



Rewarding Learning

General Certificate of Secondary Education
2025

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 2

Foundation Tier



[GCM21]

GCM21

FRIDAY 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 questions in black ink and use a dark HB pencil for drawings and graphs.

Do not write with a gel pen.

Answer all **six** 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.

You may use a scientific calculator.

Quality of written communication will be assessed in Question **3(b)**.

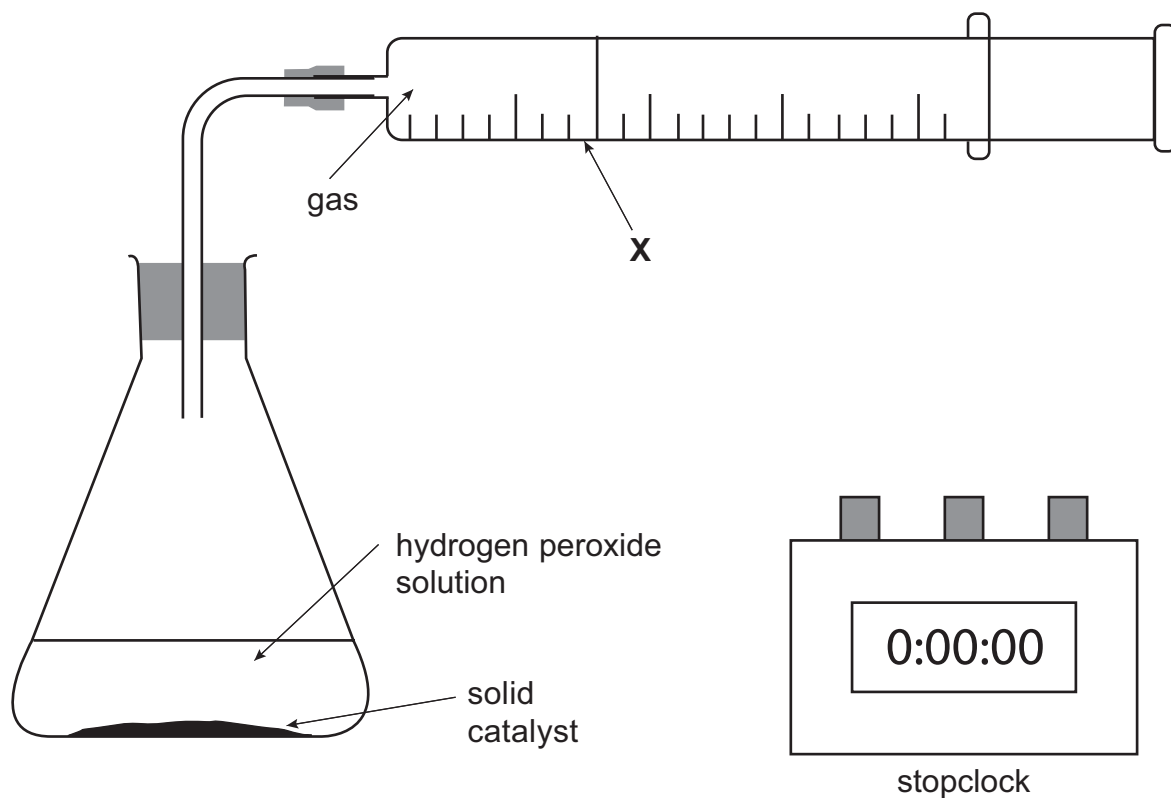
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

14543



24GCM2101

- 1 (a) An experiment was set up to investigate the effect of four different solid catalysts on the decomposition of hydrogen peroxide solution. A diagram of the apparatus used is shown below. 25.0 cm^3 of hydrogen peroxide solution and 1 g of solid catalyst were used in each reaction and the time taken to produce 100 cm^3 of gas was recorded.



Results of experiment

Solid catalyst	Time taken to collect 100 cm^3 of gas / s
A	120
B	35
C	11
D	54



(i) Name the piece of apparatus labelled **X**.

_____ [1]

(ii) Name the products formed in the decomposition of hydrogen peroxide.

_____ [1]

(iii) State and explain which solid (A, B, C or D) is the most effective catalyst.

