Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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, ruler

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.

Turn over ▶

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P 7 1 8 8 6 A 0 1 2 4

Pearson

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 Which compound contains 2.35×10^{22} molecules in 2.50 g?

[Avogadro constant $L = 6.02 \times 10^{23}\ mol^{-1}$

M_r values: CO = 28.0 CO_2 = 44.0 SO_2 = 64.1 SO_3 = 80.1]

☒ **A** CO

☒ **B** CO_2

☒ **C** SO_2

☒ **D** SO_3

(Total for Question 1 = 1 mark)

2 What is the concentration of hydroxide ions in a solution containing 5.00 g of $Ba(OH)_2$ in 250 cm^3?

[M_r $Ba(OH)_2$ = 171.3]

☒ **A** 0.0292 mol dm^{-3}

☒ **B** 0.0584 mol dm^{-3}

☒ **C** 0.1168 mol dm^{-3}

☒ **D** 0.2335 mol dm^{-3}

(Total for Question 2 = 1 mark)

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

3 A sample of 15.0 g of vanadium reacted completely with 7.07 g of oxygen.

What is the formula of the oxide?

[A_r values: V = 50.9 O = 16.0]

☒ **A** VO

☒ **B** V_2O_3

☒ **C** VO_2

☒ **D** V_2O_5

(Total for Question 3 = 1 mark)

4 What is the pressure when 5.00 mol of nitrogen in a container with a volume of 1.50 m^3 is heated to 500 K?

[$pV = nRT$ $R = 8.31\ J\ K^{-1}\ mol^{-1}$]

☒ **A** 13.9 Pa

☒ **B** 6 290 Pa

☒ **C** 13 900 Pa

☒ **D** 31 200 Pa

(Total for Question 4 = 1 mark)

5 Which is the equation for the reaction of magnesium chloride solution with sodium hydroxide solution?

☒ **A** $Mg^+(aq) + OH^-(aq) \rightarrow MgOH(s)$

☒ **B** $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$

☒ **C** $MgCl(aq) + NaOH(aq) \rightarrow MgOH(aq) + NaCl(aq)$

☒ **D** $MgCl_2(aq) + 2NaOH(aq) \rightarrow Mg(OH)_2(aq) + 2NaCl(aq)$

(Total for Question 5 = 1 mark)

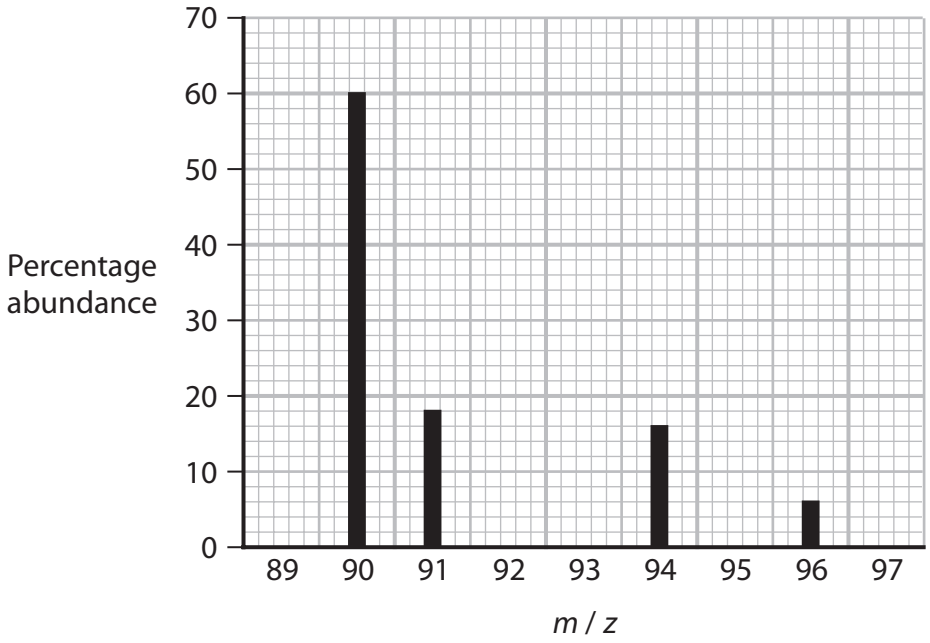
Use this space for any rough working. Anything you write in this space will gain no credit.

6 How many neutrons and electrons are there in $^{190}_{79}Au^{2+}$?

		Neutrons	Electrons
☒	**A**	111	77
☒	**B**	111	81
☒	**C**	190	79
☒	**D**	190	77

(Total for Question 6 = 1 mark)

7 The mass spectrum of an element is shown.



What is the relative atomic mass of this element?

