THE OPEN UNIVERSITY OF SRI LANKA

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

1 hour

5th March 2012 (Monday) 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	=	$10^{5}\ Pa\left(Nm^{-2}\right)$
$Log_e(X)$	=	$2.303\ Log_{10}(X)$

1. Partial molar volume of a component in a solution

   (i) is independent of the mole fraction of that component.

   (ii) is an intensive thermodynamic property.

   (iii) is an extensive thermodynamic property.

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

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

2. Molar property of an i^{th} component in a mixture is

   (a) any property in a closed system.

   (b) molar value of any extensive thermodynamic property of the i^{th} component in a closed system.

   (c) molar value of any intensive thermodynamic property of the i^{th} component in a closed system.

   (d) molar value of any extensive thermodynamic property of the i^{th} component in an open system.

   (e) molar value of any intensive thermodynamic property of the i^{th} component in an open system.

3. Pure ethanol has a molar volume of $0.059\ \text{L mol}^{-1}$. When 1 mole of pure ethanol was added to a mixture of 1×10^4 moles of water and 2×10^4 moles of ethanol, the increase in volume of the mixture was $0.056\ \text{L}$. The partial molar volume of ethanol in a mixture containing 20,000 moles of water and 40,000 moles of ethanol is

(a) $0.059\ \text{L mol}^{-1}$ (b) $0.056\ \text{L mol}^{-1}$ (c) $0.112\ \text{L mol}^{-1}$
(d) $0.028\ \text{L mol}^{-1}$ (e) $0.118\ \text{L mol}^{-1}$

4 For a binary mixture containing components 1 and 2 the Gibbs Duhem equation indicates that the partial molar properties of the

(i) components in the mixture change independently.

(ii) components in the mixture do <u>not</u> change independently.

(iii) two components have opposite signs.

The correct statements out of (i), (ii) and (iii) above are
(a) (i) only (b) (ii) only (c) (iii) only
(d) (i) and (iii) only (e) (ii) and (iii) only

5. The four fundamental thermodynamic equations $dA=-PdV-SdT$, $dG=VdP-SdT$, $dU=TdS-PdV$, $dH=TdS+VdP$ can be applied for

(i) deriving Maxwell relationships.

(ii) deriving thermodynamic equations of state.

(iii) reversible transformations in open systems.

(iv) reversible transformations in closed systems.

The correct statements out of (i), (ii), (iii) and (iv) above are
(a) (i), (ii) and (iii) only (b) (i) (ii) and (iv) only (c) (ii) (iii) and (iv) only
(d) (i) (iii) and (iv) only (e) All (i), (ii), (iii) and (iv)

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

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

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

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

(d) $\Delta G=H-T\ \log(K)$

(e) $\Delta G=R\ \log(K)$

7. The Clausius-Clapeyron equation is applicable
   (a) to all types of univariant phase transformations.
   (b) to reversible isothermal expansion
   (c) to adiabatic reversible process
   (d) only for vapourization and sublimation.
   (e) to a solid solid equilibrium system

8. The correct form of Clausius – Clapeyron equation is
   (a) $\Delta H/T\Delta V = dP/dT$
   (b) $\log_{10}(P_2/P_1) = (\Delta H/2.303R)[1/T_1 - 1/T_2]$
   (c) $\log_{10}(P_1/P_2) = (\Delta H/2.303R)[1/T_1 - 1/T_2]$
   (d) $\log_{10}(P_2/P_1) = (\Delta H/R)[1/T_1 - 1/T_2]$
   (e) $\Delta H/T\Delta V = dT/dP$

9. Depression of vapour pressure of a solvent due to the dissolution of a solute is referred to as
   (a) cryoscopy (b) ebullioscopy (c) isobaric
   (d) a colligative property (e) a phase transformation

10 Chemical potential
   (i) is another form of partial molar Gibbs Free energy.
   (ii) is an intensive thermodynamic property.
   (iii) is applicable only to open systems.
   The correct statements out of (i), (ii) and (iii) above are
   (a) (i) only (b) (ii) only (c) (i) and (ii) only
   (d) (i) and (iii) only (e) All (i), (ii) and (iii).

