MURANG'A UNIVERSITY COLLEGE
(A Constituent College of Jomo Kenyatta University College of Technology)
SCHOOL OF PURE AND APPLIED SCIENCES

PHYSICAL CHEMISTRY FOR DIPLOMA IN ANALYTICAL CHEMISTRY

TERM II JULY 2015

End of term Examinations

UNIT CODE: ASC 1302

DATE: 23rd July 2015 TIME: 3 HOURS

Instructions; Answer all questions in section A and any three questions in question B

SECTION A

1. (a) State qualitatively, the pHof CH_3COONa [1mks]

   (b) Give a reason for the answer in (a) (i) above [1mks]

   (c) Calculate the pH of 0.15 M CH_3COONa ($K_a = 1.8 \times 10^{-5}$, $K_b = 5.56 \times 10^{-10}$).

   [2mks]

2. Given that the solubility product of lead (II) chloride ($PbCl_2$) is 2.0×10^{-5} mol^3 dm^{-9} at 25^0 C. Find the solubility of lead (II) chloride.

   [4mks]

3. Differentiate between enantiotropy and monotropy giving an example in each.

   [4mks]

4. A 0.001M solution of ethanoic acid was found to have a molar conductivity of 14.3 $\Omega^{-1}cm^2mol^{-1}$. If conductivity of ethanoic acid at infinite dilution is 390.7 $\Omega^{-1}cm^2mol^{-1}$ calculate;
   (i) the degree of dissociation of the acid [2mks
   (ii) the equilibrium constant [2mks[

5. What are the properties of eutetics. [4mks]
6. Outline the basic principles of steam distillation.]4mks]
7. The table I below shows rate of formation of I_2 against the concentration of ICl_2 and H_2 respectively.

Table I

ICl	**H_2**	**Rate of formation of I_2 in mmo11^{-1}s^{-1}**
1.5	1.5	3.7×10^{-7}
2.3	1.5	5.7×10^{-7}
2.3	3.7	14.0×10^{-7}

Determine the rate equation for the reaction; [4mks]

$2ICl_{(S)} + H_2 \rightarrow 2HCl + I_2$

8. The resistance of 0.1M solution of potassium nitrate is found to be 29.0 Ω. If the conductivity of this solution is 1.29 $\Omega^{-1}m^{-1}mol^{-1}$ determine ;
   (i) The cell constant
   (ii) Using the cell constant in (i) above determine the conductivity of 0.1M silver nitrate with resistance of 34.9Ω. (4mks)

9. You have been given a solution that contains equal concentration of copper (II) ions and lead (II) ions, if you passed hydrogen sulphide through the solutions, which sulphate would be precipitated first? Given Ksp for CuS = 6.3×10^{-36} and Ksp for PbS= 1.3×10^{-28} mol^2dm^{-6}. If you wanted to be sure that only one of the sulphides was precipitated, would you add an acid or an alkali to the solution before bubbling through the hydrogen sulphide? Explain. [4mks]
10. What will the pH of buffer solution made from a mixture of 0.2 M aqueous ammonia and 0.1 M ammonium chloride? ($pk_b$for ammonia is 4.75) [4mks]

SECTION B

11. (a) The table below shows the variation of the product of pressure and volume (PV) with pressure for hydrogen at 0^0 C and carbon dioxide at 40^0 C.

Table II

Pressure in atms	PV in atm cm^3	
	H_2 at 0^0 C	CO_2
1	1.00	1.00
50	1.033	0.741
100	1.064	0.0270
200	1.134	0.409
400	1.277	0.718
800	1.566	1.299

(i) Plot a graph of PV against P for both gases and on the same set of axis. [10mks]

(ii) Explain the shape of the curves. [3mks]

