Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 9 October 2026

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH11/01**

Chemistry

International Advanced Subsidiary/Advanced Level
UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

You must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

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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 about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The numbers of subatomic particles in four species are shown.

Species	Number of protons	Number of neutrons	Number of electrons
P	11	23	11
Q	11	24	10
R	12	24	12
S	12	25	10

Which two species are ions?

☒ **A** **P** and **Q**

☒ **B** **P** and **R**

☒ **C** **Q** and **S**

☒ **D** **R** and **S**

(Total for Question 1 = 1 mark)

2 Which equation represents the **first** ionisation energy of bromine?

☒ **A** $Br(g) \rightarrow Br^{+}(g) + e^{-}$

☒ **B** $Br(g) + e^{-} \rightarrow Br^{-}(g)$

☒ **C** $Br^{-}(g) + e^{-} \rightarrow Br^{2-}(g)$

☒ **D** $\frac{1}{2}Br_2(g) \rightarrow Br^{+}(g) + e^{-}$

(Total for Question 2 = 1 mark)

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3 What is the electronic configuration of a copper atom?

- ☒ **A** [Ar] $3d^9 4s^1$
- ☒ **B** [Ar] $3d^{10} 4s^1$
- ☒ **C** [Ar] $3d^9 4s^2$
- ☒ **D** [Ar] $3d^{10} 4s^0$

(Total for Question 3 = 1 mark)

4 Which sequence shows the elements in order of **decreasing** melting temperature?

- ☒ **A** C > B > Be > Li
- ☒ **B** Li > Be > B > C
- ☒ **C** Mg > Al > Si > Na
- ☒ **D** Na > Si > Al > Mg

(Total for Question 4 = 1 mark)

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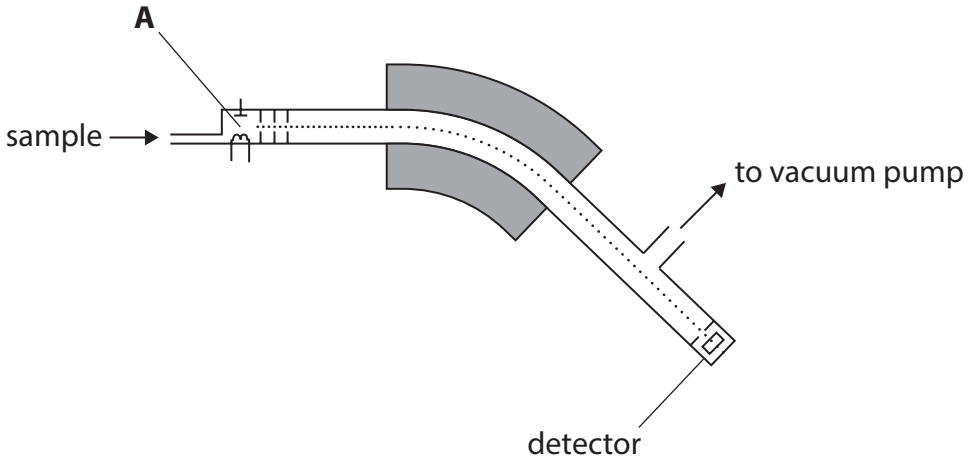
5 The diagram shows a mass spectrometer.



Which process occurs in region **A**?

- ☒ **A** acceleration of cations by an electric field
- ☒ **B** deflection of cations by a magnetic field
- ☒ **C** electrons are added to atoms or molecules, to form cations
- ☒ **D** electrons are removed from atoms or molecules, to form cations

(Total for Question 5 = 1 mark)

6 Which ion has the **greatest** polarising power?

- ☒ **A** Na^+
- ☒ **B** Mg^{2+}
- ☒ **C** K^+
- ☒ **D** Ca^{2+}

(Total for Question 6 = 1 mark)

7 Which ion has the smallest radius?

- ☒ **A** O^{2-}
- ☒ **B** F^-
- ☒ **C** Na^+
- ☒ **D** Mg^{2+}

(Total for Question 7 = 1 mark)

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8 What is the relative formula mass of $Na_2CO_3 \cdot 10H_2O$?

