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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Monday 18 May 2020

Morning (Time: 1 hour 30 minutes) | Paper Reference **WCH11/01**

Chemistry

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

Candidates must have: Scientific calculator
Ruler

Total Marks

Instructions

- Use **black** ink or **black** 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.*
- 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.
- There is a Periodic Table 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.
- Check your answers if you have time at the end.

Turn over ▶

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P 6 2 5 9 0 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 What is the empirical formula of butane?

☒ **A** C_4H_{10}

☒ **B** C_2H_5

☒ **C** $CH_{2.5}$

☒ **D** C_nH_{2n+2}

(Total for Question 1 = 1 mark)

2 When zinc is added to copper(II) sulfate solution, copper is formed.

(a) Which of these is the best name for this type of reaction?

(1)

☒ **A** addition

☒ **B** displacement

☒ **C** neutralisation

☒ **D** substitution

(b) Which is the ionic half-equation for a process that takes place during this reaction?

(1)

☒ **A** $Cu^{2+} + e^- \rightarrow Cu^+$

☒ **B** $Cu^+ + e^- \rightarrow Cu$

☒ **C** $Zn \rightarrow Zn^+ + e^-$

☒ **D** $Zn \rightarrow Zn^{2+} + 2e^-$

(Total for Question 2 = 2 marks)

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3 How many molecules are there in 44.0 g of carbon monoxide?

[Avogadro constant $L = 6.02 \times 10^{23}\ mol^{-1}$
A_r values: C = 12.0 O = 16.0]

☒ **A** 3.83×10^{23}

☒ **B** 6.02×10^{23}

☒ **C** 9.46×10^{23}

☒ **D** 1.89×10^{24}

(Total for Question 3 = 1 mark)

4 A compound has $M_r = 84$ and its composition by mass is 71.4 % carbon, 9.6 % hydrogen and 19.0 % oxygen.

What is the molecular formula of this compound?

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

☒ **A** $C_4H_3O_2$

☒ **B** $C_4H_4O_2$

☒ **C** C_5H_8O

☒ **D** $C_6H_{10}O$

(Total for Question 4 = 1 mark)

5 The formula of barium chloride is $BaCl_2$.

Which is correct for barium chloride?

[A_r values: Ba = 137.3 Cl = 35.5]

☒ **A** barium chloride exists as a molecule

☒ **B** barium chloride is a compound

☒ **C** the empirical formula of barium chloride is BaCl

☒ **D** the M_r of barium chloride is 172.8

(Total for Question 5 = 1 mark)

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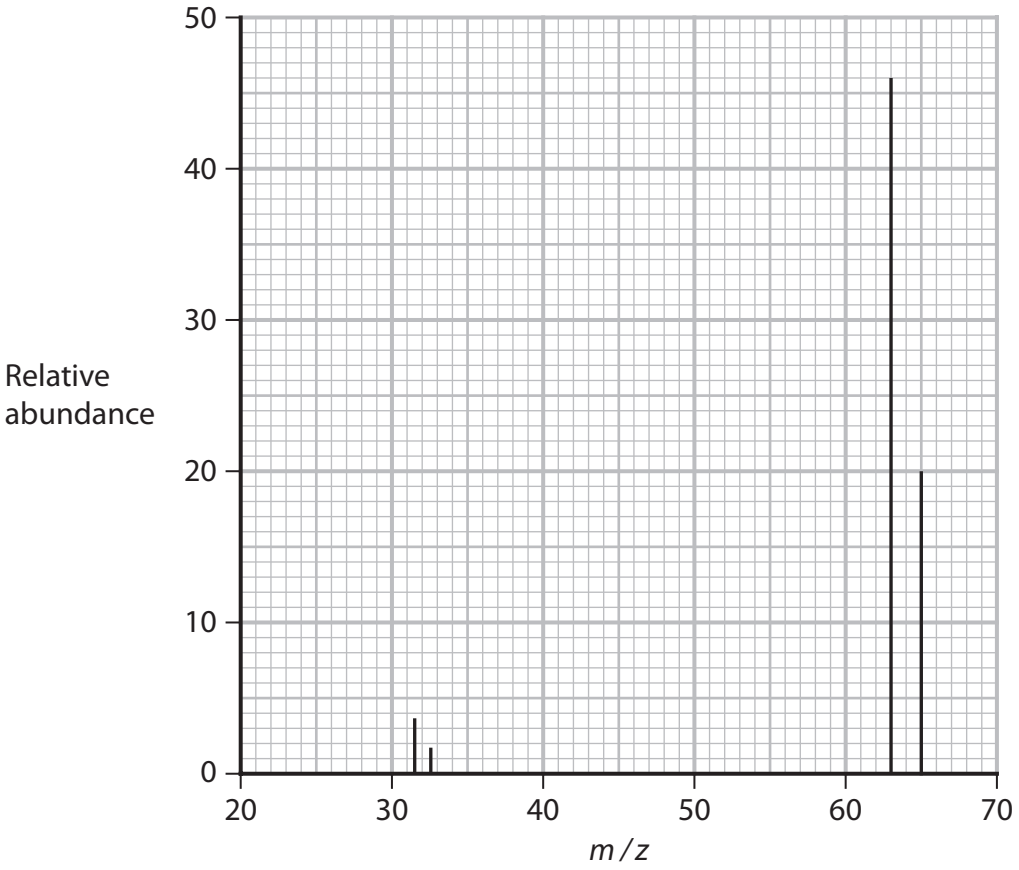
6 The mass spectrum of a sample of an element is shown.



