



General Certificate of Secondary Education
2023–2024

Centre Number

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Candidate Number

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Single Award Science: Chemistry

Unit 2
Higher Tier



[GSA22]

GSA22

TUESDAY 14 NOVEMBER 2023, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

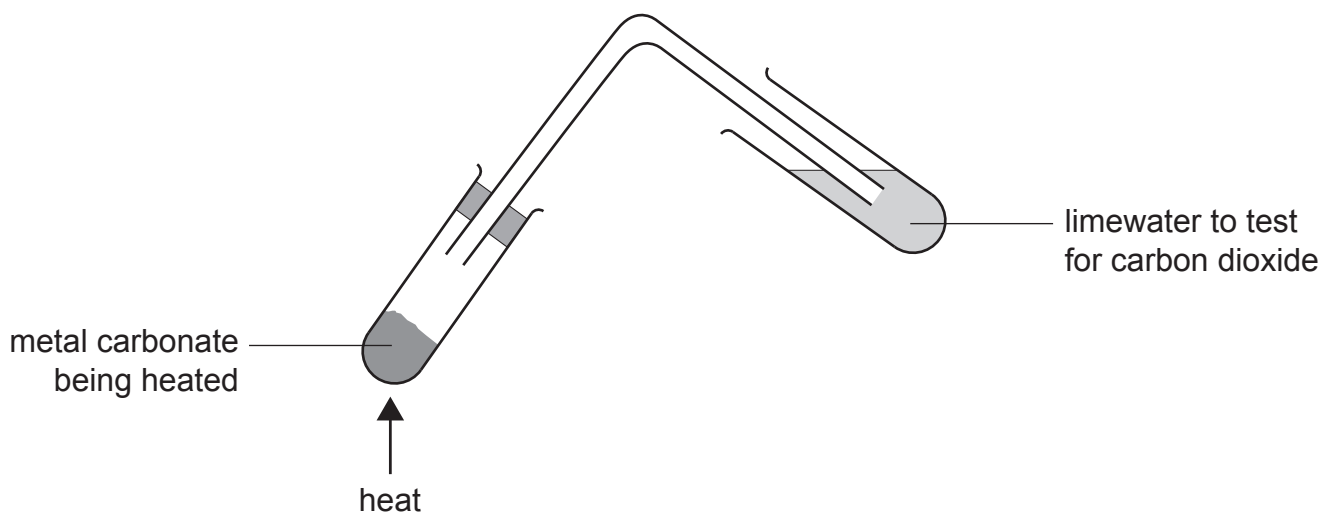
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **2(a)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.



- 1 A student investigated the effect of heat on different metal carbonates using the apparatus shown in the diagram.



He recorded the mass and colour of the solid before and after heating.

The results are shown below.

Metal carbonate	Mass before heating/g	Mass after heating/g	Colour before heating	Colour after heating	Carbon dioxide produced
copper carbonate	2.3	1.8	green	black	yes
manganese carbonate	2.5	2.0	pink	black	yes
sodium carbonate	2.5	2.5	white	white	no
zinc carbonate	2.6	1.9	white	white	yes



- (a) Name the piece of apparatus that could be used to heat the metal carbonate in this investigation.

_____ [1]

- (b) Suggest **one** reason for the **decrease** in mass during some of these reactions.

_____ [1]

- (c) Which metal carbonate lost the **most** mass during the investigation?

_____ [1]

- (d) Which metal carbonate does **not** decompose when heated? Use evidence from the table to explain your answer.

_____ [2]

- (e) The formula for copper carbonate is CuCO_3 .

- (i) How many **elements** are in copper carbonate (CuCO_3)?

