

UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION 2014/2015

TITLE OF PAPER : CHEMISTRY FOR HEALTH AND ENVIRONMENTAL SCIENCES

COURSE CODE : HSC106

TIME : THREE (3) HOURS

TOTAL MARKS : 100 MARKS

EXAMINER : DR. J. M. THWALA

**INSTRUCTIONS : ANSWER ALL QUESTIONS FROM SECTION A
(TOTAL 40 MARKS) AND ANY TWO QUESTIONS FROM
SECTION B (EACH QUESTION IS 30 MARKS AND A TOTAL
OF 60 MARKS)**

NON-PROGRAMMABLE ELECTRONIC CALCULATORS MAY BE USED.

USE THE ANSWER SHEET IS PROVIDED FOR ANSWERING SECTION A

**A PERIODIC TABLE AND OTHER USEFUL DATA HAVE BEEN PROVIDED WITH THIS
EXAMINATION PAPER**

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

SECTION A

MULTIPLE CHOICE [40 MARKS]

Indicate the best option for each of the following multiple choice questions:

- What is the chemical symbol of iron?
(A) I (B) Fe (C) Ir (D) In (E) F
- Which of the following has 17 protons, 18 neutrons, and 18 electrons?
(A) $^{32}\text{S}^{2-}$ ($Z = 16$) (B) ^{40}Ar ($Z = 18$) (C) ^{18}Si ($Z = 14$)
(D) $^{35}\text{Cl}^-$ ($Z = 17$) (E) $^{41}\text{P}^{3-}$ ($Z = 15$)
- The simplest alkyne is _____.
(A) ethylene (B) ethane (C) acetylene (D) propyne
(E) propene
- An example of a chemical property is
(A) chlorine melts at -101°C .
(B) chlorine requires energy to boil.
(C) chlorine burns in hydrogen to form hydrogen chloride.
(D) chlorine liberates energy when it freezes.
(E) chlorine is green-yellow in colour.
- If the molar mass of Ni is 58.71 g/mol, what mass contains 3.022 moles Ni?
(A) 177.4 g (B) 88.70 g (C) 29.48 g (D) 51.47 g (E) 19.43 g
- Calcium, Ca, reacts with water, H_2O , to form calcium hydroxide, $\text{Ca}(\text{OH})_2$, and hydrogen, H_2 . In the balanced equation for this reaction, what is the coefficient of hydrogen?
(A) 1 (B) 2 (C) 3 (D) 5 (E) $\frac{1}{2}$
- An electron in a hydrogen atom has the quantum numbers $n = 4$, $l = 3$, $m_l = 0$. In what type of orbital is the electron located?
(A) 4p (B) 4f (C) 4s (D) 4d (E) 3d
- Alkenes have the general formula _____.
(A) C_nH_{2n} (B) $\text{C}_n\text{H}_{2n-2}$ (C) $\text{C}_n\text{H}_{2n+2}$ (D) C_nH_n (E) $\text{C}_n\text{H}_{2n+1}$
- An electron in an atom has a magnetic quantum number, m_l of -2 . What is the lowest possible value for the principal quantum number, n , of this electron?
(A) -2 (B) 3 (C) 2 (D) 1 (E) -1
- What four quantum numbers are permissible for a 3d-electron? The answers are expressed as (n, l, m_l, m_s) .

- (A) $(3, 0, 0, -\frac{1}{2})$ (B) $(3, 2, 2, 1)$ (C) $(3, 2, 2, -\frac{1}{2})$
 (D) $(2, 1, 0, +\frac{1}{2})$ (E) $(3, 1, -1, +\frac{1}{2})$
11. What is the ground state electron configuration of a bromine atom?
 (A) $[\text{Ar}]3d^{10}4s^24p^2$ (B) $[\text{Ar}]3d^{10}4s^24p^6$
 (C) $[\text{Ar}]3d^{10}4s^24p^5$ (D) $[\text{Ar}]3d^{10}4s^24p^3$
 (E) $[\text{Ar}]3d^{10}4s^24p^4$
12. What is the electron configuration of the Fe^{2+} ion?
 (A) $[\text{Ar}]3d^54s^2$ (B) $[\text{Ar}]3d^5$ (C) $[\text{Ar}]3d^6$
 (D) $[\text{Ar}]3d^54s^1$ (E) $[\text{Ar}]3d^44s^2$
13. One liter of 1.0 M K_3PO_4 solution contains which of the following?
 (A) One mole of potassium ions (B) One mole of oxygen atoms
 (C) One mole of phosphorus atoms (D) No ions
 (E) Four moles of phosphate ions
14. An alkane used primarily for heating purposes is _____.
 (A) methane (B) ethane (C) octane (D) decane (E) hexane
15. Which of the following structures is a secondary alcohol?
 (A) CH_3OH (B) $\begin{array}{c} \text{CH}_3\text{-CH-CH}_3 \\ | \\ \text{OH} \end{array}$
 (C) $\text{CH}_3\text{-O-CH}_2\text{-CH}_3$ (D) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{-CH-CH}_3 \\ | \\ \text{OH} \end{array}$
 (E) $\text{CH}_3\text{CH}_2\text{OH}$
16. The ion involved in the contraction of the heart is _____.
 (A) Na^+ (B) K^+ (C) Fe^{2+} (D) Mg^{2+} (E) Zn^{2+}
17. $50 \mu\text{g} =$ _____ mg
 (A) 0.050 (B) 0.50 (C) 5.0 (D) 50 (E) 0.0050
18. An example of a mixture is

