



Rewarding Learning

General Certificate of Secondary Education
2024

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 1

Higher Tier

MV24

[GCM12]

WEDNESDAY 22 MAY, MORNING

Time

1 hour 15 minutes, plus your additional time allowance.

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 on blank pages.

Complete in black ink only.

Answer **all five** questions.

Information for Candidates

The total mark for this paper is 80.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **4(c)**.

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

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(Questions start overleaf)

1 The positions of some elements in the Periodic Table are shown opposite.

(a) Select the correct **symbol** from the Periodic Table opposite to answer the following questions.

(i) Which element has five electrons in the outer shell of its atom?
[1 mark]

(ii) Which element has three shells containing electrons in its atom?
[1 mark]

(iii) Which element forms an ion with a charge of 2-? [1 mark]

(iv) Which element is a transition metal?
[1 mark]

(v) Which element forms an ion with the same electronic configuration as argon? [1 mark]

(b) Group 1 of the Periodic Table contains reactive elements. They show similar chemical properties and there is a trend in reactivity down the group.

(i) How are the Group 1 elements stored in the laboratory? [1 mark]

(ii) State the name by which the Group 1 elements are known. [1 mark]

(iii) Explain why the Group 1 elements show similar chemical properties. [1 mark]

(iv) State and explain the trend in reactivity down Group 1. [3 marks]

Trend: _____

Explanation: _____

(c) Group 1 elements react vigorously with cold water.

(i) State two observations which are made when a piece of potassium reacts with cold water but are not made when a piece of lithium reacts with cold water. [2 marks]

1. _____

2. _____

(ii) Write a half equation for the formation of a potassium ion from a potassium atom. [2 marks]

2 Magnesium chloride and hydrogen chloride are compounds of chlorine.

(a) (i) Draw a dot and cross diagram to show how magnesium chloride forms from atoms of magnesium and chlorine. [6 marks]

(ii) State two physical properties of magnesium chloride. [2 marks]

1. _____

2. _____

(b) (i) Draw a dot and cross diagram to show the bonding in a molecule of hydrogen chloride. Label a lone pair of electrons in the diagram.
[2 marks]

(ii) Write a balanced symbol equation for the formation of hydrogen chloride from hydrogen and chlorine.
[3 marks]

(c) Complete the table below to give the name of bonding and type of structure which are found in magnesium chloride and in hydrogen chloride. [4 marks]

| Compound | Bonding | Structure |
|--------------------|----------------|------------------|
| magnesium chloride | | |
| hydrogen chloride | | |

3 Acidic, neutral and alkaline solutions may be classified using indicators.

(a) Complete the table below. [3 marks]

| Solution | pH | Indicator | Colour of indicator |
|-------------------|-----------|---------------------|----------------------------|
| sodium hydroxide | 12 | phenolphthalein | |
| hydrochloric acid | | universal indicator | |

(b) Sulfuric acid is a strong acid that ionises completely in water.

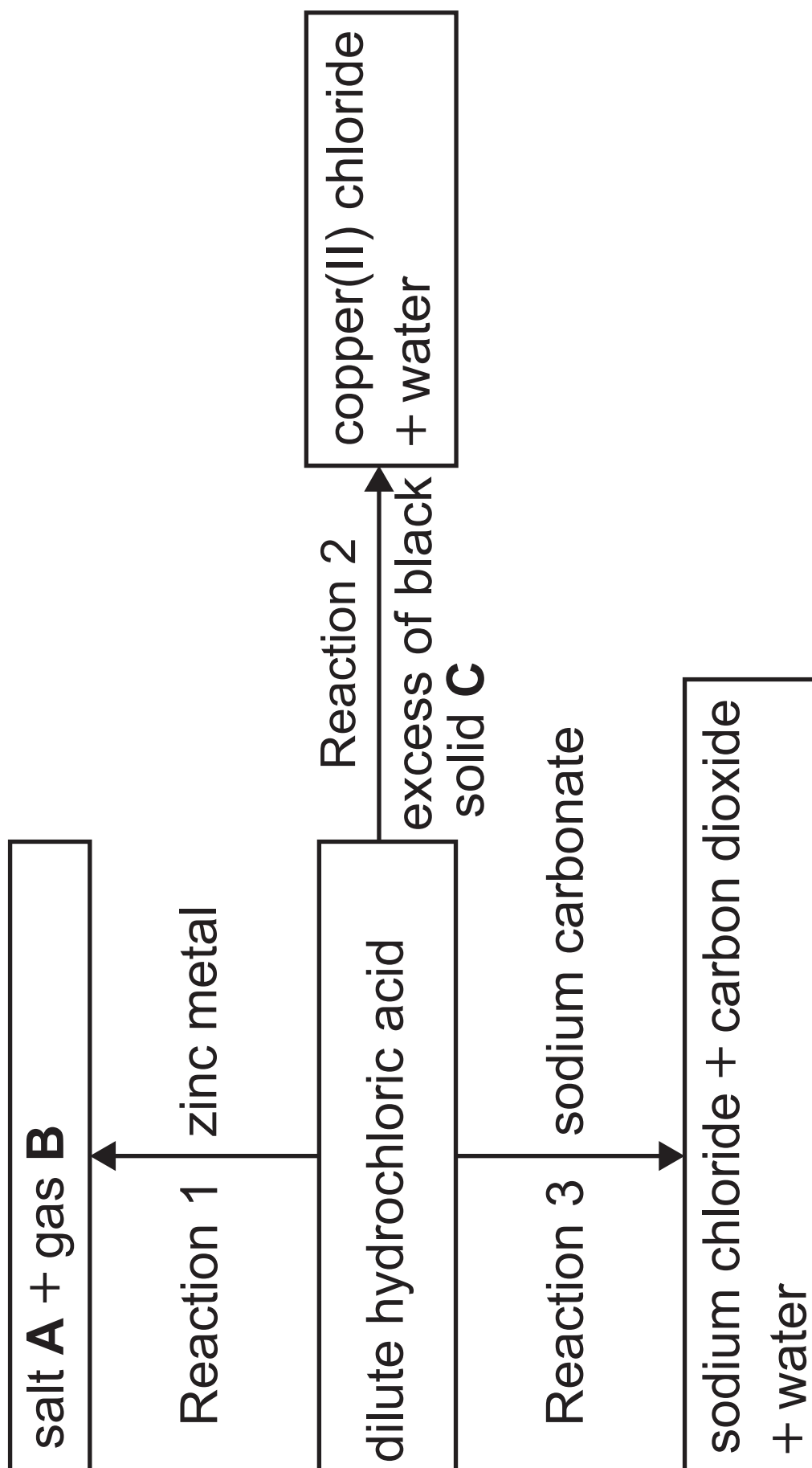
(i) Write an ionic equation to show the complete ionisation of sulfuric acid.
[3 marks]

