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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

Tuesday 8 October 2019

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

Chemistry

Advanced Subsidiary

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.
- 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.
- Check your answers if you have time at the end.

Turn over ▶

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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 Which element is in the d-block of the Periodic Table?

☒ **A** argon

☒ **B** chlorine

☒ **C** iron

☒ **D** sodium

(Total for Question 1 = 1 mark)

2 What is the equation for the **third** ionisation energy of aluminium?

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

☒ **B** $Al(s) \rightarrow Al^{3+}(s) + 3e^-$

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

☒ **D** $Al^{2+}(s) \rightarrow Al^{3+}(s) + e^-$

(Total for Question 2 = 1 mark)

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3 The first three ionisation energies of carbon are shown.

	1st	2nd	3rd
Ionisation energy / kJ mol^{-1}	1086	2353	4621

Which is the approximate fourth ionisation energy, in kJ mol^{-1}, of carbon?

☒ **A** 3500

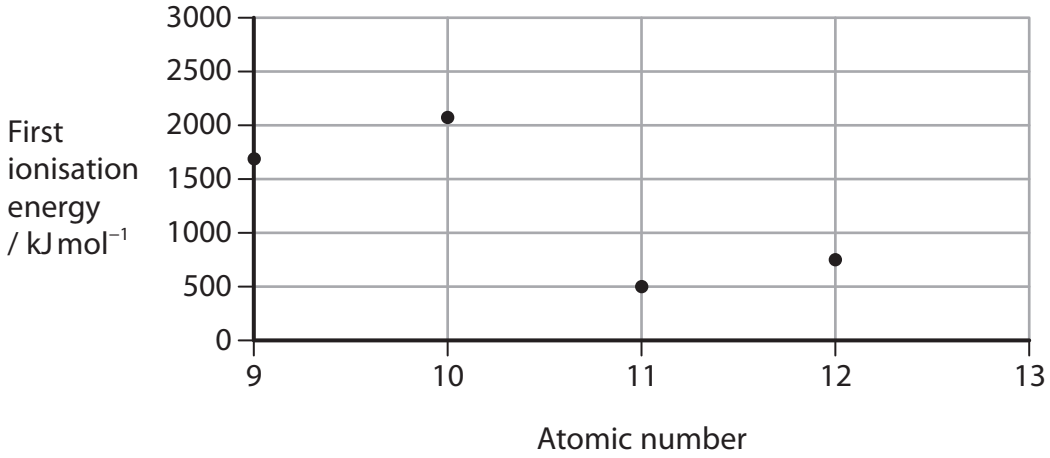
☒ **B** 6200

☒ **C** 11 000

☒ **D** 38 000

(Total for Question 3 = 1 mark)

4 The chart shows the first ionisation energy of each of the elements from fluorine to magnesium.



Which is the approximate first ionisation energy, in kJ mol^{-1}, of aluminium (atomic number 13)?

☒ **A** 300

☒ **B** 600

☒ **C** 900

☒ **D** 1200

(Total for Question 4 = 1 mark)

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5 The decrease in first ionisation energy down Group 1 in the Periodic Table is caused by the **increase** in

- ☒ **A** force of attraction between the nucleus and outer electron
- ☒ **B** number of neutrons in the nucleus
- ☒ **C** number of protons in the nucleus
- ☒ **D** shielding of the outer electron from the nuclear charge

(Total for Question 5 = 1 mark)

6 What is the relative formula mass of hydrated ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2.6H_2O$?

[Relative atomic masses (A_r): H = 1.0 N = 14.0 O = 16.0 S = 32.1 Fe = 55.8]

- ☒ **A** 284
- ☒ **B** 302
- ☒ **C** 312
- ☒ **D** 392

(Total for Question 6 = 1 mark)

7 How many **atoms** are there in 36.0 g of water?

[Avogadro constant = 6.02×10^{23} mol^{-1}]

- ☒ **A** 3.010×10^{23}
- ☒ **B** 1.204×10^{24}
- ☒ **C** 2.408×10^{24}
- ☒ **D** 3.612×10^{24}

(Total for Question 7 = 1 mark)

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8 Some ionic radii are shown.

