MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION

KST 104: FUNDAMENTALS OF CHEMISTRY

DATE: 14/12/2017 **TIME: 2.00-4.00 PM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A (COMPULSORY)

QUESTION 1 (30 MARKS)

(a) Briefly, explain the following terms

(ii) Titration error [1 mark]

(iii) Functional group [1 mark]

(b) Using examples, illustrate the difference between

(i) Molarity and normality [2 marks]

(ii) Polar and non-polar molecules [2 marks]

(c) Volumetric analysis is one of the classical methods for quantification of analytes in samples. Its application in the determination of protein content samples via Kjeldahl analysis for nitrogen has been widely explored. To determine the amount of protein, 0.9814 g sample was digested, where the nitrogen content was oxidized to NH_4^+, then converted to NH_3 with NaOH followed by distillation of NH_3 into a collection flask contain 50.00 mL of 0.1047 M HCl. The excess HCl was back titrated with 22.84 ml 0.1183 M NaOH, requiring 22.84 mL. Calculate the % protein in the sample, given that there is 6.38 g of protein for every gram of nitrogen in the sample. (5 marks)

(d) Analytical chemistry is useful in determination of pollutants in the environment. A KST 104 student was given a water sample in which to determine the level of chloride ions. By applying gravimetric methods of analysis, describe how the student would go about to solve this problem. (4 marks)

(e) Alkalinity is defined as the buffering capacity of water. Briefly, explain what this means. (2 marks)

(f) A shampoo has a pH of 8.7. What are $[H_3O^+]$ & $[OH^-]$ in the shampoo? (4 marks)

(g) The energy difference between two states in the OH^- molecule is 35714 cm^{-1}. Calculate the wavelength (nm) needed to excite the molecule. (3 marks)

(h) Ion exchange chromatography has come in handy in softening of hard water and making of deionized water.

(i) Water containing $CaSO_4$ is passed through a column containing cation-exchange resin (Na^+ form). Describe what happens to render the water soft.

(3 marks)

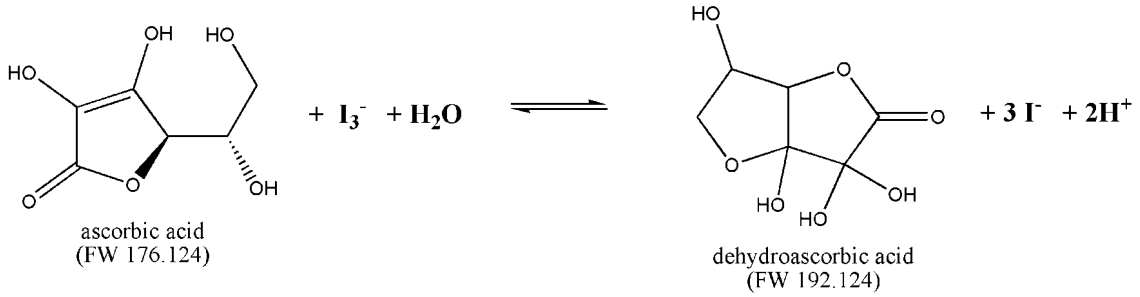
(ii) Water is passed through an anion-exchange resin (OH^- form) and cation-exchange resin (H^+ form), describe what happens to $Cu(NO_3)_2$ if present in the water? (3 marks)

SECTION B: ATTEMPT ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

(a) Precipitation titration is one of the different types of titrations applied in quantitative determination of analytes. In the determination of chloride ions in water, the sample is titrated with silver nitrate. Describe three ways in which one can determine the end point. (6 marks)

(b) To standardize I_3^- solution with ascorbic acid, 29.41 mL of I_3^- solution was required to react with 0.1970 g of pure ascorbic acid, determine the molarity of the I_3^- solution. Below is the equation for the reaction. (3 marks)



ascorbic acid
(FW 176.124)

dehydroascorbic acid
(FW 192.124)

(c) A mixture containing only Al_2O_3 and Fe_2O_3 weighs 2.019 g. When heated under a stream of H_2, Al_2O_3 is unchanged, but Fe_2O_3 is converted into metallic Fe plus H_2O (g). If the residue weighs 1.774 g, what is the weight percent of Fe_2O_3 in the original mixture? (5 marks)

(e) In the titration of 25 mL of 0.05 M of $AgNO_3$ solution with 0.02 M KSCN solution, calculate the molar concentration of Ag^+ in the conical flask solution after the following additions of titrant KSCN solution given that Ksp (AgSCN)= 1.0×10^{-12}:

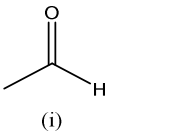
(i) 30 mL

(ii) At equivalent point

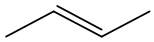
(iii) 100 mL? (6 marks)

QUESTION THREE (20 MARKS)

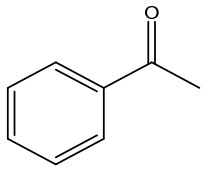
(a) Identify the functional groups in the following compounds:



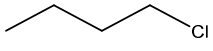
(i)



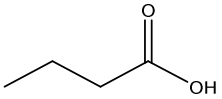
(ii)



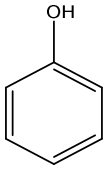
(iii)



(iv)



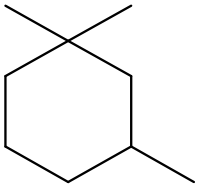
(v)