[Data: A_r values H = 1.0 C = 12.0 O = 16.0 Na = 23.0]

- ☒ **A** 106
- ☒ **B** 142
- ☒ **C** 274
- ☒ **D** 286

(Total for Question 8 = 1 mark)

9 Which solution contains the **smallest** number of ions?

- ☒ **A** 0.25 dm^3 of 0.080 mol dm^{-3} NaCl(aq)
- ☒ **B** 0.40 dm^3 of 0.050 mol dm^{-3} K_2SO_4(aq)
- ☒ **C** 0.30 dm^3 of 0.060 mol dm^{-3} $Ca(NO_3)_2$(aq)
- ☒ **D** 0.20 dm^3 of 0.040 mol dm^{-3} NH_4NO_3(aq)

(Total for Question 9 = 1 mark)

10 When iron is added to copper(II) sulfate solution, copper is formed.

What is the name of this type of reaction?

- ☒ **A** addition
- ☒ **B** displacement
- ☒ **C** neutralisation
- ☒ **D** precipitation

(Total for Question 10 = 1 mark)

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11 The manufacture of nitric acid involves the conversion of ammonia into nitrogen monoxide, NO. The equation for this reaction is shown.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

[Data: A_r values H = 1.0 N = 14.0 O = 16.0]

(a) What is the percentage atom economy, by mass, for the formation of NO?

(1)

- ☒ **A** 13.2%
- ☒ **B** 35.7%
- ☒ **C** 52.6%
- ☒ **D** 62.5%

(b) The yield of NO is 65% by mass.

What mass, in kg, of NH_3 is needed to produce 50 kg of NO?

(1)

- ☒ **A** 10.9
- ☒ **B** 18.4
- ☒ **C** 28.3
- ☒ **D** 43.6

(Total for Question 11 = 2 marks)

12 When one molecule of $C_{22}H_{46}$ is cracked, the products are two molecules of ethene, one molecule of butane, and two molecules of hydrocarbon **E**.

What is the molecular formula of **E**?

- ☒ **A** C_7H_{14}
- ☒ **B** C_8H_{16}
- ☒ **C** $C_{14}H_{28}$
- ☒ **D** $C_{14}H_{30}$

(Total for Question 12 = 1 mark)

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13 Which molecule is polar?

- ☒ **A** H_2S
- ☒ **B** CO_2
- ☒ **C** CCl_4
- ☒ **D** C_2H_4

(Total for Question 13 = 1 mark)

14 How many sigma bonds are there in a cyclohexene molecule?

- ☒ **A** 6
- ☒ **B** 15
- ☒ **C** 16
- ☒ **D** 18

(Total for Question 14 = 1 mark)

15 How many cycloalkanes have the molecular formula C_5H_{10}?

- ☒ **A** 3
- ☒ **B** 4
- ☒ **C** 5
- ☒ **D** 6

(Total for Question 15 = 1 mark)

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16 The Claus process involves the removal of the gaseous sulfur compounds hydrogen sulfide, H_2S, and sulfur dioxide, SO_2, from oil refinery emissions.

The process occurs in two steps.

Step **1** $H_2S(g) + 1\frac{1}{2}O_2(g) \rightarrow SO_2(g) + H_2O(g)$

Step **2** $2H_2S(g) + SO_2(g) \rightarrow 2H_2O(g) + 3S(s)$

(a) How many atoms are there in 9.74 g of H_2S?

(1)

[Data:
A_r values H = 1.0 O = 16.0 S = 32.1
Avogadro constant, $L = 6.02 \times 10^{23}\,mol^{-1}$
Molar volume of a gas at room temperature and pressure (r.t.p.) = $24.0\,dm^3\,mol^{-1}$]

☒ **A** 1.72×10^{23}

☒ **B** 5.16×10^{23}

☒ **C** 5.86×10^{24}

☒ **D** 1.76×10^{25}

(b) What is the **minimum** volume of oxygen at r.t.p. needed to produce 68.0 kg of sulfur dioxide in Step **1**?