☒ **A** 90.0

☒ **B** 90.9

☒ **C** 91.2

☒ **D** 92.8

(Total for Question 7 = 1 mark)

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

8 Which is the equation for the **second** ionisation of element J?

- ☒ **A** $J(g) \rightarrow J^{2+}(g) + 2e^-$
- ☒ **B** $J^+(g) \rightarrow J^{2+}(g) + e^-$
- ☒ **C** $J^+(g) \rightarrow J^{3+}(g) + 2e^-$
- ☒ **D** $J^{2+}(g) \rightarrow J^{3+}(g) + e^-$

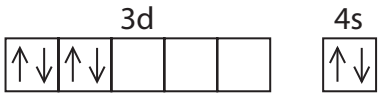
(Total for Question 8 = 1 mark)

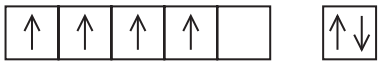
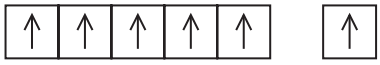
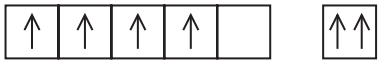
9 Which is a reason why fluorine has a higher first ionisation energy than oxygen?

- ☒ **A** a fluorine atom has fewer unpaired electrons
- ☒ **B** a fluorine atom has fewer shells of electrons
- ☒ **C** a fluorine atom has more electrons
- ☒ **D** a fluorine atom has more protons

(Total for Question 9 = 1 mark)

10 Which is the electronic configuration of chromium?

- ☒ **A** [Ar] 

- ☒ **B** [Ar] 
- ☒ **C** [Ar] 
- ☒ **D** [Ar] 

(Total for Question 10 = 1 mark)

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

11 Which combination of ions would be expected to form the compound with the **highest** melting temperature?

- ☒ **A** Li^+ and Br^-
- ☒ **B** Mg^{2+} and O^{2-}
- ☒ **C** Sr^{2+} and S^{2-}
- ☒ **D** Rb^+ and Cl^-

(Total for Question 11 = 1 mark)

12 Which is a use of graphene based on its electrical properties?

- ☒ **A** drill tips
- ☒ **B** pencils
- ☒ **C** touch screens
- ☒ **D** body armour

(Total for Question 12 = 1 mark)

13 Which molecule has the **largest** bond angle?

- ☒ **A** BCl_3
- ☒ **B** CO_2
- ☒ **C** H_2O
- ☒ **D** NH_3

(Total for Question 13 = 1 mark)

14 Which molecule is polar?

- ☒ **A** 1,1-dibromopropane
- ☒ **B** *E*-1,2-dibromoethene
- ☒ **C** hexafluoroethane
- ☒ **D** tetrachloromethane

(Total for Question 14 = 1 mark)

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

15 Prop-2-en-1-ol is flammable, toxic and an environmental hazard.

Which hazard symbols should be shown on its container?

☒ **A**

☒ **B**

☒ **C**

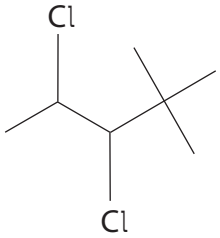
☒ **D**

(Total for Question 15 = 1 mark)

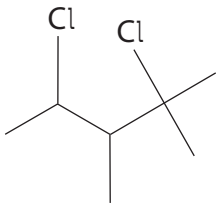
Use this space for any rough working. Anything you write in this space will gain no credit.

16 Which is the skeletal structure for 3,4-dichloro-2,2-dimethylpentane?

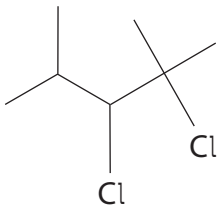
☒ **A**



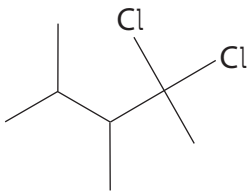
☒ **B**



☒ **C**

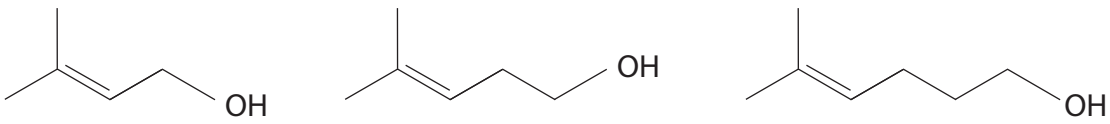


☒ **D**



(Total for Question 16 = 1 mark)