_____ [1]

(iv) Name one compound which could be used as a catalyst for the decomposition of hydrogen peroxide.

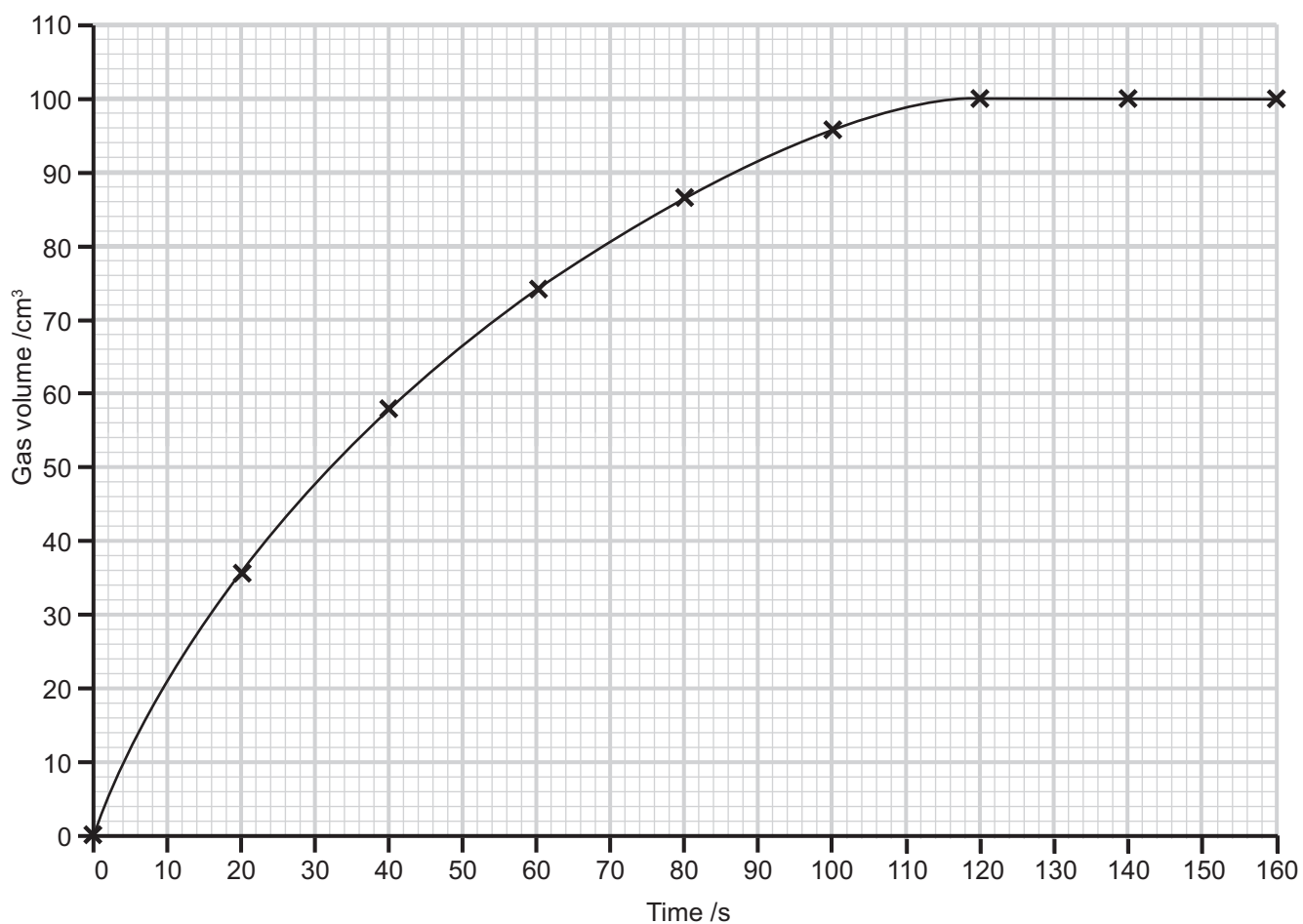
_____ [1]

[Turn over



(b) The experiment was repeated using the same apparatus and the gas volume collected was recorded at intervals of 20 seconds. Catalyst A was used.

