Write your name here

| Surname | Other names |
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**Edexcel GCE**

| Centre Number | Candidate Number |
|---|---|
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# Chemistry

## Advanced Subsidiary
## Unit 1: The Core Principles of Chemistry

Thursday 13 January 2011 – Morning
**Time: 1 hour 30 minutes**

Paper Reference
**6CH01/01**

**Candidates may use a calculator.**

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

## Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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N 3 7 9 6 2 A 0 1 2 4

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## SECTION A

**Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** The compound butane has

☒ **A** the empirical formula $C_4H_{10}$ and the molecular formula $C_2H_5$.

☒ **B** the empirical formula $C_2H_5$ and the molecular formula $C_4H_{10}$.

☒ **C** the empirical formula $C_2H_5$ and the molecular formula $C_nH_{2n+2}$.

☒ **D** the empirical formula $C_nH_{2n+2}$ and the molecular formula $C_4H_{10}$.

**(Total for Question 1 = 1 mark)**

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**2** For the oxidation of ammonia

$$a\ NH_3 + b\ O_2 \rightarrow c\ NO + d\ H_2O$$

the values of the coefficients in the balanced equation are

☒ **A** a = 2, b = 3, c = 2 and d = 3

☒ **B** a = 4, b = 7, c = 4 and d = 4

☒ **C** a = 4, b = 5, c = 4 and d = 6

☒ **D** a = 6, b = 7, c = 6 and d = 9

**(Total for Question 2 = 1 mark)**

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**3** The Avogadro constant is $6.0 \times 10^{23}$ $mol^{-1}$. Therefore the number of **atoms** in 1 mol of carbon dioxide is

☒ **A** $2.0 \times 10^{23}$

☒ **B** $6.0 \times 10^{23}$

☒ **C** $1.2 \times 10^{24}$

☒ **D** $1.8 \times 10^{24}$

**(Total for Question 3 = 1 mark)**

---

**4** The equation for the complete combustion of octane is

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(a) The mass of 10 mol of octane is

**(1)**

☒ **A** 0.66 kg

☒ **B** 1.14 kg

☒ **C** 2.10 kg

☒ **D** 2.28 kg

(b) The volume of 1 mol of any gas (measured at room temperature and pressure) is 24 $dm^3$. Hence the volume of oxygen (measured at room temperature and pressure) required for the complete combustion of 10 mol of octane is

**(1)**

☒ **A** 240 $dm^3$

☒ **B** 300 $dm^3$

☒ **C** 3000 $dm^3$

☒ **D** 6000 $dm^3$

**(Total for Question 4 = 2 marks)**

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**5** The enthalpy change for the reaction