17 What is the name of a series such as the one shown?



☒ **A** addition

☒ **B** heterolytic

☒ **C** homologous

☒ **D** homolytic

(Total for Question 17 = 1 mark)

18 Which is **not** a step in the reaction of chlorine with propane in ultraviolet radiation?

- ☒ **A** $C_3H_7^{\bullet} + Cl^{\bullet} \rightarrow C_3H_7Cl$
- ☒ **B** $C_3H_7^{\bullet} + C_3H_7^{\bullet} \rightarrow C_6H_{14}$
- ☒ **C** $C_3H_7^{\bullet} + Cl_2 \rightarrow C_3H_7Cl + Cl^{\bullet}$
- ☒ **D** $C_3H_7^{\bullet} + HCl \rightarrow C_3H_7Cl + H^{\bullet}$

(Total for Question 18 = 1 mark)

19 Why does free radical substitution have limited use in industrial chemistry?

- ☒ **A** the reactions only occur in the upper atmosphere
- ☒ **B** initiation requires ultraviolet radiation
- ☒ **C** further substitution products are formed
- ☒ **D** termination reactions produce unwanted products

(Total for Question 19 = 1 mark)

20 Which molecule can exist as *E-Z* isomers?

- ☒ **A** 2-chloro-4-ethylhex-3-ene
- ☒ **B** 3-chloro-2-methylhex-2-ene
- ☒ **C** 2,3-dimethylhex-2-ene
- ☒ **D** 2,5-dichlorohex-3-ene

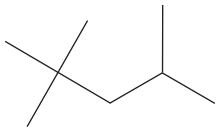
(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

21 The structure of a compound **X** is shown. **X** is present in petrol.



(a) (i) Give the molecular formula and IUPAC name for **X**.

(2)

.....

.....

(ii) Name the industrial process used to produce **X** from the straight-chain isomer.

(1)

.....

(b) Heptane is also present in petrol.

(i) Write an equation for the **complete** combustion of heptane.
Include state symbols.

(2)

(ii) Identify, by name or formula, a pollutant that may result from the **incomplete** combustion of heptane.

(1)

.....

(c) Recently, sales of electric cars have increased.

Give **two** environmental benefits of using electric cars.
Justify your answers.

(2)

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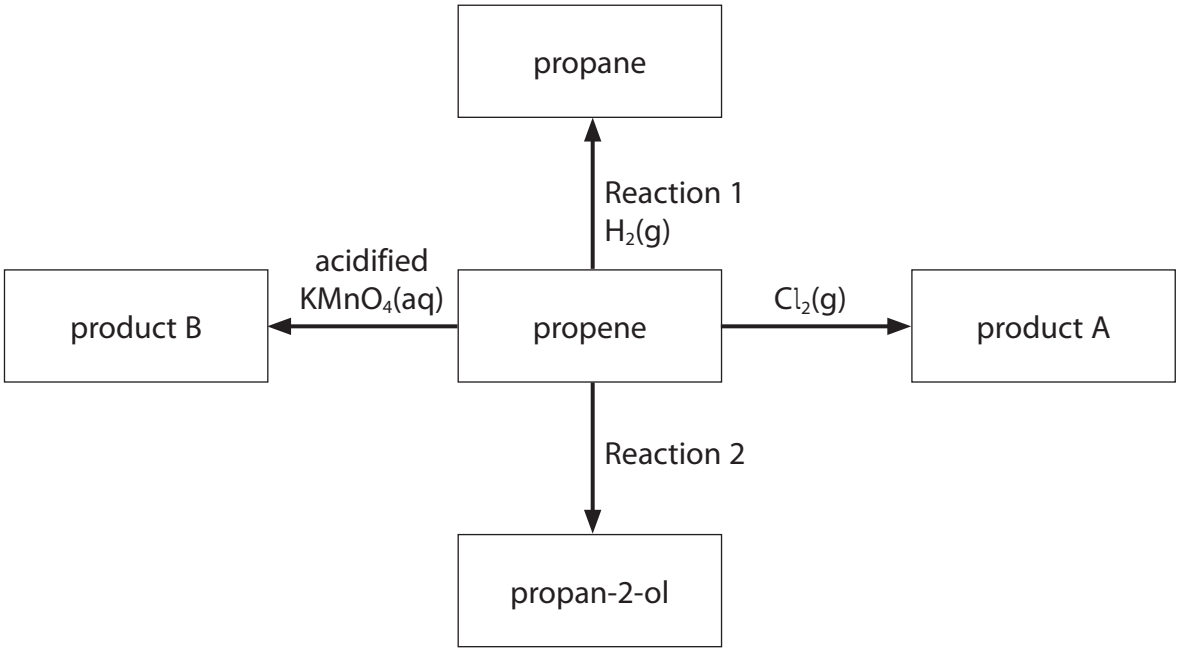
(Total for Question 21 = 8 marks)

22 This question is about propene and some related compounds.

(a) Some reactions of propene are shown.