_____ [1]

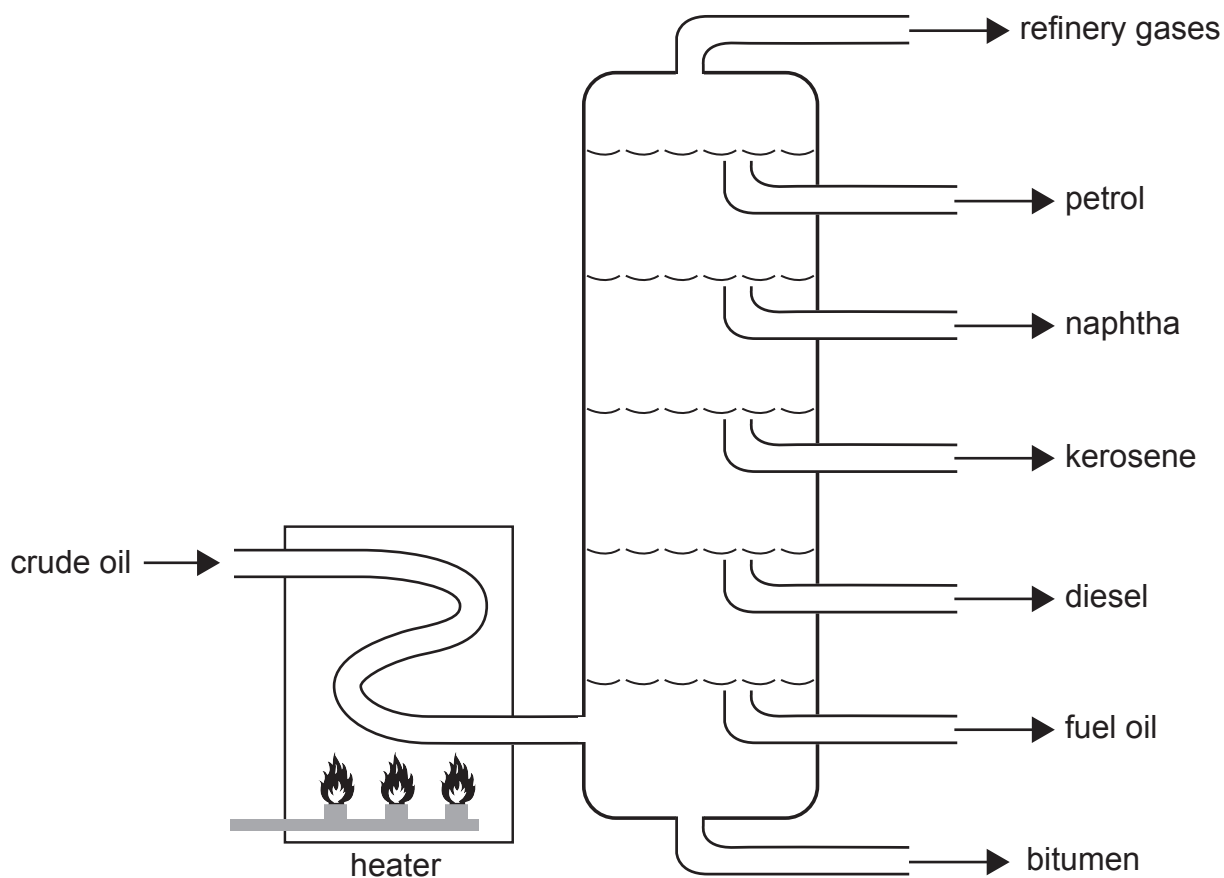
- (ii) How many **atoms** are represented by the formula CuCO_3 ?

_____ [1]

[Turn over]



- 2 Crude oil is a mixture of hydrocarbons that can be separated into the useful chemicals shown below.



- (a) Describe how crude oil is formed and how the process shown above separates it into useful chemicals.

Your answer should include:

- a description of the formation of crude oil; and
- the name of the process shown above and how it separates crude oil.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.



A description of the formation of crude oil: _____

The name of the process and how it separates crude oil: _____

[6]

[Turn over



- (b) The table below shows some properties of the chemicals produced from crude oil.

Fraction	Number of carbon atoms in chain	State at room temperature	Ease of catching fire
refinery gas	1 – 4	gas	
petrol	5 – 9	liquid	
naphtha	6 – 11	liquid	
kerosene	11 – 18	liquid	
diesel oil	16 – 20	liquid	
fuel oil	21 – 70	liquid	
bitumen	more than 70	solid	

- (i) Complete the sentence below to give **one** trend shown by this information.

As the number of carbon atoms _____

[1]

- (ii) Use information from the table to give **two** reasons why petrol is a good choice as a fuel for cars.

1. _____

2. _____ [2]



(c) One of the hydrocarbons found in the refinery gas fraction is ethane (C_2H_6).

(i) In the box below draw the structure of ethane.



