



Rewarding Learning

General Certificate of Secondary Education
2023

Centre Number

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Candidate Number

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Double Award Science: Chemistry

Unit C2

Higher Tier



[GDW52]

GDW52

TUESDAY 13 JUNE, MORNING

TIME

1 hour 15 minutes.

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 eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.

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(c)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

13894



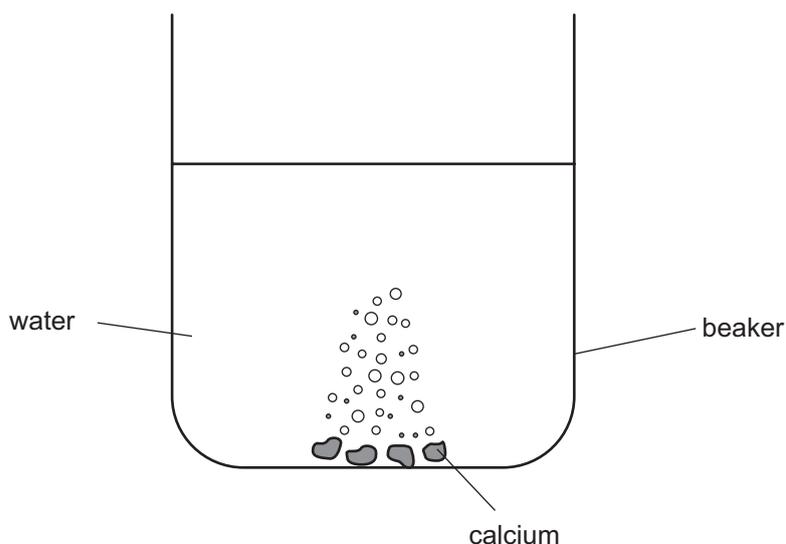
24GDW5201

1 (a) When some calcium granules are placed in a beaker of water a chemical reaction occurs and bubbles of gas form.

(i) Name the gas formed when calcium reacts with water.

_____ [1]

(ii) The diagram below shows calcium metal reacting with water in a beaker.



Name one other piece of apparatus which would be required to collect the gas produced in this reaction.

_____ [1]

(iii) State three other observations which would be made during the reaction between calcium and water.

1. _____
2. _____
3. _____ [3]



(iv) A strip of magnesium ribbon is placed in a beaker of water.
Describe how the rate of this reaction would compare to the rate of the
reaction between calcium and water.

_____ [1]

[Turn over

13894



24GDW5203

(b) A student investigated the reactivity of the metals tin, copper, zinc and nickel.

A small amount of tin was added to 3 separate test tubes each containing a salt solution of a different metal. The results are shown in the table below. This was repeated with copper, zinc and nickel. If a reaction occurred, a tick (✓) is shown in the results table below.

Metal	Solutions			
	Tin sulfate	Copper(II) sulfate	Zinc sulfate	Nickel sulfate
Tin		✓	X	X
Copper	X		X	X
Zinc	✓	✓		✓
Nickel	✓	✓	X	

(i) Write a balanced symbol equation for the reaction between zinc and copper(II) sulfate.

_____ [2]

(ii) Predict the colour of the solid formed in the reaction between zinc and copper(II) sulfate.

_____ [1]

(iii) Use the results to place the metals tin, copper, zinc and nickel in their correct positions in a reactivity series.

Most reactive _____

Least reactive _____

[1]





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24GDW5205

2 The thermite reaction is the reaction between a mixture of iron(III) oxide and aluminium forming molten iron and aluminium oxide.

(a) Complete and balance the symbol equation for the thermite reaction below.

