Name:……Signature:…….

P525/1
CHEMISTRY
Paper 1
NOVEMBER 2023
2 ¾ hours.

Uganda Advanced Certificate of Education

END OF TERM THREE EXAMINATIONS

S.5 CHEMISTRY

Paper 1
2 hours 45 minutes

INSTRUCTIONS:

Answer **all** questions in this section **A** and **six** questions in section **B**.
All answers must be written in the spaces provided.
The Periodic Table, with relative atomic masses, is attached at the end of the paper.
Mathematical tables (3-figure tables) are adequate or non-programmable scientific electronic calculators may be used.
Illustrate your answers, with equations where applicable.
Where necessary, use the following;

Molar gas constant, R=8.31 $JK^{-1}mol^{-1}$.
Molar volume of a gas at s.t.p is 22.4 litres.
Standard temperature = 273K.
Standard pressure = $101325Nm^{-2}$

For Teachers' Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	**Total**

SECTION A (46 MARKS)

Answer **all** *questions in this section.*

1. (a) Complete the following nuclear reactions and name the particles emitted in each case

(i) $^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{93}Pu +$……

Name of particle; ……

(ii) $^{241}_{95}Am + {}^{4}_{2}He \longrightarrow {}^{243}_{97}Bk +$……

Name of particle; ……

(iii) $^{27}_{14}Si \longrightarrow {}^{27}_{13}Al +$ ……

Name of particle; ……

(b) The mass of a radioisotope, **T**, reduced by 32% in 40 days. Calculate the half life of **T**. (2 ½ marks)

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2. An organic compound, **R** has the structure;

$$CH_3CH = CHC \equiv CH$$

(a) Name the functional groups present in **R**. (01 mark)

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(b) Write equation for the reaction between **R** and:

(i) alkaline potassium manganate(vii) solution. (01 mark)

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(ii) ammoniacal copper(i) chloride solution. (01 mark)

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(c) State what would be observed in (b) (i) and (ii) (02 marks)

(i)

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(ii)

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3. (a) Write an equation for the reaction between hot concentrated sodium hydroxide solution and.

(i) Al_2O_3 (1 ½ marks)

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(ii) Silicon dioxide (1 ½ marks)

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(iii) phosphorus (1 ½ marks)

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(iv) aluminium powder (1 ½ marks)

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4. (a) State three characteristics of an equilibrium reaction ($1\frac{1}{2}$ marks)

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(b) Hydrogen reacts with iodine according to the equation

$$H_{2\ (g)} + I_{2\ (g)} \leftrightharpoons 2H_{(g)}$$

0.2 moles of iodine and 0.3 moles of hydrogen are reacted in a 1dm^3 vessel, the equilibrium was attained and it was found to contain 25.2% hydrogen iodide. Determine the equilibrium concentration **Kc** (03$\frac{1}{2}$ marks)

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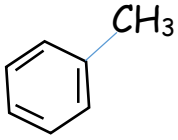
5. (a) Complete the following organic reactions by stating the major organic product in each case.

(i)  $+ \ HBr \longrightarrow$ …… ($\frac{1}{2}$ mark)

(ii) 

$\xrightarrow{Cl_2/uv\ light}$ …… ($\frac{1}{2}$ mark)

(iii) $CH_3CH = CH_2 \xrightarrow[2.\ H_2O/\ warm]{1.\ Conc.\ H_2SO_4}$ …… ….($\frac{1}{2}$ mark)

b) 14cm^3 of a gaseous hydrocarbon **R** with formula C_xH_y was exploded with 121cm^3 of excess oxygen. The residual gas occupied 86cm^3. On treatment with concentrated potassium hydroxide solution, its volume reduced to 30cm^3.

