UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

B.Sc. Degree in Environmental Health Science
B.Sc. Degree in Nursing Science
MAIN EXAMINATION PAPER DECEMBER 2015

TITLE OF PAPER : CHEMISTRY FOR HEALTH SCIENCES

COURSE CODE : EHS111

DURATION : 2 HOURS

MARKS : 100

INSTRUCTIONS : THERE ARE FIVE QUESTIONS IN THIS EXAM

: ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS

: EACH QUESTION CARRIES A MAXIMUM MARK OF 25%

Question 1

A student performs a titrimetric analysis to determine the amount of iron in a sample using dichromate in acid medium.

1.1.1 Construct a balanced chemical equation for the reaction. (8)

1.1.2 Identify the reducing and oxidizing agents. (2)

1.2 Complete and balance the following equations and classify the type of reaction represented. (Include state symbols).

1.2.1 $CH_3OH + O_2 \longrightarrow$??? (4)

1.2.2 ??? $\longrightarrow$ calcium chloride + hydrogen sulfide (4)

1.3 A 25.00 mL sample of HCl(aq) was added to a 0.1000 g sample of $CaCO_3$. All the $CaCO_3$ reacted leaving some unreacted moles of HCl (aq).

$$CaCO_3(s) + 2HCl(aq) \_ CaCl_2(aq) + H_2O(l) + CO_2(g)$$

The unreacted moles of HCl required 43.82 mL of a 0.01185 M $Ba(OH)_2$ (aq) to react completely, according to the following balanced equation:

$$2HCl(aq) + Ba(OH)2(aq) \_ BaCl2(aq) + 2H2O(l)$$

1.3.1 Calculate the number of moles of HCl that reacted with $CaCO_3$. (2)

1.3.2 Calculate the number of moles of HCl that reacted with $Ba(OH)_2$. (2)

1.3.3 Determine the molarity of the original solution of HCl. (3)

[25]

Question 2

2.1 In the process of attempting to characterize a substance, a chemist makes the following observations:-

The substance is a silvery white, lustrous metal. It melts at 649°C and boils at 1105°C. The substance burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into thin sheets or drawn into wires. It is a good conductor of electricity.

Identify any two chemical and two physical properties of the unknown substance. (4)

2.2 Account for the following facts:-

2.2.1 Graphite conducts electricity. (2)

2.2.2 Most ionic compounds have high melting points. (2)

2.2.3 Ionic compounds are brittle. (2)

2.3 Write formulas of:-

2.1.1 Auric chlorate (3)
2.1.2 Hydrotelluric acid (3)
2.1.3 Calcium hydride (3)

2.4 Name the following compounds:-

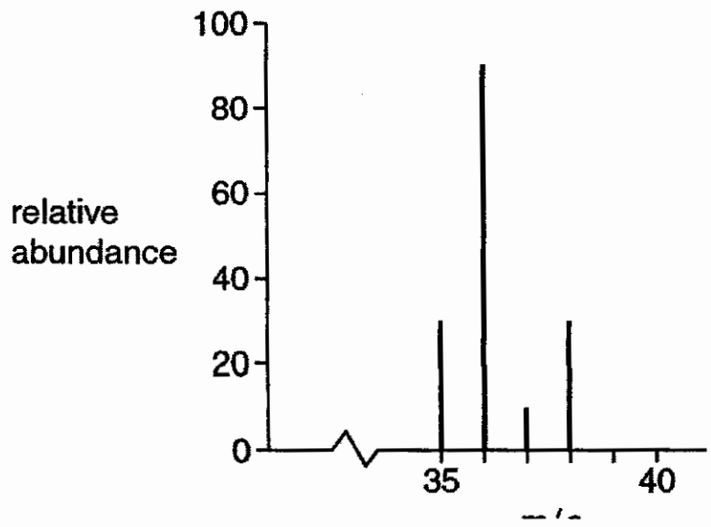
2.4.1 HgO (1)
2.4.2 HIO_2 (1)
2.4.3 $Sn(HSO_3)_2$ (1)
2.4.4 CO (1)