Ion	Ionic radius / nm
Na^+	0.102
K^+	0.138
F^-	0.133
Cl^-	0.180

Which compound has the strongest ionic bonding?

☒ **A** sodium fluoride

☒ **B** sodium chloride

☒ **C** potassium fluoride

☒ **D** potassium chloride

(Total for Question 8 = 1 mark)

9 In which pair are the ions isoelectronic?

☒ **A** Ca^{2+} and S^{2-}

☒ **B** K^+ and Br^-

☒ **C** Li^+ and F^-

☒ **D** Mg^{2+} and Cl^-

(Total for Question 9 = 1 mark)

10 The bonding **within** an ammonium ion, NH_4^+, is formed by

☒ **A** covalent bonding only

☒ **B** covalent and dative covalent bonding only

☒ **C** covalent and ionic bonding only

☒ **D** covalent, dative covalent and ionic bonding

(Total for Question 10 = 1 mark)

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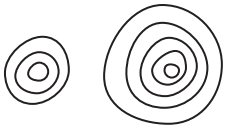
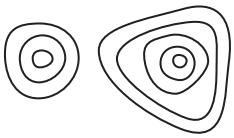
11 Which diagram best represents the electron density map of a hydrogen chloride molecule?

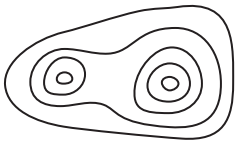
☒ **A**



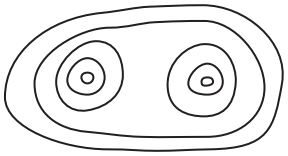
☒ **B**



☒ **C**



☒ **D**



(Total for Question 11 = 1 mark)

12 What is the polarity of the Al—Cl bond and the polarity of a trigonal planar $AlCl_3$ molecule?

	Polarity of Al—Cl bond	Polarity of $AlCl_3$ molecule
☒ **A**	non-polar	non-polar
☒ **B**	non-polar	polar
☒ **C**	polar	non-polar
☒ **D**	polar	polar

(Total for Question 12 = 1 mark)

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13 What is the atom economy, by mass, for the formation of iron in this reaction?

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

[A_r values: C = 12.0 O = 16.0 Fe = 55.8]

☒ **A** 29.7 %

☒ **B** 45.8 %

☒ **C** 55.9 %

☒ **D** 71.7 %

(Total for Question 13 = 1 mark)

14 A 2 kg sample of water contains 40 parts per million (ppm) by mass of nitrate ions.

What is the mass, in g, of nitrate ions in this sample?

☒ **A** 8×10^{-2}

☒ **B** 5×10^{-5}

☒ **C** 8×10^{-5}

☒ **D** 5×10^{-8}

(Total for Question 14 = 1 mark)

15 A sample of hydrated calcium sulfate, $CaSO_4.\mathbf{x}H_2O$, was heated to constant mass. 3.405 g of anhydrous calcium sulfate and 0.900 g of water were formed.

What is the value of **x**?

[Relative formula mass: $CaSO_4$ = 136.2]

☒ **A** 0.5

☒ **B** 2

☒ **C** 3

☒ **D** 4

(Total for Question 15 = 1 mark)

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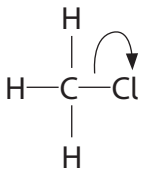
16 During a cracking reaction, each molecule of an alkane with formula $C_{10}H_{22}$ formed only two molecules of ethene and one molecule of hydrocarbon **A**.

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

- ☒ **A** C_6H_{10}
- ☒ **B** C_6H_{14}
- ☒ **C** C_8H_{16}
- ☒ **D** C_8H_{18}

(Total for Question 16 = 1 mark)

17 Curly arrows are used in reaction mechanisms.

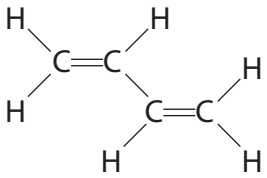


The curly arrow shown represents the movement of

- ☒ **A** an electron from a bond to an atom, forming free radicals
- ☒ **B** an electron from a bond to an atom, forming ions
- ☒ **C** a pair of electrons from a bond to an atom, forming free radicals
- ☒ **D** a pair of electrons from a bond to an atom, forming ions

(Total for Question 17 = 1 mark)

18 The structure of a diene is shown.



How many σ bonds and π bonds are there in one molecule of this diene?

