UNIVERSITY OF SWAZILAND
SECOND SEMESTER EXAMINATION 2007/2008

TITLE OF PAPER	:	**Instrumental Methods For Environmental Analysis - 2**
COURSE NUMBEER	:	**EHS 574**
TIME ALLOWED	:	**Three(3) Hours**
INSTRUCTIONS	:	**Answer any four (4) questions. Each question carries 25 marks.**

A periodic table and other useful data have been provided with this paper.

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Question 1(25 marks)

(a) For the following atomic spectroscopic methods, state whether it is emission or absorption, and give the analytical ~~s~~signal/quantity measured in each case.

(i) FES, (ii) FAAS, (iii) EAAS. (iv) ICP. [4]

(b) State the difference in the instrumental setup of FASS and FES. [2]

(c) What is a 'hollow cathode lamp' in FASS? [2]

(d) For the 'hollow cathode lamp' of FASS:
- (i) With the aid if a diagram in addition, describe its configuration. [6]
- (ii) Discuss the working principles. [8]
- (iii) What is the essence(importance), of the cup-like nature of the cathode? [1]
- (iv) What are the limitations of multi-element hollow cathode lamps? [2]

Question 2(25 marks)

(a) For the EAAS technique :
- (i) With an additional illustrative diagram, describe the design of the electrothermal furnace. [5]
- (ii) Discuss the three main steps/processes involved in the atomization of an analyte in an electrotheral furnace. [7]
- (iii) What is the essence of using a matrix modifier during EAAS analysis? Give an example of a matrix modifier and the elemental analysis for which it is employed. [3]
- (iv) State two functions of the inert gass that flows through the furnace during an EAAS analysis.
- (v) Give four advantages and two disadvantages of EAAS over FAAS. [6]

(b) In each of the following pairs of atomic spectroscopic methods, identify the one that has better sensitivity:

(i) FES & AFS (ii) FAAS & EAAS
(iii) FES & EAAS.

Question 3(25 marks)

(a) In gas chromatography (GC) what is column efficiency? How is its value affected by N, the number of theoretical plates, and H, the plate height? What other factors affect it? [5]

(b) What is temperature programming in GC? Use graphical illustration toshow how it affects the resolution, R_o the retention time, t_r and the number of solutes eluded during a GC analysis. [5]

(c) What are the functions and the ideal properties of the liquid stationary phase for GC analysis? [5]

(d) Give four general applications of 'Gas Chromatographic analysis'. Give an example of an industry in Swaziland where this method is being used on routine bases. [5]

Question 4(25 marks)

(a) Define the following chromatographic terms:
  (i) Retention time, t_R
  (ii) Retention volume, V_R [2]

(b) Using an illustrative chromatogram, discuss how chromatographic methods can be employed for both quantitative and qualitative analysis of a sample. [6]

(c) Draw and label the schematic diagram of a 'Gas Chromatographic'(GC) [5]

(d) For the GC, discuss
  (i) The main features of a packed column. [4]
  (ii) The function and the ideal properties of the solid support for the column. [4]
  (iii) The function and ideal properties of the liquid for the column. [4]

Question 5(25 marks)

(a) Distinguish between 'Thin Layer Chromatography' (TLC) and 'Paper Chromatography' from the following points of view:

(i) The nature of the mobile phase.
(ii) The nature of the stationary phase.
(iii) Resolution and sensitivity. [8]

(b) Define R_f value, with regards to qualitative analysis in planar chromatography. [2]

(c) For the analysis of a polar substance using the TLC method, give a brief procedure for the :

(i) TLC plate preparation [8]
(ii) Identification of the separated components on the TLC plate. [7]

