# UNIVERSITY OF SWAZILAND
# DIPLOMA IN ENVIRONMENTAL HEALTH SCIENCE
# FINAL EXAMINATION PAPER 2007/8

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|---|---|---|
| **TITLE OF PAPER** | : | **INTEGRATED BASIC SCIENCES** |
| **COURSE CODE** | : | **HSC 106** |
| **TIME** | : | **2 HOURS** |
| **TOTAL MARKS** | : | **100 MARKS** |
| **INSTRUCTIONS** | : | **THIS QUESTION PAPER HAS FIVE QUESTIONS** |
| | : | **ANSWER FOUR QUESTIONS ONLY** |
| | : | **EACH QUESTION IS 25 MARKS** |
| | : | **AT LEAST TWO QUESTIONS MUST BE ANSWERED FROM EACH SECTION.** |
| | : | **A PERIODIC TABLE AND DATA SHEETS ARE PROVIDED WITH THIS EXAMINATION PAPER** |
| | : | **NO FORM OF ANY PAPER SHOULD BE BROUGHT INTO NOR TAKEN OUT OF THE EXAMINATION ROOM** |
| | : | **BEGIN THE ANSWER TO EACH QUESTION ON A SEPARATE SHEET OF PAPER** |
| | : | **ALL CALCULATIONS/WORKOUT DETAILS SHOULD BE SUBMITTED WITH YOUR ANSWER SHEET(S)** |

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

**QUESTION 1** **20 MARKS]**

a) Convert the following figures to the units indicated: [6]

i) 2.02 kg/L ..... g/ml
ii) 25 ml..... .....L
iii) 50 000 mg..... µg
iv) $2.4x10^{24}$ atoms..... ...moles
v) 72 pulse/min.....pulses/sec
vi) 20 oz/gal.....g/L

*Recall:* *1 minute = 60 secs* *1 oz = 28.4 g*
*1 in. = 2.54 cm* *1 gal = 3.8 L* $6.023x10^{23}$ *= 1mole*

b) Carry out the following calculations and express each answer with the **correct number of decimal, significant figures and units**. [2]

i) $4.6742\ g \div 0.00\ 371\ L =$

ii) $\frac{3.41\ g - 0.02310\ g}{5.2331\ ml} * 0.2051\ ml =$

c) Write short notes explaining the differences between the following **pairs**:
i) Accuracy and precision [2]
ii) Systematic and random errors [2]

d) A patient was to be given 3.231 mg of de-worming tablets. Two doctors Bongi and Mqondile weighed tablets five times to get the following readings:

| Bongi | Mqondile |
|---|---|
| **3.151** | **3.217** |
| **3.314** | **3.193** |
| **3.291** | **3.208** |
| **3.014** | **3.226** |
| **3.352** | **3.301** |

Calculate (for both Bongi and Mqondile):
i) the mean [1]
ii) Standard deviation [1]
iii) % Coefficient of variation [1]
iii) % Relative error [1]

e) Which measurements from 2(c) above are the most ? [1]
i) accurate
ii) precise

f) What type(s) of error are in the measurements by ? [1]
i) Bongi
ii) Mqondile

g) What appropriate action would you take to prevent the errors you have given in 2(d) above ? [2]

**Useful Formulae:**

$$standard\ deviation\ S_x = \sqrt{\frac{\sum_{i=1}^{N}\left(\bar{x} - x_i\right)^2}{N-1}}; \quad mean\ \ \bar{x} = \frac{\sum_{i=1}^{N} x_i}{N}$$

**QUESTION 2** **[20 MARKS]**

a). Explain the difference between Any Two of the following pairs of terms. Give examples for each pair.

i). Ionic bonding and Covalent bond [5]
ii). Co-ordinate bond and Metallic bonding [5]
ii). Octet Rule and the periodic Law [5]
iv). Compounds and elements [5]
v) Hunds rule and Agfbau builing up principle [5]

b). Draw Lewis structures or diagrams to show and name the type of bonding for each of the following: [5]

(i) calcium chloride

(ii) $NH_4^+$

(iii) $H_2O$

(iv)

$$NH_3 + BF_3 \rightarrow NH_3BF_3$$

(v) $CH_2CH_2$

c). i) Using Hunds rule, Agfbau builing up principle and the periodic table write the electronic configurations of **any Two** of the following elements. [2]

ii) Also indicate their environmental hazards and most likely source of the **Two** you have chosen in c(i): [3]

Arsenic Lead Cadmium Mercury

**QUESTION 3** **[20 MARKS]**

a) i) Define a buffer solution [2]
ii) Name three kinds of buffers found in the body. [3]

b) Briefly discuss **any one** of the following: [6]
i) Respiratory Alkolosis
ii) Metabolic Alkolosis