- (A) water (B) air (C) iron (D) sand (E) salt
19. The oxidation number of S in H_2SO_4 is _____.
 (A) 2 (B) 4 (C) 5 (D) 8 (E) 6
20. Using the following balanced equation:

$$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$$
 How many grams of water will be produced from 2 moles of H_2 ?
 (A) 9 (B) 18 (C) 72 (D) 36 (E) 27
21. How many milliliters of 10% NaCl solution will be used to prepare 400 mL of a 1% solution?
 (A) 10 (B) 40 (C) 100 (D) 400 (E) 4
22. The compound CH_3COCH_3 is
 (A) an ester (B) a ketone (C) an ether
 (D) an aldehyde (E) an alcohol
23. A combination of sand, salt, and water is an example of a _____.
 (A) homogeneous mixture (B) compound (C) solid
 (D) pure substance (E) heterogeneous mixture
24. Which of the following alkali metals reacts most violently with water?
 (A) Cs (B) Rb (C) K (D) Na (E) Li
25. Express the following addition to the correct degree of precision.

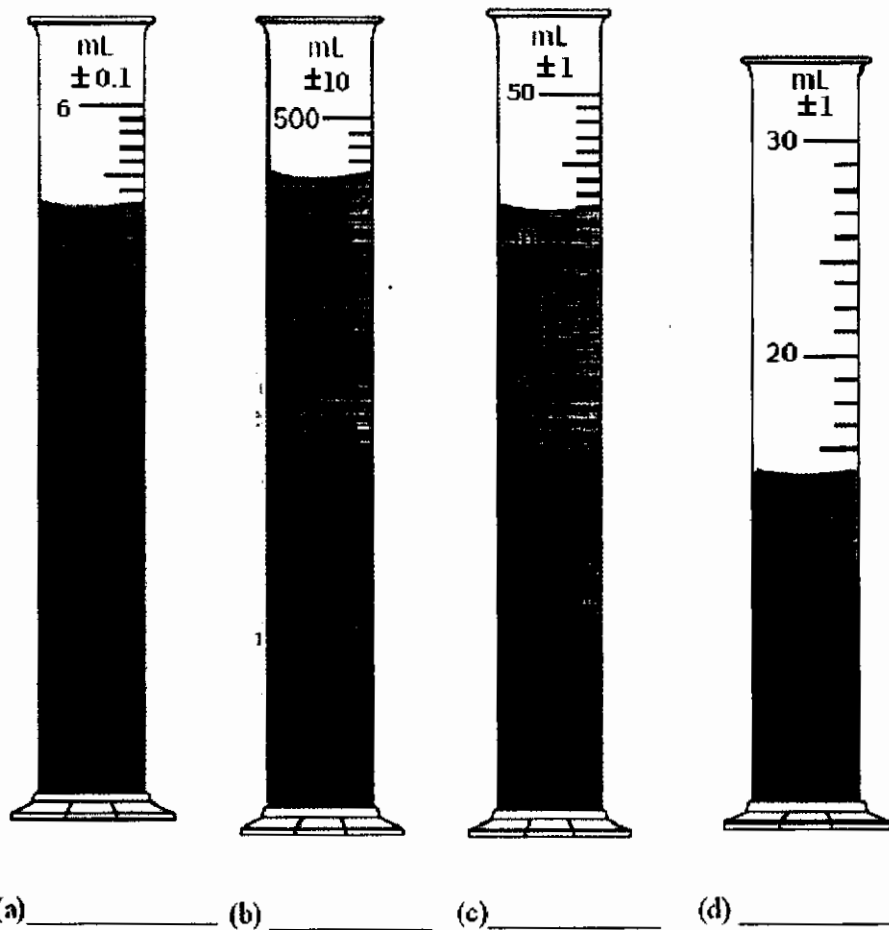
$$2.234 + 0.01 =$$
 (A) 2 (B) 2.244 (C) 2.250 (D) 2.25 (E) 2.24
26. How many grams of Fe_2O_3 can be formed from 6.50 moles of Fe?