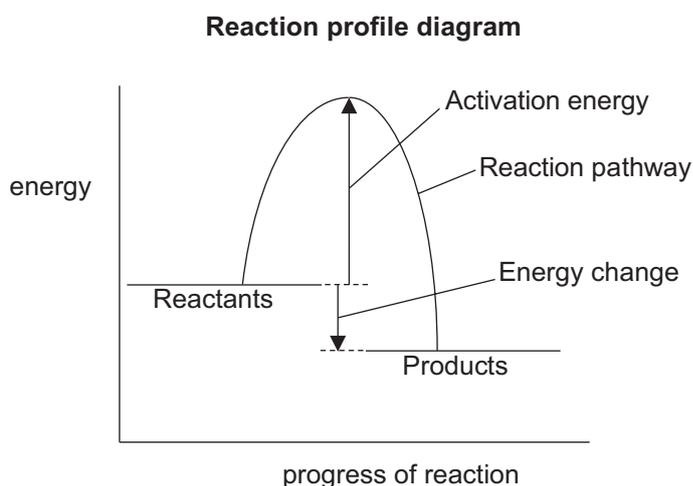


[2]

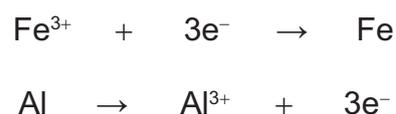
(b) Explain, in terms of reactivity, why the thermite reaction occurs.

[1]

(c) A reaction profile diagram and the half equations for the thermite reaction are given below.



Half equations



Use the information above about the thermite reaction and your own knowledge to:

- State what is meant by activation energy
- State and explain the type of energy change happening
- Explain, in terms of electrons, why this reaction is described as a redox reaction.



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

State what is meant by activation energy:

State and explain the type of energy change happening:

Explain, in terms of electrons, why this reaction is described as a redox reaction:

[6]

[Turn over



- 3 (a) Substances conduct electricity when charged particles are able to move and carry the charge.

Aluminium conducts electricity.

Lead(II) bromide does not conduct electricity when solid but does conduct electricity when molten.

Molten lead(II) bromide is an electrolyte.

- (i) Complete the table below to show how molten lead(II) bromide conducts electricity.

Substance	Name of particle which can move and carry the charge
solid aluminium	delocalised electrons
molten lead(II) bromide	

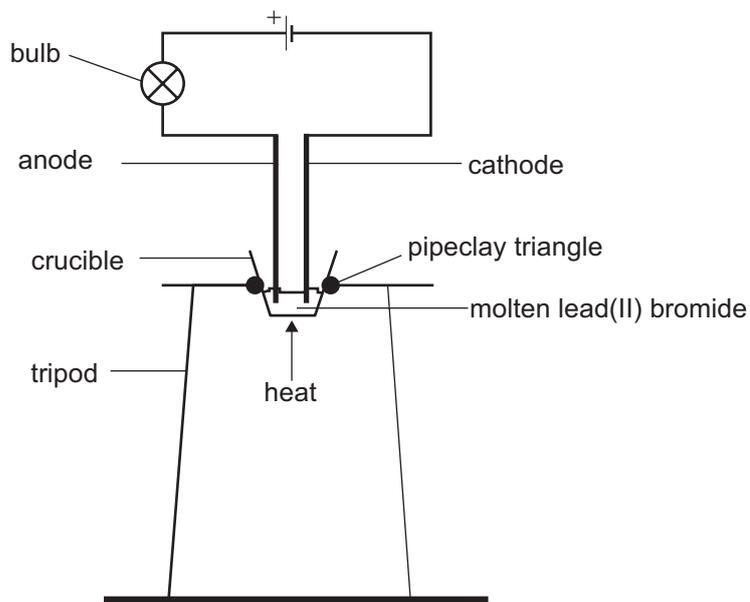
[1]

- (ii) What happens to electrolytes, such as molten lead(II) bromide, when they conduct electricity?

[1]



(b) The labelled diagram below shows the apparatus used for the electrolysis of molten lead(II) bromide.



(i) The anode and cathode are both made from graphite.

State two reasons, apart from cost, why graphite is a suitable material to use for the anode and the cathode.

1. _____

2. _____ [2]



- (ii) Complete the table below by predicting the observations and names of the products formed at the anode and cathode for the electrolysis of molten lead(II) bromide.

Anode		Cathode	
Observations	Name of product formed	Observations	Name of product formed
		Grey liquid formed	

[4]

- (iii) Write a half equation for the reaction occurring at the cathode.