$$CH_4(g) \rightarrow C(g) + 4H(g)$$

is +1648 kJ $mol^{-1}$. Hence the mean bond enthalpy for the C–H bond is

☒ **A** +329.6 kJ $mol^{-1}$

☒ **B** +412.0 kJ $mol^{-1}$

☒ **C** +1648 kJ $mol^{-1}$

☒ **D** +6592 kJ $mol^{-1}$

**(Total for Question 5 = 1 mark)**

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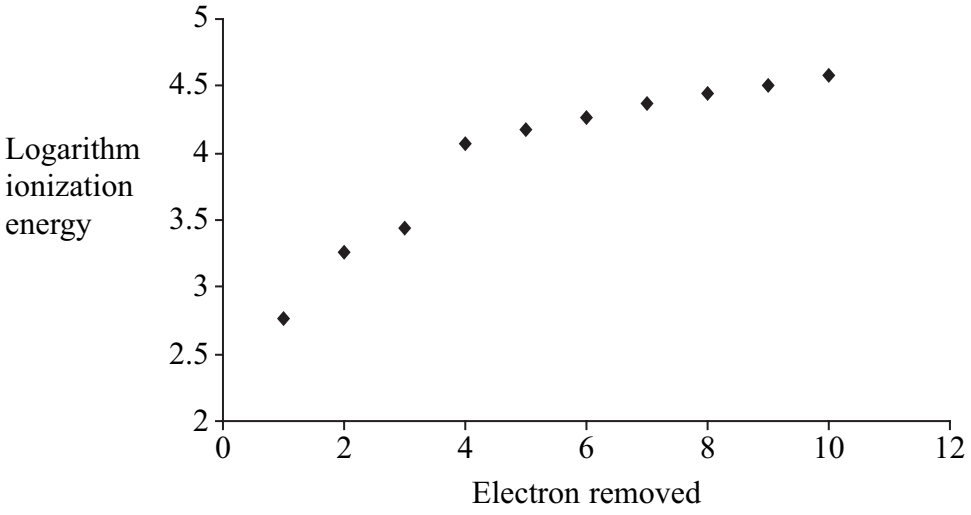
**6** The graph below represents the successive ionization energies of an element **X** plotted against the number of the electron removed. **X** is not the symbol for the element.




(a) From this graph it is possible to deduce the group in the Periodic Table to which **X** belongs. **X** is in

**(1)**

☒ **A** Group 1

☒ **B** Group 3

☒ **C** Group 5

☒ **D** Group 7

(b) From the graph it is possible to deduce that the most stable ion of **X** will be

**(1)**

☒ **A** $X^{3+}$

☒ **B** $X^{+}$

☒ **C** $X^{-}$

☒ **D** $X^{3-}$

**(Total for Question 6 = 2 marks)**

**Use this space for any rough working. Anything you write in this space will gain no credit.**

**7** Element **R** is in Group 1 of the Periodic Table and element **T** is in Group 6. **R** and **T** are not the symbols for the elements.

(a) The compound of **R** and **T** will have the formula

**(1)**

☒ **A** RT

☒ **B** $RT_6$

☒ **C** $RT_2$

☒ **D** $R_2T$

(b) The compound of **R** and **T** will have bonding which is predominantly

**(1)**

☒ **A** ionic.

☒ **B** covalent.

☒ **C** dative covalent.

☒ **D** metallic.

(c) In terms of its electrical conductivity, the compound of **R** and **T** will

**(1)**

☒ **A** conduct when solid and liquid.

☒ **B** conduct when solid but not when liquid.

☒ **C** conduct when liquid but not when solid.

☒ **D** not conduct when solid or liquid.

**(Total for Question 7 = 3 marks)**

**Use this space for any rough working. Anything you write in this space will gain no credit.**

**8** Ethane reacts with chlorine when the substances are exposed to UV radiation.

(a) The equation for this reaction is

**(1)**

☒ **A** $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

☒ **B** $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

☒ **C** $C_2H_6 + Cl_2 \rightarrow 2CH_3Cl$

☒ **D** $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$

(b) The role of the UV radiation in the reaction is to

**(1)**

☒ **A** break the Cl—Cl bond forming Cl• free radicals.

☒ **B** break the Cl—Cl bond forming $Cl^+$ and $Cl^-$ ions.

☒ **C** break the C—C bond in ethane forming $CH_3$• free radicals.

☒ **D** break a C—H bond in ethane forming $C_2H_5$• free radicals.

(c) The overall reaction between ethane and chlorine is best described as

**(1)**

☒ **A** addition.

☒ **B** homolytic fission.

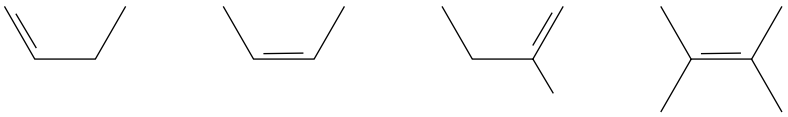
☒ **C** heterolytic fission.

☒ **D** substitution.

**(Total for Question 8 = 3 marks)**

**Use this space for any rough working. Anything you write in this space will gain no credit.**

**9** This question concerns the following compounds



**A** **B** **C** **D**

Which of these compounds will show geometric (*E–Z* or *cis/trans*) isomerism?