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 4** **[20 MARKS]**

a) Define the difference between empirical and molecular formular [5]

b) 6.853 mg of a sex hormone containing C, H and O was burned to determine its molecular formula. On burning 20.08 mg $CO_2$ and 5.023 mg of $H_2O$ were obtained. The formula weight of the substance was found to be 270 g/mol.

i) Calculate the Empirical formula for the hormone [10]
ii) Calculate the molecular formula for the hormone [5]
[note that the unit 1 mg = 0.001 g = $1x10^{-3}$g]

**QUESTION 5 [25 Marks]**

a) Using equations define the following terms:
   i) Molarity [4]
   ii) Normality [2]

b) Balance each of the following chemical equations.
   i) $C_3H_8+O_2 \rightarrow CO_2 + H_2O$ [3]
   ii) $SO_2 + HNO_3 + H_2O \rightarrow H_2SO_4 + NO$ [3]
   iii) $Fe_2(SO4)_3+NH_3+H_2O \rightarrow Fe(OH)_3+(NH_4)_2SO_4$ [3]

d) An antacid tablet was given to a patient to relieve stomach discomfort. Given that the antacid was magnesium hydroxide, $Mg(OH)_2$ which reacts with hydrochloric acid.
How many grams acid in the stomach will 1.50 g antacid tablet neutralize ?[10]

## Useful Relations

$(RT)_{298.15K}$=2.4789 kJ/mol

$(RT/F)_{298.15K}$=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 78x$10^{-2}$ m K

| **1atm** | 1 cal | 1 eV | $1cm^{-1}$ |
|---|---|---|---|
| **=1.01325x$10^{5}$ $Nm^{-2}$** | =4.184 J | =1.602 189x$10^{-19}$ J | =0.124x$10^{-3}$ eV |
| **=760torr** | | =96.485 kJ/mol | =1.9864x$10^{-23}$J |
| **=1 bar** | | = 8065.5 $cm^{-1}$ | |

## SI-units:

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

1 dm = 0.1 m

1 cal (thermochemical) = 4.184 J

dipole moment: 1 Debye = 3.335 64x$10^{-30}$ 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 925x$10^{8}$ $ms^{-1}$** |
| charge of proton | *e* | 1.602 19x$10^{-19}$ C |
| Faraday constant | F=L*e* | 9.648 46x$10^{4}$ C $mol^{-1}$ |
| **Boltzmann constant** | **k** | **1.380 66x$10^{-23}$ J $K^{-1}$** |
| **Gas constant** | **R=Lk** | **8.314 41 J $K^{-1}$ $mol^{-1}$** |
| | | **8.205 75x$10^{-2}$ $dm^3$ atm $K^{-1}$** |
| **Planck constant** | **h** | **6.626 18x$10^{-34}$ Js** |
| | $\hbar = \frac{h}{2\pi}$ | 1.054 59x$10^{-34}$ Js |
| **Avogadro constant** | **L or $N_{av}$** | **6.022 14x$10^{23}$ $mol^{-1}$** |
| Atomis mass unit | u | 1.660 54x$10^{-27}$ kg |
| **Electron mass** | **$m_e$** | **9.109 39x$10^{-31}$ kg** |
| Proton mass | $m_p$ | 1.672 62x$10^{-27}$ kg |
| Neutron mass | $m_n$ | 1.674 93x$10^{-27}$ kg |
| Vacuum permittivity | $\varepsilon_o = \mu_o^{-1}c^{-2}$ | 8.854 188x$10^{-12}$ $J^{-1}$ $C^2$ $m^{-1}$ |
| Vacuum permeability | $\mu_o$ | 4πx$10^{-7}$ $Js^2C^{-2}$ $m^{-1}$ |
| Bohr magneton | $\mu_B = e\hbar/2m_e$ | 9.274 02x$10^{-24}$ $JT^{-1}$ |
| Nuclear magneton | $\mu_N = e\hbar/2m_p$ | 5.05079x$10^{-27}$ $JT^{-1}$ |
| Gravitational constant | G | 6.67259x$10^{-11}$ $Nm^2kg^{-2}$ |
| **Gravitational acceleration** | **g** | **9.80665 $ms^{-2}$** |
| Bohr radius | $a_0$ | 5.291 77x$10^{-11}$ m |

# THE PERIODIC TABLE OF ELEMENTS

| Group | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IA | IIA | IIIB | IVB | VB | VIB | VIIB | VIIIB | | | IB | IIB | IIIA | IVA | VA | VIA | VIIA | V |
| Period 1 | 1 **H** 1.008 | | | | | | | | | | | | | | | | | 4 |
| 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 | 2 |
| 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 | 3 |
| 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 | 8 |
| 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 | 1 |
| 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 | |
| 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.*

*SOURCE: International Union of Pure and Applied Chemistry, I mills, ed., Quantities, Units, and symbols in Physical Chemistry, Blackwell Scientific publications, Boston, 1988, pp 86-98.*