Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2017–2018

# Science: Single Award

## Unit 2 (Chemistry)
## Higher Tier

GSS22

## [GSS22]

## THURSDAY 8 NOVEMBER 2018, 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.
Write your answers in the spaces provided in this question paper.
Answer **all ten** questions.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 75.
Quality of written communication will be assessed in Questions **4(a)** and **9**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.

| For Examiner's use only | |
|---|---|
| Question Number | Marks |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Total Marks | |

| Examiner Only | |
|---|---|
| Marks | Remark |

**1** Coal, oil and gas are fossil fuels that are useful sources of energy.

**(a)** Complete the following sentences.

The main chemical element in coal is _____.

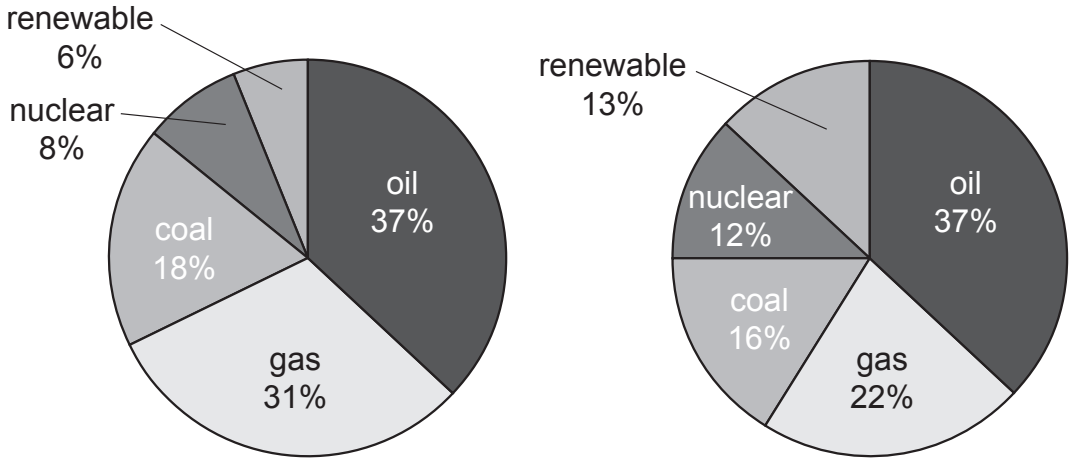
Natural gas ($CH_4$) contains the elements

_____ and _____.

A molecule containing **only** the two elements found in $CH_4$ can be

described as a _____. [3]

**(b)** The pie charts below show the percentage of different energy sources used in the USA and in Europe.






**(i)** Calculate the total percentage of coal, oil and gas used in **Europe**.

_____ % [1]

**(ii)** State **one** similarity and **one** difference in the energy sources used in the USA and in Europe as shown in the pie charts above.

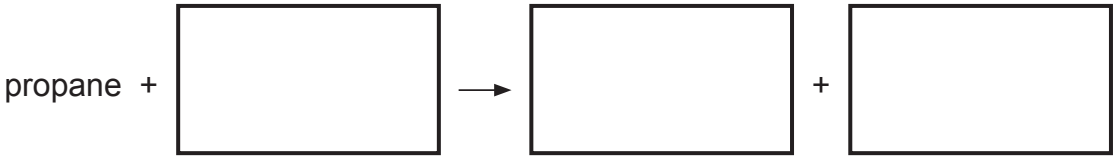
Similarity _____

_____

Difference _____

_____ [2]

**(c)** Propane can be used as a fuel. Complete the word equation below for the combustion of propane.




[2]

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

| Examiner Only | |
|---|---|
| Marks | Remark |

**2** Thermochromic plastic is an example of a smart material, it changes colour as temperature changes. It is used in making baby bottles and forehead thermometers.

**(a)** What is meant by the term **smart material**?

_____

_____ [2]

**(b)** The table below gives information about the colour changes of four thermochromic plastics (**P**, **Q**, **R** and **S**) as they are heated.

| | Temperature at which colour changes/°C | | | |
|---|---|---|---|---|
| **Plastic** | **Red** | **Green** | **Blue** | **Black** |
| **P** | 20 | 21 | 25 | 41 |
| **Q** | 36 | 39 | 41 | 45 |
| **R** | 25 | 70 | 100 | 105 |
| **S** | 34 | 36 | 38 | 40 |

A child's temperature is normally around 36°C, but when they are ill it can go as high as 38°C.