(i) Write equation for the reaction that took place. ($1\frac{1}{2}$ marks)

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(ii) Determine the molecular formula of **R** ($2\frac{1}{2}$ marks)

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(iii) Write the structural formulae and IUPAC names of all possible isomers of **R**. (02 marks)

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6. (a) Define diagonal relationship (01 mark)

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(i) State two properties in which beryllium resembles aluminium

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(ii)State two reasons why beryllium resembles aluminium (01 mark)

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b) State any other pair of elements on a periodic table that exhibit diagonal relationship. (01 mark)

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7. (a) Define the term bond energy (01 mark)

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(b) (i) The standard enthalpy change of formation of silicon(IV) chloride is -160 $kJmol^{-1}$.
The standard enthalpy changes of atomisation of silicon and chlorine are +338 and +122$kJmol^{-1}$ respectively. Use these values to construct a Born-Haber cycle for the formation of silicon(IV) chloride from its elements and indicate the energy changes involved. (02marks)

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(ii) Calculate the average bond energy of the $Si - Cl$ bond (01 mark)

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b) Some bond energies are given below

Bond	**Average bond energy($kJmol^{-1}$)**
$Cl - Cl$	**242**
$C - H$	**435**
$Cl - H$	**431**
$C - Cl$	**339**

Determine the enthalpy change for the reaction below

$$CH_4\,(g) + Cl_2\,(g) \longrightarrow CH_3Cl\,(g) + HCl\,(g)$$

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8. Complete the following reactions and suggest the possible IUPAC mechanism for each reaction.

(a) $CH_3CH = CH_2 \xrightarrow[\textbf{heat}]{\boldsymbol{H^+/H_2O}}$ ($2\frac{1}{2}$ marks)

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(b) $CH_3C \equiv CH \xrightarrow{HBr}$ (03marks)

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$\xrightarrow[heat]{Conc.HNO_3/Conc.\ H_2SO_4}$ ($2\frac{1}{2}$ marks)

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9. (a) Explain what is meant by the term **first election affinity**. (01mark)

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(b) State **two** factors that can affect electron affinity. (01 mark)

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(c) The first electron affinities of some elements of period – 3 are given in the table below

Element	**Al**	**Si**	**P**	**S**
First electron affinity ($KJmol^{-1}$)	– 44	– 134	– 71.7	– 200

(i) State the trend in variation of electron affinities (0 ½ mark)

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(ii) Explain your answer in c (i) above (02mks)

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(d) The thermochemical data for some processes are given below

Process	**$\Delta H^{\theta}(Kjmol^{-1})$**
$Rb(s) \longrightarrow Rb(g)$	+78
$Rb_{(g)} \longrightarrow Rb^{+}(g) + e$	+402
$F_2(g) \longrightarrow 2F(g)$	+160
$Rb^{+}(g) + F^{-}_{(g)} \longrightarrow RbF(s)$	–762
$F_{2(g)} + 2Rb_{(s)} \longrightarrow 2RbF(s)$	–1104

Calculate the electron affinity of the fluorine atom. (3 marks)

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SECTION B: (54 MARKS)

Answer any **six** *questions from this section.*

10. (a) State and explain how the following factors affect the rate of reaction

(i) Temperate (1 ½ marks)

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(ii) Catalyst (1 ½ marks)