The graph shows the results obtained.



(i) What volume of gas was produced in the first 10 seconds?

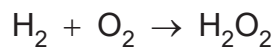
_____ [1]

(ii) Describe fully how the gas volume produced changes with time.

_____ [2]



(c) Hydrogen peroxide can be produced industrially from hydrogen and oxygen as shown in the equation below.



(i) This reaction has a 100% atom economy. Explain how you can tell this from the equation.

[1]

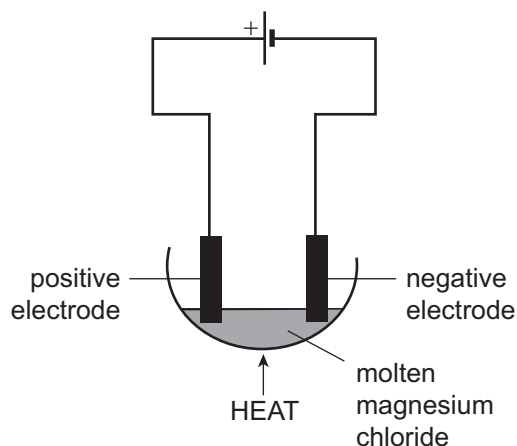
(ii) Explain why industrial chemical processes should have as high an atom economy as possible.

[1]



2 Molten magnesium chloride and dilute sulfuric acid can undergo electrolysis.

(a) The diagram below shows the apparatus which may be used to carry out the electrolysis of molten magnesium chloride.



(i) Explain why molten magnesium chloride can undergo electrolysis.

_____ [1]

(ii) What is the name of the positive electrode?

_____ [1]

(iii) Use the words in the box below to complete the sentence about the electrolysis of molten magnesium chloride.

chlorine	hydrogen	hydroxide	magnesium	oxide
----------	----------	-----------	-----------	-------

When molten magnesium chloride is electrolysed, _____ is produced at the positive electrode and _____ is produced at the negative electrode. [2]



(iv) Circle the observation which occurs at the positive electrode during the electrolysis of molten magnesium chloride.

yellow-green
gas produced

orange liquid
produced

red-brown gas
produced

grey metal
produced

colourless gas
produced

[1]

(v) Write the formula for magnesium chloride.

_____ [1]

(vi) Use the words in the box below to complete the sentence to define an electrolyte.

decomposed	dissolved	gas	heat	electricity
liquid	metal	oxidised	reduced	solid

An electrolyte is a _____ or solution which conducts
_____ and is _____ . [3]



(b) When dilute sulfuric acid undergoes electrolysis, hydrogen gas is produced at the negative electrode.

(i) Describe the test for hydrogen gas.

[1]

(ii) Select two physical properties of hydrogen gas from the list below by placing a tick (✓) in the appropriate boxes on the right.

Yellow	<input type="checkbox"/>
Colourless	<input type="checkbox"/>
High boiling point	<input type="checkbox"/>
Pungent smell	<input type="checkbox"/>
Odourless	<input type="checkbox"/>

[2]





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(Questions continue overleaf)

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[Turn over



24GCM2109

3 The alcohols are a homologous series of organic compounds.

(a) The table below shows information about three different alcohols.

Alcohol	Melting point /°C	Boiling point /°C
CH ₃ OH	-94	65
C ₂ H ₅ OH	-118	78
C ₃ H ₇ OH	-129	97

(i) State one piece of evidence from the table which shows that the three alcohols belong to the same homologous series.

_____ [1]

(ii) Write the formula of the alcohol from the table which has the highest boiling point.

_____ [1]

(iii) Which alcohol(s) will be liquid at -100°C?

_____ [1]



- (iv) There are two alcohols which have the molecular formula C_3H_7OH . Complete the table below by giving the structural formula and name of each alcohol.

	Structural formula	Name
1		
2		

[2]

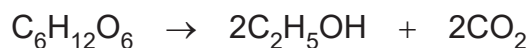
- (v) Complete the table below for the alcohol C_3H_7OH .

