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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

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 **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.*
- Show all your working in calculations and include units where appropriate.

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.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

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 The numbers of subatomic particles present in four species **W**, **X**, **Y** and **Z** are given in the table.

Species	Number of protons	Number of neutrons	Number of electrons
W	19	20	18
X	19	20	19
Y	20	20	18
Z	20	22	20

Which of these species are isotopic?

☒ **A** **W** and **X**

☒ **B** **W** and **Y**

☒ **C** **X** and **Z**

☒ **D** **Y** and **Z**

(Total for Question 1 = 1 mark)

2 Iodine exists as one isotope with mass number 127.

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

How many molecular ion (ICl_3^+) peaks are there in the mass spectrum of ICl_3?

☒ **A** 2

☒ **B** 3

☒ **C** 4

☒ **D** 5

(Total for Question 2 = 1 mark)

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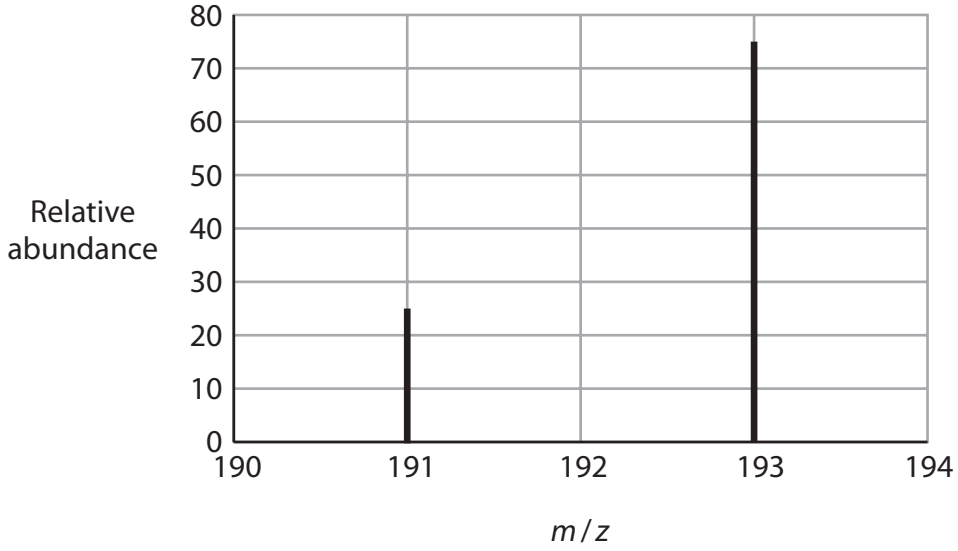
3 The mass spectrum of a sample of an element has only two peaks.



What is the approximate relative atomic mass of the element in this sample?

- ☒ **A** 191.5
- ☒ **B** 192.0
- ☒ **C** 192.5
- ☒ **D** 193.0

(Total for Question 3 = 1 mark)

4 Which equation represents the **second** ionisation energy of magnesium?

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

(Total for Question 4 = 1 mark)

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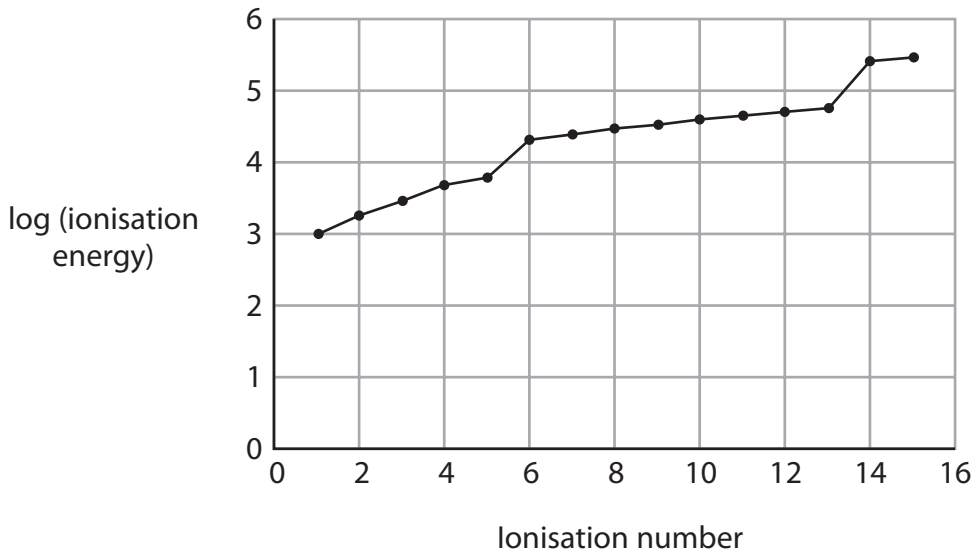
5 The graph shows log (ionisation energy) against ionisation number for the successive ionisations of an element.