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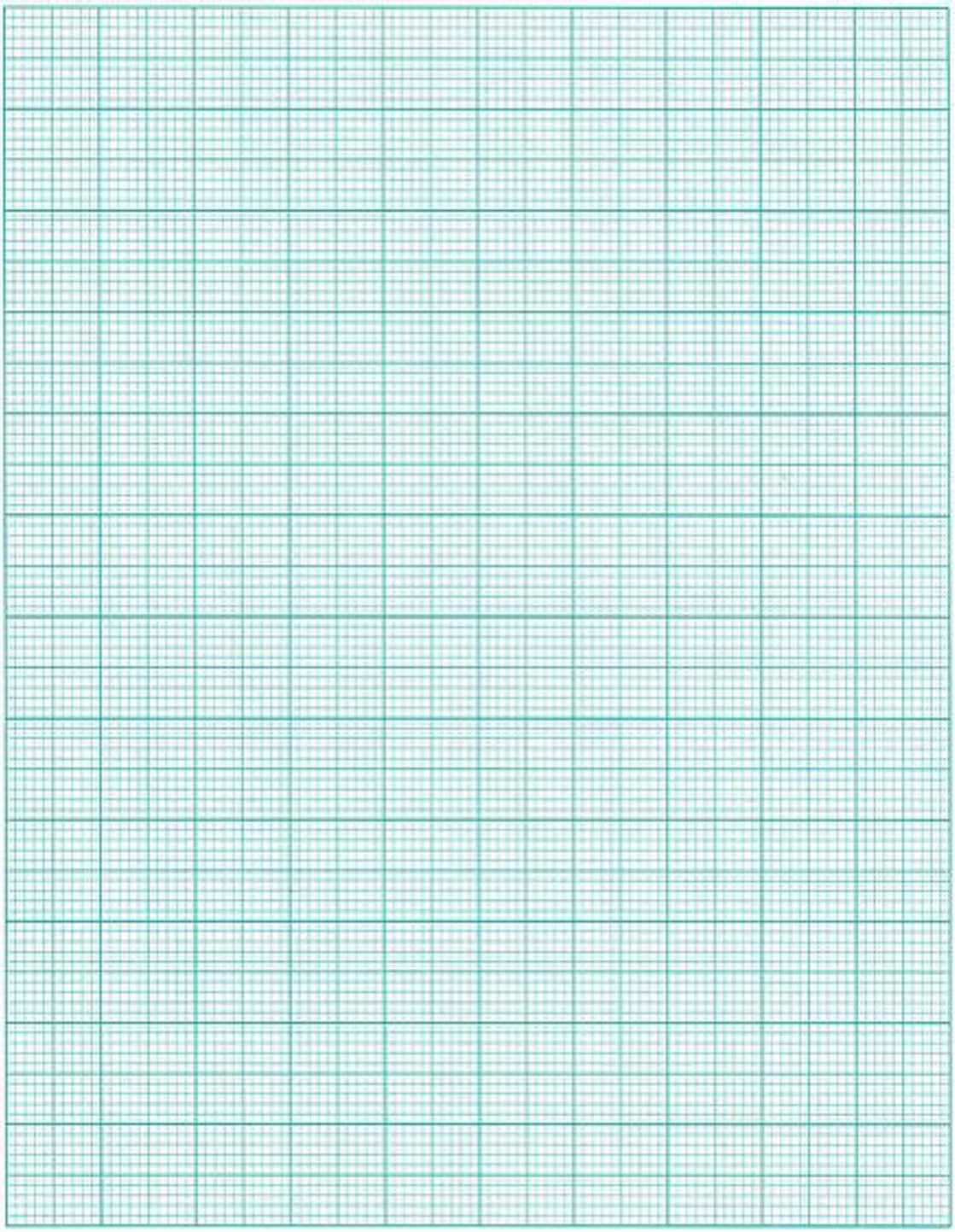
(b) The table below shows the kinetic data obtained for the decomposition of nitrogen (V) oxide dissolved in carbon tetrachloride at 45°C.

Time(s)	0	250	750	1500	2000	2500
$[N_2O_5]$ ($moldm^{-3}$)	2.33	1.95	1.42	0.95	0.70	0.50

Plot a graph of $\log_{10} [N_2O_5]$ against time.



(c)Use the graph in (b) to

(ii) determine the half life of nitrogen (V) oxide (1 ½ marks)

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(ii) deduce order of the reaction and give a reason for your answer.
(1 ½ marks)

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(a) Calculate the rate constant (**K**) for the reaction and indicate its units.
(1 ½ marks)

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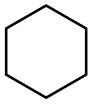
11. Write equations to show how the following compounds can be synthesised. Indicate the condition(s) for the reaction(s).

(a)  from ethyne. (2 ½ marks)

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(b) Benzene from ethene (3 ½ marks)

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(c) CH_3COCH_3 from propan-1-ol (3 ½ marks)

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12. The elements; sodium, magnesium, silicon and Sulphur belong to Period 3 of the Periodic Table.