(a) What is the A_r of the element?

(1)

- ☒ **A** 42.0
- ☒ **B** 48.0
- ☒ **C** 63.6
- ☒ **D** 64.0

(b) Which species could be responsible for the peak at $m/z = 32.5$?

(1)

- ☒ **A** $^{32}S^{+}$
- ☒ **B** $^{63}Cu^{2+}$
- ☒ **C** $^{65}Cu^{2+}$
- ☒ **D** $^{98}Tc^{3+}$

(Total for Question 6 = 2 marks)

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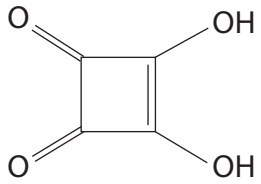
7 What is the molecular formula of the compound shown?



☒ **A** C_2HO_2

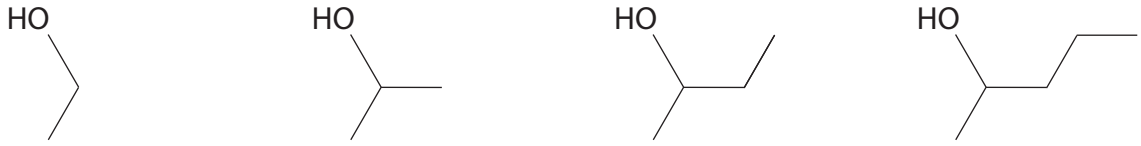
☒ **B** $C_4H_2O_4$

☒ **C** $C_4H_4O_4$

☒ **D** $C_4H_6O_4$

(Total for Question 7 = 1 mark)

8 A sequence of four molecules is shown.



1 2 3 4

(a) What is the molecular formula for the fifth molecule in this sequence?

(1)

☒ **A** CH_4O

☒ **B** $C_6H_{11}O$

☒ **C** $C_6H_{14}O$

☒ **D** $C_7H_{16}O$

(b) What is the name of this type of sequence?

(1)

☒ **A** functional group

☒ **B** homologous series

☒ **C** homolytic series

☒ **D** skeletal formulae

(Total for Question 8 = 2 marks)

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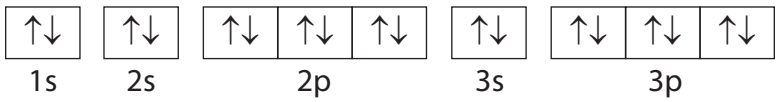
9 Which ion does **not** have the electronic configuration shown?