(1)

☒ **A** $1590\,dm^3$

☒ **B** $25\,500\,dm^3$

☒ **C** $38\,200\,dm^3$

☒ **D** $76\,400\,dm^3$

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(c) In Step **2**, 6000 dm^3 of H_2S and 5000 dm^3 of SO_2 are mixed and allowed to react.

What is the **total** volume of gas at the end of this reaction?

Assume all volumes are measured at the same temperature and pressure.

(1)

☒ **A** 6000 dm^3

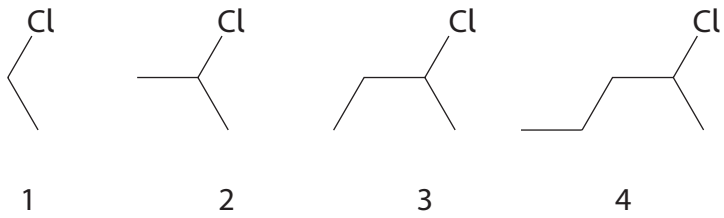
☒ **B** 8000 dm^3

☒ **C** 17 000 dm^3

☒ **D** 26 000 dm^3

(Total for Question 16 = 3 marks)

17 A sequence of four molecules is shown.



What is the molecular formula of the **fifth** molecule in the sequence?

☒ **A** CH_3Cl

☒ **B** $C_6H_{11}Cl$

☒ **C** $C_6H_{13}Cl$

☒ **D** $C_7H_{15}Cl$

(Total for Question 17 = 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.

18 This question is about phosphorus and its compounds.

(a) The first six ionisation energies of phosphorus are shown.

Ionisation number	Ionisation energy / kJ mol^{-1}
1	1012
2	1903
3	2912
4	4957
5	6274
6	21 269

Explain how the **trend** in the ionisation energy values shows that phosphorus is in Group 5 of the Periodic Table.

(2)

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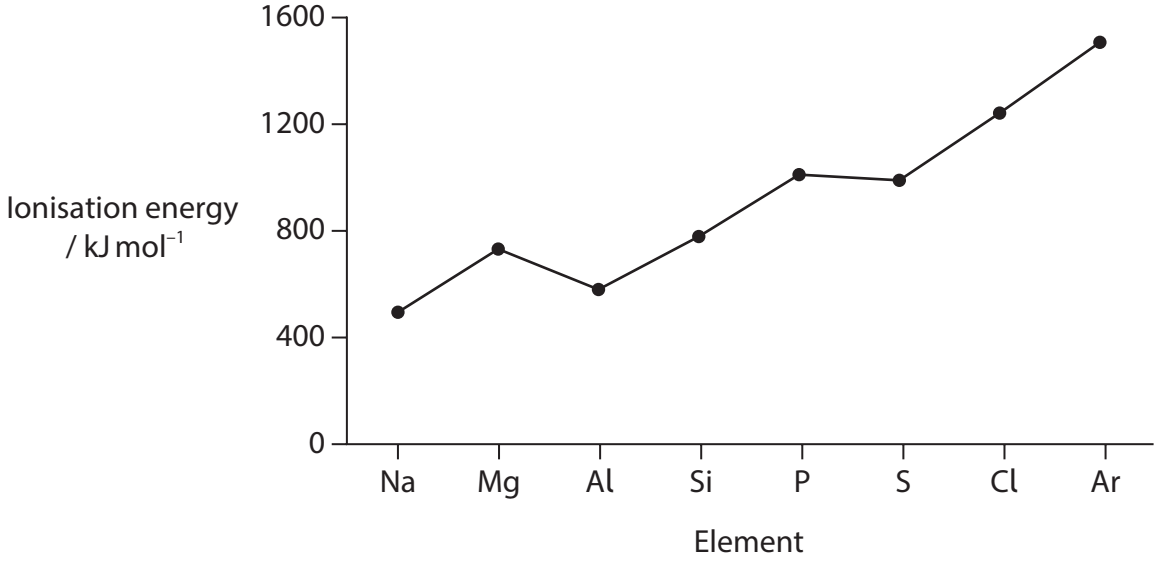
(b) The graph shows the first ionisation energies for the elements in Period 3.