☒ **A**

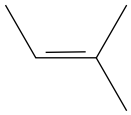
☒ **B**

☒ **C**

☒ **D**

**(Total for Question 9 = 1 mark)**

**10** The correct name for the compound shown below is



☒ **A** 2-methylbut-3-ene

☒ **B** 3-methylbut-2-ene

☒ **C** 3-methylbut-3-ene

☒ **D** 2-methylbut-2-ene

**(Total for Question 10 = 1 mark)**

**11** Most compounds of lead are insoluble, an exception being lead(II) nitrate. Therefore a good method of preparing lead(II) sulfate is

☒ **A** adding dilute sulfuric acid to lead metal.

☒ **B** adding concentrated sulfuric acid to lead metal.

☒ **C** adding dilute sulfuric acid to lead(II) nitrate solution.

☒ **D** adding dilute sulfuric acid to solid lead(II) oxide.

**(Total for Question 11 = 1 mark)**

**12** Metals usually have high melting temperatures and boiling temperatures because there are

☒ **A** strong attractions between the ions.

☒ **B** strong attractions between the delocalised electrons.

☒ **C** strong attractions between the ions and the delocalised electrons.

☒ **D** strong intermolecular forces.

**(Total for Question 12 = 1 mark)**

**13** In 2006, the concentration of carbon dioxide in the atmosphere was 382 ppm. This is equivalent to

☒ **A** 0.00382%

☒ **B** 0.0382%

☒ **C** 0.382%

☒ **D** 3.82%

**(Total for Question 13 = 1 mark)**

**14** A hazard that is particularly associated with alkanes is that they are

☒ **A** corrosive.

☒ **B** flammable.

☒ **C** toxic by inhalation.

☒ **D** toxic by skin absorption.

**(Total for Question 14 = 1 mark)**

**TOTAL FOR SECTION A = 20 MARKS**

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## SECTION B

**Answer ALL the questions. Write your answers in the spaces provided.**

**15** The relative atomic mass of an element is determined using a mass spectrometer.

(a) Define the term **relative atomic mass**.

**(2)**

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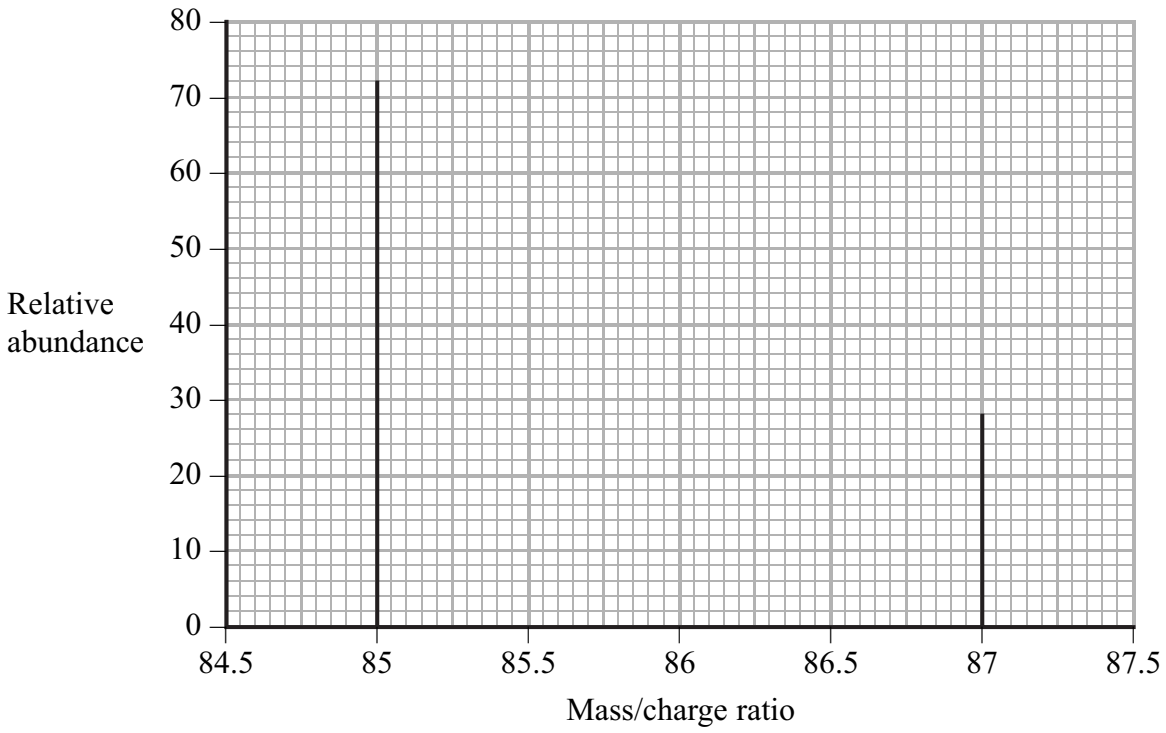
.....