[1]

(ii) Name the type of bonding present in ethane.

_____ [1]

(iii) Ethane is an alkane. What is the general formula for alkanes?

Circle your answer.

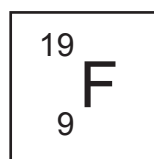
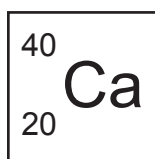
C_nH_{2n} : C_nH_{2n+1} : C_nH_{2n+2}

[1]

[Turn over]



- 3 (a) Calcium and fluorine are represented on the Periodic Table as shown below.



They can react to form calcium fluoride (CaF_2).

- (i) Complete the table below to give the number of electrons and neutrons in a molecule of calcium fluoride (CaF_2).

Particle	Number
proton	38
electron	
neutron	

[2]

- (ii) Describe, in terms of electrons, how calcium fluoride (CaF_2) is formed from calcium and fluorine.

[3]

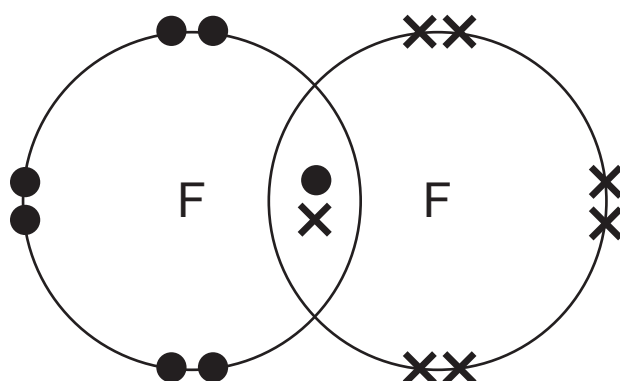
A student carried out a flame test on a sample of calcium fluoride.

- (iii) What colour flame would be observed?

[1]



(b) The diagram below shows a molecule of fluorine.



(i) Name the Group in the Periodic Table that fluorine belongs to.

_____ [1]

(ii) How many **lone pairs** of electrons are shown in the diagram above?

_____ [1]

(iii) Place a tick (✓) beside the two correct statements that describe the properties of an electron.

an electron has a relative mass of 1

☐

an electron has a relative charge of +1

☐

an electron has a relative mass of $\frac{1}{1840}$

☐

an electron has a relative charge of -1

☐

an electron has a relative charge of 0

☐

[2]

[Turn over]



- 4 (a) The table below gives information about the colours of four indicators made from plants.

Indicator \ pH	1	2	3	4	5	6	7	8	9	10	11	12
Blueberry	R	R	V	V	G	G	G	G	G	G	G	G
Red cabbage	P	P	P	V	V	B	B	B	G	G	G	Y
Grape juice	R	R	R	R	R	R	G	G	G	G	G	G
Litmus solution	R	R	R	R	R	R	V	B	B	B	B	B

Key	
P	Pink
R	Red
Y	Yellow
G	Green
B	Blue
V	Violet

Use this information to answer the following questions.

- (i) Name the indicator that stays the same colour over the largest pH range.

_____ [1]

- (ii) Name the indicator that would be a different colour when added to solutions of ammonia and sodium hydroxide.

_____ [1]



A student adds an acid to an alkali and wants to find out when the solution becomes neutral.

- (iii) Name the indicator that would be best to use to follow this reaction.
Explain your choice.

[2]

- (b) Litmus paper, universal indicator and a pH meter can be used to follow a neutralisation reaction.

- (i) Put these methods in order of how useful they are at determining pH, putting the most accurate first.

most accurate

[1]

- (ii) Explain why you have put these **three** methods in this order.

[2]

[Turn over



5 The table below gives some information about five plastics.

Plastic	Properties	Colours available	Cost
PVC	hard, keeps its shape, weather resistant	wide range of colours	medium
nylon	hard, long lasting	white or cream	high
polythene	soft, flexible, good electrical insulator	wide range of colours but they fade easily	medium
acrylic	stiff, weather resistant, good electrical insulator	wide range of colours	high
polystyrene	does not keep its shape, good heat insulator	white	low

- (a) Which plastic, named in the table, would be most suitable to cover electrical cables? Explain your choice.