In this element, how many quantum shells contain electrons, and how many electrons are in the outer quantum shell?

	Number of quantum shells containing electrons	Number of electrons in the outer quantum shell
☒ **A**	3	2
☒ **B**	3	5
☒ **C**	5	2
☒ **D**	5	5

(Total for Question 5 = 1 mark)

6 Which ion has the electronic configuration $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$ in its ground state?

☒ **A** Al^{3+}

☒ **B** Cl^-

☒ **C** N^{3-}

☒ **D** Na^+

(Total for Question 6 = 1 mark)

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7 What is the relative formula mass of hydrated sodium carbonate, $Na_2CO_3.10H_2O$?

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

- ☒ **A** 106
- ☒ **B** 142
- ☒ **C** 263
- ☒ **D** 286

(Total for Question 7 = 1 mark)

8 Which of these isoelectronic ions has the **largest** radius?

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

(Total for Question 8 = 1 mark)

9 Which ion is the most polarisable?

- ☒ **A** Mg^{2+}
- ☒ **B** Ca^{2+}
- ☒ **C** Cl^-
- ☒ **D** I^-

(Total for Question 9 = 1 mark)

10 Which substance has a giant lattice of atoms?

- ☒ **A** diamond
- ☒ **B** ice
- ☒ **C** poly(ethene)
- ☒ **D** sodium chloride

(Total for Question 10 = 1 mark)

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11 Which compound has bonds that are the most polar?

- ☒ **A** H_2O
- ☒ **B** H_2S
- ☒ **C** NH_3
- ☒ **D** PH_3

(Total for Question 11 = 1 mark)

12 Which molecule is planar?

- ☒ **A** CF_4
- ☒ **B** C_2F_4
- ☒ **C** PF_5
- ☒ **D** SF_6

(Total for Question 12 = 1 mark)

13 When $C_{20}H_{42}$ is cracked, each molecule produces one molecule of ethene, one molecule of butane and two molecules of hydrocarbon **E**.

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

- ☒ **A** C_7H_{13}
- ☒ **B** C_7H_{14}
- ☒ **C** $C_{14}H_{26}$
- ☒ **D** $C_{14}H_{28}$

(Total for Question 13 = 1 mark)

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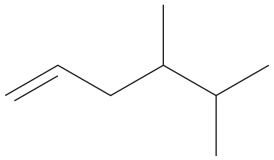
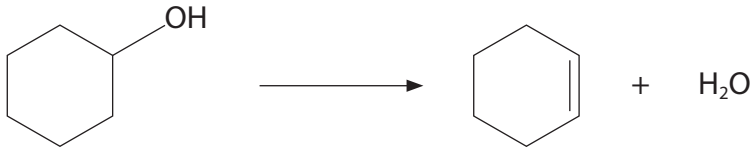
14 What is the systematic name of this compound?



- ☒ **A** 1,1,2-trimethylpent-4-ene
- ☒ **B** 2,3-dimethylhex-5-ene
- ☒ **C** 4,5-dimethylhex-1-ene
- ☒ **D** 4,5,5-trimethylpent-1-ene

(Total for Question 14 = 1 mark)

15 Cyclohexene may be prepared by the dehydration of cyclohexanol.



cyclohexanol
$M_r = 100$

cyclohexene
$M_r = 82$

What mass of cyclohexene can be made from 12.5 g of cyclohexanol if the yield is 51.2 %?

- ☒ **A** 5.25 g
- ☒ **B** 6.40 g
- ☒ **C** 7.80 g
- ☒ **D** 10.25 g

(Total for Question 15 = 1 mark)

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16 Which of these gases occupies 6.0 dm^3 at room temperature and pressure (r.t.p.)?

[molar volume of gas at r.t.p. = 24.0 dm^3 mol^{-1}

A_r values: He = 4.0 C = 12.0 N = 14.0 O = 16.0]

☒ **A** 2.0 g of helium

☒ **B** 4.0 g of oxygen

☒ **C** 11.0 g of carbon dioxide

☒ **D** 14.0 g of nitrogen

(Total for Question 16 = 1 mark)

17 An oxide of lead contains 90.7 % by mass of lead.

What is the formula of this oxide?