(ii) State how the pH of a sulfuric acid solution changes as the concentration of hydrogen ions increases.
[1 mark]

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(Questions continue overleaf)

(c) The diagram below shows three reactions used to prepare soluble salts.



(i) What is meant by the term salt?
[2 marks]

(ii) Write the formula of salt **A** produced in Reaction 1. [1 mark]

(iii) Identify gas **B** produced in Reaction 1 and describe a test used to confirm the identity of this gas. [2 marks]

Gas **B**: _____

Test: _____

(iv) Write the formula of the black solid **C** used in Reaction 2. [1 mark]

(v) Explain why an excess of black solid **C** is used in Reaction 2. [1 mark]

(vi) Write a balanced symbol equation for Reaction 3. [3 marks]

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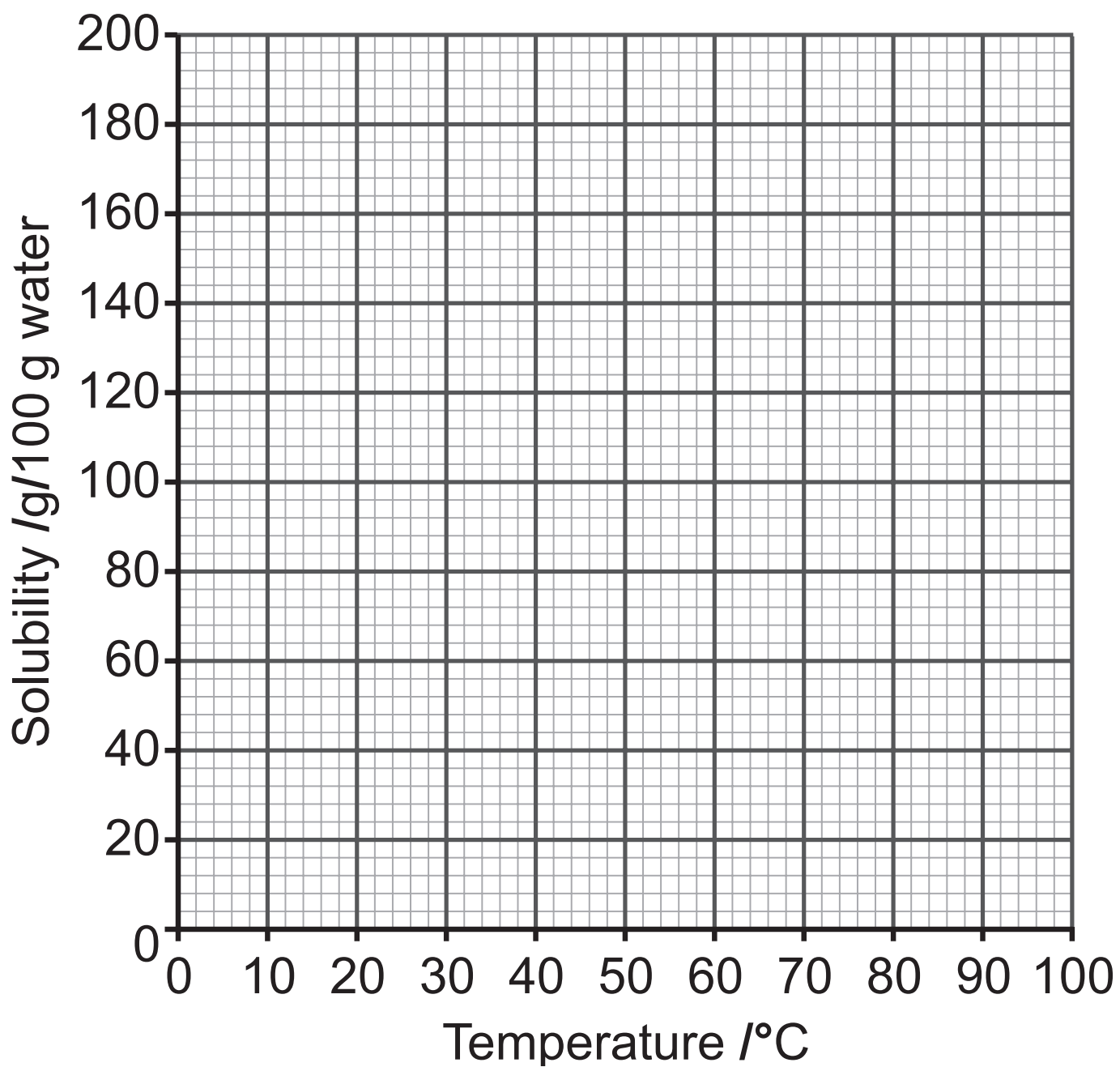
(Questions continue overleaf)