11. For a reaction to occur spontaneously in a closed system at constant temperature and pressure,
   (a) ($\Delta H - T\Delta S$) must be negative
   (b) ($\Delta H + T\Delta S$) must be negative
   (c) ΔH must be negative
   (d) ΔS must be negative
   (e) ($\Delta H - T\Delta S$) must be zero

12. At 0°C ice and water are in equilibrium. If ΔH for the process $H_2O(s) \rightarrow H_2O(l)$ is 6.0 kJ mol^{-1} the value of ΔS for the conversion of water to ice in J K^{-1} mol^{-1} is

(a) 21.97 (b) – 21.97
(c) 6.0 (d) – 6.0 (e) 0

13. A change of state occurs within a system and produces 64.0 kJ of heat. This heat is transferred to the surroundings at a constant pressure and a constant temperature of 300 K. For this process, ΔS of the surroundings is

(a) 64.0 J/K (b) – 64.0 J/K
(c) – 213 J/K (d) 213 J/K (e) 0 J/K

14. The value of ΔS for the process $H_2O(s) \rightarrow H_2O(l)$ at 1 atm pressure and 260K is greater than zero. The value of ΔG will

(a) be greater than zero.
(b) be less than zero.
(c) be equal to zero.
(d) lies between –1 and zero.
(e) be one.

15. Consider the following system in equilibrium.
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$.
According to the phase rule, the number of independent components and the number of phases, respectively, are

(a) 2 and 1 (b) 2 and 3 (c) 3 and 2
(d) 3 and 3 (e) 1 and 2

16. A solution is made by mixing 8.0 g of A [relative molar mass = 40] and 100.0 ml of B (Density = 1.2×10^3 kg m^{-3} and relative molar mass = 60).
The mole fraction of the solvent in the above mixture is approximately equal to

(a) 0.1 (b) 0.2 (c) 0.5
(d) 0.6 (e) 0.9

17. Consider the following statements.

(i) Raoults Law can be applied to any solution.

(ii) 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.

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

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.

Answers to Question **(18)** to **(21)** are based on the following information

Liquids A and B form an ideal mixture, miscible at all compositions. When the mole fraction of A in the liquid phase is 0.25, the vapour pressure of the system is 5.0×10^5 Pa . The vapour pressure of pure B is 4.0×10^5 Pa .

18. The vapour pressure of Pure A (in 10^5 Pa) is

(a) 8.0 (b) 0.5 (c) 4.0
(d) 2.7 (e) 8.0×10^5

19. The mole fraction of B in the vapour phase is equal to

(a) 0.4 (b) 0.5 (c) 0.6
(d) 0.8 (e) 1.7

20. Which one of the following statements is correct?

(a) This system shows negative deviation from Raoults Law.
(b) Raoults Law cannot be applied to such systems.
(c) Boiling point of A is expected to be greater than that of B
(d) Boiling point of B is expected to be greater than that of A
(e) Information not sufficient to compare boiling points of A and B

21. Which one of the following statements is true?

In principle (theoretically) fractional distillation

(a) can be used to separate A and B from any given mixture of A and B.
(b) can be used to separate A and B only from an equimolar mixture of A and B.
(c) can only yield pure B
(d) can only yield pure A.
(e) will give pure B as the distillate.

22. Which one of the following is the correct representation of a combination of Raoults and Daltons Law?

(a) $P = X_B\left(P_B^o - P_A^o\right) + P_B^o$

(b) $P = X_A\left(P_B^o - P_A^o\right) + P_A^o$

(c) $P = X_B\left(P_A^o - P_B^o\right) + P_A^o$

(d) $P = X_A\left(P_A^o - P_B^o\right) + P_A^o$

(e) $P = X_A\left(P_A^o - P_B^o\right) + P_B^o$

23. An Azeotropic mixture is a constant boiling mixture which

(a) obeys Raoults law under certain conditions ONLY.

(b) is formed by systems that shows ONLY negative deviation from Raoults Law.

(c) is formed by systems that shows ONLY positive deviation from Raoults Law.

(d) can show either a maxima or minima in the boiling point versus composition diagram.

(e) shows ONLY a maximum boiling point.

24. Consider the following statements:

(i) A Cooling curve is obtained by plotting temperature versus time.

(ii) The shapes of cooling curves corresponding to a pure solid and that of a eutectic composition are similar.

(iii) Eutectic composition refers to the composition that has the highest melting point in a simple eutectic system.

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

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

25. The following statements are with respect to a "brake" and a "halt" in a cooling curve

(i) A phase change occurs at a "brake" but not at a "halt".

(ii) Rate of change of temperature decreases on reaching a "brake".

(iii) Number of phases decreases at a "brake"

(iv) Rate of change of temperature is zero on reaching a "halt".

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

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