- ☒ **A** K^+
- ☒ **B** Ca^{2+}
- ☒ **C** Ti^{2+}
- ☒ **D** Sc^{3+}

(Total for Question 9 = 1 mark)

10 What is the electronic configuration of the nitride ion, N^{3-}?

- ☒ **A** $1s^2\ 2s^2$
- ☒ **B** $1s^2\ 2s^2\ 2p^3$
- ☒ **C** $1s^2\ 2s^2\ 2p^4$
- ☒ **D** $1s^2\ 2s^2\ 2p^6$

(Total for Question 10 = 1 mark)

11 Which of these ions has the smallest ionic radius?

- ☒ **A** Al^{3+}
- ☒ **B** Ga^{3+}
- ☒ **C** Mg^{2+}
- ☒ **D** F^-

(Total for Question 11 = 1 mark)

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12 What is the percentage atom economy, by mass, for the production of hydrogen in the reaction shown?

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

[A_r values: H = 1.00 C = 12.0 O = 16.0]

☒ **A** 8.8%

☒ **B** 17.6%

☒ **C** 21.4%

☒ **D** 82.4%

(Total for Question 12 = 1 mark)

13 How many lone pairs of electrons are there in the outer shell of the sulfur atom in a molecule of H_2S?

☒ **A** zero

☒ **B** one

☒ **C** two

☒ **D** four

(Total for Question 13 = 1 mark)

14 Which equation represents the **third** ionisation energy for element J?

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

☒ **B** $J^{3+}(g) \rightarrow J^{4+}(g) + e^-$

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

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

(Total for Question 14 = 1 mark)

15 In which sequence are the molecules in order of **decreasing** bond angle?

☒ **A** $BeCl_2 > BCl_3 > CH_4$

☒ **B** $BeCl_2 > NH_3 > CH_4$

☒ **C** $CH_4 > BCl_3 > BeCl_2$

☒ **D** $CH_4 > NH_3 > BeCl_2$

(Total for Question 15 = 1 mark)

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16 Which pair of ions will form the compound with the most covalent character?

☒ **A** Li^+ and I^-

☒ **B** Na^+ and Br^-

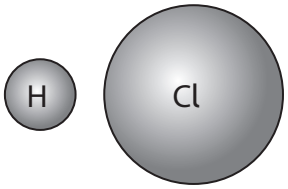
☒ **C** K^+ and Cl^-

☒ **D** Rb^+ and F^-

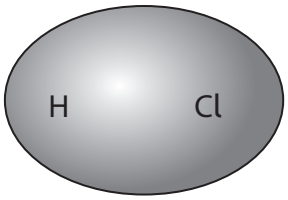
(Total for Question 16 = 1 mark)

17 Which diagram best represents the electron density in a molecule of hydrogen chloride?

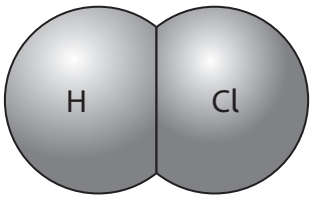
☒ **A**



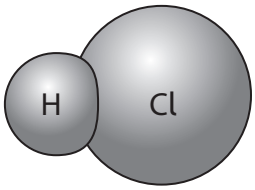
☒ **B**



☒ **C**



☒ **D**



(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 the structure of atoms.

(a) State what is meant by the term orbital.

(2)

(b) State the shape of an s orbital and the shape of a p orbital.

(1)

(c) Describe what can be deduced about the electronic structure of sodium from its successive ionisation energies.

(3)

