UNIVERSITY OF SWAZILAND

FINAL EXAMINATION 2014/2015

TITLE OF PAPER	**:**	**CHEMISTRY FOR HEALTH AND ENVIRONMENTAL SCIENCES**
COURSE CODE	**:**	**HSC106**
TIME	**:**	**THREE (3) HOURS**
TOTAL MARKS	**:**	**100 MARKS**
EXAMINER	**:**	**DR. J. M. THWALA**
INSTRUCTIONS	**:**	**ANSWER ALL QUESTIONS FROM SECTION A (TOTAL 40 MARKS) AND ANY TWO QUESTIONS FROM SECTION B (EACH QUESTION IS 30 MARKS AND A TOTAL OF 60 MARKS)**

NON-PROGRAMMABLE ELECTRONIC CALCULATORS MAY BE USED.

A PERIODIC TABLE AND OTHER USEFUL DATA HAVE BEEN PROVIDED WITH THIS EXAMINATION PAPER

PLEASE DO NOT OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

SECTION A

MULTIPLE CHOICE [50 MARKS]

Indicate the best option for each of the following multiple choice questions:

1. The symbol for the element mercury is _____.
   (A) Me (B) Pb (C) Sn (D) Hg (E) Ag

2. A small amount of salt dissolved in water is an example of a _____.
   (A) homogeneous mixture (B) heterogeneous (C) compound
   (D) pure substance (E) solid

3. Muddy water is placed on a porous surface and clear water allowed to seep through. This process is called
   (A) centrifugation (B) recrystallization (C) filtration
   (D) distillation (E) decantation

4. Which one of the following has the element name and symbol correctly matched?
   (A) S, sodium (B) Tn, tin (C) Fe, iron
   (D) N, neon (E) B, bromine

5. Which one of the following is a pure substance?
   (A) concrete (B) wood (C) salt water
   (D) elemental copper (E) milk

6. Which of the following are chemical processes?
   I. Rusting of a nail.
   II. Freezing of water.
   III. Decomposition of water into hydrogen and oxygen gases.
   IV. Compression of oxygen gas.
   (A) II, III, IV (B) I, III, IV (C) I, III
   (D) I, II (E) I, IV

7. Which atom has the smallest number of neutrons?
   (A) Chlorine-17 (B) nitrogen-14 (C) oxygen-16
   (D) fluorine-19 (E) neon-20

8. There are _____ electrons, _____ protons, and _____ neutrons in an atom of $^{132}_{54}Xe$
   (A) 132, 132, 54 (B) 54, 54, 132 (C) 78, 78, 54
   (D) 54, 54, 78 (E) 78, 78, 132

9. Of the following, only _____ is **not** a metalloid.
   (A) B (B) Al (C) Si (D) Ge (E) As

10. The element X has two naturally occurring isotopes. The masses (amu) and % abundances of the isotopes are given in the Table below. The average atomic mass of the element is _____.

Isotope	Abundance (%)	Mass (amu)
^{31}X	35.16	31.16
^{34}X	64.84	34.30

(A) 30.20 (B) 33.20 (C) 34.02 (D) 35.22 (E) 32.73

11. Which species has 54 electrons?
(A) $^{132}_{54}Xe^{+}$ (B) $^{128}_{52}Te^{2-}$ (C) $^{118}_{50}Sn^{2+}$ (D) $^{112}_{48}Cd$ (E) $^{132}_{54}Xe^{2+}$

12. Which of the following compounds would you expect to be ionic?
(A) SF_6 (B) H_2O (C) H_2O_2 (D) NH_3 (E) CaCl

13. When the following equation is balanced, the coefficients are _____.

$$NH_3 + O_2 \rightarrow NO_2 + H_2O$$

(A) 1, 1, 1, 1 (B) 4, 7, 4, 6 (C) 2, 3, 2, 3
(D) 1, 3, 1, 2 (E) 4, 3, 4, 3

14. There are _____ hydrogen atoms in 25 molecules of $C_4H_4S_2$.
(A) 25 (B) 3.8×10^{24} (C) 6.0×10^{25}
(D) 100 (E) 1.5×10^{25}