$$4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$$
 (A) 12.3 (B) 1.04×10^3 (C) 5.19
 (D) 2.08×10^3 (E) 653
27. How much Fe can be produced if 100 g Fe_2O_3 and 100 g CO are mixed and react?

$$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$$
 (A) 297.9 g (B) 35.0 g (C) 147 g (D) 70.0 g (E) 200 g
28. 19.9 g H_2O are formed when 45.0 g $\text{Mg}(\text{OH})_2$ react with excess HCl. What is the percentage yield of H_2O ?

$$\text{Mg}(\text{OH})_2 + 2\text{HCl} \rightarrow 2\text{H}_2\text{O} + \text{MgCl}_2$$
 (A) 69.8% (B) 71.6% (C) 44.2% (D) 34.9% (E) 100%
29. How many grams of NaNO_3 are required to prepare 125 mL of 3.00 M NaNO_3 ?
 (A) 31.9 g (B) 46.1 g (C) 227 g (D) 3.54 g (E) 28.3 g

30. Convert the following figures to the unit indicated 2.02 kg/L pg/ml
 (A) 2.02×10^{15} (B) 2.02×10^{-12} (C) 2.02×10^{-9} (D) 2.02×10^{-15}
 (E) 2.02×10^{12}
31. Calculate the following and express your answer to the correct degree of precision.
 $4.6742 \text{ g} \div 0.00371 \text{ L}$
 (A) $1.26 \times 10^3 \text{ g/L}$ (B) $1.26 \times 10^3 \text{ g}$ (C) $1.259 \times 10^3 \text{ g/L}$ (D) 1.26 L
 (E) 1259.89 g/l
32. Calculate the following and express your answer to the correct degree of precision.
 $\frac{3.41 \text{ g} - 0.02310 \text{ g}}{5.2331 \text{ ml}} * 0.2051 \text{ ml} =$
 (A) 133 g (B) 133.00 g (C) 0.133g (D) 0.001 g
 (E) 0.13 g
33. What is the derived unit for pressure ?
 (A) kg/ms (B) $\text{kgm}^{-1}\text{s}^{-2}$ (C) kgms^{-1} (D) Nm^{-1}
 (E) kgm/s
34. Determine the derived SIU units for Density
 (A) g/ml (B) kgm^{-3} (C) gcm^{-3} (D) kgcm^{-3}
 (E) kg/ml
35. The temperature of a sample of water from Mbabane river was taken by an environmentalist Alicia and obtained a reading of 134 °F. What is the reading in Kelvin
 (A) 432 (B) 56.7 (C) 329 (D) 298
 (E) 407
36. Replicate measurements for the concentration of cadmium in waste water gave 33.5 g/ml, 35.2 g/ml, 34.7 g/ml, 30.4 g/ml and 40 g/ml. What is the percentage relative standard deviation of the sample ?
 (A) 10 % (B) 34.8 % (C) 5 %
 (D) 3.5 % (E) 9.1 %
37. What are the correct reading for instrument (a) below



- (A) 5.3 ± 0.1 (B) 5.1 ± 0.1 (C) 4.1 ± 0.1
 (D) 4.3 ± 0.1 (E) 5.30 ± 0.01

38. Estimate the % relative error in the readings given in 36(b) above

- (A) 21.73 % (B) 2.17 % (C) 2.27 %
 (D) 4.5 % (E) 5.3 %

39. Estimate the following % relative standard deviation in the readings given in 36(c).

- (A) 5.2 % (B) 7.1 % (C) 14 %
 (D) 2.3 % (E) 1.9 %

40. What type of error is in instrument 36 (c) above?

- (A) random (B) systematic (C) indeterminate
 (D) accuracy (E) personal

SECTION B

ANSWER ANY TWO QUESTIONS

QUESTION 1 [30 MARKS]

