

Name:Signature:

P525/1
CHEMISTRY
Paper 1
August 2023
2 $\frac{3}{4}$ hours.

Uganda Advanced Certificate of Education
END OF TERM TWO 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, $R=8.31 \text{ JK}^{-1}\text{mol}^{-1}$.

Molar volume of a gas at s.t.p is 22.4 litres.

Standard temperature = 273K.

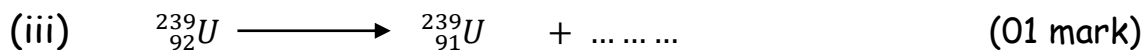
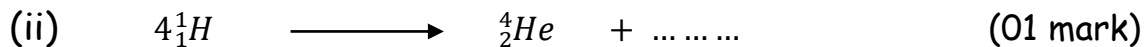
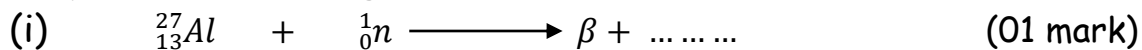
Standard pressure = 101325 Nm^{-2}

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.

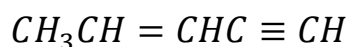
1. (a) Complete the following equations.



b) The half-life of a radioactive element **Z** is 36 years. After how many years will the substance take to decay to 25%. (02 marks)

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



(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 silver nitrate 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 $\frac{1}{2}$ marks)

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(ii) Silicon (1 $\frac{1}{2}$ marks)

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(iii) phosphorus (1 $\frac{1}{2}$ marks)

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(iv) aluminium powder (1 $\frac{1}{2}$ marks)

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4. (a) What is meant by relative abundance?

(01 mark)

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(b) Bromine has two naturally occurring isotopes with isotopic masses and relative abundances as shown below.

Isotopic mass	Relative abundance
79	50.5
81	49.3

- (i) Bromine has two isotopes, **Br-79** and **Br-81**. Write the ion formed on the mass spectrum when the two isotopes combine
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(01 mark)

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- (ii) Calculate the average atomic mass of **bromine**. (03 marks)

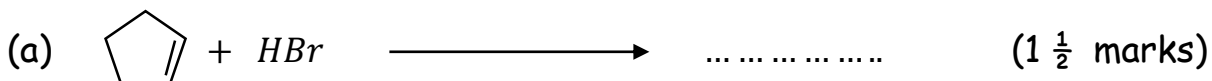
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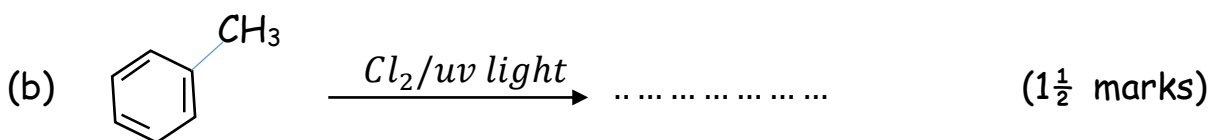
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5. Complete the following organic reactions and name the major organic product in each case.



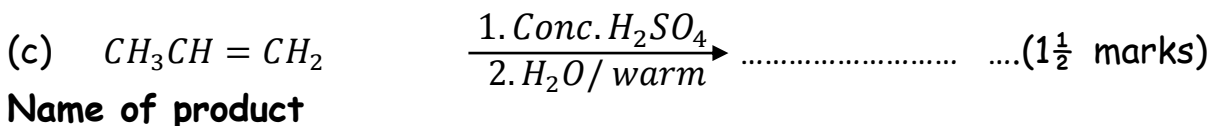
Name of product

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Name of product

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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)

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

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

(a) (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 $+122 \text{ kJmol}^{-1}$ 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)