15. The formula of nitrobenzene is $C_6H_5NO_2$. The molecular weight of this compound is _____ amu.
(A) 107.11 (B) 43.03 (C) 109.10 (D) 123.11 (E) 3.06

16. A sample of CH_2F_2 with a mass of 19 g contains _____ atoms of F.
(A) 2.2×10^{23} (B) 38 (C) 3.3×10^{24}
(D) 4.4×10^{23} (E) 9.5

17. How many grams of sodium carbonate, Na_2CO_3, contain 1.773×10^{17} carbon atoms?
(A) 3.121×10^{-5} (B) 1.011×10^{-5} (C) 1.517×10^{-5}
(D) 9.100×10^{-5} (E) 6.066×10^{-5}

18. The concentration (M) of an aqueous methanol produced when 0.200 L of a 2.00 M solution was diluted to 0.800 L is _____ M.
(A) 0.800 (B) 0.200 (C) 0.500 (D) 0.400 (E) 8.00

19. All of the orbitals in a given subshell have the same value of the _____ quantum number.
(A) principal, n (B) azimuthal, l (C) spin, ms (D) A and B
(E) B and C

20. Which of the subshells below do **not** exist due to the constraints upon the subshell quantum number, l?
(A) 4f (B) 4d (C) 3f (D) 4s (E) 4p

21. An electron **cannot** have the quantum numbers n = ___, l = ___, m_l = ___.
(A) 6, 1, 0 (B) 3, 2, 3 (C) 3, 2, –2 (D) 1, 0, 0 (E) 3, 2, 1

22. Which set of three quantum numbers (n, l, m_l) corresponds to a 3d orbital?
(A) 3, 2, 2 (B) 3, 3, 2 (C) 3, 2, 3 (D) 2, 1, 0 (E) 2, 3, 3

23. The ground state electron configuration of fluorine is _____.
(A) $[He]2s^2 2p^2$ (B) $[He]2s^2 2p^3$ (C) $[He]2s^2 2p^4$
(D) $[He]2s^2 2p^5$ (E) $[He]2s^2 2p^6$

24. What is the electron configuration for the Co^{2+} ion?
(A) $[Ar]4s^1 3d^6$ (B) $[Ar]3d^7$ (C) $[Ar]3d^5$
(D) $[Ar]4s^2 3d^9$ (E) $[Ne]3s^2 3p^{10}$

25. Which of the following would have to gain two electrons in order to achieve a noble gas electron configuration?
O Sr Na Se Br
(A) Br (B) Sr (C) Na (D) O, Se (E) Sr, O, Se

26. The Lewis structure of NH_3 shows that the central phosphorus atom has _____ nonbonding (lone) and _____ bonding electron pairs.
(A) 2, 2 (B) 1, 3 (C) 3, 1 (D) 1, 2 (E) 3, 3

27. What is 0.00950 in standard scientific notation?
(A) 950 (B) 0.950×10^{-2} (C) 9.50×10^{3}
(D) 9.5×10^{-3} (E) 9.50×10^{-3}

28. In a triple covalent bond, how many electrons are shared?
(A) 6 (B) 4 (C) 2 (D) 8 (E) 10

29. A 20.0 ml sample of sulphuric acid from a lake near a mine was titrated to the stoichiometric point with 9.92 ml of 0.0120 M NaOH. What is the molarity of the sulphuric acid in the sample?
(A) 0.00398 M (B) 0.0119 M (C) 0.00238 M
(D) 0.00298 M (E) 0.00198 M

30. Which of the following correctly describes a 10% (w/v) glucose solution?
(A) 10 g of glucose per 1000 ml of solution.
(B) 1.0 g of glucose per 10 ml of solution.
(C) 0.1 g of glucose per 1.0 ml of solution.
(D) 10 g of glucose per 100 ml of solution.
(E) 10 g of glucose per 10 ml of solution.