	σ bonds	π bonds
☒ **A**	7	2
☒ **B**	7	4
☒ **C**	9	2
☒ **D**	9	4

(Total for Question 18 = 1 mark)

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19 When hydrogen bromide, HBr, reacts with propene, a higher percentage of 2-bromopropane forms than 1-bromopropane.

Which is the best explanation for this?

☒ **A** 1-bromopropane is more stable than 2-bromopropane

☒ **B** 2-bromopropane is more stable than 1-bromopropane

☒ **C** a primary carbocation is more stable than a secondary carbocation

☒ **D** a secondary carbocation is more stable than a primary carbocation

(Total for Question 19 = 1 mark)

20 Propene, C_3H_6, is produced in the dehydration of propanol.

$$C_3H_7OH \rightarrow C_3H_6 + H_2O$$

What is the mass, in g, of propene formed from 3.42 g of propanol when the yield is 85.2 % ?

[Relative molecular masses (M_r): $C_3H_7OH = 60$ $C_3H_6 = 42$]

☒ **A** 2.04

☒ **B** 2.39

☒ **C** 2.91

☒ **D** 4.16

(Total for Question 20 = 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.

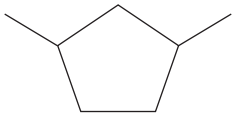
21 This question is about cycloalkanes.

(a) When alkanes from crude oil are reformed, the products include cycloalkanes.

Write the equation for reforming hexane into cyclohexane using **skeletal** formulae for the organic compounds.

(2)

(b) The skeletal formula of cycloalkane **D** is shown.



(i) Give the name of **D**.

(1)

(ii) Give the molecular formula of **D**.

(1)

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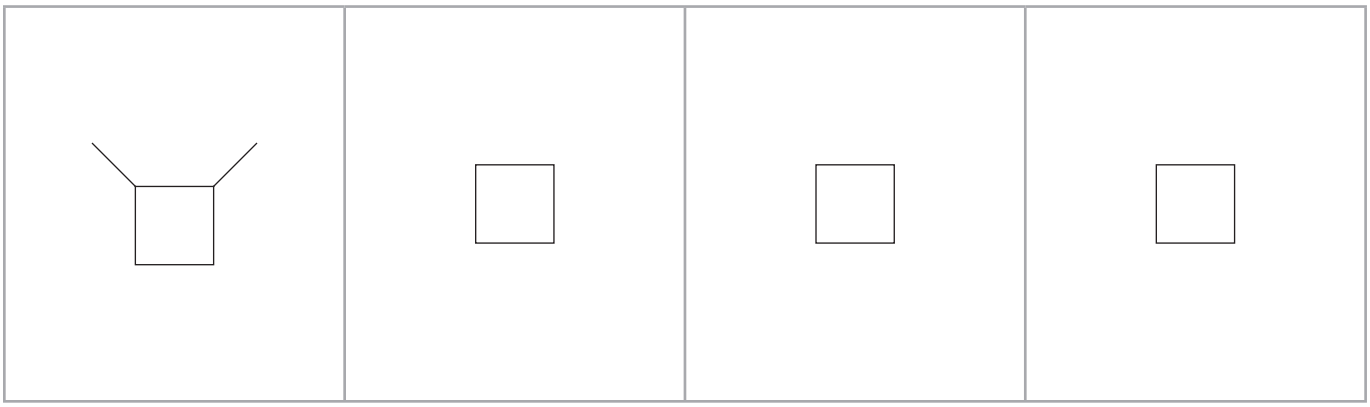
(c) There are four structural isomers of C_6H_{12} with a ring of four carbon atoms.

One of these isomers is shown, in the first box.

Complete the **skeletal** formulae of the other three isomers.

(2)



(d) A cycloalkane, **E**, has a molar mass of 126 g mol^{-1}.

Deduce the molecular formula of **E**.

(1)

.....