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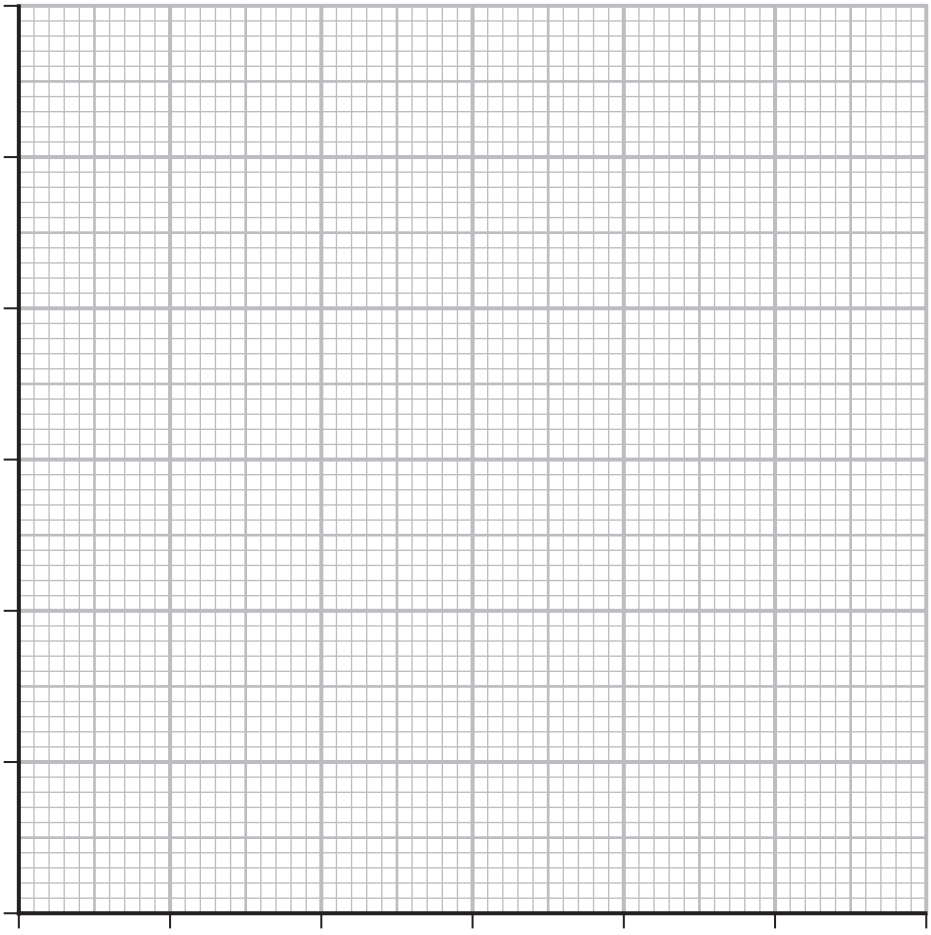
(d) (i) The log of the **fourth** ionisation energy for six elements is shown in the table.

Element	$\log_{10}$ (fourth ionisation energy / kJ mol^{-1})
O	3.87
F	3.92
Ne	3.97
Na	
Mg	4.02
Al	4.06

Plot a graph of these data.

(3)



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(ii) Use your graph to estimate the fourth ionisation energy for sodium, in kJ mol^{-1}.

(1)

(iii) Suggest why the fourth ionisation energies of neon and sodium are similar in magnitude even though the elements are in different periods of the Periodic Table.

(1)

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(Total for Question 18 = 11 marks)

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19 This question is about the compound ammonium dichromate(VI), $(NH_4)_2Cr_2O_7$.

(a) $(NH_4)_2Cr_2O_7$ breaks down at around 180 °C, producing an oxide of chromium, nitrogen and water as the only products.

(i) Write an equation for the reaction.
State symbols are not required.

(2)

(ii) Give a name for this type of reaction.

(1)

(b) When 0.00100 mol of ammonium dichromate(VI) was heated, 25.2 cm^3 of nitrogen gas, measured at laboratory temperature, was formed.

Calculate the temperature in the laboratory, in degrees Celsius, using the ideal gas equation. Use atmospheric pressure = 101 kPa.

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

(4)

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(c) (i) Draw a dot-and-cross diagram of the ammonium ion.

Use dots (●) for the nitrogen electrons and crosses (×) for the hydrogen electrons.

(2)

(ii) Explain the shape of the ammonium ion using electron-pair repulsion theory.

(2)

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(d) Ammonium dichromate(VI) comes with several warnings on its packaging.

- This compound is toxic when inhaled and by passing through the skin.
- Handle with extreme caution.
- Contact can irritate and burn the skin and eyes, with possible eye damage.
- Inhaling can irritate the nose and throat.
- Ammonium dichromate(VI) is a strong oxidiser that enhances the combustion of other substances.

(i) Some of the symbols shown are used for ammonium dichromate(VI).

Identify the symbols for ammonium dichromate(VI) by placing a tick (✓) in the box under each relevant symbol.

(2)

		

		

(ii) Suggest why ammonium dichromate(VI) is **not** stored in the same cupboard as alkanes.

