THE OPEN UNIVERSITY OF SRI LANKA

B.Sc Degree Programme — Level 4

Assignment III (Test) — 2015/2016

CMU 2220/CME 4220 — Concepts in Chemistry

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

Reg. No.

FOR EXAMINER'S USE ONLY		
Answers	No.	Marks
Single marked		
Unacceptably marked		
Total marked		
Unmarked		0.0
Correct		
Incorrect		—
Total		
Correct + Incorrect		

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																		

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Assignment III (Test) — 2015/2016

CMU 2220/CME4220— Concepts in Chemistry

1 hour

⊠ 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 withmore 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. Molality is defined as the number of moles of solute per kilogram of solvent. If the molality of an aqueous solution of an acetic acid is $10.0 \ mol \ kg^{-1}$, the mole fraction of acetic acid is approximately equal to (C: = 12.0; O = 16.0; H = 1.0)

   (a) 1.5   (b) 0.91   (c) 0.09   (d) 0.15   (e) 0.03

2. Which one of the following statements is <u>correct</u>?

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

   (b) Extensive Variables are those that are independent of the size of the system.

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

   (d) Temperature of a system is an example of an Extensive Variable.

   (e) Air is a single phase system.

3. A solution is made by mixing 180.0 g of water and Y cm^3 of ethanol. If the mole fraction of water in this solution is 2/3, the value of Y is

[C=12; H = 1.0, O = 16.0; Assume, density of ethanol = 0.92 g cm^{-3}]

(a) 400   (b) 200   (c) 250   (d) 25   (e) 1000

4. The phase diagram shown in the figure corresponds to a one-component system. Consider the following statements about it.

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

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

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

(iv) The number of phases at the triple point is three.
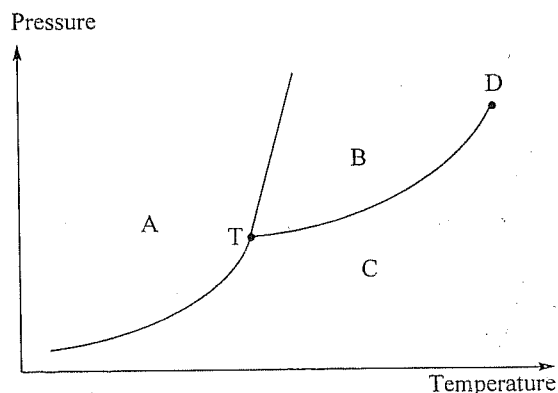
The correct statements out of (i), (ii), (iii) and (iv) above are

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

(d) Only (ii) and (iv).   (e) All of (i), (ii), (iii) and (iv).

5. Consider the following statements.

(i) Raoults Law can be applied only to ideal solutions.

(ii) The correct representation of a combination of Raoults and Daltons Law, with respect to a binary system formed by A and B is $P = x_B\left(P_B^0 - P_A^0\right) + P_A^0$.

(iii) Mathematically, Raoults Law can be expressed as $P_A = x_A P_A^0$.

(iv) The value of total vapour pressure of an ideal binary solution is independent of its composition.

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

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

(d) Only (ii), (iii) and (iv).   (e) All of (i), (ii), (iii) and (iv).

Answers to Questions (6), (7) and (8) are based on the following information.

A and B are two liquids that are miscible at all compositions, 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 at 75°C, respectively. An equimolar mixture is formed by mixing 25.0 g of A with X g of B at the above temperature.

6. X is equal to

(a) 50   (b) 40   (c) 30   (d) 20   (e) 10

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

(a) 2.2×10^4 (b) 5.0×10^5 (c) 5.5×10^5 (d) 5.5×10^4 (e) 5.0×10^4

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

(a) $\dfrac{1}{3}$ (b) $\dfrac{2}{3}$ (c) $\dfrac{4}{7}$ (d) $\dfrac{3}{7}$ (e) $\dfrac{2}{7}$

9. Two liquids, 46.0 g of methylbenzene and 80.0 g of a compound Q, were mixed together to form an ideal binary mixture at room temperature. The vapour pressures of pure methylbenzene and pure Q at this temperature are 45 torr and 30 torr respectively and the total vapour pressure of the mixture is 40 torr at this temperature. [H=1; C= 12; O=16]

The molar mass of Q $\left(\text{in g mol}^{-1}\right)$ is

(a) 240   (b) 80   (c) 160   (d) 320   (e) 40

Answers to Question (10) and (11) is based on the following information.

Liquid A and liquid B form a fully miscible binary system at all compositions. At standard atmospheric pressure, liquid A and liquid B form a constant boiling mixture.

10. Which one of the following statements is correct?

     (a) Boiling point of the constant boiling mixture is always less than that of A or B.

     (b) This system shows negative deviation from Raoults Law.

     (c) This system shows positive deviation from Raoults Law.

     (d) The constant boiling mixture correspond to an equimolar mixture of A and B.

     (e) Fractional distillation can yield either pure A or pure B.