Total number of atoms in C_3H_7OH	
Number of hydrogen atoms in C_3H_7OH	
Relative formula mass of C_3H_7OH	

[3]



- (c) The alcohol C_2H_5OH can be manufactured from glucose, $C_6H_{12}O_6$, by fermentation according to the following equation.

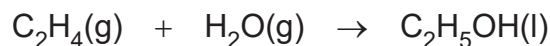


Select the **two** conditions required for fermentation from the list below by placing a tick (✓) in the appropriate boxes on the right.

High temperature	<input type="checkbox"/>
Warm temperature	<input type="checkbox"/>
Presence of air	<input type="checkbox"/>
Absence of air	<input type="checkbox"/>

[1]

- (d) The alcohol C_2H_5OH can also be manufactured by the reaction shown in the equation below.



- (i) State the name of:

$C_2H_4(g)$ _____

$H_2O(g)$ _____

$C_2H_5OH(l)$ _____ [3]

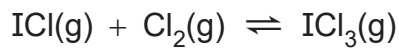
- (ii) Name the type of reaction shown in the equation above.

_____ [1]

[Turn over



(c) Iodine monochloride reacts in an exothermic reaction with more chlorine to form iodine trichloride (ICl₃). A dynamic equilibrium forms.



(i) State one feature of a dynamic equilibrium.

_____ [1]

(ii) What is meant by the term exothermic?

_____ [1]

[Turn over



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24GCM2116



5 Some metals, such as gold, can be found uncombined in nature.

(a) Suggest why gold metal is found uncombined in nature.

[1]

(b) Other metals such as aluminium, copper, zinc and iron are found combined with other elements in rocks called ores. These metals can be extracted from their ore by electrolysis or by chemical reduction.

(i) Cuprite is an ore of copper which contains copper(I) oxide. Copper(I) oxide contains the copper(I) ion, Cu^+ . Write the formula of copper(I) oxide.

[1]

(ii) Name the ore from which aluminium is extracted.

[1]

(iii) For each metal in the table below, select the correct method of extraction, electrolysis or chemical reduction. Place a tick (\checkmark) in one box in each row.

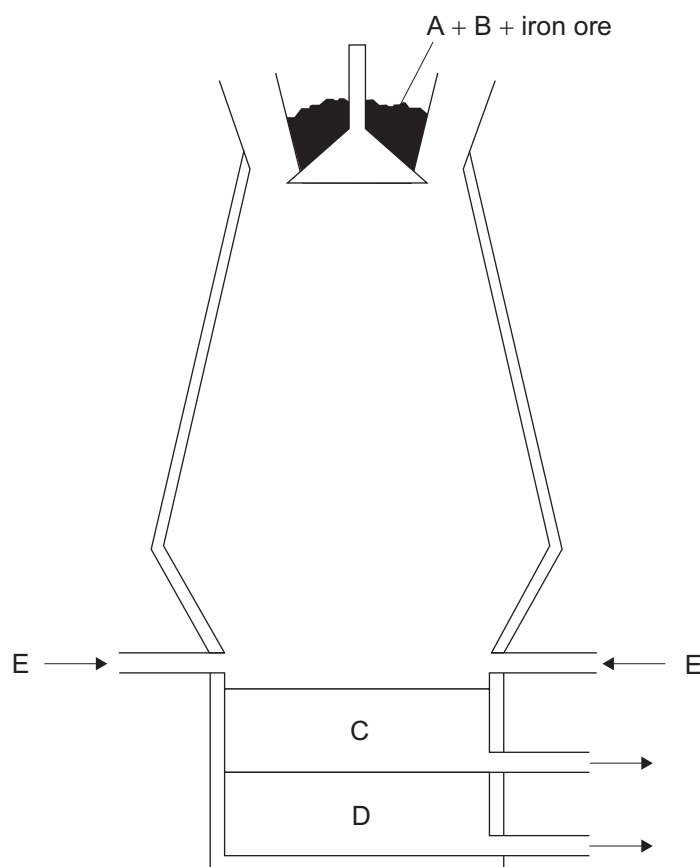
Metal	Electrolysis	Chemical reduction
Aluminium		
Copper		
Zinc		

[3]

[Turn over



(c) The diagram below shows a Blast Furnace used for the extraction of iron from iron ore.