(i) Identify, by name or formula, the catalyst needed for Reaction 1.

(1)

.....

(ii) Name product A.

(1)

.....

(iii) Identify, by name or formula, the substances needed for Reaction 2.

(2)

.....

.....

(iv) Draw the **displayed** formula of product B.

(1)

(b) (i) Propene can undergo addition polymerisation.

Write the equation for the polymerisation of propene.

(2)

(ii) Over 70 million tonnes of poly(propene) are produced each year.

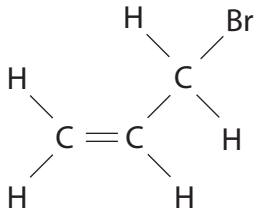
State **two** problems with the disposal of polymers such as poly(propene).

(2)

(c) Hydrogen bromide reacts with 3-bromopropene to form 1,2-dibromopropane as the major product.

(i) Complete the mechanism to show this reaction.
Include curly arrows, and any relevant lone pairs and dipoles.

(4)



(ii) Explain why 1,2-dibromopropane is the major product instead of 1,3-dibromopropane.

(2)

.....

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.....

(Total for Question 22 = 15 marks)

23 Oxygen is vital in the treatment of respiratory diseases. Oxygen is traditionally produced by the fractional distillation of air.

(a) Suggest **one** difference between the fractional distillation of air and of crude oil.

(1)

.....

.....

(b) Hospital patients sometimes need to breathe air with a higher than normal concentration of oxygen.
The oxygen concentration can be increased to 90 % by passing dry air through a tube filled with zeolite which adsorbs most of the nitrogen.

(i) Dry air contains 21.0 % oxygen by volume.
The average human breath has a volume of 500 cm^3.

Calculate the volume of air, in dm^3, that would have to pass over the zeolite to obtain 500 cm^3 of gas containing 90 % oxygen by volume.

(2)

(ii) Nitrogen molecules bind to zeolite using their outer electrons.

Draw a dot-and-cross diagram of the bonding in a nitrogen molecule.
Show outer electrons only.

(2)

(c) Liquid oxygen is transported across the world.
Liquid oxygen has a density of 1140 g dm^{-3}.

(i) Calculate the volume of gas, **in m^3**, measured at room temperature and pressure (r.t.p.) that can be obtained from a bottle containing 13.9 dm^3 of liquid oxygen.

(4)

[Molar volume at r.t.p. = 24.0 dm^3 mol^{-1}]

(ii) The total mass of the bottle is 80.0 kg when it is full of oxygen.

Calculate the mass of an empty bottle, using your working from (c)(i).
Give your answer to an appropriate number of significant figures.

(1)

(iii) Explain why the container needs to have such a large mass.

(2)

.....

.....

.....

.....