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	$F = eN_A$	9.6485×10^{4} C mol^{-1}
Boltzmann constant	k	$1.380\,66 \times 10^{-23}$ J K^{-1}
Gas constant	$R = kN_A$	$8.314\,51$ J K^{-1} mol^{-1}
		$8.205\,78 \times 10^{-2}$ dm^3 atm K^{-1} mol^{-1}
		62.364 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 of 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 permeability†	μ_0	$4\pi \times 10^{-7}$ J s^2 C^{-2} m^{-1}
		$4\pi \times 10^{-7}$ T^2 J^{-1} m^3
Vacuum permittivity	$\varepsilon_0 = 1/c^2\mu_0$	$8.854\,19 \times 10^{-12}$ J^{-1} C^2 m^{-1}
	$4\pi\varepsilon_0$	$1.112\,65 \times 10^{-10}$ J^{-1} C^2 m^{-1}
Bohr magneton	$\mu_B = e\hbar/2m_e$	$9.274\,02 \times 10^{-24}$ J T^{-1}
Nuclear magneton	$\mu_N = e\hbar/2m_p$	$5.050\,79 \times 10^{-27}$ J T^{-1}
Electron g value	g_e	$2.002\,32$
Bohr radius	$a_0 = 4\pi\varepsilon_0\hbar^2/m_e e$	$5.291\,77 \times 10^{-11}$ m
Rydberg constant	$R_\infty = m_e e^4/8h^3c$	$1.097\,37 \times 10^{5}$ cm^{-1}
Fine structure constant	$\alpha = \mu_0 e^2 c/2h$	$7.297\,35 \times 10^{-3}$
Gravitational constant	G	$6.672\,59 \times 10^{-11}$ N m^2 kg^{-2}
Standard acceleration of free fall†	g	$9.806\,65$ m s^{-2}

† Exact (defined) values

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}

PERIODIC TABLE OF ELEMENTS

GROUPS

Atomic mass
Symbol
Atomic No.

TRANSITION ELEMENTS

PERIODS	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1.008 H 1																	4.003 He 2
2	6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.180 Ne 10
3	22.990 Na 11	24.305 Mg 12											26.982 Al 13	28.086 Si 14	30.974 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
4	39.098 K 19	40.078 Ca 20	44.956 Sc 21	47.88 Ti 22	50.942 V 23	51.996 Cr 24	54.938 Mn 25	55.847 Fe 26	58.933 Co 27	58.69 Ni 28	63.546 Cu 29	65.39 Zn 30	69.723 Ga 31	72.61 Ge 32	74.922 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
5	85.468 Rb 37	87.62 Sr 38	88.906 Y 39	91.224 Zr 40	92.906 Nb 41	95.94 Mo 42	98.907 Tc 43	101.07 Ru 44	102.91 Rh 45	106.42 Pd 46	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.75 Sb 51	127.60 Te 52	126.90 I 53	131.29 Xe 54
6	132.91 Cs 55	137.33 Ba 56	138.91 *La 57	178.49 Hf 72	180.95 Ta 73	183.85 W 74	186.21 Re 75	190.2 Os 76	192.22 Ir 77	195.08 Pt 78	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.2 Pb 82	208.98 Bi 83	(209) Po 84	(210) At 85	(222) Rn 86
7	223 Fr 87	226.03 Ra 88	(227) **Ac 89	(261) Rf 104	(262) Ha 105	(263) Unh 106	(262) Uns 107	(265) Uno 108	(266) Une 109	(267) Uun 110								

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*Lanthanide Series	140.12 Ce 58	140.91 Pr 59	144.24 Nd 60	(145) Pm 61	150.36 Sm 62	151.96 Eu 63	157.25 Gd 64	158.93 Tb 65	162.50 Dy 66	164.93 Ho 67	167.26 Er 68	168.93 Tm 69	173.04 Yb 70	174.97 Lu 71
**Actinide Series	232.04 Th 90	231.04 Pa 91	238.03 U 92	237.05 Np 93	(244) Pu 94	(243) Am 95	(247) Cm 96	(247) Bk 97	(251) Cf 98	(252) Es 99	(257) Fm 100	(258) Md 101	(259) No 102	(260) Lr 103

( ) indicates the mass number of the isotope with the longest half-life.