[2]





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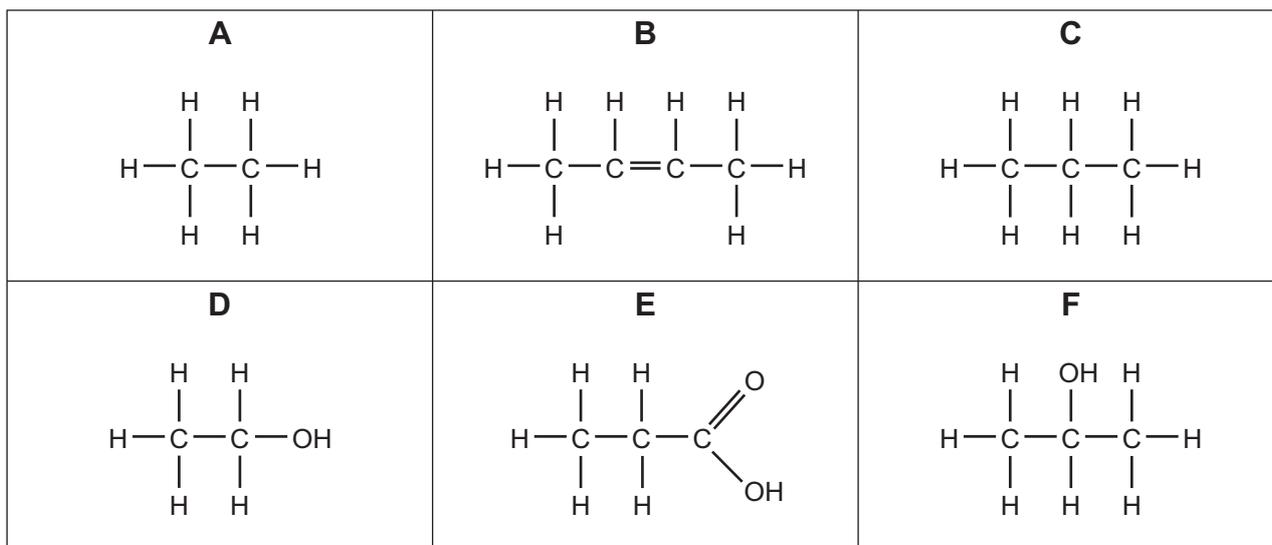
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24GDW5211

- 4 (a) The structural formulae of six organic compounds labelled **A** to **F** are given below.



- (i) State the name of compound **B**.

_____ [1]

- (ii) Write the molecular formula of compound **E**.

_____ [1]

- (iii) Write the general formula of the homologous series to which compound **C** belongs.

_____ [1]

- (iv) What is the physical state at room temperature and pressure of compound **F**?

_____ [1]

- (v) Identify the compound (**A** to **F**) that will react with magnesium.

_____ [1]



(b) Alkenes such as ethene and propene undergo addition reactions.

(i) Draw the structural formula of propene.

[1]

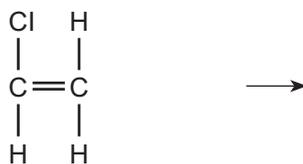
(ii) Write a balanced symbol equation for the reaction of ethene with hydrogen and name the product.

Equation: _____

Name of product: _____ [3]

(iii) Chloroethene is a monomer that undergoes addition polymerisation to form the polymer poly(chloroethene).

Complete the structural equation for the polymerisation of chloroethene.



[2]



(c) Ethanol can be prepared from ethene or from a solution of sugars.

(i) Name the substance which reacts with ethene to form ethanol.

_____ [1]

(ii) Name the process used to prepare ethanol from a solution of sugars.

_____ [1]

(iii) Ethanol is highly flammable. Write the formulae of all the products formed from the complete combustion of ethanol.

_____ [1]





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24GDW5215

5 Hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$, may be heated to constant mass to form anhydrous sodium carbonate.

(a) What is meant by the term **hydrated**?

_____ [1]

(b) Describe how you would heat a sample of hydrated sodium carbonate to constant mass.