Plastic _____

Explanation _____

_____ [2]

- (b) A large hardware store wants to produce cheap blue plastic buckets. Which plastic should they use?

_____ [1]

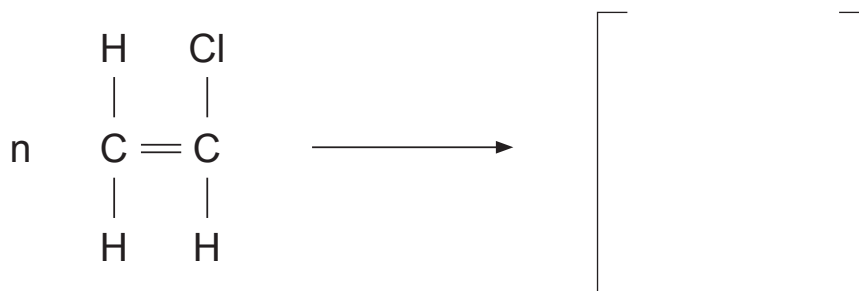


(c) PVC (polyvinyl chloride) is made from chloroethene.

- (i) Name the type of reaction that produces PVC using chloroethene molecules.

_____ [1]

- (ii) Complete the balanced symbol equation below for the reaction that produces PVC.



[2]

- (iii) PVC is non-biodegradable. What is meant by the term **non-biodegradable**?

_____ [1]

[Turn over]

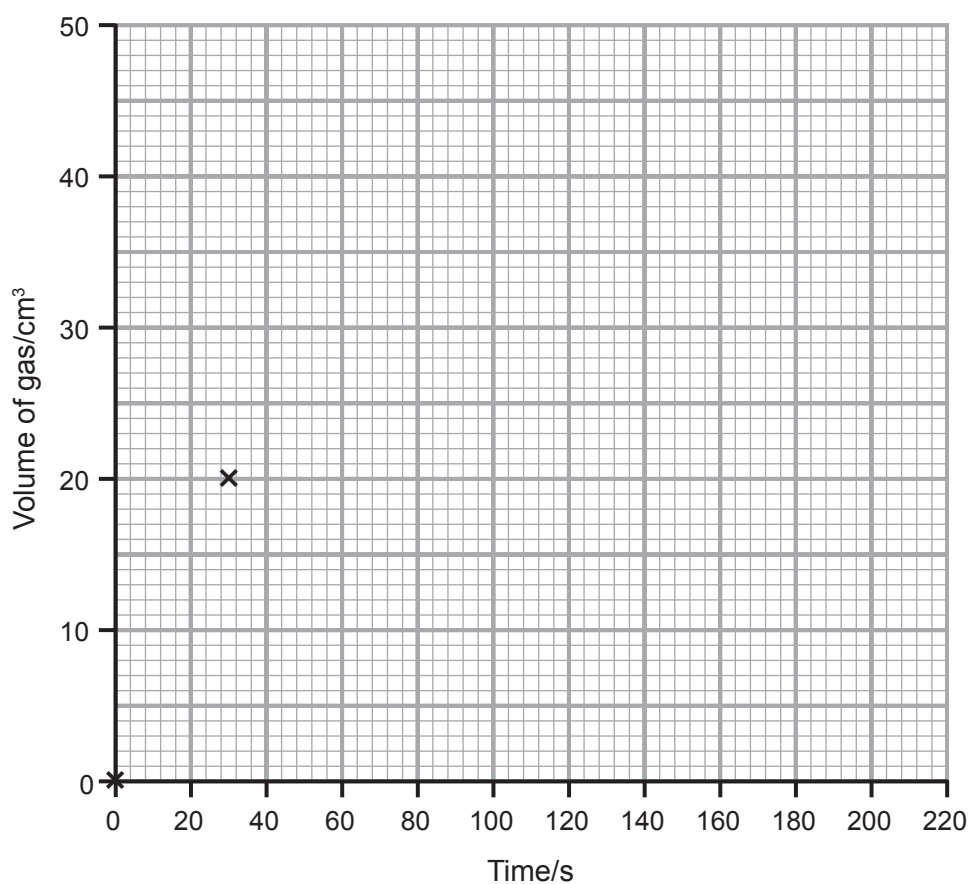


- 6 (a) A student investigated the rate of reaction between zinc and excess hydrochloric acid. He measured the volume of gas produced every 30 seconds.