- (a) Briefly define the following terms [12]
- (i) Pauli's principle
 - (ii) Agfbau building-up principle
 - (iii) An Element
- (b) (i) Classify each of the following changes as physical or chemical:
- (1) The metal used in artificial hip-joint implants is not corroded by body fluids. [2]
 - (2) An antacid tablet is dissolved in water. [2]
- (ii) A 175 lb patient is to undergo surgery and will be given an anaesthetic intravenously. The safe dosage of anaesthetic is 12 mg/kg of body weight. Determine the maximum dose of anaesthetic in mg that should be used using the correct degree of precision (number of digits). [2]
- Note: 1 lb = 0.4536 kg*
- (c) (i) Creatinine is a substance found in the blood. An analysis of a blood serum sample detected 1.1 mg of creatinine. Express this amount in grams. [2]
- (ii) A hypodermic syringe was used to deliver 5.0 ml of alcohol into an empty container that had a mass of 25.12 g when empty. The container with the alcohol sample weighed 29.08 g. Calculate the density of the alcohol using the correct degree of precision (number of digits). [3]
- (iii) A 3.455 g sample of a mixture was analysed for barium ion, Ba^{2+} , by adding a small excess of sulphuric acid, H_2SO_4 , to an aqueous solution of the sample. The resultant reaction produced a precipitate of barium sulphate, BaSO_4 , which was collected by filtration, washed, dried and weighed. If 0.2815 g of the barium sulphate was obtained, what was the mass percentage of barium in the sample? [4]
- (d) (i) Calculate the atomic weight of chlorine, given that the naturally occurring element consists of 75.53% chlorine-35 (mass = 34.97 amu) and 24.47% chlorine-37 (mass = 36.97 amu). [3]

Question 2 [30 Marks]

- (a) Briefly discuss the differences between following pairs of terms.
- (i). Compounds and Mixtures [4]
 - (ii). Colloids and solutions [4]
 - (iii). Law of Multiple Proportions and Law of Conservation of Mass [4]
- (b) Which of the following events are chemical changes and which ones are physical changes.
- (1) When heated in a pan, sugar turns brown (caramelizes). [1]
 - (2) When stirred in water, table salt seems to disappear. [1]
 - (3) A bleaching agent causes a coloured fabric to lose its colour. [1]
 - (4) A silver fork tarnishes slowly in air. [1]
- (c) Define the Daltons' Atomic Theory. In your answer, using an example of your choice, explain the flaws (problem) with this theory. [5]
- (d) Given that the natural abundance of oxygen isotopes: ^{16}O is 99.76%, ^{17}O is 0.04% and ^{18}O is 0.20%, Calculate the relative atomic weight (in g/mole) of oxygen. [2]
- (e) Methane and propane are both constituents of natural gas. A sample of methane contains 5.70 g of carbon atoms and 1.90 g of hydrogen atoms combined in a certain way, whereas as a sample of propane contains 4.47 g of carbon atoms and 0.933 g of hydrogen atoms combined in a different way. Prove that the two compounds obey the Law of Multiple Proportions. [2]
- (f) Identify and match the correct elements of K, F, Pb, Fe, Au, P, S, Cl, Na and As represented by the pictures below: [5]



- (i)----- (ii)..... (iii) (iv)..... (v).....

QUESTION 3 [30 MARKS]

- a) i) Define a buffer solution [5]
ii) Name three kinds of buffers found in the body. [6]
- b) Briefly discuss any one of the following: [8]
i) Respiratory Acidosis
ii) Metabolic Acidosis

In your discussion include the cause, the symptoms and the treatment.

- c) A 28 year old homeless man is rushed to Mbabane Clinic. He is comatose and in respiratory depression. The emergency department nurse recognizes this patient as having a previous history of drug use including heroin. The arterial blood gases show a pH of 7.21; total CO₂ of 52 mm Hg; and a HCO₃⁻ of 28 mmol/L.
- i) Using the data given diagnose the condition of the patient, giving specific reasons for your diagnoses. [3]
ii) What treatment would you prescribe. [2]

Write short notes on any Two of the following terms:

- i) isotonic solutions [2]
ii) hypotonic solutions [2]
iii) hypertonic solutions [2]

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

Question 4 [30 Marks]

You must use equations and diagrams to clarify your answers in this question.