**(i)** Which plastic (**P**, **Q**, **R** or **S**) would be most suitable to make a forehead thermometer to show if a child is ill?

_____ [1]

The following instructions were given to make up a bottle of powdered milk for a baby.

1. Boil water in a kettle to 100°C to kill the bacteria that cause illness.
2. Fill the baby bottle with the boiled water.
3. Allow the water to cool, but not below 70°C.
4. Add the powdered milk to the bottle.
5. Leave to cool to room temperature.

*© TEK Image / Science Photo Library*

**(ii)** Explain fully why the colour changes of plastic **R** would make it most suitable to manufacture baby bottles.

_____

_____

_____

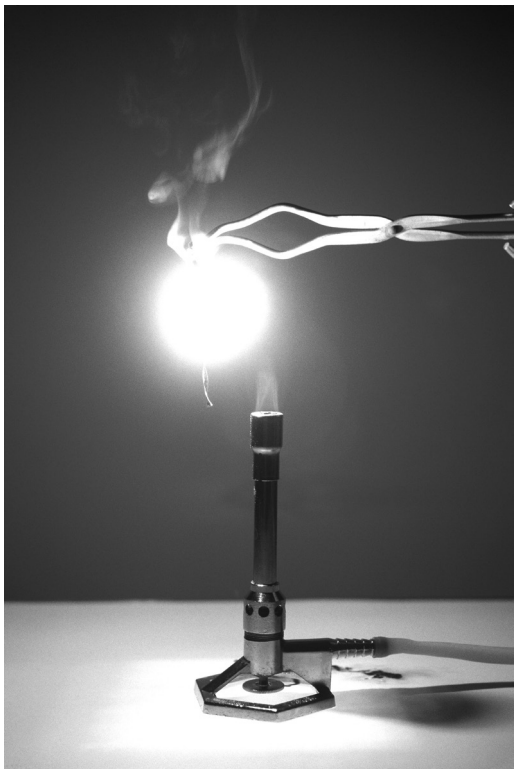
_____ [2]

Examiner Only

| Marks | Remark |
|---|---|
| | |

| Examiner Only | |
|---|---|
| Marks | Remark |

**3** **(a)** Magnesium burns in oxygen to form magnesium oxide as shown in the photograph below.



*Source: © Charles D Winters/Science Photo Library*

**(i)** Describe the appearance of magnesium **before** it is burnt.

_____ [1]

**(ii)** Describe **one** observation that could be made during this reaction.

_____ [1]

**(iii)** Describe the appearance of magnesium oxide **after** the reaction.

_____ [1]

**(b)** In this reaction oxygen is added to magnesium. What name is given to this **type** of reaction?

_____ [1]

| Examiner Only | |
|---|---|
| Marks | Remark |

**4** **(a)** Describe how you could carry out an investigation to determine if a sample of water was temporary hard water.

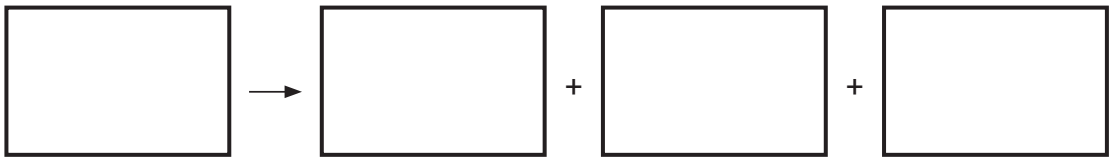
Your answer should include:

- the name of **one** metal ion that causes hard water
- how to make the investigation a fair test
- the result you would expect for temporary hard water

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

[6]

**(b)** Hard water can form undesirable deposits known as 'fur' in kettles. Write a balanced symbol equation for the formation of 'fur'.



[3]

| Examiner Only | |
|---|---|
| Marks | Remark |

**5** The diagrams below show the Earth 150 million years ago and as it is in the present day.

**150 million years ago**

*© Claus Lunau / Science Photo Library*

**present day**

*© Mikkel Juul Jensen / Science Photo Library*

The German geophysicist Alfred Wegener proposed a theory to explain the differences.

