



UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

AWM 106: WATER CHEMISTRY

DATE: APRIL 10, 2017

TIME: 8:30-10:30AM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

The periodic table of elements is provided at the last page.

Constants:

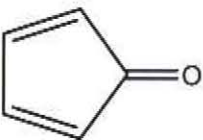
$$h = 6.626 \times 10^{-34} \text{ J-s}$$

$$c = 3.0 \times 10^8 \text{ m/s}$$

$$K_a(\text{CH}_3\text{COOH}) = 1.8 \times 10^{-5}$$

QUESTION ONE (30 MARKS)

- a) What dissolved species are present in a solution of: (2 marks)
- KCN,
 - NaClO_4 ?
- b) Classify the following compounds as soluble or insoluble in water: (3 marks)
- Cobalt(II) hydroxide,
 - Barium nitrate,
 - Ammonium phosphate.
- c) What is the difference between: (6 marks)
- Monoprotic acid and diprotic acid,
 - Weak acid and strong acid,
 - An acid and a base?

- iv) What is the molarity of a NaOH solution if 48.0 mL is needed to neutralize 35.0 mL of 0.144 M H₂SO₄? (3 marks)
- v) Formic acid, HCOOH, is a weak electrolyte. What solute particles are present in an aqueous solution of this compound? Write the chemical equation for the ionization of HCOOH. (4 marks)
- d) Define oxidation and reduction in terms of: (4 marks)
- Electron transfer
 - Oxidation numbers.
- e) Identify the functional groups in each of the following compounds: (4 marks)
- H₃C-CH₂-OH
 - 
 - CH₃CCCH₂COOH
 - CH₃CH₂CH₂CH₂CHO
- f) What is the difference between: (4 marks)
- Constitutional isomers and stereoisomers.
 - Enantiomers and diastereomers.

QUESTION TWO (20 MARKS)

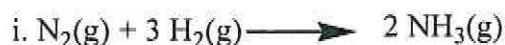
- a) A solution of 100.0 mL of 0.200 M KOH is mixed with a solution of 200.0 mL of 0.150 M NiSO₄.
- Write the balanced chemical equation for the reaction that occurs. (2 marks)
 - What precipitate forms? (1 mark)
 - What is the limiting reactant? (2 marks)
 - How many grams of this precipitate form? (3 marks)
 - What is the concentration of each ion that remains in solution? (4 marks)
- b) Explain why a mixture of CH₃COOH and CH₃COONa can act as a buffer while a mixture of HCl and NaCl cannot. (3 marks)
- c) What is the pH of a buffer that is 0.12 M in lactic acid [CH₃COOH]COOH, or HC₃H₅O₃] and 0.10 M in sodium lactate [CH₃CH(OH)COONa or NaC₃H₅O₃] ? For lactic acid, K_a = 1.4 × 10⁻⁴. (5 marks)

QUESTION THREE (20 MARKS)

a) Determine the oxidation number for the indicated element in each of the following substances: (6 marks)

- i) S in SO_2 ,
- ii) C in COCl_2 ,
- iii) Mn in MnO_4^-

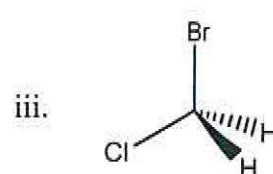
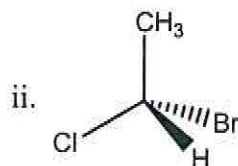
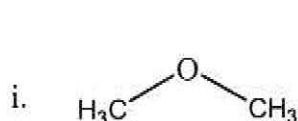
b) Which element is oxidized and which is reduced in the following reactions? (4 marks)



c) The metal cadmium tends to form Cd^{2+} ions. The following observations are made: (I) When a strip of zinc metal is placed in $\text{CdCl}_2(\text{aq})$, cadmium metal is deposited on the strip. (II) When a strip of cadmium metal is placed in $\text{Ni}(\text{NO}_3)_2(\text{aq})$, nickel metal is deposited on the strip. (4 marks)

- i) Write net ionic equations to explain each of the observations made above.
- ii) What can you conclude about the position of cadmium in the activity series?

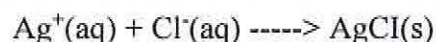
d) Draw the mirror image of each compound, and label the compound as chiral or achiral. (6 marks)



QUESTION FOUR (20 MARKS)

a) How many grams of $\text{Ca}(\text{OH})_2$ are needed to neutralize 25.0 mL of 0.100 M HNO_3 ? (4 marks)

b) The quantity of Cl^- in a municipal water supply is determined by titrating the sample with Ag^+ . The reaction taking place during the titration is



The end point in this type of titration is marked by a change in color of a special type of indicator.

- i) How many grams of chloride ion are in a sample of the water if 20.2 mL of 0.100 M Ag^+ is needed to react with all the chloride in the sample? (4 marks)
- ii) If the sample has a mass of 10.0 g, what percent Cl^- does it contain? (2 marks)
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- a) A 35.0-mL sample of 0.150 M acetic acid (CH_3COOH) is titrated with 0.150 M NaOH solution. Calculate the pH after the following volumes of base have been added:
- i) 0 mL, (4 marks)
- ii) 17.5 mL (6 marks)

QUESTION FIVE (20 MARKS)

- a) The yellow light given off by a sodium vapor lamp used for public lighting has a wavelength of 589 nm. What is the frequency of this radiation? (3 marks)
- b) Ionic solids dissolve in water as strong electrolytes, that is, as separated ions in solution. What properties of water facilitate this process? (3 marks)
- c) By titration, 15.0 mL of 0.1008 M sodium hydroxide is needed to neutralize a 0.2053-g sample of an organic acid.
- i) What is the molar mass of the acid if it is monoprotic? (4 marks)
- ii) An elemental analysis of the acid indicates that it is composed of 5.89% H, 70.6% C, and 23.5% O by mass. What is its molecular formula? (4 marks)
- d) You know that an unlabeled bottle contains a solution of one of the following: AgNO_3 , CaCl_2 , or $\text{Al}_2(\text{SO}_4)_3$. A friend suggests that you test a portion of the solution with $\text{Ba}(\text{NO}_3)_2$ and then with NaCl solutions. Explain how these two tests together would be sufficient to determine which salt is present in the solution. (6 marks)

PERIODIC TABLE

1	2																	18
1 H 1.008																		2 He 4.003
3 Li 6.941	4 Be 9.012																	
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
												13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95	
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3	
55 Cs 132.9	56 Ba 137.3	57* La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra (226)	89** Ac (227)	104 Db (261)	105 Jl (262)	106 Rf (263)	107 Bh (262)	108 Hn (?)	109 Mt (?)										

*	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
**	90 Th (232)	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (239)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (252)	99 Es (252)	100 Fm (257)	101 Md (256)	102 No (259)	103 Lr (260)

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