_____ [2]

(c) When a sample of 28.6 g of hydrated sodium carbonate is heated to constant mass, 10.6 g of anhydrous sodium carbonate are obtained.
(Relative atomic masses: H = 1; C = 12; O = 16; Na = 23)

(i) Calculate the mass of water present in the sample.

mass of water _____ g [1]



(ii) Calculate the number of moles of water present in the sample.

moles of water _____ [1]

(iii) Calculate the number of moles of anhydrous sodium carbonate obtained.

moles of anhydrous sodium carbonate _____ [1]

(iv) Use your answers to (c)(ii) and (iii) to determine the value of x in $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$.

x _____ [1]

[Turn over

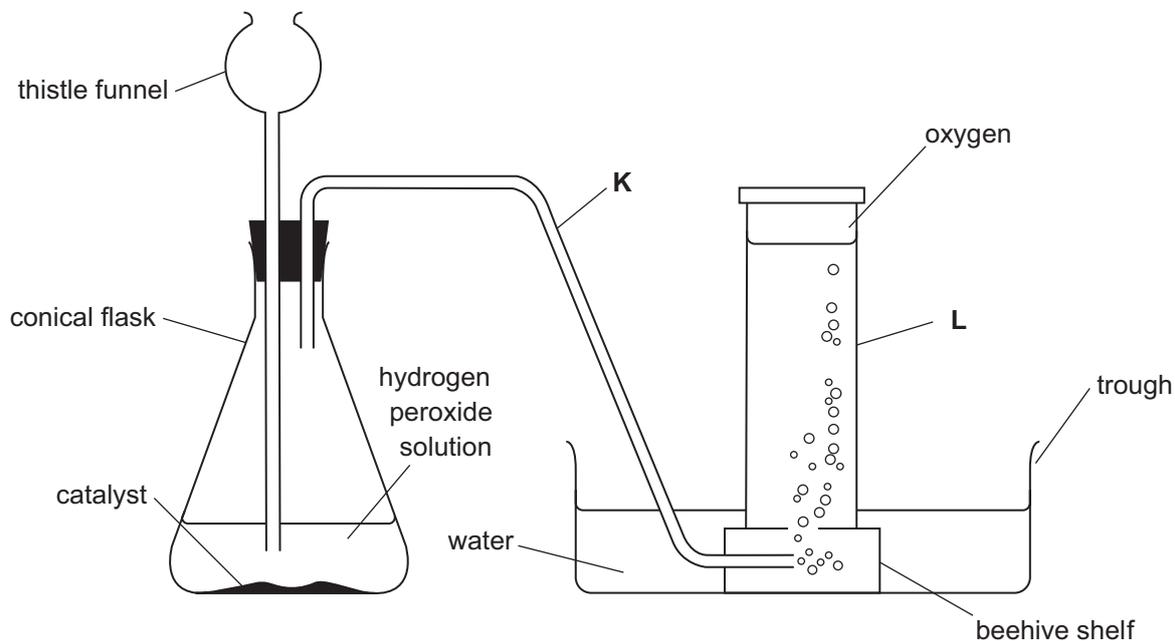
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24GDW5217

6 Hydrogen peroxide decomposes rapidly into water and oxygen in the presence of a catalyst.

(a) The diagram below shows the apparatus used to prepare and collect oxygen gas from hydrogen peroxide solution using a catalyst.



(i) What labels should be placed at **K** and **L**?

K _____

L _____ [2]

(ii) Write a balanced symbol equation for the decomposition of hydrogen peroxide.

_____ [3]

(iii) Name the catalyst used for this preparation.

_____ [1]



(iv) Describe the test for oxygen gas.

[1]

(b) A student heated some magnesium and some copper in air using a Bunsen burner.

Complete the table below giving the observations which occur during heating and a description of the appearance of the products.