[A_r values: O = 16.0 Pb = 207.2]

☒ **A** PbO

☒ **B** PbO_2

☒ **C** Pb_2O_3

☒ **D** Pb_3O_4

(Total for Question 17 = 1 mark)

18 Propane burns completely in oxygen as shown.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

100 cm^3 of propane was mixed with 600 cm^3 of oxygen and the mixture was ignited.

What is the **total** volume, in cm^3, of the gas mixture at the end of the reaction?
All gas volumes were measured at room temperature and pressure.

☒ **A** 300

☒ **B** 400

☒ **C** 700

☒ **D** 800

(Total for Question 18 = 1 mark)

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19 Which aqueous solution contains the greatest number of **ions**?

- ☒ **A** 200 cm^3 of 1.5 mol dm^{-3} $MgCl_2$
- ☒ **B** 400 cm^3 of 0.8 mol dm^{-3} $MgSO_4$
- ☒ **C** 500 cm^3 of 1.0 mol dm^{-3} NaCl
- ☒ **D** 1000 cm^3 of 0.25 mol dm^{-3} Na_2SO_4

(Total for Question 19 = 1 mark)

20 A sample of seawater with a mass of 1 kg contains 6×10^{-9} g of gold.

How many atoms of gold, to one significant figure, are there in 1 g of this seawater?

[A_r value: Au = 197 Avogadro constant = 6×10^{23} mol^{-1}]

- ☒ **A** 2×10^{10}
- ☒ **B** 4×10^{12}
- ☒ **C** 2×10^{13}
- ☒ **D** 4×10^{15}

(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 Heptane, C_7H_{16}, is an alkane found in crude oil.

(a) Heptane can undergo incomplete combustion.

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

(1)

.....

.....

.....

(ii) Write the equation for the incomplete combustion of heptane, forming carbon monoxide and water as the **only** products.
State symbols are not required.

(1)

(b) Heptane is reformed into branched-chain and cyclic hydrocarbons that are used in petrol.

(i) Draw the **skeletal** formulae of a branched-chain alkane and a cycloalkane, each containing **seven** carbon atoms.

(2)

Branched-chain alkane
Cycloalkane

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(ii) Write the equation for the reforming of heptane into a cycloalkane.
Use molecular formulae.

(1)

(iii) Give a reason for adding cycloalkanes to petrol.

(1)

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(c) Heptane, C_7H_{16}, reacts with chlorine in the presence of ultraviolet radiation.

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

(2)

.....

(ii) Give the mechanism for the reaction to produce $C_7H_{15}Cl$, $C_{14}H_{30}$ and HCl as the **only** products.

Include the name of each of the steps in your mechanism.

Curly half-arrows are **not** required.

(7)

(Total for Question 21 = 15 marks)

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22 This question is about the elements in Period 3 of the Periodic Table, and some of their compounds.

(a) The atomic radii of six of the elements are given.

Symbol	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	15	16	17	18
Atomic radius / nm	0.191	0.160	0.130			0.102	0.099	0.095

(i) Plot a graph of atomic radius against atomic number.

(2)

(ii) Use the graph to estimate the atomic radius of silicon, Si.

(1)

.....

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(iii) Suggest an explanation for the decrease in atomic radius as atomic number increases across a period.

(3)

(b) The melting temperatures of sodium, sodium chloride and chlorine are given in the table.

Complete the table to show the type of structure, the type of bond or force broken on melting and the particles involved.

(6)

Substance	Sodium	Sodium chloride	Chlorine
Melting temperature / °C	98	801	−101
Type of structure	giant		simple molecular
Type of bond or force broken on melting			
Particles involved			chlorine molecules

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(c) Solid phosphorus(V) chloride contains PCl_4^+ ions.

(i) Draw a dot-and-cross diagram of a PCl_4^+ ion.

Show only outer shell electrons.

(1)

(ii) Predict the shape of a PCl_4^+ ion.

Justify your answer.

(3)

Shape .....

Justification

.....

.....

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(Total for Question 22 = 16 marks)

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23 This question is about alkenes.

(a) An alkene has a molar mass of 112 g mol^{-1}.

Deduce the molecular formula of this alkene.

(1)

(b) There are a number of different alkenes with the molecular formula C_4H_8.

(i) Draw the structure of the **branched-chain** alkene with the molecular formula C_4H_8.

(1)

(ii) Give the structures and names of the two geometric isomers with the molecular formula C_4H_8.