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(e) A sample of gaseous cyclopentane with a volume of 25 cm^3 was mixed with 250 cm^3 of oxygen (an excess) and the mixture was ignited.
Only gaseous products were formed.

$$2C_5H_{10}(g) + 15O_2(g) \rightarrow 10CO_2(g) + 10H_2O(g)$$

Calculate the volume of each gas remaining after the reaction.
All the gas volumes were measured at the same temperature and pressure.

(3)

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(f) Cyclobutane, C_4H_8, reacts with chlorine in sunlight.

(i) Name the mechanism and type of reaction that is occurring.

(2)

.....

(ii) Complete the equation for the initiation step of this reaction mechanism. Include appropriate curly arrows.

(2)

Cl——Cl →

(iii) Write the equations for the **two** propagation steps to form chlorocyclobutane.

Use C_4H_8 as the formula for cyclobutane.

Curly arrows and state symbols are not required.

(2)

(iv) A small amount of a hydrocarbon forms in this reaction.

Deduce the **skeletal** formula of this hydrocarbon. Justify your answer.

(2)

Skeletal formula of product

Justification

.....

.....

.....

(Total for Question 21 = 18 marks)

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22 This question is about atomic structure and gases.

(a) Chlorine exists as two isotopes with mass numbers 35 and 37.

(i) State the number and type of each of the particles in the **nucleus** of a chlorine-35 atom.

(2)

.....

.....

(ii) Complete the electronic configuration of a chloride **ion**, Cl^-, using the s, p, d notation.

(1)

$1s^2$.....

(iii) A sample of chlorine contains 75.53 % of chlorine-35 atoms.

Calculate the relative atomic mass of this sample of chlorine.
Give your answer to **two** decimal places.

(2)

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(b) Fluorine has one naturally occurring isotope with mass number 19.

Chlorine and fluorine react to form chlorine trifluoride, ClF_3.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of chlorine trifluoride.
Show the outer shell electrons only.

(2)

(ii) State, in terms of electrons, what is unusual about the dot-and-cross diagram you have drawn.

(1)

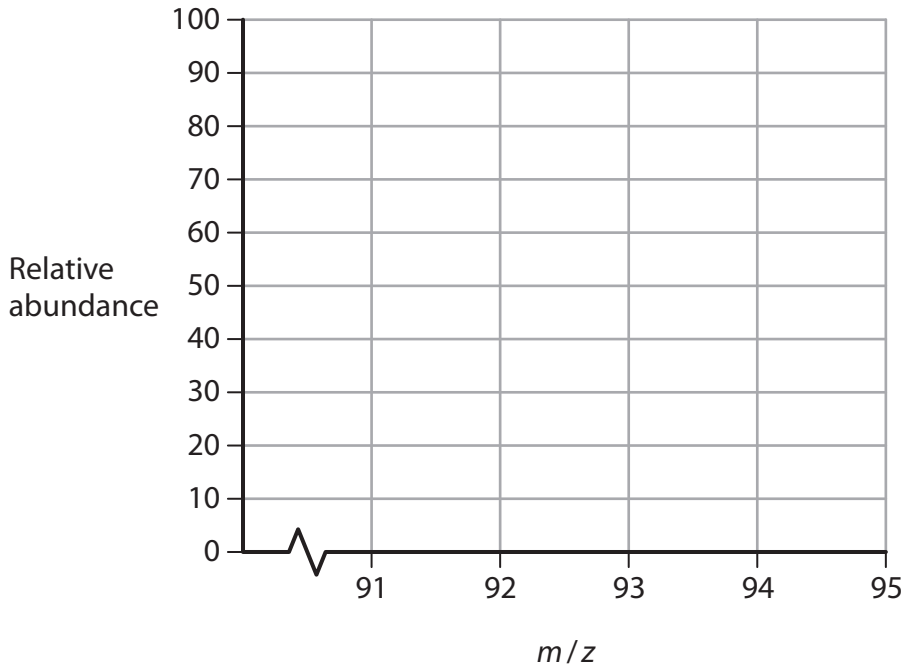
.....

.....

.....

(iii) Complete the mass spectrum to show the peaks you would expect for the molecular ion ClF_3^+.

(3)



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(iv) Calculate, using the ideal gas equation, the volume in **cm^3** occupied by 0.0200 mol of ClF_3 gas at a temperature of 60 °C and a pressure of 1.28×10^5 Pa. Give your answer to an appropriate number of significant figures.