2.5 There are 1.699×10^{22} atoms in 1.00 g of chlorine. Assume that chlorine atoms are spheres of radius 0.99 Å and that they are lined up side-by-side. How many kilometres is the line of the chlorine atoms? (5)

[25]

QUESTION 3

3.1 In a mass spectrometer some hydrogen chloride molecules will split into atoms. The mass spectrum of HCl is given. Chlorine has two isotopes. The hydrogen involved in this molecule is the isotope $^{1}_{1}H$ only.



3.1.1 Define the term isotope. (1)

3.1.2 What particle is responsible for the peak mass 35? (1)

3.1.3 What particle is responsible for the peak mass 38? (1)

3.1.4 Use your relative heights of the peaks to determine the proportions of the two isotopes of chlorine. Show how you obtained your answer. (2)

3.1.5 Use your answer in **3.1.4** to prove that the relative atomic mass of chlorine is 35.5 amu. (2)

3.2 The molecular formula of aspartame, an artificial sweetener, is $C_{14}H_{18}N_2O_5$. Calculate the mass of carbon atoms that are present in 1.00 mg of aspartame. (7)

3.3 Explain in detail how to make up 150.0 mL of 0.9200 M sucrose solution. You need to include calculations in your answer too. Molar mass of sucrose = 342.30 g mol^{-1} (5)

3.4 Complete the table below:- (6)

Ion	Number of			Atomic number	Mass number
	Protons	Neutrons	Electrons		
Mg^{2+}	12	12	**3.4.1**	**3.4.2**	**3.4.3**
Br^-	**3.4.4**	**3.4.5**	**3.4.6**	35	85

[25]

QUESTION 4

4.1 In an experiment, 45.0 cm^3 of 0.270 M barium hydroxide were mixed with 28.0 cm^3 of 0.330 M aluminium sulphate.

4.1.1 Write the net ionic equation for the reaction that takes place. (3)

4.1.2 What is the total mass of the precipitate that forms? (3)

4.1.3 What are the molar concentrations of the ions that remain in the solution after the reaction is complete? (3)

4.2 Qualitative analysis of an unknown acid was found to contain only carbon, hydrogen and oxygen. In a quantitative analysis, a 10.46 mg sample was burned in oxygen and gave 22.17 mg carbon dioxide and 3.40 mg water.

The molecular mass determined to be 166 $gmol^{-1}$. When 0.1680 g of the acid was titrated with 0.1250 M sodium hydroxide, the end point was reached after 16.18 mL of the base added.

4.2.1 What is the empirical formula of the acid? (8)

4.2.2 What is its molecular formula? (2)

4.2.3 Is the acid mono-, di- or triprotic? (1)

4.2.4 Calculate the percentage composition of the acid. (5)

[25]

Question 5

5.1 Account for the following facts:-

5.1.1 Atomic size decreases across the period. (2)

5.1.2 Group VIIIA elements have positive electron affinity values. (2)

5.1.3 The electron configuration of Cr^{3+} is $[Ar]4s^23d^1$ instead of $[Ar]4s^13d^2$. (2)

5.1.4 There is a decrease in the first ionization energy from Be to B and Mg to Al. (2)

5.2 The amount of calcium in a 13.5 g sample was determined by converting the calcium found in the sample to calcium oxalate, Ca_2CO_4. If the mass of CaC_2O_4 is 13.9 g, what is the percentage of calcium in the original sample? (5)

5.3 Give the charge and electron configuration on the ion which is underlined in the following compounds

5.3.1 $K\underline{Mn}O_4$ (3)

5.3.2 $(H\underline{P}O_4)^{2-}$ (3)

5.3.3 $Zn\underline{S}O_4$ (3)

