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

BACHELOR OF SCIENCE IN ENVIRONMENTAL HEALTH SCIENCES

MAIN EXAMINATION PAPER 2017

TITLE OF PAPER	:	INSTRUMENTAL METHODS FOR ENVIRONMENTAL ANALYSIS II
COURSE CODE	:	EHS 224
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
	:	ANSWER **ANY FOUR** QUESTIONS
	:	EACH QUESTION **CARRIES 25** MARKS.
	:	WRITE NEATLY & CLEARLY
	:	NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE EXAMINATION ROOM.
	:	BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION ONE

a. What type of transitions do IR and UV active molecules undergo? Use diagrams to illustrate these transitions. **[6 Marks]**

b. Discuss the effect of the slit width on the resolution of a spectrophotometer and the adherence to Beer's law. **[5 Marks]**

c. State Beer's Law and explain its importance in spectrophotometry. Use appropriate equations to explain **[7 Marks]**

d. Draw a schematic diagram of a flame atomic absorption spectrophotometer. **[7 Marks]**

[Total: 25 Marks]

QUESTION TWO

a. Briefly describe the working principles of refractive and diffractive monochromators. **[10 Marks]**

b. Titanium is reacted with hydrogen peroxide in 1 M sulphuric acid to form a coloured complex. If a 3.31×10^{-3} absorbs 31.5% of the radiation at 415 nm, calculate:

i) The absorbance? **[3 Marks]**

ii) Transmittance and %T for a 6.00×10^{-3} M solution? **[4 Marks]**

c. **List four attributes** of merit when choosing a suitable detector for instrumental methods? **[8 Marks]**

[Total: 25 Marks]

QUESTION THREE

a. Discuss the advantage(s) of the internal calibration method over external calibration method? **[6 Marks]**

b. Explain how flame temperature affects the sensitivity of a flame atomic absorption spectrophotometer. **[5 Marks]**

c. Why is the nebulization of liquid samples important in atomic absorption spectrophotometry? **[3 Marks]**

d. Draw and label a hollow cathode lamp. **[6 Marks]**

e. What is the function of the reference beam in a double beam AAS instrument?

[5 marks]

[Total: 25 Marks]

QUESTION FOUR

a. What are the implications of having a signal to noise ratio of 1 for a given signal? **[6 Marks]**

b. Outline the sample preparation steps for the analysis of a solid sample using IR spectroscopy. **[7 Marks]**

c. Explain the term deviation from Beer's law and list the different types of deviations **[6 Marks]**

d. What are the possible causes for signal suppression/ amplification in instrumental analysis? Suggest possible corrective measures for each scenario. **[6 Marks]**

[Total: 25 Marks]

QUESTION FIVE

a. The molar absorptivity of aqueous solutions of *o*-nitrophenol at 345 nm is 6.17×10^{-1} L cm^{-1} mol^{-1}. Calculate the permissible range of *o*-nitrophenol concentrations if the transmittance is to be less than 78% and greater than 7%. Assume measurements are made in a 1.5 cm cuvette. **[8 Marks]**

b. What is the relationship between absorbance and transmittance in absorption spectrophotometry? **[3 Marks]**

c. Obtain an expression that relates the two terms in (b). **[2Marks]**

d. For each of the following spectral regions, suggest an appropriate monochromator and state the reasons for each choice

(i) Microwave

(ii) IR

(iii) Visible

(iv) X-ray **[12 Marks]**

[Total: 25 Marks]