**(a)** Name and describe Alfred Wegener's theory.

_____

_____

_____

_____ [3]

**(b)** Scientists can find the age of the Earth by dating rocks.

**(i)** What name is given to the modern method of dating rocks?

_____ [1]

**(ii)** What age is the Earth according to this modern method?

_____ [1]

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**(Questions continue overleaf)**

| Examiner Only | |
|---|---|
| Marks | Remark |

**6** **(a)** Most mobile phones use lithium-ion batteries.
The lithium is used with other elements in the positive electrode while graphite is used in the negative electrode.


*© TEK Image / Science Photo Library*

**(i)** Suggest **one** property that graphite must have to make it suitable to use as an electrode.

_____ [1]

**(ii)** Graphite is a form of carbon. An atom of carbon has 6 electrons. Draw a diagram below to show the electron arrangement of a carbon atom.

[1]

| Examiner Only | |
|---|---|
| Marks | Remark |

**(b)** In making the positive electrode, some batteries use lithium cobalt oxide ($LiCoO_2$) and others use lithium manganese oxide ($LiMn_2O_4$).

In terms of the **numbers of elements** present give one similarity and one difference between these two compounds.

Similarity _____

_____

Difference _____

_____ [2]

**(c)** The battery casing is made from aluminium. Aluminium has to be extracted from its ore but aluminium that has been used can be easily recycled.

**(i)** Name the method used to extract aluminium from its ore.

_____ [1]

**(ii)** Electrodes are used during the extraction of aluminium. What name is given to the negative electrode?

_____ [1]

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

_____ [1]

**(iv)** Give **one** reason why recycling aluminium is important.

_____

_____ [1]

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**7** **(a)** The diagram below represents the four elements identified by the Greeks.


*© tassel78 / iStock / Thinkstock*

**(i)** Name the four elements the Greeks used.

**A** _____

**F** _____

**W** _____

**E** _____ [2]

**(ii)** Suggest one reason why these four Greek elements do **not** appear in the modern Periodic Table.

_____

_____ [1]

| Examiner Only | |
|---|---|
| Marks | Remark |

**(b)** John Newlands and Dmitri Mendeleev are two scientists that contributed to the development of the Periodic Table.

**(i)** Name the theory put forward by John Newlands.

_____ [1]

**(ii)** In what order did Mendeleev put the elements in his periodic table?

_____ [1]

**(iii)** Explain fully why Mendeleev did **not** have the noble gases in his periodic table.

_____

_____ [2]

**(c)** Shown below are the elements of the first two Groups of the modern Periodic Table.

| Group 1 | Group 2 |
|---|---|
| Li | Be |
| Na | Mg |
| K | Ca |
| Rb | Sr |
| Cs | Ba |
| Fr | Ra |

**(i)** What name is given to the elements in Group 1 of the Periodic Table?

_____ [1]

**(ii)** Name the most reactive metal shown in the table above.

_____ [1]

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**(d)** Potassium reacts with oxygen to form potassium oxide ($K_2O$).

**(i)** Balance the symbol equation below for the formation of potassium oxide.

$$K \quad + \quad O_2 \quad \longrightarrow \quad K_2O$$

[1]

**(ii)** Complete the table below giving the total number of each named particle in potassium oxide ($K_2O$).

You may find your Data Leaflet useful.

| Particle | Number |
|---|---|
| electron | |
| proton | |
| neutron | |

[3]

**(iii)** Which of the particles named in the table has the lowest mass?

_____ [1]

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**(Questions continue overleaf)**