5.3.4 $\underline{V}O_2$ (3)

[25]

General data and fundamental constants

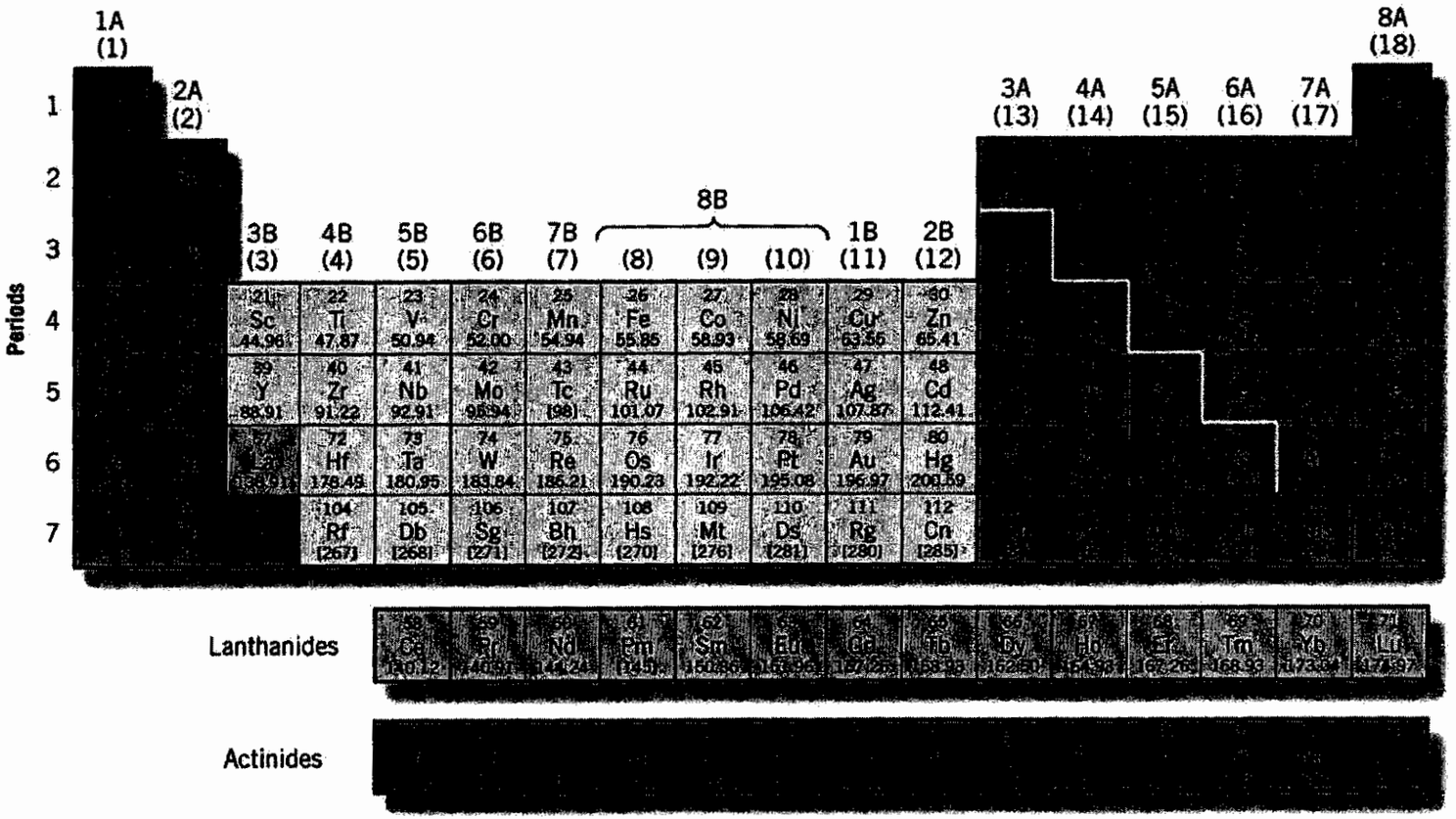
Quantity	Symbol	Value
Speed of light	c	$2.997\,924\,58 \times 10^{8}$ m s^{-1}
Elementary charge	e	$1.602\,177 \times 10^{-19}$ C
Faraday constant	$F = N_A e$	9.6485×10^{4} C mol^{-1}
Boltzmann constant	k	$1.380\,66 \times 10^{-23}$ J K^{-1}
Gas constant	$R = N_A k$	8.314 51 J K^{-1} mol^{-1}
		$8.205\,78 \times 10^{-2}$ dm^3 atm K^{-1} mol^{-1}
		6.2364×10 L Torr K^{-1} mol^{-1}
Planck constant	h	$6.626\,08 \times 10^{-34}$ J s
	$\hbar = h/2\pi$	$1.054\,57 \times 10^{-34}$ J s
Avogadro constant	N_A	$6.022\,14 \times 10^{23}$ mol^{-1}
Atomic mass unit	u	$1.660\,54 \times 10^{-27}$ Kg
Mass		
electron	m_e	$9.109\,39 \times 10^{-31}$ Kg
proton	m_p	$1.672\,62 \times 10^{-27}$ Kg
neutron	m_n	$1.674\,93 \times 10^{-27}$ Kg
Vacuum permittivity	$\varepsilon_0 = 1/c^2\mu_0$	$8.854\,19 \times 10^{-12}$ J^{-1} C^2 m^{-1}
	$4\pi\varepsilon_0$	$1.112\,65 \times 10^{-10}$ J^{-1} C^2 m^{-1}
Vacuum permeability	μ_0	$4\pi \times 10^{-7}$ J s^2 C^{-2} m^{-1}
		$4\pi \times 10^{-7}$ T^2 J^{-1} m^3
Magneton		
Bohr	$\mu_B = e\hbar/2m_e$	$9.274\,02 \times 10^{-24}$ J T^{-1}
nuclear	$\mu_N = e\hbar/2m_p$	$5.050\,79 \times 10^{-27}$ J T^{-1}