(a) For each element, write the formula and name the structure of the hydride it forms. (02 marks)

Element	Formula of hydride	Structure
Sodium		
Magnesium		

(b) Describe the reaction of magnesium and silicon with water. Where possible, write equation for reaction. (03 marks)

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(c) Write equation for the reaction that takes place between water and the hydride of;

(i) Sodium (01 mark)

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(ii) Sulphur (01 mark)

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(d) Write equation for the reaction that takes place between hot concentrated sulphuric acid and;

(i) Magnesium (01 mark)

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(ii) Sulphur (01 mark)

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13. (a) What is meant by the following terms

(i) Hydration energy (01 mark)

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(ii) Lattice energy (01 mark)

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(iii) Enthalpy of solution (01 mark)

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(b) State two factors which can affect the magnitude of lattice energy

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c) The lattice hydration energies of salts **RX** and **TX** are given in the table below

Salt	Lattice energy(kjmol^{-1})	Hydration energy (kjmol^{-1})
RX	880	860
TX	790	800

(c) Calculate the enthalpy of solution of each salt

(i) **RX** (02 marks)

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(ii) **TX** (02 marks)

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(ii) Which one of the two salts is more soluble in water at a given temperature? ($0\frac{1}{2}$ mark)

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(iii) Give a reason for your answer in c(ii) above. ($0\frac{1}{2}$ mark)

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14. 1.363g of compound **Y** containing carbon, hydrogen and bromine on complete combustion gave 1.10g of carbon dioxide and 0.45g of water. When 0.35g of **Y** was vapourised, it occupied 39.5cm^3 at 20^{0}c and 750mmHg. Calculate

(i) the empirical formula of **Y**

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(ii)the molecular formula of **Y**

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b) **Y** forms a compound **Z** when treated with a mixture of potassium hydroxide solution and ethanol under reflux.**Z** reacts with ammoniacal silver nitrate solution to form a white precipitate **Q**.

identify;

(i) **Y**

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(ii) Z

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(iii) Q

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c) Write

(i) an equation for the reaction between **Z** and ammoniacal silver nitrate solution

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(ii)the mechanism for the reaction leading to formation of **Z**

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15. (a) Potassium manganate(vii) is **not** a good primary standard in a laboratory.

(i) Define a primary standard (01 mark)

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(ii) State two characteristics of a good primary standard (1 mk)

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(iii) State one advantage of potassium manganate(vii) in volumetric analysis

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(iii) State one disadvantage of using potassium manganate(vii) in volumetric analysis

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b) Potassium manganate(vii) is not acidified using nitric acid neither hydrochloric acid. Explain

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c) Determine the oxidation state of manganese in Manganate(vii) ion

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(ii)Write an equation for the reaction between acidified potassium manganate(vii) solution and hydrogen peroxide solution.

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16. (a). What is meant by **order of reaction?** (01 mark)

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(c). The table below shows some kinetic data for the reaction

$3A + B \rightarrow$ Products

Experiment	**[A] ($moldm^{-3}$)**	**[B] ($moldm^{-3}$)**	**Rate($moldm^{-3}\ s^{-1}$)**
1	**0.2**	**0.2**	**1.2×10^{-8}**
2	**0.2**	**0.6**	**1.2×10^{-8}**
3	**0.4**	**0.6**	**4.8×10^{-8}**

(i). Determine the order of reaction with respect to **A** and **B**

(i) **A** (02 marks)

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(ii) **B** (02 marks)

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(ii).Write the **rate equation** for the reaction. (01 mark)

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(c).Calculate the:

(i). **Overall order of reaction**. (01 mark)

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(ii) **Rate constant** for the reaction and state it's units.(02 marks)

17. Name one reagent that can be used to distinguish between the following pairs of compounds. In each case state what would be observed if each member of the pair is treated with the named reagent.

(a) But-2-yne and But-1-yne

Reagent. (01 mark)

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Observations. (02 marks)

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(b) Propane and propene

Reagent. (01 mark)

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Observations. (02 marks)

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(c) Ba^{2+} and Ca^{2+}

Reagent. (01 mark)

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Observations. (02 marks)

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END.

THE PERIODIC TABLE

1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.4 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 TI 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															

		139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
		227 Ac 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

END.