# UNIVERSITY OF SWAZILAND
# DIPLOMA IN ENVIRONMENTAL HEALTH SCIENCE
# EXAMINATION PAPER 2011/12

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|---|---|---|
| **TITLE OF PAPER** | : | **CHEMISTRY FOR HEALTH SCIENCES** |
| **COURSE CODE** | : | **HSC 106** |
| **TIME** | : | **3 HOURS** |
| **TOTAL MARKS** | : | **100 MARKS** |
| **INSTRUCTIONS** | : | **THIS QUESTION PAPER HAS EIGHT (8) QUESTIONS** |
| | : | **ANSWER FOUR (4) QUESTIONS ONLY** |
| | : | **EACH QUESTION IS 25 MARKS** |
| | : | **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 [25 MARKS]**

a) Define the term SIU used in measurements and testing. [2]

b) Express the following in SIU system. i) 250 μg ii) 53 dm [2]

c) Give the SI units for the following: [2]
i) Mass ii) Length

d) What do the following prefixes indicate ? [3]
i) pico, p ii) femto, f iii) Mega, M

e) Convert the following figures to the units indicated: [7]

i) 3.02 kg/L .....mg/cm$^3$
ii) 453 fm..... .....pm
iii) 55 000 μg..... mg
iv) 7.6x10$^{24}$ atoms..... ...moles
v) 5400 pulses/hr.....pulses/min
vi) 0.434 ml.....m$^3$
vii) 20.13 gal----------ml

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

f) An intravenous solution (IV) contains 35 mg of a drug per 10 mL of solution. You are to administer 2.75 g of the drug. What volume of the solution should be used? [3]

***Express your answer to the correct degree of precision***

f) A Swazi environmentalist, Lazarus, visited Germany and wanted to set a room air conditioner to 78°F. What is the setting in °C ? [3]

*Useful equation:*

$$^oF = \frac{9}{5}{}^oC + 32^o$$

***Express your answer to the correct degree of precision***

h) 20.3 g sugar is dissolved in 200 mL water to give a total volume of 201 mL solution. What is the specific gravity of the solution given that the density of water is 0.99 g/ml at 100°C? [3]

***Express your answer to the correct degree of certainity***

## QUESTION 2 [25 MARKS]

a) Write short notes explaining the differences between the following **pairs**:
   i) relative error (%RE) and relative standard deviation (%RSD) [2]
   ii) determinate and indeterminate errors [3]

b) A patient was to be given 6.256 mg of de-worming tablets. Two doctors Majahonkhe and Yolanda weighed tablets five times to get the following readings:

| Majahonkhe | Yolanda |
|---|---|
| **6.456** | **6.217** |
| **6.293** | **6.993** |
| **6.454** | **4.698** |
| **6.441** | **6.226** |
| **6.494** | **6.301** |

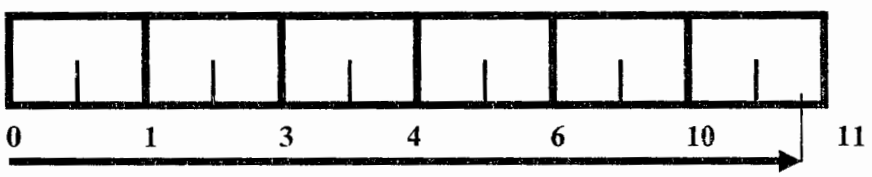
Calculate (for both Majahonkhe and Yolanda):
   i) the mean [2]
   ii) Standard deviation [2]
   iii) % Relative standard deviation [2]
   iv) % Relative error [2]

c) Which measurements from 2(b) above are the most ? [2]
   i) accurate
   ii) precise
   Justify your answers.

d) What type(s) of error are in the measurements by ? [2]
   i) Majahonkhe and
   ii) Yolanda

e) What appropriate action would you take to minimise the errors,if any, you have given in 2(d) (i) and 2d(ii) above ? [2]

g) i) Express the reading of the following analog instrument in the form $\bar{x} \pm Sx$ where $\bar{x}$ is the average and $Sx$ is the deviation. [2]




   ii) Using appropriate calculations estimate the degree of precision and accuracy in g(i). [2]
   iii) What is the source of the most significant error in the instrument in 2(g). [2]

**Useful Formulae:**

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

## QUESTION 3 [25 MARKS]

a) Define the Aufbau building up principle [3]

b) Write short notes on any Three of the following terms. [6]
   i). Ionisation energy
   ii). Electropositivity
   iii) Electronegativity
   iv) Electron Affinity
   v) Atomic radii

c) Explain the following trends:

(i) Atomic Radii in Angstrom units [2]

| H | Li | Na | K | Rb | Cs |
|---|---|---|---|---|---|
| 0.30 | 1.23 | 1.57 | 2.03 | 2.16 | 2.35 |

(ii) ionisation energies in kJ/mol [2]

| Na | Mg | Al | Si | P | S | Cl | Ar |
|---|---|---|---|---|---|---|---|
| 496 | 737 | 577 | 786 | 1012 | 999 | 1255 | 1521 |

(iii) Pauling's Electronegativity coefficients (Unitless) [2]

| Li | Be | B | C | N | O | F |
|---|---|---|---|---|---|---|
| 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |

d). i) Using Hunds rule, Aufbau builing up principle and the periodic table write the electronic configurations of **any Two** of the following elements. [4]

ii) Also indicate their nutritional value and food source of the **Two** elements you have chosen in d(i): [6]