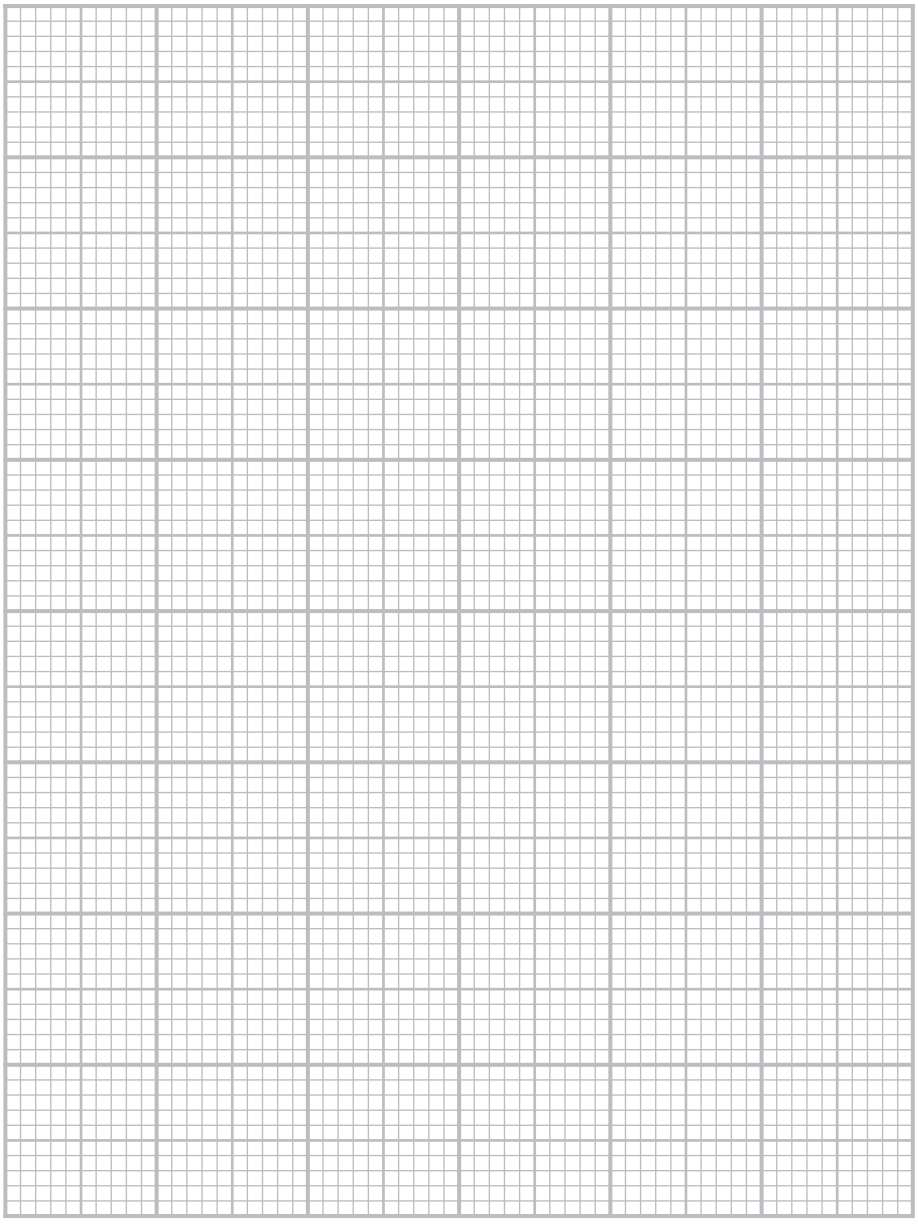
(Total for Question 23 = 12 marks)

24 The radii of ions of some successive elements in the Periodic Table are shown.

Ion	N^{3-}	O^{2-}	F^{-}	Na^{+}	Mg^{2+}	Al^{3+}
Ionic radius / pm	171	140	133	102		54

(a) (i) Plot a graph of the data.

(2)



N^{3-} O^{2-} F^{-} (Ne) Na^{+} Mg^{2+} Al^{3+}

(ii) Predict the radius of the magnesium ion using a straight line of best fit on your graph.

(2)

(iii) Explain the trend in the ionic radii from the nitride ion to the aluminium ion.

(3)

(b) Sodium and fluorine react to form a compound.

(i) State the structure and bonding of sodium fluoride.

(1)

(ii) Explain how the electrical conductivity of sodium fluoride provides evidence for the existence of ions.

(3)

(iii) Explain why the fluoride ion is difficult to polarise.

(2)

(Total for Question 24 = 13 marks)

25 This question is about aluminium and its compounds.

(a) (i) State the shape of a molecule of aluminium trichloride, $AlCl_3$.

(1)

.....

(ii) Aluminium chloride can exist as a dimer formed from two molecules of aluminium trichloride.

Draw a diagram of this dimer, showing the bonding between the two molecules.

(2)

(b) Aluminium trichloride reacts vigorously with water to produce hydrogen chloride and aluminium hydroxide, $Al(OH)_3$.

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

(1)

(c) Aluminium trichloride also reacts with sodium hydroxide.

$$AlCl_3(g) + 3NaOH(aq) \rightarrow Al(OH)_3(s) + 3NaCl(aq)$$

Calculate the maximum mass of aluminium hydroxide precipitated when excess aluminium trichloride reacts with 150 cm^3 of 1.5 mol dm^{-3} sodium hydroxide.

(3)

(d) (i) Describe the metallic bonding in aluminium.

(3)

(ii) Explain how metallic bonding leads to the properties of electrical conductivity and malleability shown by aluminium.

(2)

(Total for Question 25 = 12 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