(b) The mass spectrum of rubidium is shown below.




(i) Explain why there are two peaks in the spectrum.

**(1)**

.....

.....

(ii) Use the spectrum to calculate the relative atomic mass of rubidium.

**(2)**

**(Total for Question 15 = 5 marks)**

**16** (a) Coral reefs are produced by living organisms and predominantly made up of calcium carbonate. It has been suggested that coral reefs will be damaged by global warming because of the increased acidity of the oceans due to higher concentrations of carbon dioxide.

(i) Write a chemical equation to show how the presence of carbon dioxide in water results in the formation of carbonic acid. State symbols are **not** required.

**(1)**

(ii) Write the **ionic** equation to show how acids react with carbonates. State symbols are **not** required.

**(2)**

(b) One method of determining the proportion of calcium carbonate in a coral is to dissolve a known mass of the coral in excess acid and measure the volume of carbon dioxide formed.

In such an experiment, 1.13 g of coral was dissolved in 25 $cm^3$ of hydrochloric acid (an excess) in a conical flask. When the reaction was complete, 224 $cm^3$ of carbon dioxide had been collected over water using a 250 $cm^3$ measuring cylinder.

(i) Draw a labelled diagram of the apparatus that could be used to carry out this experiment.

**(2)**

(ii) Suggest how you would mix the acid and the coral to ensure that no carbon dioxide escaped from the apparatus.

**(1)**

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.....

.....

(iii) Calculate the number of moles of carbon dioxide collected in the experiment.

[The molar volume of any gas is 24 000 $cm^3\ mol^{-1}$ at room temperature and pressure.]

**(1)**

(iv) Complete the equation below for the reaction between calcium carbonate and hydrochloric acid by inserting the missing state symbols.

**(1)**

$CaCO_3$(.....) + 2HCl(.....) → $CaCl_2$(.....) + $H_2O$(l) + $CO_2$(.....)

(v) Calculate the mass of 1 mol of calcium carbonate.

[Assume relative atomic masses: Ca = 40, C = 12, O = 16.]

**(1)**

(vi) Use your data and the equation in (iv) to calculate the mass of calcium carbonate in the sample and the percentage by mass of calcium carbonate in the coral. Give your final answer to **three** significant figures.

**(2)**

(vii) When this experiment is repeated, the results are inconsistent. Suggest a reason for this other than errors in the procedure, measurements or calculations.

**(1)**

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.....

**(Total for Question 16 = 12 marks)**

**17** This question is about the element chlorine (atomic number = 17).

(a) Complete the electronic structure of chlorine.

**(1)**

$1s^2\ 2s^2$ .....

(b) Chlorine forms compounds with magnesium and with carbon.

(i) Draw a dot and cross diagram to show the electronic structure of the compound magnesium chloride (only the outer electrons need be shown).
Include the charges present.

**(2)**

(ii) Draw a dot and cross diagram to show the electronic structure of the compound tetrachloromethane (only the outer electrons need be shown).