Iron Iodine Fluorine Calcium

## QUESTION 4 [25 MARKS]

a) Write brief notes on **any one** of the following: [12]
   (i) respiratory acidosis
   (ii) metabolic alkalosis
   Define the cause, symptoms and treatment.

b) Define a buffer solution [3]

c) Give the four types of buffer systems in the body [4]

d) A patient had the following laboratory values for his blood sample:

| | | | |
|---|---|---|---|
| $HCO_3^-$ | 23 mEq/L | pH | 7.6 |
| $PCO_2$ | 24 mm Hg | | |

i) What is the mechanism of this acid-base imbalance, justify your answer [3]
ii) What treatment would you prescribe [3]

**Question 5 [25 Marks]**

a) Write a brief outline of the water molecule as a solvent taking into account intra-molecular and intermolecular bonding properties. [5]

b) Write short notes on the following terms: [15]
i) isotonic solutions
ii) hypotonic solutions
iii) hypertonic solutions

Give examples for each and define the use or dangers of each in the body.

c) A nurse was instructed to prepare 150 ml of a 5% antibiotic from a 500 ml of a 50% stock solution to be administered orally to patients. Using the appropriate calculations explain how the required medication could be prepared. [5]

**Question 6 [25 Marks]**

a) i) Balance the following chemical equations.
$KCO_3$ (s)+ $H_2SO_4$ (aq)⟶ $K_2SO_4$ (aq)+ $CO_2$(g)+$H_2O$(l) [2]

ii) Using the reaction in b(i) how much salt in grams would be produced from 90 $KCO_3$ [3]

iii) If the total volume of solution was 500 ml, what would be the final concentration of $K_2SO_4$ in moles per L (M). [3]

b) 13 g of dichloromethane ($CH_2Cl_2$) reacts with 13 g of chlorine to produce carbon tetrachloride and hydrogen chloride. [12]

Determine
i) the limiting reactant
ii) theoretical yield in terms of $CCl_4$ produced.
iii) Amount of excess reactant remaining
iv) Percentage yield if 15 g of product is produced

c) Give the name of the following compounds: [5]
i) $H_2S$ iii) $HClO_2$ v) $FeCl_2$
ii) $Na_2SO_3$ iv) $Na_2Cr_2O7$

**Question 7 [25 Marks]**

a. (i) Write short notes on any Three of the following pollutants. [9]
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. [4]

**Question 8 [25 Marks]**

a) Write short notes on ANY TWO of the following citing examples and/or related metabolic processes [8]

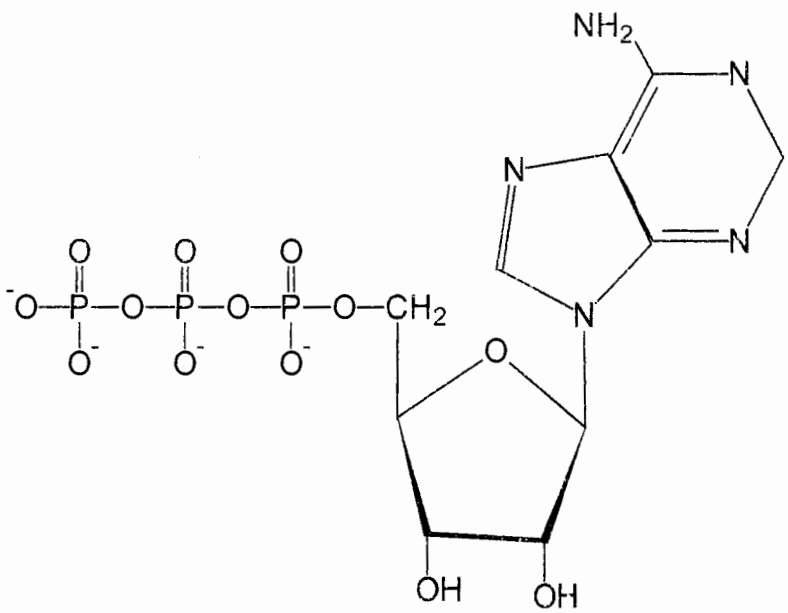
i) carbohydrates
ii) proteins
iii) lipids

b) Using chemical formulae and the names give examples of the compounds belonging to the following classes of compounds: [8]

i) esters
ii) alkanes
iii) aldehydes
iv) carboxylic acids

c) Give and describe the four levels of protein structure. Using examples of your choice define the functions of each of the levels in body. [5]

d) Define the role of Adenosine triphosphate, ATP, in the body.[6]




ATP

# NORMAL LABORATORY VALUES FOR BLOOD TESTS

| | USUAL REFERENCE RANGE | |
|---|---|---|
| Specific Gravity | | 1.056 |
| Hemoglobin Count Hb | | Men: 14 - 18g /dL<br>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<br>Women: 0.15 - 0.46 mmol/L | Men: 3 - 9 mg/dL<br>Women: 2.5 - 7.5 mg/dL<br>Children: 1.5 g/L<br>(150mg/dL) |

# THE PERIODIC TABLE OF ELEMENTS

| 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

$(RT)_{298.15K}$=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 $K^{-1}$ $mol^{-1}$** |
| **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 | $a_o$ | 5.291 77x$10^{-11}$ m |