(1)

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(Total for Question 19 = 14 marks)

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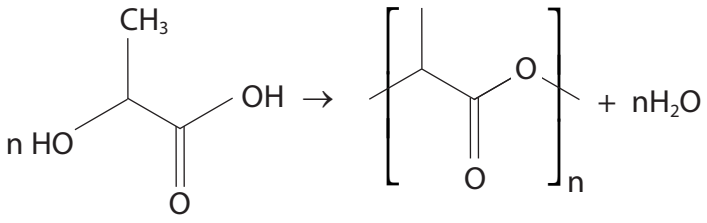
20 This question is about polymers.

(a) Plastic bags can be made from poly(lactic acid) (PLA), which is biodegradable.
Lactic acid is obtained from corn.
An equation for the polymerisation of lactic acid is shown.



(i) Write a balanced equation for the polymerisation of propene using displayed formulae.

(2)

(ii) Give **one** difference between the polymerisation of propene and that of lactic acid.

(1)

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(iii) State the meaning of the term biodegradable.

(1)

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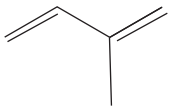
(iv) Give **three** advantages of biodegradable polymers.

(3)

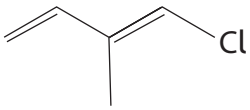
(b) Isoprene is used to make synthetic rubber. The skeletal formula for isoprene is shown.



(i) State why isoprene does **not** have geometric isomers.

(1)

(ii) A related molecule does show geometric isomerism.



Draw the geometric isomer of this molecule.

(1)

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(iii) Give a reason why a double bond may result in geometric isomerism.

(1)

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(Total for Question 20 = 10 marks)

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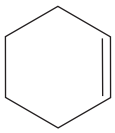
21 This question is about the liquids cyclohexene, C_6H_{10}, and bromine, Br_2.



cyclohexene

(a) Calculate the volume, in cm^3, of 0.0300 mol of cyclohexene.
Give your answer to an appropriate number of significant figures.
You must show your working.

Data A_r values: H = 1.0 C = 12.0
Density of cyclohexene = 0.811 g cm^{-3}

(2)

(b) Bromine reacts with cyclohexene.

(i) State the colour change when an excess of cyclohexene is added to liquid bromine.

(2)

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(ii) This reaction is very similar to the reaction of ethene with bromine.

Draw the mechanism for this reaction of cyclohexene with bromine.
Include curly arrows, and any relevant dipoles and lone pairs.

(4)

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(c) Bromine vapour in the atmosphere can cause irritation to the eyes at a concentration of 1.1 ppm and to the lungs at a concentration of 10 ppm.

(i) State the meaning of ppm.

(1)

(ii) A sample of 3.25 cm^3 of bromine vapour leaks into a laboratory.

Calculate the minimum volume, in **dm^3**, of the laboratory for the resulting concentration of bromine to be at a safe level.

(3)

(d) Because bromine is so hazardous it is usually used in the laboratory in aqueous solution.
A sample of bromine reacts with exactly 0.0300 mol of cyclohexene.

Calculate the minimum volume of water needed to completely dissolve this sample of bromine at room temperature.

Data A_r value: Br = 79.9
Concentration of bromine in water at room temperature = 35 g dm^{-3}

(3)

(Total for Question 21 = 15 marks)

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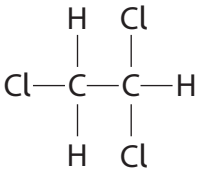
22 In the upper atmosphere, ozone can react with halogens and with halogen-containing compounds, such as molecule **X**.



molecule **X**

(a) Name molecule **X**.

(1)

.....

(b) The C—Cl bond undergoes homolytic fission in the upper atmosphere.

(i) State the essential condition necessary for this process.

(1)

.....

(ii) Write an equation for this fission in molecule **X**.
Include curly half-arrows.

(2)

(iii) Write an equation for the reaction of a chlorine free radical with a molecule of **X**.
Curly half-arrows are not required.

(2)

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(iv) Write an equation, using displayed formulae, for a free radical formed in this sequence to give a molecule with the formula $C_4H_4Cl_6$.

(2)

(v) State the type of reaction occurring in (b)(iv) and the name of the product with the formula $C_4H_4Cl_6$.

(2)

.....

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(Total for Question 22 = 10 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

* Actinide 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
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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