(ii) Calculate the average bond energy of the $\text{Si} - \text{Cl}$ bond (01 mark)

b) Some bond energies are given below

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

Determine the enthalpy change for the reaction below



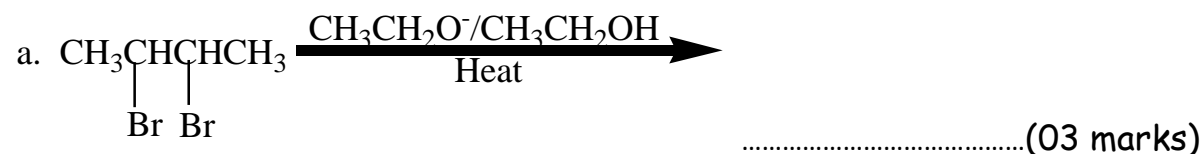
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8. Complete the following reactions and suggest the possible IUPAC mechanism for each reaction.

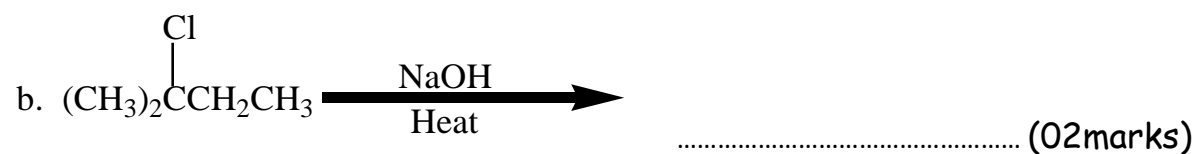


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9. (a) What is meant by the following terms.

(i) Enthalpy of combustion

(01 mark)

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(iii) Standard heat of formation

(01 mark)

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b) Calculate the enthalpy of **combustion** of **methane** from the following thermochemical data.

(03 marks)

Enthalpy of combustion of carbon = -393 kJmol^{-1}

Enthalpy of combustion of hydrogen = -286 kJmol^{-1}

Enthalpy of formation of methane = -75 kJmol^{-1}

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SECTION B: (54 MARKS)

Answer any six questions from this section.

10. (a) State what is meant by the term **freezing point constant** of a substance.

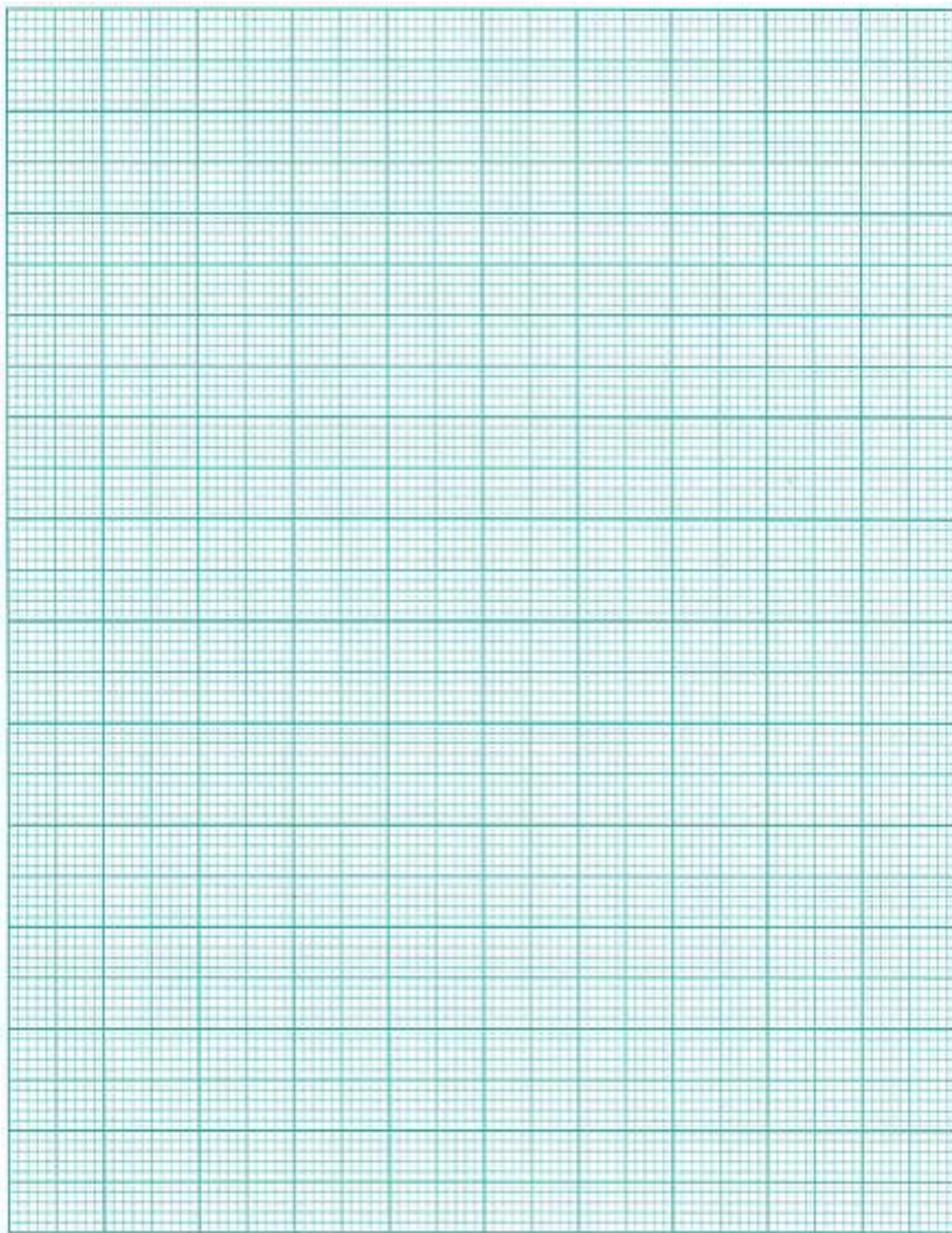
(01 mark)