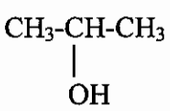
31. Which of the following is not a covalent compound?
(A) Sodium chloride (B) Water (C) Ammonia
(D) Ethanol (E) Ethane

32. What is the name of $CH_3CH_2CH_2CH_3$?
(A) pentane (B) butane (C) cyclopentane
(D) hexane (E) 1-methylpentane

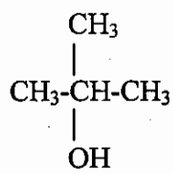
33. Which of the following is an ether?
(A) $CH_3CH_2OCH_2CH_3$ (B) CH_3CH_2OH (C) CH_3NH_2
(D) CH_3COCH_3 (E) CH_3CHO

34. Which of the following structures is a primary alcohol?

(A) CH_3OH

(B) 

(C) $CH_3\text{-}O\text{-}CH_2\text{-}CH_3$

(D) 

(E) CH_3CHO

35. What does the acronym SIU stand for ?
(A) Standard international units (B) International system of units
(B) Le Systeme de'unite international (C) Standardised system of units
(E) System International units

36. A temperature reading of 77 ^oF is measured with a Fahrenheit thermometer. What reading would this temperature give if a Kelvin thermometer were used?
(A) 77 K (B) 350 K (C) 298 K
(D) 25 K (E) 300 K

37. Replicate measurements for the concentration of cadmium in waste water gave 33.5 g/ml, 35.2 g/ml, 34.7 g/ml, 30.4 g/ml and 40 g/ml. What is the percentage relative standard deviation of the sample ?
(A) 10 % (B) 34.8 % (C) 5 %
(D) 3.5 % (E) 9.1 %

38. If the true value for the concentration of cadmium in question 37 above is 40.5 g/ml, what is the percentage relative error ?
(A) 16.5 % (B) 5.74 % (C) 40.5 %
(D) 85.8 % (E) 9.1 %

39. A laboratory technician uses a micropipet to measure a 50 μL (50 microliter) sample of blood serum for analysis. Express the sample volume in cm^3.
(A) 5 (B) $5.0x10^3$ (C) $5.0x10^{-6}$
(D) 0.05 (E) 0.005

40. The recommended daily intake of thiamin is 1.423 mg for a male adult. Suppose such a person takes in only 1.02 mg/day. What percentage of the recommended intake, expressed at the correct degree of precision, is he receiving?
(A) 71.697 % (B) 0.72% (C) 56.43%
(D) 71.7 % (E) 72%

SECTION B

ANSWER ANY TWO QUESTIONS

QUESTION 1 [30 MARKS]

a) (i) Write short notes on any Three of the following pollutants. [12]
Oxygen Demanding Wastes
Eutrophication
Inorganic Wastes
Organic Pesticides

(ii) Using examples briefly describe the chemical process involved in each of the following water purification methods. [12]
Ion exchange resins
Chlorination
Coagulation and sedimentation
Sequestration

b) Explain the difference between permanent and temporary water hardness. [6]

QUESTION 2 [30 MARKS]

a) i) Define a buffer solution [4]
ii) Name three kinds of buffers found in the body. [9]

b) Briefly discuss **any one** of the following: [8]
i) Respiratory acidosis
ii) Metabolic acidosis

In your discussion include the cause, the symptoms and the treatment.

c) A 19 year old man is admitted to hospital.. On admission his laboratory results were as follows:

Blood pressure	90/20 mm Hg	Sodium	132mmol/L
Deep respirations	35/min	Potassium	6.5mmol/L
Pulse	120/min	pH	6.75
glucose	20 mmol/l	PCO_2	11 mm Hg
protein	100 µg/dl	Blood ketones	positive

i) Using the data given diagnose the condition of the patient, giving specific reasons for your diagnoses. [6]
ii) What treatment would you prescribe. [3]

QUESTION 3 [30 MARKS]

a) Explain the difference between the following pairs of terms. Give examples for each pairs.
   i) Ionic bonding and Covalent bond [6]
   ii) Hunds rule and Pauli Exclusion Principle [6]

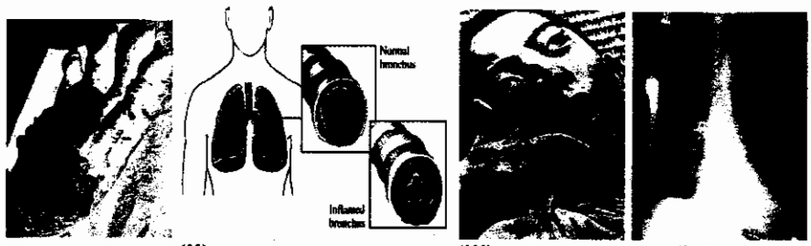
b) Based on the electronic configurations of the elements, explain why each of the following is true [5]:

   (i) ionisation of neon is greater than that of Fluorine
   (ii) atomic radius of sulfur is less than that of sodium
   (iii)ionisation of oxygen is less than that of nitrogen
   (iv)electron affinity of carbon is greater than that of nitrogen
   (v) Electronegativety of bromine is greater than that of potassium

c) Draw Lewis structures or diagrams to show and name the type of bonding for each of the following: [4]
   (i) calcium chloride
   (ii) NH_4^+
   (iii) H_2O

c). i) Using Hunds rule, Aufbau buidling up principle and the periodic table write the electronic configurations of the following elements. [5]
   Arsenic Berylium Lead Cadmium Mercury

   ii) Identify and name environmental hazards of the elements in 3c(i) from the pictures below and indicate the most likely sources. [4]



(i).....(ii).....(iii).....(iv).....

QUESTION 4 [30 MARKS]

(a) Using diagrams explain why water dissolves NaCl to form an electrolyte solution [5].

(b) A chemist wants to produce urea (N_2CH_4O) by reacting ammonia (NH_3) and carbon dioxide (CO_2). The balanced equation for the reaction is

$$2NH_3(g) + CO_2(g) \rightarrow N_2CH_4O(s) + H_2O(l)$$

The chemist reacts 5.11 g NH_3 with excess CO_2 and isolates 3.12 g of solid N_2CH_4O. Calculate the percentage yield of the experiment. [5]

(c) Stomach acid is essentially 0.10 M HCl. An active ingredient found in a number of popular antacids is calcium carbonate, $CaCO_3$ which reacts with HCl according to the balanced equation below.

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

Calculate the number of grams of $CaCO_3$ needed to exactly react with 250 ml of stomach acid. [5]

(d) A certain alcohol contains only three elements, carbon, C, hydrogen, H, and oxygen, O. Combustion of a 50.00 gram sample of the alcohol produced 95.50 grams of CO_2 and 58.70 grams of H_2O. What is the empirical formula of the alcohol? [6]

NORMAL LABORATORY VALUES FOR BLOOD TESTS

	USUAL REFERENCE RANGE	
Specific Gravity		1.056
Hemoglobin Count Hb		Men: 14 - 18g /dL Women: 12 -16 g/dL
HCO^-_3 Bicarbonate	24 - 28 mmol/L	24 - 28 mEq/L
Glucose	(3.6-6.1 mmol/L)	65 - 110 mg/dL
BUN (Blood Urea Nitrogen)	2.9 - 7.1 mmol/L	8 - 20 mg/dL
Ca^{+2}	(2.1-2.6 mmol/L)	8.5 - 10.3 mg/dL
Cl^-	(96-106 mmol/L)	96 - 106 mEq/L
Cholesterol		150 - 220 mg/dL
CO_2	24-29 mmol/L	24-29 mEq/L
PCO_2		35-45 mmHg
PO_2		80 - 100 mm Hg
pH		7.35 - 7.45
Fatty acids	0.3-0.8 mmol/L	0.3-2 mg/dL
Protein		6-8 µg/dL
Phosphate	1 - 1.5 mmol/L	3-4.5 mg/dL
ketone bodies		0.3-2 mg/dL
K^+	3.5-5 mmol/L	3.5 - 5 mEq/L
Na^+	136-145 mmol/L	136 - 145 mEq/L
Uric Acid	Men: 0.18 - 0.54 Women: 0.15 - 0.46 mmol/L	Men: 3 - 9 mg/dL Women: 2.5 - 7.5 mg/dL Children: 1.5 g/L (150mg/dL)