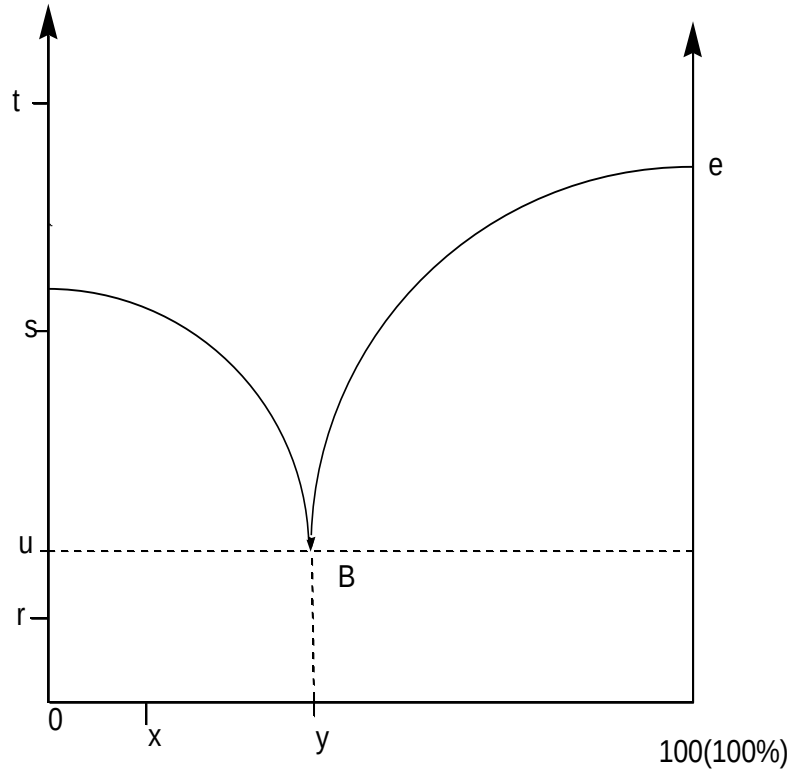
(b) One mole of carbon dioxide was found to occupy 132 liters at 48^0 C and pressure of 18.40 atms. Calculate the pressure that would have been expected;

(i) From the ideal gas equation [3mks

(ii) From Van der Waals equation [4mks

A= $3.60L^2$ atm. Mol^2 b= 4.28×10^{-2} $Lmol^{-1}$, R=0.082L atm K^{-1} [4mks]

12. The following diagram is a temperature composition diagram for a system containing two components, X and Y.



(a) (i) label main areas of the phase diagram. [5mks]

(ii) Name point B. [1mks]

(b) State what curves AB and BC represent. [2mks]

(c) (i) Describe what happens when a mixture of composition x is cooled from t^o c to r^o c. [3mks]

(ii) Sketch the curve that indicates this. [3mks]

(c) Describe how the above phase diagram can be used in a practical separation of mixture of X and Y (6mks)

13. (a) Define the following terms giving an example of a substance that exhibits each of the property;

(i) Polymorphism

(ii) Allotropy

(iii) metastable

(b) The triple point of CO_2 comes at 217K and 5.1 atmospheres and the critical point is 304K, 72.9 atm. Unlike water, carbon dioxide contracts in volume when it changes from liquid to a solid. Sketch the phase diagram for CO_2.

(c)Given that the solubility product of silver chromate (VI)(Ag_2CrO_4) is 3.0×10^{-12} mol^3 dm^{-9} at 25^0 C. Find the solubility of lead (II) chloride in grams per liter given molar mass of chromium as 52 silver 108 and oxygen as 16. [5mks]

14. (a) The following table gives the molar conductivities 298K of aqueous solutions of acetic acid and sodium acetate

Molar conductivity / $\Omega^{-1}m^2mol^{-1}$				
Concentration/$moldm^{-3}$	0	0.001	0.01	0.1
CH_3COOH	391	49	16	5
CH_3COONa	91	89	84	73

(a) Derive an expression for "molar conductivity" and state its units. [4mks]

(b) Explain the meaning of "Zero concentration" in the table above. [2mks]

(c) (i) Sketch a graph of the relationship between molar and concentration of the two substances

(ii) Account for the different shapes of the graphs in (c)(i) above. [6mks]

(d) Calculate:

(i) the degree of ionization

(ii) the pH of 0.01M acetic acid [3mks]

(e) (i) Derive an expression relating α, the concentration C and the dissociation constant, Ka, for the acetic acid

(ii) Calculate the dissociation constant of 0.001M ethanoic acid.

15. (a) By referring to an aqueous solution of hydrogen chloride. Explain the lewis and Bronsted-Lowry theories of acids and bases.

(b) Write equations for the following reactions and using Bronsted-Lowry theory; identify the acids and bases.

(i) The interaction between hydrogen chloride and ethanoic acid

(ii) The thermal decomposition of ammonium chloride

(iii) There action between sodium dihydrogen phosphate and sodium carbonate (for H_3PO_4, $Pka_{(2)} = 7.21$, $Pka_{(3)} = 12.36$, for H_2CO_3, $Pka_{(2)} = 10.32$) [6mks]

(c) State ***four*** factors that affect the resistance of solution. [4mks]

(d) (ii) Give the equilibrium that exists in:
(I) water
(II) liquid ammonia [2mks]

(e) State ***three*** factors that make an acid strong. [3mks]