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(b) The table below shows the freezing points of various concentrations of a non-volatile solute Q in water at 760mmHg.

Concentration of Q (gdm^{-3})	0	30	60	90	120	150
Freezing point($^{\circ}\text{C}$)	0	-0.16	-0.32	-0.49	-0.65	-0.81

Plot a graph of freezing point depression against concentration of Q



(c) Determine the :

(i) slope of the graph you have drawn in (b). (1 $\frac{1}{2}$ marks)

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(ii) relative molecular mass of Q. (K_f of water is $1.86\text{ }^{\circ}\text{C kg}^{-1}\text{ mol}^{-1}$) (2 $\frac{1}{2}$ 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 $\frac{1}{2}$ marks)

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(b) Benzene from ethene

(3 $\frac{1}{2}$ marks)

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(c) $\text{CH}_3\text{CH}_2\text{COCH}_3$ from propyne

(3 $\frac{1}{2}$ 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. (04 marks)

Element	Formula of hydride	Structure
Sodium		
Magnesium		
Silicon		
Sulphur		

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

(i) Magnesium (01½ marks)

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(ii) Sulphur (01½ marks)

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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? (0½ mark)

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(iii) Give a reason for your answer in c(ii) above. (0½ 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 39.5cm³ at 20^oc 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)(i) What is meant by the term first ionisation energy? (01mark)

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(ii) Write an equation for the first ionisation energy of aluminium (01 mark)

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(iii) State two factors that can affect the value of first ionisation energy

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(b) State and explain how first ionisation energy varies

(i) Down a group. (03 marks)

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(i) Across a given period. (03 marks)

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

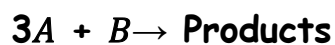
(01 mark)

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



Experiment	[A] (mol dm ⁻³)	[B] (mol dm ⁻³)	Rate (mol dm ⁻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 its units. (02 marks)

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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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(a) Propane and propene

Reagent. (01 mark)

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Observations. (02 marks)

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(a) Bromoethane and chloroethane

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 Tl 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.