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

(4)

(Total for Question 22 = 15 marks)

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23 This question is mainly about alkenes.

(a) A few drops of bromine water are added to separate test tubes of propane and propene and the mixtures are shaken.

Describe what is seen at the end of each experiment.

(2)

Propane .....

Propene .....

(b) Give the reagents and conditions for each of these conversions.

(i) $CH_2{=}CH_2 \rightarrow CH_3CH_2OH$

(1)

.....

.....

(ii) $CH_2{=}CH_2 \rightarrow CH_2OHCH_2OH$

(1)

.....

.....

(c) Draw the structure of *Z*-3-methylpent-2-ene.

(1)

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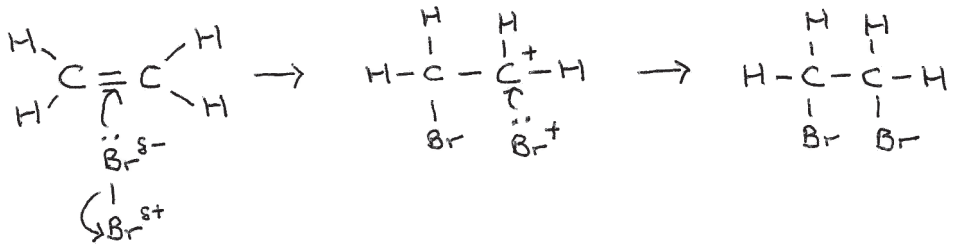
(d) Exactly 720 cm^3 of hydrogen gas, measured at room temperature and pressure (r.t.p.), reacted with 0.010 mol of an alkene to form an alkane.

Deduce the number of double bonds in one molecule of the alkene.
You **must** show your working.

[Molar volume of gas at r.t.p. = 24 000 $cm^3 mol^{-1}$]

(2)

(e) A student drew a mechanism for the addition of bromine to ethene.



Describe the three changes needed to correct this student's mechanism.

(3)

Change 1

Change 2

Change 3

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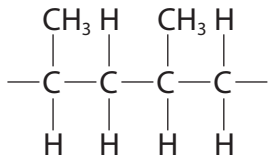
(f) Part of the structure of a polymer is shown.



Draw the structure of the monomer used to make this polymer.

(1)

(Total for Question 23 = 11 marks)

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24 This question is about phosphorus and some of its compounds.

(a) The atomic number of phosphorus is 15.

(i) Complete the electronic configuration of a phosphorus atom using the electrons-in-boxes notation.

(1)



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

(2)

(b) Phosphorus has a melting temperature of 44 °C.

Silicon has a melting temperature of 1410 °C.

Explain why the melting temperature of phosphorus is much lower than that of silicon.

(3)

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(c) Phosphorus(V) chloride, PCl_5, exists as covalent molecules in the gaseous state.

(i) Complete the table for a PCl_5 molecule.

(3)

Number of bonding pairs of electrons on phosphorus		
Number of lone pairs of electrons on phosphorus		
Shape of molecule		
Cl—P—Cl bond **angles**		

(ii) In the solid state, phosphorus(V) chloride is ionic.

The cation and anion each have one phosphorus atom but a different number of chlorine atoms.

The cation is tetrahedral and the anion is octahedral.

Predict the formula of each ion. Include the charge on each ion.

(2)

.....

.....

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(d) In an experiment, 8.00 cm^3 of 0.250 mol dm^{-3} sodium hydroxide, NaOH, reacted completely with 10.0 cm^3 of 0.100 mol dm^{-3} phosphoric acid, H_3PO_4.

Use these data to deduce the balanced equation for this reaction.
You **must** show your working.

(3)

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(e) Hydrated magnesium phosphate has the formula $Mg_3(PO_4)_2.\mathbf{y}H_2O$.

A sample of this compound contains 78.5% by mass of anhydrous magnesium phosphate.

Deduce the value of **y**.

You **must** show your working.

[Molar mass of anhydrous magnesium phosphate, $Mg_3(PO_4)_2 = 262.9\,g\,mol^{-1}$]

(2)

(Total for Question 24 = 16 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)
							1.0 H hydrogen 1										(18) 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

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