- a) Define water solvency in terms of bonding to form electrolyte solutions [6].
- b) Define water pollution. [4]
- c) List and describe Three major sources of water pollution. [10]
- d) Explain the difference between permanent and temporary water hardness. [6]
- e) Explain any Two methods of purification. [4]

Question 5 [30 Marks]

a) Give the general chemical formulae for the following major classes of organic compounds. [10]

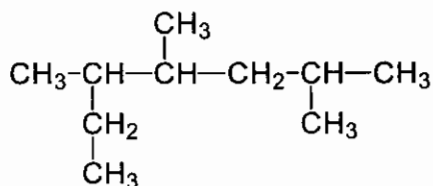
- a) carboxylic acids
- b) aldehydes
- c) alcohols
- d) esters
- e) alkenes

b) Give an example and one general use for each of the following [8]

- (i) Alkane
- (ii) Alkene

b) Name the following organic compounds

a) $\text{CH}_3\text{CH}_2\text{Cl}$ [2]

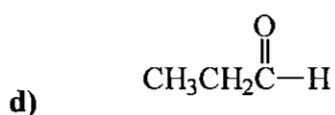


b)

[2]

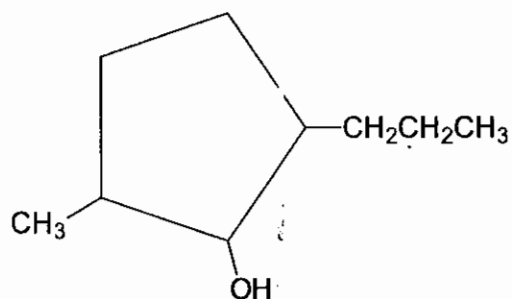
c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ [2]

[2]



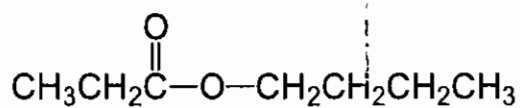
[2]

e)



f)

(2)



[2]

NORMAL LABORATORY VALUES FOR BLOOD TESTS

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

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	VIIA	VIII	VIII	VIII	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	57 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																																							
	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 15%;">Lanthanides</td> <td>57 La 138.9</td> <td>58 Ce 140.1</td> <td>59 Pr 140.9</td> <td>60 Nd 144.2</td> <td>61 Pm 146.9</td> <td>62 Sm 150.9</td> <td>63 Eu 151.3</td> <td>64 Gd 157.3</td> <td>65 Tb 158.9</td> <td>66 Dy 162.5</td> <td>67 Ho 164.9</td> <td>68 Er 167.3</td> <td>69 Tm 168.9</td> <td>70 Yb 173.0</td> </tr> <tr> <td>Actinides</td> <td>89 Ac 227.0</td> <td>90 Th 232.0</td> <td>91 Pa 231.0</td> <td>92 U 238.0</td> <td>93 Np 237.1</td> <td>94 Pu 239.1</td> <td>95 Am 241.1</td> <td>96 Cm 247.1</td> <td>97 Bk 249.1</td> <td>98 Cf 251.1</td> <td>99 Es 254.1</td> <td>100 Fm 257.1</td> <td>101 Md 258.1</td> <td>102 No 255</td> </tr> </table>																		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
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																																		

magnetic flux: $1\text{T}=1\text{Vs m}^{-2}=1\text{JCs m}^{-2}$		current: $1\text{A}=1\text{Cs}^{-1}$		Nuclear magneton	$\mu_N = \frac{e\hbar}{2m_p}$	$5.05079 \times 10^{-27} \text{ JT}^{-1}$					
Prefixes:											
p	n	m	m	c	d	k	M	G	Gravitational constant	G	$6.67259 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$
pico	nano	micro	milli	centi	deci	kilo	mega	giga	Gravitational acceleration	g	9.80665 ms⁻²
10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^3	10^6	10^9	Bohr radius	a_0	$5.29177 \times 10^{-11} \text{ m}$

CANDIDATES' ID NUMBER:.....DATE OF EXAM:.....
 EXAMINATION CENTRE:.....COURSE CODE:.....

Instructions:

- 1) Fill in the correct answers for questions 1-40 by making one cross (X) for each question in the correct grid below. Each question is worth one mark. Total marks are 40.
- 2) No grade will be earned if more than one cross is made for any one question.

SECTION A						<u>Do not write in this column</u>
<i>Fill in the correct answers for questions 1-40 by making <u>one cross (X)</u> for each question in the correct grid below.</i>						
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	
<i>Example</i>				<i>X</i>		
QUESTIONS						
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