.0 g of A with 40.0 g of B at the above temperature.

8. Mole fraction of A in this mixture is

(a) 5/21 (b) 4/9 (c) 5/9
(d) 16/21 (e) 1/2

9. The partial vapour pressure of A (in Pa) corresponding to this mixture is

(a) 2.2×10^4 (b) 5.5×10^5 (c) 4.4×10^5
(d) 5.5×10^4 (e) 2.8×10^4

10. The mole fraction of B in the vapour phase corresponding to the above mixture is

(a) 1/3 (b) 2/3 (c) 3/4
(d) 3/7 (e) 2/7

11. The value of total vapour pressure of an ideal binary solution is

(a) independent of its composition.

(b) independent of the temperature.

(c) is less than that of either of the pure components.

(d) is greater than that of either of the pure components.

(e) lies between those of the pure components.

12. The conditions under which Univariant phase transformations are carried out are given below.

(i) isobaric (ii) isochoric (iii) isothermal (iv) reversible

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

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

13. Variation of transition temperature with equilibrium pressure for any Univariant phase transformation is given by

(a) $\frac{dP}{dT} = \frac{\Delta U}{T\,\Delta V}$ (b) $\frac{dT}{dP} = \frac{\Delta H}{T\,\Delta V}$ (c) $\frac{dT}{dP} = \frac{T\,\Delta V}{\Delta H}$

(d) $\frac{dP}{dT} = \frac{V\,\Delta T}{\Delta U}$ (e) $\frac{dH}{dP} = \frac{\Delta T}{T\,\Delta V}$

14. Which of the following represents the Maxwell relationship derived from the fundamental thermodynamic equation, $dG = V\,dP - S\,dT$.

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

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

15. Under what conditions or to what type of system the Helmholtz free enrgy criterion is applicable?

(i) constant temperature and volume.

(ii) constant temperature and pressure.

(iii) reversible process.

The correct answer/s out of (i), (ii) and (iii) above are

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

16. What would be the value of entropy change, when one mole of an ideal gas expands reversibly from $0.01\ m^3$ to $0.10\ m^3$?

(a) $19.15\ JK^{-1}\ mol^{-1}$ (b) $2.303\ JK^{-1}\ mol^{-1}$ (c) $-19.15\ JK^{-1}\ mol^{-1}$

(d) $83.14\ JK^{-1}\ mol^{-1}$ (e) $831.4\ JK^{-1}\ mol^{-1}$

17. Under what conditions can the following equation be applied $\Delta T_b = K_b\ m$?

(a) Ideal solution in a non-volatile solute.

(b) Non- ideal solution in a non volatile solute.

(c) Ideal solution in a volatile solute.

(d) Non ideal solution in a volatile solute.

(e) Any solute dissolved in a aqueous solution.

18. The chemical potential of a constituent in mixture at constant composition in an open system is its contribution per mole to the total Gibbs free energy of the system at

(a) constant temperature and pressure.

(b) constant temperature and volume.

(c) constant volume and pressure.

(d) any temperature and pressure.

(e) any temperature and volume.

19. Partial molar free energy, μ_i, of the i^{th} component in a mixture containing two components, 1 and 2, is given by

(a) $\mu_i = \left(\frac{\partial G}{\partial n_1}\right)_{T,P,n_2} + \left(\frac{\partial G}{\partial n_2}\right)_{T,P,n_1}$ (b) $\mu_i = \left(\frac{\partial G}{\partial n_1}\right)_{T,P,n_2} - \left(\frac{\partial G}{\partial n_2}\right)_{T,P,n_1}$

(c) $\mu_i = \left(\frac{\partial G}{\partial n_1}\right)_{V,P,n_2} + \left(\frac{\partial G}{\partial n_2}\right)_{V,P,n_1}$ (d) $\mu_i = \left(\frac{\partial G}{\partial n_1}\right)_{V,T} + \left(\frac{\partial G}{\partial n_2}\right)_{V,T}$

(e) $\mu_i = \left(\frac{\partial G}{\partial n_1}\right)_{T,P,n_1} + \left(\frac{\partial G}{\partial n_2}\right)_{T,P,n_2}$

20. The pressure coefficient of the chemical potential in a closed system at constant temperature is referred as

(a) partial molar entropy.

(b) partial molar volume.

(c) partial molar enthalpy.

(d) molar entropy.

(e) molar volume.

21. The variation of equilibrium constant with temperature is given by

(a) Clausius –Clapeyron equation.

(b) Van't Hoff Reaction Isotherm.

(c) Kirchoff equation.

(d) Nernst equation.

(e) Gibbs Duhem equation.

22. The entropy of a perfectly crystalline compound is zero. This is referred to as

(i) First law of thermodynamics.

(ii) Second law of thermodynamics.

(iii) Third law of thermodynamics.

The correct statement/s out of (i), (ii) and (iii) above is/are

(a) Only (i). (b) Only (ii). (c) Only (iii).

(d) Only (i) and (ii). (e) Only (ii) and (iii).

23. Consider the following statements.

(i) Spontaneous reactions are always exothermic.

(ii) The entropy of the universe is continuously increasing.

(iii) The Gibbs free energy is a function of both enthalpy and entropy.

The correct statement/s out of (i), (ii) and (iii) above is/are

(a) Only (i). (b) Only (ii). (c) Only (iii).

(d) Only (i) and (ii). (e) Only (ii) and (iii).

24. For a binary mixture containing components 1 and 2, the Gibbs Duhem equation indicates that the partial molar properties of the two components in the mixture

(i) change independently.

(ii) do <u>not</u> change independently.

(iii) have opposite signs.

The correct statement/s out of (i), (ii) and (iii) above is/are

(a) Only (i). (b) Only (ii). (c) Only (iii).

(d) Only (i) and (iii). (e) Only (ii) and (iii).

25. The correct relationship between free energy change and equilibrium constant (K)is

(a) $\Delta G = RT \log(K)$.

(b) $\Delta G^{\circ} = RT \log(K)$.

(c) $\Delta G^{\circ} = -RT \ln(K)$.

(d) $\Delta G = RT \ln(K)$.

(e) $\Delta G = R \ln(K)$.