11. Suppose the mole fraction of A corresponding to the constant boiling mixture in the above system is 0.6 and that it exhibits negative deviation from Raoults Law. Considering any mixture of A and B, which one of the following statements is correct?

     (a) Fractional distillation can be used to separate both A and B only in the case of the constant boiling mixture.

     (b) Fractional distillation can yield pure A only if the mole fraction of A is less than 0.6.

     (c) Fractional distillation can yield pure A only if the mole fraction of B is greater than 0.4.

     (d) Fractional distillation can yield pure A only if the mole fraction of B is less than 0.4.

     (e) Fractional distillation will always give pure B as the distillate.

12. Which of the following represents a fundamental thermodynamic equation?

     (a) $H = U + PV$ (b) $dG = dH + TdS$ (c) $dG = VdP - SdT$

     (d) $G - A = H - U$ (e) $dH = VdP - SdT$

13. The correct relationship between standard Gibbs free energy change and the equilibrium constant of a reaction at constant temperature is given by,

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

     (d) $\Delta G^0 = -R \ln(K)$ (e) $\Delta G^0 = -RT \ln(K)$

14. Chemical potential is
    (i) referred as Partial Molar Free Energy.
    (ii) an intensive thermodynamic property.
    (iii) the total Gibbs free energy of a system.

    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 (i) and (iii).

15. The change in volume per mole when a component is added to a binary mixture in a closed system is referred as,
    (i) molar volume   (ii) partial molar volume   (iii) partial pressure

    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 (i) and (iii).

16. Which one of the following is always positive when a spontaneous process occurs?

    (a) ΔS_{sys} (b) ΔS_{surr} (c) ΔS_{univ} (d) ΔH_{surr} (e) ΔH_{univ}

17. It is known that $\Delta H^0 = +137 \, kJ \, mol^{-1}$ and $\Delta S^0 = +120 \, J \, K^{-1} \, mol^{-1}$, for the reaction $C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$. One can say that

    (a) that this reaction is spontaneous at all temperatures.
    (b) that this reaction is spontaneous only at high temperatures.
    (c) that this reaction is non spontaneous at all temperatures.
    (d) that this reaction is spontaneous only at low temperatures.
    (e) the spontaneity of this reaction does not depend on temperature.

18. Which of the following is true about the equilibrium constant, if ΔG^0 for a reaction is negative?
    (a) $K = 0$ (b) $K = 1$ (c) $K < 1$ (d) $K > 1$ (e) None of the above.

19. Partial molar volume of a component in a solution
    (i) is independent of the mole fraction of that component.
    (ii) is an extensive thermodynamic property.
    (iii) is an intensive thermodynamic property.

    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 (i) and (iii).

20. The variation of equilibrium constant with temperature is given by the
    (a) Clausius –Clapeyron equation.
    (b) Van't Hoff Reaction Isotherm.
    (c) Kirchoff equation.
    (d) Nernst equation.
    (e) Gibbs Duhem equation.

21. For a binary mixture containing components A and B, the Gibbs Duhem equation indicates that
    (i) the partial molar properties of the components in the mixture change independently.
    (ii) the partial molar properties of the components in the mixture do not change independently.
    (iii) the partial molar properties of the two components 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).

22. The Helmholtz free energy criterion is applicable under which of the following conditions?
    (i)   Constant temperature and volume.
    (ii) Constant temperature and pressure.
    (iii) Constant volume and pressure.

    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).

23. What is the Maxwell relationship that you can derive from the thermodynamic expression, $dC = Y\,dM - X\,dL$, where C, L, M, Y and X are thermodynamic properties,

    (a) $\left(\partial M / \partial L\right)_V = \left(\partial Y / \partial X\right)_X$

    (b) $\left(\partial Y / \partial L\right)_M = \left(\partial X / \partial M\right)_L$

    (c) $\left(\partial C / \partial M\right)_Y = -\left(\partial C / \partial L\right)_X$

    (d) $\left(\partial Y / \partial L\right)_L = \left(\partial X / \partial M\right)_M$

    (e) $\left(\partial Y / \partial L\right)_M = -\left(\partial X / \partial M\right)_L$

24. The pressure coefficient of chemical potential at constant temperature in a closed system is referred as
    (a) partial molar volume.
    (b) partial molar enthalpy.
    (c) partial molar entropy.
    (d) partial molar free energy.
    (e) chemical potential.

25. In a univariant transformation the variation of transition temperature with equilibrium pressure is given by,

    (a) $\dfrac{dP}{dT} = \dfrac{\Delta U}{T\,\Delta V}$

    (b) $\dfrac{dT}{dP} = \dfrac{\Delta H}{T\,\Delta V}$

    (c) $\dfrac{dT}{dP} = \dfrac{T\,\Delta V}{\Delta H}$

    (d) $\dfrac{dP}{dT} = \dfrac{V\,\Delta T}{\Delta U}$

    (e) $\dfrac{dH}{dP} = \dfrac{\Delta T}{T\,\Delta V}$