4 The oceans and seas are valuable sources of many chemical compounds which are dissolved in the water.

The table below gives solubility values of a solid obtained from sea water.

| | | | | | | |
|------------------------------------|----|----|-----|-----|-----|-----|
| Temperature /°C | 0 | 20 | 40 | 60 | 80 | 100 |
| Solubility of solid /g/100 g water | 80 | 87 | 100 | 120 | 145 | 178 |

(a) Plot a solubility curve for the solid on the axes opposite using the data in the table.
[3 marks]



(b) Use the solubility data and the graph you have drawn in **(a)** to answer the following questions.

(i) What is the solubility of the solid at 90°C? [1 mark]

_____ g/100 g water

(ii) 28 g of the solid are mixed with 25 g of water at 60°C. Explain whether the solution formed is saturated or unsaturated. [2 marks]

(iii) Calculate the mass of solid that will crystallise when a saturated solution containing 40 g of water at 70°C is cooled to 20°C. [4 marks]

mass of solid = _____ g

(c) Sea water contains dissolved magnesium ions and chloride ions.

Describe chemical tests that could be carried out on a sample of sea water to confirm the presence of magnesium ions and of chloride ions. [6 marks]

Your answer should include:

- the reagents used in each test
- the results for a positive test
- ionic equations for any reactions which occur.

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

- 5 Silica gel is a desiccant which is often found in small packets in boxes of shoes and optical equipment.



A small quantity of anhydrous cobalt(II) chloride, CoCl_2 , may be added to the silica gel. A colour change from blue to pink is observed as the silica gel absorbs water. The pink colour indicates that the silica gel is no longer effective.

- (a) (i) Suggest what is meant by the term desiccant. [1 mark]

(ii) Name another compound which could be used in place of anhydrous cobalt(II) chloride. [1 mark]

(b) A solution containing 0.15 moles of cobalt(II) chloride is mixed with another solution containing 0.26 moles of potassium hydroxide. A precipitate of cobalt(II) hydroxide forms. The equation for the reaction is:



(i) How many moles of potassium hydroxide are required to react with 0.15 moles of cobalt(II) chloride? [1 mark]

(ii) Which reactant is the limiting reactant? [1 mark]

(iii) How many moles of cobalt(II) hydroxide are formed? [1 mark]

(iv) Calculate the mass of cobalt(II) hydroxide formed. Give your answer to 1 decimal place. [2 marks]

mass of cobalt(II) hydroxide = _____ g

(c) A 3.57 g sample of hydrated cobalt(II) chloride crystals, $\text{CoCl}_2 \cdot x\text{H}_2\text{O}$, was heated to constant mass. 1.95 g of solid remained after heating.

(i) Calculate the number of moles of water lost. [2 marks]

moles of water = _____

(ii) Calculate the number of moles of anhydrous cobalt(II) chloride remaining after heating to constant mass. [1 mark]

moles of anhydrous cobalt(II) chloride = _____

(iii) Calculate the value of x in
 $\text{CoCl}_2 \cdot x\text{H}_2\text{O}$. [1 mark]

x = _____

(d) Cobalt(II) oxide reacts with oxygen at 700°C to form Co_3O_4 as shown in the equation below.



Calculate the mass of Co_3O_4 , in kg, formed from the reaction of 945 g of cobalt(II) oxide with excess oxygen. Give your answer to 2 decimal places. [4 marks]

mass of Co_3O_4 = _____ kg

**This is the end of the
question paper**

SOURCE

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|-------------------------|-------|
| Question Number | Marks |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| Total Marks | |

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

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 |

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

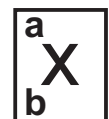
gcse examinations chemistry

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



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 |