(i) Explain the general increase in the first ionisation energy across Period 3.

(2)

(ii) Explain why the first ionisation energy of sulfur is less than the first ionisation energy of phosphorus.

(2)

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(c) Phosphorus(III) fluoride, PF_3, is used as a fluorinating agent.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of gaseous PF_3.
Use dots (•) for the fluorine electrons and crosses (×) for the phosphorus electrons.
Include **all** electron shells in your diagram.

(2)

(ii) Name the shape of a PF_3 molecule.
Justify your answer.

(3)

Shape

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Justification

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(Total for Question 18 = 11 marks)

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19 The alkane octane, C_8H_{18}, is an important component of petrol.

(a) Octane can undergo incomplete combustion.

(i) Give a reason why incomplete combustion sometimes occurs.

(1)

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(ii) Write the equation for the incomplete combustion of octane, forming carbon monoxide and water only.

State symbols are not required.

(1)

(b) Octane can also be used to form other components of petrol.

(i) Write the equation for the reforming of octane into a cycloalkane.

Use **skeletal** formulae in your equation.

(1)

(ii) Give one reason why cycloalkanes are added to petrol.

(1)

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(c) Octane, C_8H_{18}, reacts with chlorine in the presence of ultraviolet radiation.

(i) State the type and mechanism of this reaction.

(1)

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(ii) Write the equation for the initiation step in this reaction.
Include relevant curly arrows and the name of the type of bond breaking.

(3)

.....

.....

(iii) Write equations for the reaction steps to form HCl, $C_8H_{17}Cl$ and $C_{16}H_{34}$, starting from octane.
Include the name of each of the steps.

(4)

(Total for Question 19 = 12 marks)

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20 This question is about nickel and some of its compounds.

(a) The isotopic composition of a sample of nickel is shown in the table.

Isotope	Percentage abundance
^{58}Ni	67.3
^{60}Ni	26.4
^{61}Ni	2.40
^{62}Ni	3.90

(i) Calculate the relative atomic mass, A_r, of nickel in this sample.
Give your answer to **three** significant figures.

(2)

(ii) Suggest the formula of the species that causes a small peak in the mass spectrum of nickel at $m / z = 29$.

(1)

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(b) Magnesium reacts with aqueous nickel(II) sulfate.

Write the **ionic** equation for this reaction.
Include state symbols.

(2)

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(c) 40.00 g of a compound contains 11.50 g of nickel and 18.94 g of oxygen.
The remaining mass is sulfur.

Calculate the empirical formula of this compound.
You **must** show your working.

[Data: A_r values O = 16.0 S = 32.1 Ni = 58.7]

(3)

(Total for Question 20 = 8 marks)

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21 This question is about compounds of copper.

(a) Anhydrous copper(II) nitrate, $Cu(NO_3)_2$, decomposes when heated, producing copper(II) oxide, nitrogen dioxide and oxygen as the only products.

Write an equation for this reaction.
State symbols are not required.

(1)

(b) (i) When a student heats a sample of anhydrous copper(II) nitrate, 0.00500 mol of a gaseous mixture is obtained.

At 101 kPa, the gaseous mixture has a volume of 120 cm^3 at the temperature of the laboratory.

Calculate the temperature, in degrees **Celsius** (°C), in the laboratory.

Use the ideal gas equation $pV = nRT$

[Data: $R = 8.31\ J\,mol^{-1}\ K^{-1}$]

(4)

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(ii) Nitrogen dioxide is toxic. A Health and Safety Executive recommends a 15-minute Short-Term Exposure Limit (STEL) of 0.5 ppm.

The student heats a different sample of copper(II) nitrate.
28.0 cm^3 of nitrogen dioxide is released into the laboratory over a 15-minute period. The laboratory has a volume of 85 000 dm^3.
Calculate whether the STEL of 0.5 ppm has been exceeded.

You **must** show your working.

(2)

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(c) Copper(II) sulfate exists as hydrated crystals, $CuSO_4 \cdot \mathbf{x}H_2O$.

The value of **x** can be determined by heating hydrated copper(II) sulfate crystals until there is no further change in mass.