(2)

Structure of geometric isomer 1	Structure of geometric isomer 2
Name of isomer 1	Name of isomer 2

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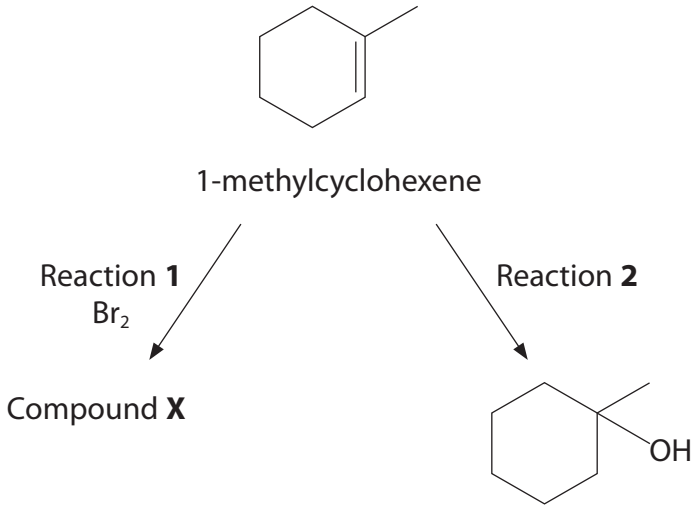
(c) Two reactions of 1-methylcyclohexene are shown.



(i) Draw the **skeletal** formula of compound **X** formed in Reaction **1**.

(1)

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

(2)

Reagent .....

Condition .....

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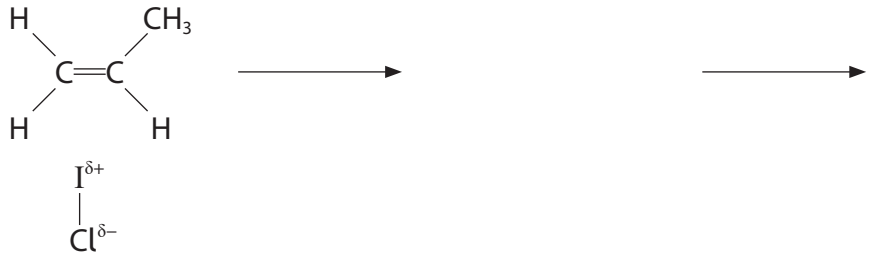
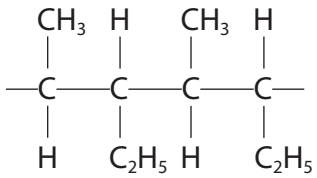
(d) Iodine monochloride, ICl, reacts with alkenes in a similar way to hydrogen bromide.

Complete the mechanism for the reaction of iodine monochloride with propene to form the **major** product.
Include curly arrows, the relevant lone pair and the structures of the intermediate and product.

(4)



(e) A section of a polymer showing two repeat units is given.



Give the **name** of the monomer that forms this polymer.

(1)

.....

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(f) 0.0100 mol of an alkene reacts completely with exactly 600 cm^3 of hydrogen gas, measured at 298 K and 1.24×10^5 Pa pressure, to form an alkane.

Use the ideal gas equation to deduce the number of double bonds in **one** molecule of the alkene.
You **must** show your working.

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

(4)

(Total for Question 23 = 16 marks)

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

(a) Complete the table to show the numbers of subatomic particles in $^{56}Fe^{2+}$.

(1)

Number of protons	Number of neutrons	Number of electrons

(b) A sample of iron contains the following isotopes.

Isotope	Percentage abundance
^{54}Fe	5.84
^{56}Fe	91.68
^{57}Fe	2.17
^{58}Fe	0.31

Calculate the relative atomic mass of this sample of iron.
Give your answer to **three** significant figures.

(2)

(c) Magnesium reacts with aqueous iron(II) sulfate in a displacement reaction.

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

(2)

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(d) 25.00 g of a compound contains 6.98 g of iron and 6.03 g of sulfur.

The remaining mass is oxygen.

Calculate the **empirical** formula of this compound.

[A_r values: O = 16.0 S = 32.1 Fe = 55.8]

(3)

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(e) When 6.95 g of $FeSO_4.\mathbf{x}H_2O$ is heated, 2.00 g of iron(III) oxide, 0.80 g of sulfur dioxide and 1.00 g of sulfur trioxide are produced. The only other product is water.

Deduce the overall equation for the reaction using these data. State symbols are not required.

You **must** show your working.

[A_r values: H = 1.0 O = 16.0 S = 32.1 Fe = 55.8]

(5)

(Total for Question 24 = 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

* 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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