**(2)**

*(iii) Suggest why the melting temperature of magnesium oxide is higher than that of magnesium chloride, even though both are almost 100% ionic.

**(3)**

(c) Magnesium chloride may be prepared from magnesium by reaction with chlorine or with hydrochloric acid. Compare these two preparations in terms of the atom economies of the reactions. No calculation is required.

**(2)**

**(Total for Question 17 = 10 marks)**

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**18** Alkenes are unsaturated hydrocarbons which, because of their reactivity, are important industrial starting materials. Alkenes for industrial use are obtained by cracking alkanes.

(a) Write the equation for the cracking of decane ($C_{10}H_{22}$) to form 1 molecule of propene as the only alkene.

**(1)**

(b) The carbon–carbon double bond in alkenes consists of a σ and a π bond.

(i) Explain, using diagrams, the difference between the σ and the π bond in the carbon–carbon double bond of an alkene.

**(4)**

Diagrams

Explanation

(ii) State the type and mechanism involved in the typical reaction of alkenes.

**(1)**

*(iii) By considering the strength and structure of the π bond, explain why alkenes are more reactive than alkanes.

**(2)**

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(c) When propene reacts with hydrogen bromide, there are two possible products.

(i) Draw a displayed formula of each of these products and label the major product.

**(2)**

(ii) Give the mechanism for the reaction of propene with hydrogen bromide which forms the major product.

**(3)**

(iii) Explain, by referring to the mechanism, why the major product is formed.

**(2)**

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(d) The polymer poly(propene) is manufactured from propene.

(i) Write an equation for the polymerization, drawing the displayed formula of the repeat unit of poly(propene).

**(3)**

(ii) UV radiation causes poly(propene) to degrade. Suggest one advantage and one disadvantage of this.

**(2)**

Advantage .....

.....

Disadvantage .....

.....

**(Total for Question 18 = 20 marks)**

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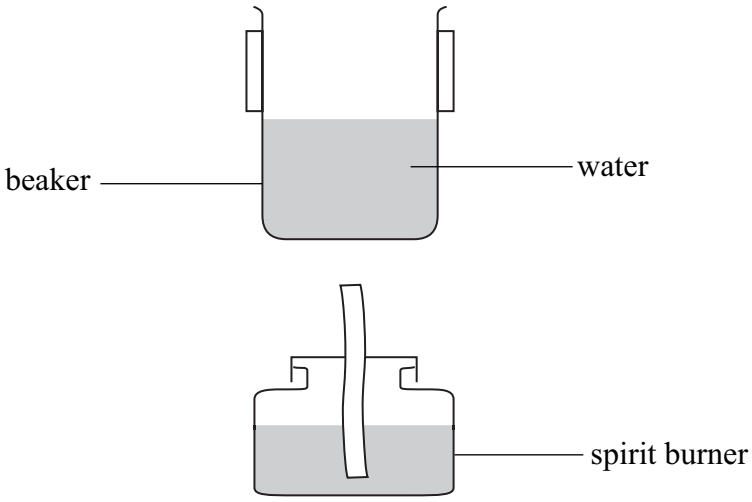
**19** The enthalpy change of combustion of ethanol was determined using the apparatus shown in the diagram below. In the experiment, the temperature increase of the water in the beaker is measured when a known mass of the ethanol is burned.




(a) The results of the experiment are summarised in the table below.

| | |
|---|---|
| Mass of water in the beaker | 250.00 g |
| Mass of spirit burner + contents (initial) | 63.21 g |
| Mass of spirit burner + contents (final) | 62.47 g |
| Temperature of water (initial) | 21.0 °C |
| Temperature of water (final) | 31.5 °C |

(i) Calculate the heat energy produced by the combustion of the alcohol using the equation

heat energy produced (J) = mass of water × 4.18 × temperature change

**(1)**

(ii) Calculate the number of moles of ethanol burned in this experiment (the formula of ethanol is $C_2H_5OH$).