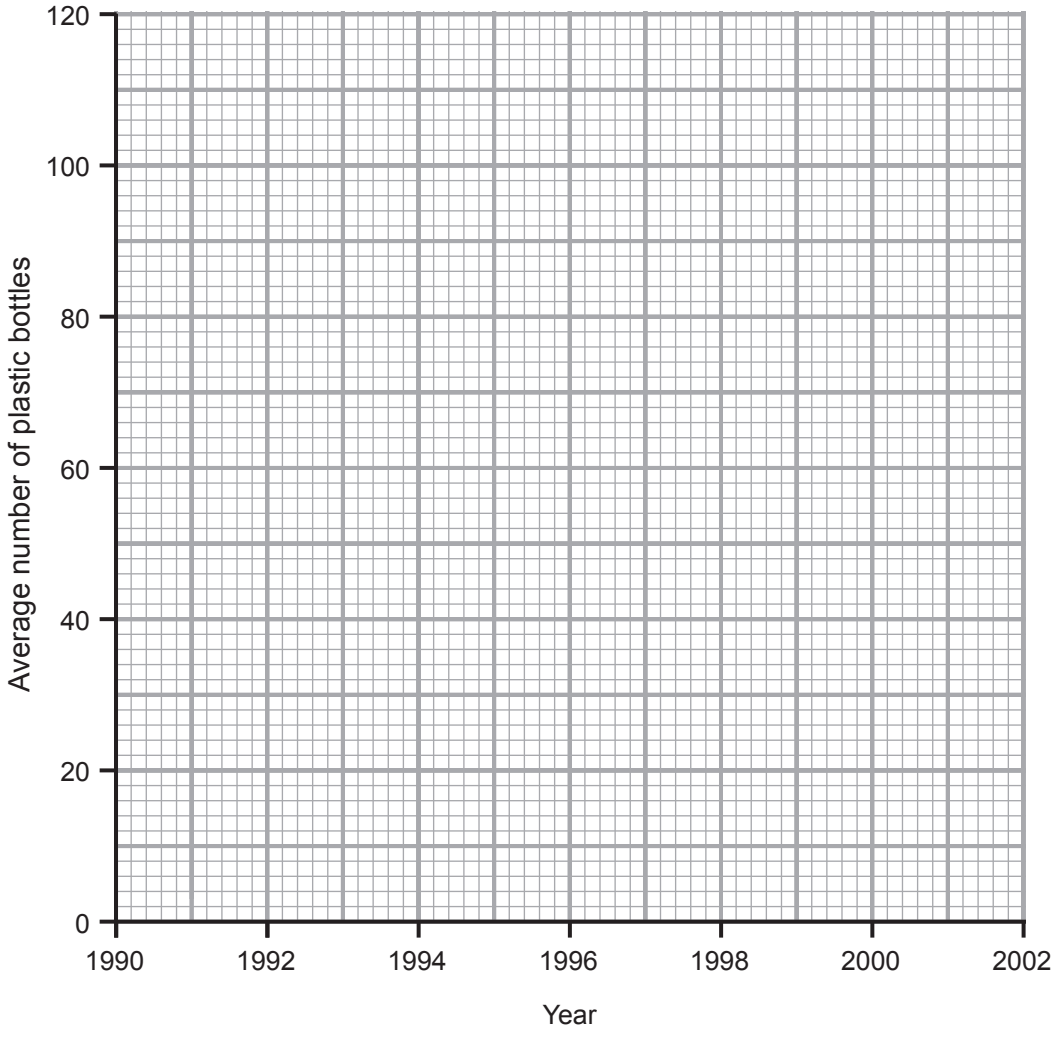
| Examiner Only | |
|---|---|
| Marks | Remark |

**8** **(a)** The table below shows how the average number of plastic bottles thrown away (per person) changed from 1990 to 2002.

| Year | Average number of plastic bottles |
|---|---|
| 1990 | 22 |
| 1992 | 22 |
| 1994 | 24 |
| 1996 | 37 |
| 1998 | 58 |
| 2000 | 80 |
| 2002 | 120 |

*© Plastic Pollution in the Pacific / http://plasticpollutioninthepacific.yolasite.com/stats.php*

**(i)** On the grid below plot a line graph for this information.




[3]

**(ii)** Describe fully the trend shown by this information.

_____

_____

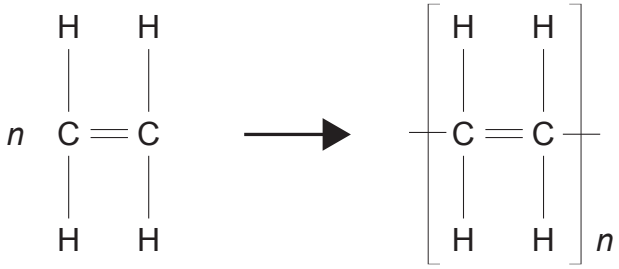
_____ [2]

**(b)** Plastics are made by a process called polymerisation.

**(i)** Name the polymer formed during the polymerisation of ethene.

_____ [1]

A student writes the following balanced symbol equation for the polymerisation of ethene.