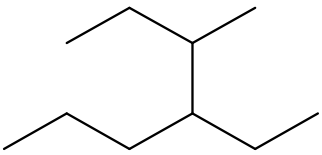
(vi)

(9 marks)

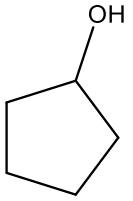
(b) Provide the IUPAC names for the following compounds



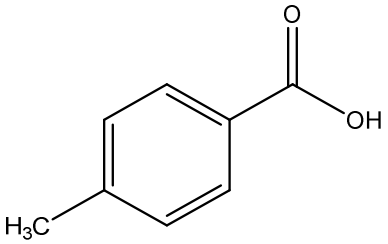
(i)



(ii)



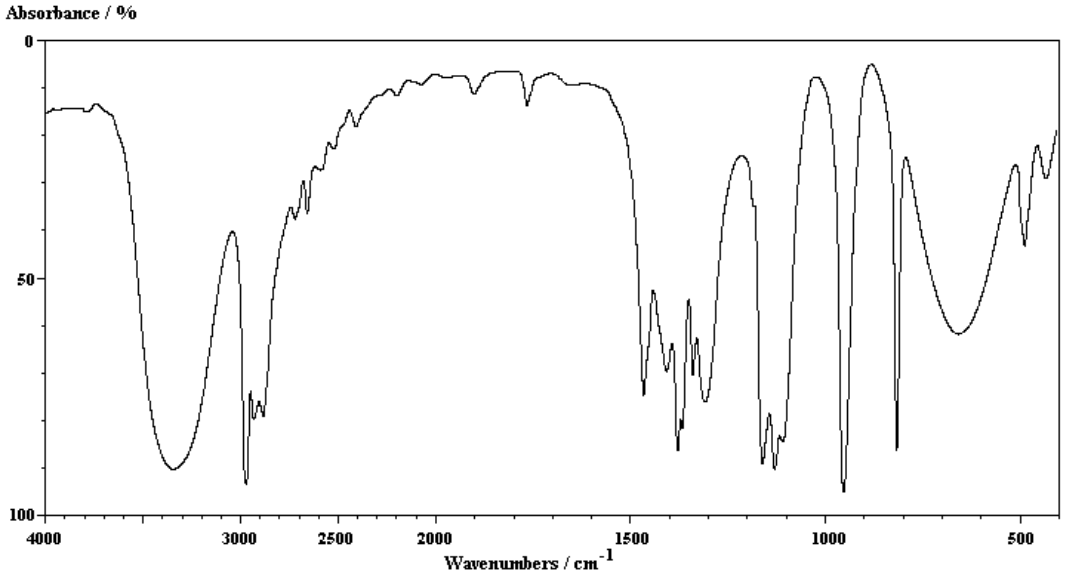
(iii)



(iv)

(6 marks)

(c) Infrared spectroscopy is an important tool for identification of functional groups. In the IR spectra shown below, identify one functional group that must be in the compound. (1 mark)



(d) Describe two ways in which one can determine the concentration of a standard solution. (4 marks)

QUESTION FOUR (20 MARKS)

(a) Write the equilibrium constant for the reaction shown below

H_2 (g) + I_2 (g) ↔ 2 HI (g) (2 marks)

(b) The Haber process is a method to produce ammonia from hydrogen and nitrogen gases.The reaction is N_2 (g) + 3 H_2 (g) ↔ 2 NH_3 (g). Explain what happens if hydrogen gas is added after the reaction has reached equilibrium. (3 marks)

(c) Consider the following reaction

CO2 (g) + H_2 (g) ⟶ CO (g) + H_2O (g)

Calculate the value of the equilibrium constant, K, for the above system, if 0.1908 moles of CO_2, 0.0908 moles of H_2, 0.0092 moles of CO, and 0.0092 moles of H_2O vapour were present in a 2.00 L reaction vessel at equilibrium. (5 marks)

(d) Explain why alcohols have much higher boiling points than alkanes of a similar size.

(2 marks)

(e) Discuss two requirements of a primary standard. (4 marks)

(f) Describe how to prepare 250 mL of 0.5 molar solution of potassium permanganate

(4 marks)

QUESTION FIVE (20 MARKS)

(a) Identify the type of colloid in the table shown below (6 marks)

	Dispersed phase	Dispersion media	**Type of colloid**
(i)	Solid	gas	
(ii)	Liquid	solid	
(iii)	Liquid	liquid	
(iv)	Gas	liquid	

(c) Describe three ways in which colloidal systems can be prepared. (6 marks)

(d) A colloidal system can be described as polydisperse or monodisperse. Differentiate between the two? (2 marks)

(e) One of the properties of colloids is Tyndall effect. Discuss what is meant by Tyndall effect. (2 marks)

(e) The advances in modern agriculture can be attributed to chemistry. Discuss 2 ways in which chemistry has contributed to agriculture. (4 marks)

1																	18
1 **H** 1.0079	2											13	14	15	16	17	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.065	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.409	31 **Ga** 69.723	32 **Ge** 72.64	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89-103 #	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (270)	109 **Mt** (268)	110 **Ds** (281)	111 **Rg** (272)	112 **Uub** (285)	113 **Uut** (284)	114 **Uuq** (289)	115 **Uup** (288)	116 **Uuh** (291)		118 **Uuo** (294)

* Lanthanide series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
# Actinide series	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)