**(3)**

(iii) Use the equation below to calculate the enthalpy change of combustion of ethanol in kJ $mol^{-1}$. Give the value an appropriate sign.

$$\Delta H = \text{heat energy produced} \div \text{number of moles}$$

**(2)**

(b) The data book value for the enthalpy change of combustion of ethanol is –1370 kJ $mol^{-1}$.

(i) Calculate the percentage error in the value calculated in (a)(iii) in comparison with the data book value.

**(1)**

(ii) List **three** ways in which the design of the experiment causes the results to be so different from the data book value. (You should be specific but detailed explanations are not required.)

**(3)**

1 .....

.....

2 .....

.....

3 .....

.....

(iii) Use the data book values for enthalpy changes of combustion given in the table below to calculate the enthalpy change of formation of ethanol.

**(3)**

| Substance | Enthalpy change of combustion / kJ $mol^{-1}$ |
|---|---|
| C(s, graphite) | –394 |
| $H_2(g)$ | –286 |
| $C_2H_5OH(l)$ | –1370 |

**(Total for Question 19 = 13 marks)**

**TOTAL FOR SECTION B = 60 MARKS**
**TOTAL FOR PAPER = 80 MARKS**

# The Periodic Table of Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 (8) (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | 4.0 He helium 2 |
| (1) | (2) | | Key: relative atomic mass / atomic symbol / name / atomic (proton) number | | | | | | | | | (13) | (14) | (15) | (16) | (17) | |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | | | | | | | | | | | 10.8 B boron 5 | 12.0 C carbon 6 | 14.0 N nitrogen 7 | 16.0 O oxygen 8 | 19.0 F fluorine 9 | 20.2 Ne neon 10 |
| 23.0 Na sodium 11 | 24.3 Mg magnesium 12 | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | 27.0 Al aluminium 13 | 28.1 Si silicon 14 | 31.0 P phosphorus 15 | 32.1 S sulfur 16 | 35.5 Cl chlorine 17 | 39.9 Ar argon 18 |
| 39.1 K potassium 19 | 40.1 Ca calcium 20 | 45.0 Sc scandium 21 | 47.9 Ti titanium 22 | 50.9 V vanadium 23 | 52.0 Cr chromium 24 | 54.9 Mn manganese 25 | 55.8 Fe iron 26 | 58.9 Co cobalt 27 | 58.7 Ni nickel 28 | 63.5 Cu copper 29 | 65.4 Zn zinc 30 | 69.7 Ga gallium 31 | 72.6 Ge germanium 32 | 74.9 As arsenic 33 | 79.0 Se selenium 34 | 79.9 Br bromine 35 | 83.8 Kr krypton 36 |
| 85.5 Rb rubidium 37 | 87.6 Sr strontium 38 | 88.9 Y yttrium 39 | 91.2 Zr zirconium 40 | 92.9 Nb niobium 41 | 95.9 Mo molybdenum 42 | [98] Tc technetium 43 | 101.1 Ru ruthenium 44 | 102.9 Rh rhodium 45 | 106.4 Pd palladium 46 | 107.9 Ag silver 47 | 112.4 Cd cadmium 48 | 114.8 In indium 49 | 118.7 Sn tin 50 | 121.8 Sb antimony 51 | 127.6 Te tellurium 52 | 126.9 I iodine 53 | 131.3 Xe xenon 54 |
| 132.9 Cs caesium 55 | 137.3 Ba barium 56 | 138.9 La* lanthanum 57 | 178.5 Hf hafnium 72 | 180.9 Ta tantalum 73 | 183.8 W tungsten 74 | 186.2 Re rhenium 75 | 190.2 Os osmium 76 | 192.2 Ir iridium 77 | 195.1 Pt platinum 78 | 197.0 Au gold 79 | 200.6 Hg mercury 80 | 204.4 Tl thallium 81 | 207.2 Pb lead 82 | 209.0 Bi bismuth 83 | [209] 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 | | | | | | | |

Elements with atomic numbers 112-116 have been reported but not fully authenticated

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 163 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 |

* Lanthanide series

* Actinide series