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
Period 1	1 **H** 1.008																	2 **He** 4.003
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.9	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.01	25 **Mn** 54.9	26 **Fe** 55.85	27 **Co** 58.71	28 **Ni** 58.71	29 **Cu** 63.54	30 **Zn** 65.37	31 **Ga** 69.7	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.91	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 91.22	42 **Mo** 95.94	43 **Tc** 98.9	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
6	55 **Cs** 132.9	56 **Ba** 137.3	71 **Lu** 174.9	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** 196.9	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 208.9	84 **Po** 210	85 **At** 210	86 **Rn** 222
7	87 **Fr** 223	88 **Ra** 226.0	103 **Lr** 257	104 **Unq**	105 **Unp**	106 **Unh**	107 **Uns**	108 **Uno**	109 **Une**									

NON-METALS

METALLOIDS

METALS

Lanthanides	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** 146.9	62 **Sm** 150.9	63 **Eu** 151.3	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0
Actinides	89 **Ac** 227.0	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.1	94 **Pu** 239.1	95 **Am** 241.1	96 **Cm** 247.1	97 **Bk** 249.1	98 **Cf** 251.1	99 **Es** 254.1	100 **Fm** 257.1	101 **Md** 258.1	102 **No** 255

*Numbers **below** the symbol indicates the **atomic masses**; and the numbers above the symbol indicates the atomic numbers.*

Useful Relations

$(RT)_{298\cdot15K}$=2.4789 kJ/mol

$(RT/F)_{298\cdot15K}$=0.025 693 V

T/K: 100.15 298.15 500.15 1000.15

T/Cm^{-1}: 69.61 207.22 347.62 695.13

1mmHg=133.222 N m^{-2}

hc/k=1.438 78x10^{-2} m K

1atm	1 cal	1 eV	$1cm^{-1}$
=1.01325x10^{5} Nm^{-2}	=4.184 J	=1.602 189x10^{-19} J	=0.124x10^{-3} eV
=760torr		=96.485 kJ/mol	=1.9864x10^{-23}J
=1 bar		= 8065.5 cm^{-1}	

SI-units:

1 L = 1000 ml = 1000cm^3 = 1 dm^3

1 dm = 0.1 m

1 cal (thermochemical) = 4.184 J

dipole moment: 1 Debye = 3.335 64x10^{-30} C m

force: ***1N=1J m^{-1}= 1kgms^{-2}***=10^5 dyne pressure: ***1Pa=1Nm^{-2}***=1Jm^{-3}

1J = 1 Nm

power: 1W = 1J s^{-1} potential: 1V =1 J C^{-1}

magnetic flux: 1T=1Vsm^{-2}=1JCsm^{-2} current: 1A=1Cs^{-1}

Prefixes:

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

General Data

speed of light	**c**	**2.997 925x10^{8} ms^{-1}**
charge of proton	*e*	1.602 19x10^{-19} C
Faraday constant	F=L*e*	9.648 46x10^{4} C mol^{-1}
Boltzmann constant	**k**	**1.380 66x10^{-23} J K^{-1}**
Gas constant	**R=Lk**	**8.314 41 J K^{-1} mol^{-1}**
		8.205 75x10^{-2} dm^3 atm K^{-1} mol^{-1}
Planck constant	**h**	**6.626 18x10^{-34} Js**
	$\hbar = \frac{h}{2\pi}$	1.054 59x10^{-34} Js
Avogadro constant	**L or N_{av}**	**6.022 14x10^{23} mol^{-1}**
Atomis mass unit	u	1.660 54x10^{-27} kg
Electron mass	**m_e**	**9.109 39x10^{-31} kg**
Proton mass	m_p	1.672 62x10^{-27} kg
Neutron mass	m_n	1.674 93x10^{-27} kg
Vacuum permittivity	$\varepsilon_o = \mu_o^{-1}c^{-2}$	8.854 188x10^{-12} J^{-1} C^2 m^{-1}
Vacuum permeability	μ_o	4πx10^{-7} Js^2C^{-2} m^{-1}
Bohr magneton	$\mu_B = e\hbar/2m_e$	9.274 02x10^{-24} JT^{-1}
Nuclear magneton	$\mu_N = e\hbar/2m_p$	5.05079x10^{-27} JT^{-1}
Gravitational constant	G	6.67259x10^{-11} Nm^2kg^{-2}
Gravitational acceleration	**g**	**9.80665 ms^{-2}**
Bohr radius	a_o	5.291 77x10^{-11} m