g value	g_e	2.002 32
Bohr radius	$a_0 = 4\pi\varepsilon_0\hbar/m_e e^2$	$5.291\,77 \times 10^{-11}$ m
Fine-structure constant	$\alpha = \mu_0 e^2 c/2h$	$7.297\,35 \times 10^{-3}$
Rydberg constant	$R_\infty = m_e e^4/8h^3 c\varepsilon_0^2$	$1.097\,37 \times 10^{7}$ m^{-1}
Standard acceleration of free fall	g	9.806 65 m s^{-2}
Gravitational constant	G	$6.672\,59 \times 10^{-11}$ N m^2 Kg^{-2}

Conversion factors

1 cal	=	4.184 joules (J)	1 erg	=	1×10^{-7} J
1 eV	=	$1.602\,2 \times 10^{-19}$ J	1 eV/molecule	=	96 485 kJ mol^{-1}

Prefixes

f	p	n	μ	m	c	d	k	M	G
femto	pico	nano	micro	milli	centi	deci	kilo	mega	giga
10^{-15}	10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{3}	10^{6}	10^{9}


1A (1)
2A (2)
3A (13)
4A (14)
5A (15)
6A (16)
7A (17)
8A (18)
3B (3)
4B (4)
5B (5)
6B (6)
7B (7)
8B
(8)
(9)
(10)
1B (11)
2B (12)
Periods
1
2
3
4
5
6
7
21 Sc 44.96
22 Ti 47.87
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 65.41
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
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
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
104 Rf [267]
105 Db [268]
106 Sg [271]
107 Bh [272]
108 Hs [270]
109 Mt [276]
110 Ds [281]
111 Rg [280]
112 Cn [285]
Lanthanides
Actinides