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

BACHELOR OF SCIENCE IN ENVIRONMENTAL HEALTH SCIENCES

RESIT 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. Describe the basic design difference between a spectrophotometer for absorption measurements and one for emission studies. **[8 Marks]**

b.

c. A solution containing a complex formed between Bi(III) and thiourea has a molar absorptivity of 9.32×10^3 $Lcm^{-1}mol^{-1}$ at 470 nm.

(i) What is the absorbance of 3.15×10^{-4} M solution of the complex at 470 in a 0.5 cm cuvette? **[5 Marks]**

(ii) What is the %T of the solution in (i)? **[6 Marks]**

(iii) What is the molar concentration of the complex solution that has the absorbance described in (i) when measured at 470 nm in a 2.5 cm cuvette? **[6 Marks]**

[Total: 25 Marks]

QUESTION TWO

a. Differentiate between continuum source background correction and pulsed hollow cathode lamp background correction. **[5 Marks]**

b. Briefly describe the working principle of diffraction gratings as monochromators. **[5 Marks]**

c. What is meant by 'deviations from Beer's Law?' How can stray radiations cause these deviations? **[7 Marks]**

d. Why is the nebulization of liquid samples important in AAS? **[3 Marks]**

e. Draw and label hollow cathode lamp. **[5 Marks]**

QUESTION THREE

a. Outline the operating principles of a flame atomic absorption spectrophotometer. **[8 Marks]**

b. Why is atomic emission more sensitive to flame instability than atomic absorption? **[6 Marks]**

c. What is the function of the reference beam in a double beam AAS instrument? **[5 marks]**

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

QUESTION FOUR

a. Why are high resolution monochromators found in in ICP atomic emission than in flame atomic absorption? **[5 Marks]**

b. Discuss the working principle of diffraction gratings. **[5 Marks]**

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

d. Describe an ideal detector for spectrophotometry. **[8 Marks]**

[Total: 25 Marks]

QUESTION FIVE

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

b. Evaluate the missing quantities in the table below. Where needed, use 185 g/mol for the molar mass of the analyte.

	A	$\%T$	a ($cm^{-1}ppm^{-1}$)	b (cm)	Concentration c	
					M	ppm
(i)		44.9	0.0258		1.35×10^{-4}	
(ii)		39.6	0.0912			1.76
(iii)	0.798			1.50		33.6
(iv)	0.179			1.00	7.19×10^{-5}	

[12 Marks]

c. Outline the sample preparation steps for the analysis of a metals in a biological sample. **[8 Marks]**

[Total: 25 Marks]

General data and fundamental constants

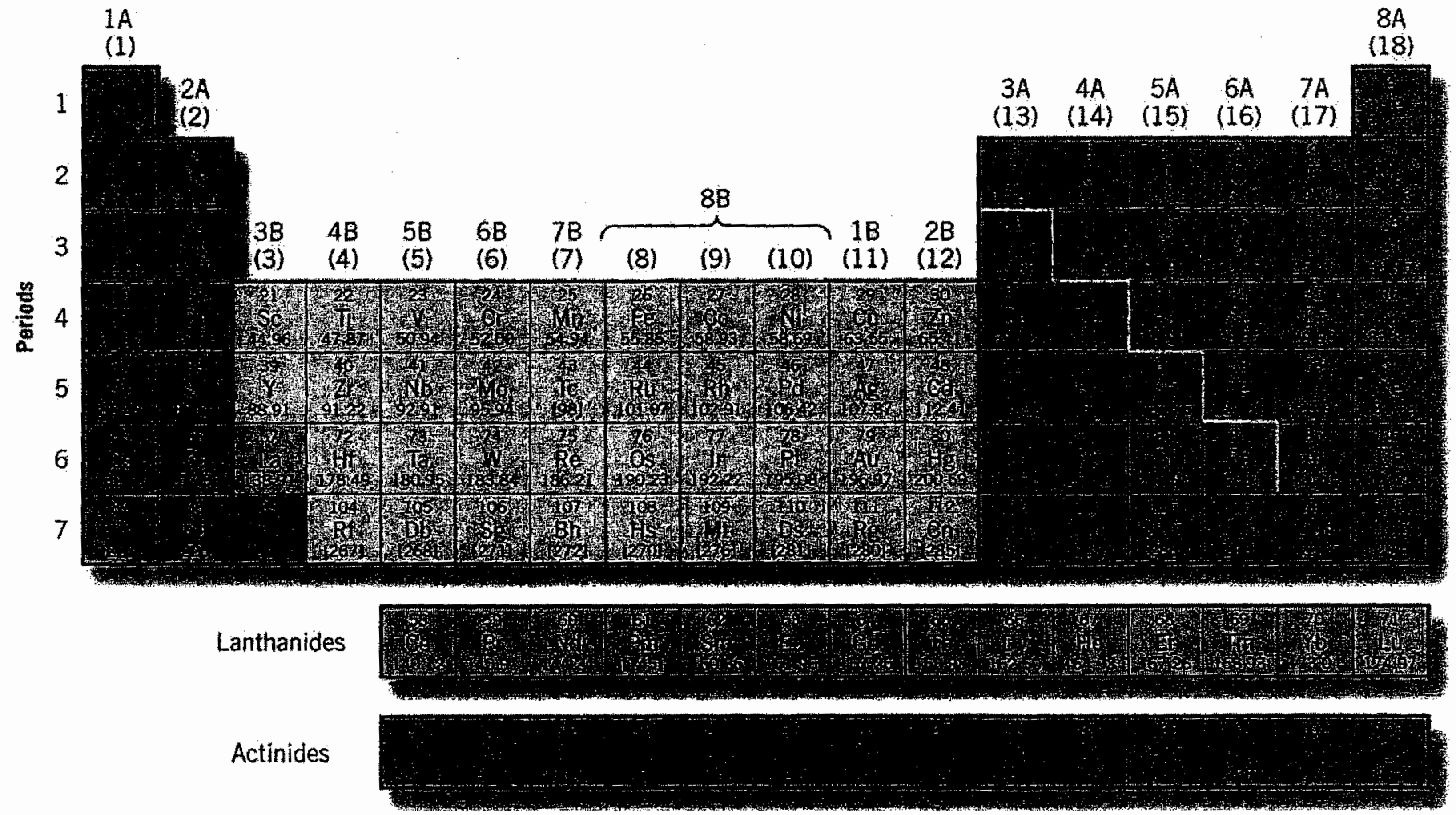
Quantity	Symbol	Value
Speed of light	c	$2.997\,924\,58 \times 10^{8}$ m s^{-1}
Elementary charge	e	$1.602\,177 \times 10^{-19}$ C
Faraday constant	$F = N_A e$	9.6485×10^{4} C mol^{-1}
Boltzmann constant	k	$1.380\,66 \times 10^{-23}$ J K^{-1}
Gas constant	$R = N_A k$	$8.314\,51$ J K^{-1} mol^{-1}
		$8.205\,78 \times 10^{-2}$ 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
	$\hbar = h/2\pi$	$1.054\,57 \times 10^{-34}$ 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	$\varepsilon_o = 1/c^2\mu_o$	$8.854\,19 \times 10^{-12}$ 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)
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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
Hf Ta W Re Os Ir Pt Au Hg
Rf Db Sg Bh Hs Mt Ds Rg Cn
Lanthanides
Actinides