**(ii)** The student has made a mistake in the equation. Circle the mistake and explain why it is incorrect.

_____

_____ [1]

Examiner Only

| Marks | Remark |
|---|---|
| | |

| Examiner Only | |
|---|---|
| Marks | Remark |

**9** Baking powder is a mixture of sodium hydrogencarbonate and tartaric acid. It is used in making cakes.

*© adphoto81 / iStock / Thinkstock*

When a cake is made **two** different chemical reactions take place. The sodium hydrogencarbonate is affected by heat and it also reacts with the tartaric acid.

Describe fully why sodium hydrogencarbonate is useful in making cakes.

Your answer should include:

- the type of reaction taking place when it is heated and the products formed
- the type of reaction taking place when it reacts with tartaric acid and the products formed.

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

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

[6]

**10** Thomas carried out an investigation in which he reacted different metals with solutions of their compounds. Some of his observations are shown below.

| Reactants | Observations |
|---|---|
| copper + iron(II) sulfate solution | no reaction |
| copper + silver nitrate solution | colourless solution turned blue, silver coloured solid formed |
| silver + copper(II) sulfate solution | no reaction |
| zinc + iron(II) sulfate solution | pale green solution turned colourless, grey solid formed |
| iron + copper(II) sulfate solution | blue solution turned pale green, pink/brown solid formed |

**(a)** What name is given to the **type** of reaction Thomas is investigating?

_____ [1]

**(b)** Place the four metals in order of reactivity. Place the most reactive first.

_____

_____

_____

_____

most reactive

↓

least reactive

[2]

Examiner Only

| Marks | Remark |
|---|---|
| | |

**(c)** Thomas also added magnesium to a solution of copper(II) sulfate and a reaction took place.

**(i)** Give **two** observations he would expect for this reaction.

1. _____

2. _____ [2]

**(ii)** Name the **two** products formed in this reaction.

1. _____

2. _____ [2]

**(d)** Suggest why Thomas was advised by his teacher **not** to use sodium in this investigation.

_____

_____ [1]

**(e)** If Thomas added iron to zinc sulfate solution what, if anything, would he observe?

_____

_____ [1]

**THIS IS THE END OF THE QUESTION PAPER**

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

113159

## 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 |
|---|---|
| Carbonate | $CO_3^{2-}$ |
| Dichromate | $Cr_2O_7^{2-}$ |
| Ethanoate | $CH_3COO^-$ |
| Hydrogen carbonate | $HCO_3^-$ |
| Hydroxide | $OH^-$ |
| Methanoate | $HCOO^-$ |
| Nitrate | $NO_3^-$ |
| Sulfate | $SO_4^{2-}$ |
| Sulfite | $SO_3^{2-}$ |

## SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

| Soluble |
|---|
| All sodium, potassium and ammonium salts |
| All nitrates |
| Most chlorides, bromides and iodides<br>EXCEPT<br>silver and lead chlorides, bromides and iodides |
| Most sulfates<br>EXCEPT<br>lead and barium sulfates<br>Calcium sulfate is slightly soluble |

| Insoluble |
|---|
| Most carbonates<br>EXCEPT<br>sodium, potassium and ammonium carbonates |
| Most hydroxides<br>EXCEPT<br>sodium, potassium and ammonium hydroxides |
| Most oxides<br>EXCEPT<br>sodium, potassium and calcium oxides which react with water |

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# DATA LEAFLET

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.**

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Rewarding Learning

# THE PERIODIC TABLE OF ELEMENTS

## Group

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 H Hydrogen 1 | | | | | | | | | | 4 He Helium 2 |
| 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 | 99 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 | 263 Sg Seaborgium 106 | 262 Bh Bohrium 107 | 265 Hs Hassium 108 | 266 Mt Meitnerium 109 | 269 Ds Darmstadtium 110 | 272 Rg Roentgenium 111 | 285 Cn Copernicium 112 | | | | | | |

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

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

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 147 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 |