(i) Raw material A is used to produce the reducing agent in the Blast Furnace. Name A and name the reducing agent.

A _____

Reducing agent _____ [2]

(ii) Describe how the reducing agent is produced in the Blast Furnace.

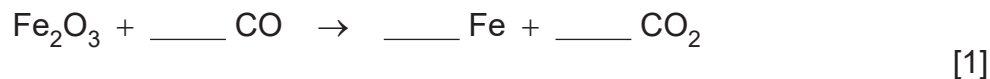
_____ [2]



(iii) What is the common name for iron ore?

_____ [1]

(iv) Balance the equation for the production of iron in the Blast Furnace.



(v) Name the raw material B added to the Blast Furnace to help remove the impurities from the iron ore.

_____ [1]

(vi) Identify C and E.

C _____

E _____ [2]

[Turn over



(d) Copper is produced when iron is added to a solution of copper(II) sulfate.

- (i) Write a balanced symbol equation for the reaction of copper(II) sulfate with iron to produce copper and iron(II) sulfate.

[2]

- (ii) Select two observations for this reaction from the list below by placing a tick (✓) in the appropriate boxes on the right.

A green gas is produced

The blue solution fades in colour

A red-brown solid is produced

Solid disappears completely

[2]



(e) Listed below are five elements which will react with oxygen.

calcium copper iron magnesium sulfur

(i) Which two elements will form white oxides?

_____ [2]

(ii) Which element will burn with a brick red flame?

_____ [1]

(iii) Which element will burn in air to form a gas?

_____ [1]

(iv) Which element forms a black layer on its surface when it is heated in air?

_____ [1]

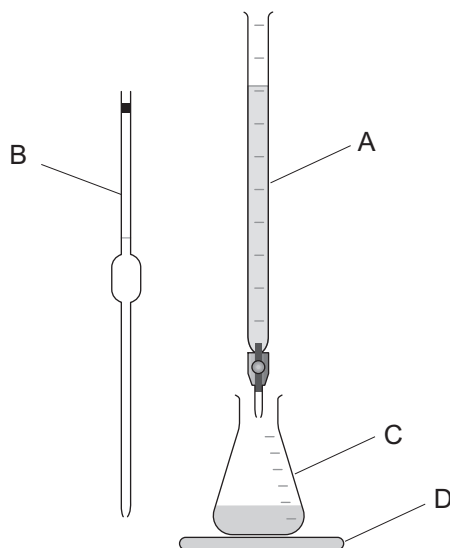
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6 Citric acid is found in many fruit juices. A titration was carried out using a solution of citric acid.

25.0 cm³ of the citric acid solution were titrated against sodium hydroxide solution. The indicator used was phenolphthalein.

(a) Some of the pieces of apparatus used in the titration are labelled A, B, C and D in the diagram below.



(i) Name the pieces of apparatus labelled A, B, C and D.

A _____

B _____

C _____

D _____

[4]

(ii) Apart from the apparatus above, a retort stand, boss and clamp, state one other essential piece of apparatus for the titration.

_____ [1]

(iii) State the colour change at the end point in this titration.

From _____ to _____

[2]



(b) The results of this titration are shown in the table below.

	Initial burette reading /cm ³	Final burette reading /cm ³	Titre /cm ³
Rough titration	0.0	33.9	33.9
First accurate titration	0.0	33.1	33.1
Second accurate titration	0.0	32.9	32.9

(i) Calculate the average titre.

average titre = _____ cm³ [1]

(ii) Citric acid has the formula C₆H₈O₇. Calculate the relative formula mass (M_r) of citric acid.

relative formula mass = _____ [1]

THIS IS THE END OF THE QUESTION PAPER



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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	

Total Marks	
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Examiner Number

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24GCM2124



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

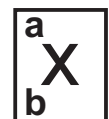
gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

																		0
		<div style="display: flex; justify-content: center; align-items: center; gap: 10px;"> <div style="border: 1px solid black; padding: 5px; text-align: left;"> 1 H Hydrogen 1 </div> </div>																4
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 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