In an experiment, 3.12 g of hydrated copper(II) sulfate produces 1.98 g of anhydrous copper(II) sulfate.

Calculate the value of **x** in $CuSO_4 \cdot \mathbf{x}H_2O$.

Give your answer as an integer.
You **must** show your working.

[Data: A_r values H = 1.0 O = 16.0 S = 32.1 Cu = 63.5]

(4)

(Total for Question 21 = 11 marks)

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22 This question is about alkenes.

(a) State a test for a C═C bond in an alkene.
Include the positive result.

(1)

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(b) An alkene has a molar mass of 84 g mol^{-1}.

Deduce the molecular formula of this alkene.

(1)

(c) Alkenes such as but-1-ene can be used to make polymers.

(i) Write a balanced equation for the polymerisation of but-1-ene, using displayed formulae.

(2)

(ii) Give two problems concerning the disposal of polyalkenes such as poly(but-1-ene).

(2)

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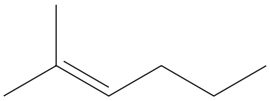
(d) (i) Give the name of the alkene shown, using IUPAC rules.

(1)



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(ii) Give a reason why this alkene does not have geometric isomers.

(1)

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(e) Draw the **displayed** formulae of the two geometric isomers of pent-2-ene.

(1)

Isomer 1	Isomer 2

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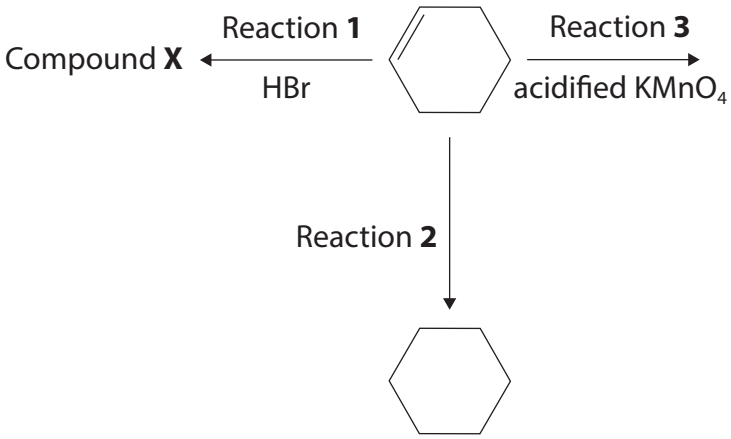
(f) Three reactions of cyclohexene are shown.



(i) Draw the **structure** of Compound **X**, formed in Reaction **1**.

(1)

(ii) Give the reagent and catalyst needed for Reaction **2**.

(2)

Reagent

.....

Catalyst

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(iii) Deduce the **empirical** formula of Compound **Y**, formed in Reaction 3.

(1)

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(g) Alkenes undergo similar electrophilic addition reactions with both hydrogen bromide and iodine monochloride.

(i) State the meaning of the term 'electrophile'.

(1)

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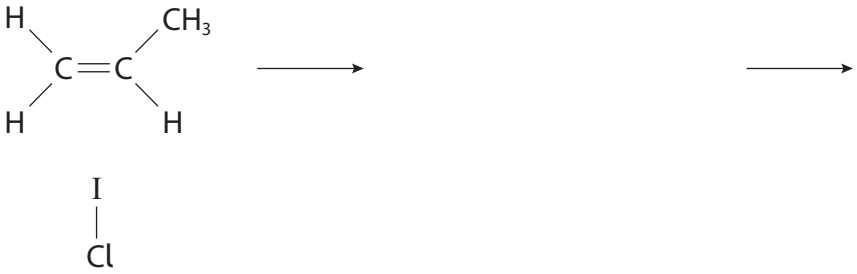
(ii) Complete the mechanism for the reaction of iodine monochloride with propene to form the **minor** product.

Include curly arrows, the relevant lone pair and the structures of the intermediate and the minor product.

(4)



(Total for Question 22 = 18 marks)

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

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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									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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

* Lanthanide series	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
* Actinide series	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

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