General data and fundamental constants

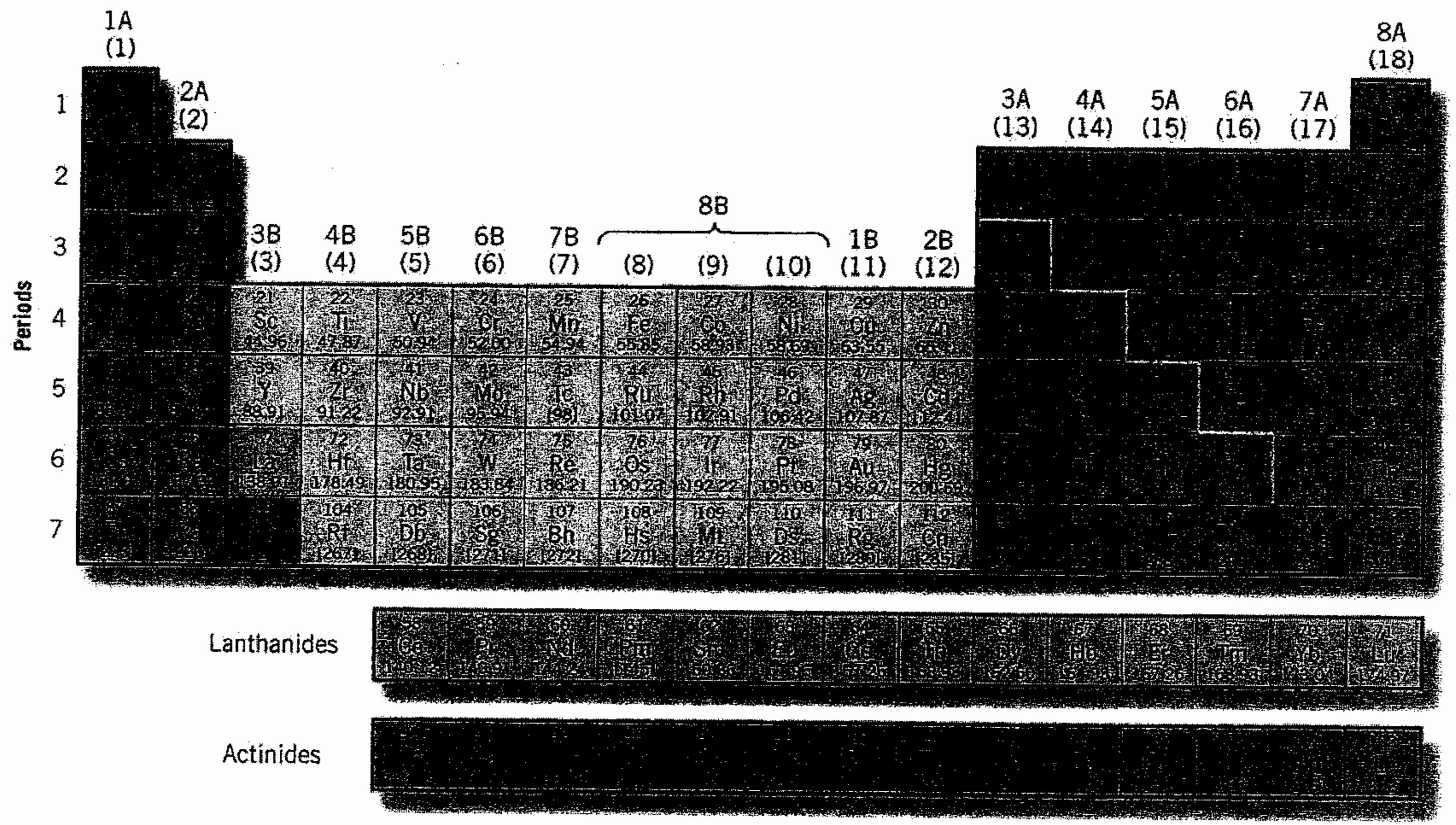
Quantity	Symbol	Value
Speed of light	c	$2.997\ 924\ 58 \times 10^{8}$ m s^{-1}
Elementary charge	e	$1.602\ 177 \times 10^{-19}$ C
Faraday constant	$F = N_A e$	9.6485×10^{4} C mol^{-1}
Boltzmann constant	k	$1.380\ 66 \times 10^{-23}$ J K^{-1}
Gas constant	$R = N_A k$	$8.314\ 51$ J K^{-1} mol^{-1}
		$8.205\ 78 \times 10^{-2}$ 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
	$\hbar = h/2\pi$	$1.054\ 57$ X-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	$\varepsilon_o = 1/c^2\mu_o$	$8.854\ 19 \times 10^{-12}$ J^{-1} C^{2} m^{-1}
	$4\pi\varepsilon_o$	$1.112\ 65 \times 10^{-10}$ J^{-1} C^{2} m^{-1}
Vacuum permeability	μ_o	$4\pi \times 10^{-7}$ 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	$a_o = 4\pi\varepsilon_o\hbar/m_e e^2$	$5.291\ 77 \times 10^{-11}$ m
Fine-structure constant	$\alpha = \mu_o e^2 c/2h$	$7.297\ 35 \times 10^{-3}$
Rydberg constant	$R_\infty = m_e e^4/8h^3 c\varepsilon_o^2$	$1.097\ 37 \times 10^{7}$ 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)
3B (3)
4B (4)
5B (5)
6B (6)
7B (7)
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(8)
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1B (11)
2B (12)
3A (13)
4A (14)
5A (15)
6A (16)
7A (17)
8A (18)
Periods
1
2
3
4
5
6
7
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Y
Zr
Nb
Mo
Tc
Ru
Rh
Pd
Ag
Cd
La
Hf
Ta
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Hs
Mt
Ds
Rg
Cn
Lanthanides
Actinides