Metal	Observations during heating	Appearance of product
Magnesium		
Copper		

[4]

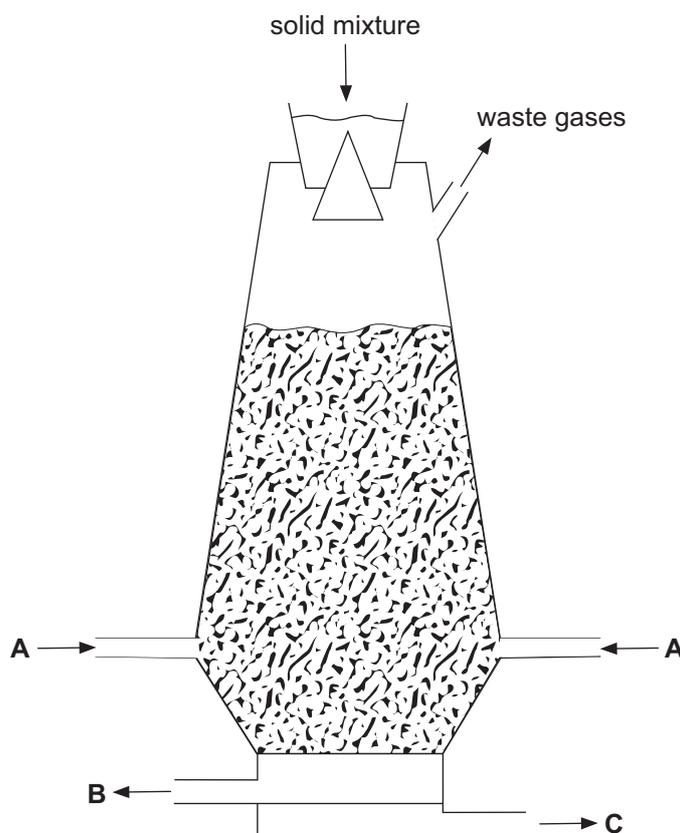
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24GDW5219

- 7 Iron is extracted from its ore in a blast furnace. A diagram of a blast furnace is shown below.



- (a) The solid mixture added at the top of the blast furnace contains iron ore, coke and one other substance.

(i) Name the other substance in the solid mixture.

_____ [1]

(ii) What is the name of iron ore?

_____ [1]

- (b) What is introduced into the blast furnace at A?

_____ [1]



(c) In the blast furnace, coke reacts to form carbon dioxide. The carbon dioxide reacts with more coke to form carbon monoxide.

(i) What is the importance of carbon monoxide in the extraction process?

_____ [1]

(ii) Write a balanced symbol equation for the reaction of carbon dioxide with coke to form carbon monoxide.

_____ [3]

(d) What is removed from the blast furnace at **B** and **C**?

B _____

C _____ [2]

(e) Iron ore contains a significant percentage of the acidic impurity silicon dioxide. Silicon dioxide reacts with calcium oxide which is produced in the blast furnace.

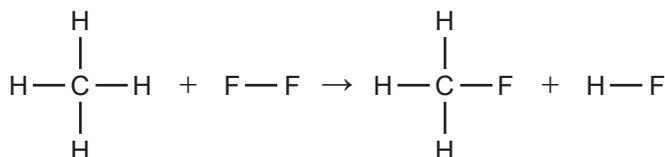
Write a balanced symbol equation for the reaction of silicon dioxide with calcium oxide.

_____ [2]

[Turn over



- 8 (a) Fluoromethane, CH₃F, and hydrogen fluoride, HF, are formed in a reaction between methane and fluorine. The equation below shows the covalent bonds in the reactants and products.



- (i) Use the bond energy values shown in the table below to calculate the energy change for the above reaction.

Bond	Energy /kJ
C—H	412
F—F	158
C—F	452
H—F	565

energy change _____ kJ [4]

- (ii) Explain, using the value you have calculated in (a)(i), whether the reaction is exothermic or endothermic.

_____ [1]



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Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number

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24GDW5224

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							4 He Helium 2
		1	2											3	4	5	6	7	0
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

$\begin{matrix} a \\ \boxed{X} \\ b \end{matrix}$ a = relative atomic mass (approx)
 x = atomic symbol
 b = atomic number

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