The results are shown below.

Time/s	0	30	60	90	120	150	180	210
Volume of gas/cm ³	0.0	20.0	29.0	36.0	41.5	44.0	45.0	45.0

- (i) On the grid below plot and draw a line graph for these results. The first two points have been plotted for you.



[3]

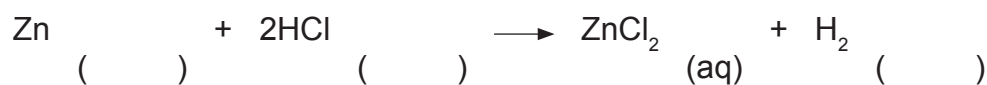


(ii) Describe fully the trend shown by these results.

[2]

(iii) Complete the symbol equation below for the reaction of zinc with hydrochloric acid by adding the state symbols.

One has been done for you.



[2]

(b) The investigation was repeated with **more** concentrated hydrochloric acid. Explain, in terms of particles, how this would speed up the reaction.

[2]

[Turn over



- (c) A student wanted to investigate the effect on the rate of reaction between zinc and sulfuric acid when he added copper powder.

His results are shown below.

Time/s	0	20	40	60	80	100	120
Volume of gas without copper/cm ³	0	30	55	70	90	90	90
Volume of gas with copper/cm ³	0	40	60	90	90	90	90

- (i) Describe the effect that adding copper powder had on the rate of reaction between zinc and sulfuric acid.

[1]

The copper powder was unchanged at the end of the reaction.

- (ii) Complete the sentence below.

In this reaction copper is acting as a _____ .

[1]



7 Electrolysis can be used to extract aluminium from its ore. The ore is first purified to produce aluminium oxide (alumina).

(a) Name the **ore** of aluminium.

_____ [1]

(b) Molten alumina is an electrolyte. Explain how an electrolyte conducts electricity.

_____ [2]

(c) Oxygen is produced at the positively charged electrode during the electrolysis of aluminium ore.

(i) What name is given to the positively charged electrode?

_____ [1]

(ii) Explain fully why the positively charged electrode needs to be replaced periodically.

_____ [2]

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Sources:

Question 1 *Principal Examiner*

Question 2 *Principal Examiner*

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Question Number	Marks
1	
2	
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Total Marks	
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Examiner Number

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SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	CO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	HCOO^-
Nitrate	NO_3^-
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
Science: Chemistry,
Science: Double Award
or Science: Single Award

Copies must be free from notes or additions of any
kind. No other type of data booklet or information
sheet is authorised for use in the examinations

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble
Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

																1 H Hydrogen 1																	0 He Helium 2
1		2																		3		4		5		6		7					
7 Li Lithium 3	9 Be Beryllium 4																	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10										
23 Na Sodium 11	24 Mg Magnesium 12																	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18										
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36																
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54																
133 Cs Caesium 55	137 Ba Barium 56	139 La* Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86																
223 Fr Francium 87	226 Ra Radium 88	227 Ac† Actinium 89	261 Rf Rutherfordium 104	262 Db Dubnium 105	266 Sg Seaborgium 106	264 Bh Bohrium 107	277 Hs Hassium 108	268 Mt Meitnerium 109	271 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112																						

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

a = relative atomic mass (approx)
x = atomic symbol
b = atomic number

140	Ce	141	Pr	144	Nd	145	Pm	150	Sm	152	Eu	157	Gd	159	Tb	162	Dy	165	Ho	167	Er	169	Tm	173	Yb	175	Lu
Cerium		Praseodymium		Neodymium		Promethium		Samarium		Europium		Gadolinium		Terbium		Dysprosium		Holmium		Erbium		Thulium		Ytterbium		Lutetium	
58		59		60		61		62		63		64		65		66		67		68		69		70		71	
232	Th	231	Pa	238	U	237	Np	242	Pu	243	Am	247	Cm	245	Bk	251	Cf	254	Es	253	Fm	256	Md	254	No	257	Lr
Thorium		Protactinium		Uranium		Neptunium		Plutonium		Americium		Curium		Berkelium		Californium		Einsteinium		Fermium		Mendelevium		Nobelium		Lawrencium	
90		91		92		93		94		95		96		97		98		99		100		101		102		103	