Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Tuesday 22 May 2018 – Morning
Time: 1 hour 30 minutes

Paper Reference
WCH01/01

Candidates must have: Scientific calculator.

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

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

Turn over ▶

P51942A

5/4/5/2/1/1/

P 5 1 9 4 2 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 The type of formula that shows all the bonds and all the atoms in a molecule is

☒ **A** an empirical formula.

☒ **B** a molecular formula.

☒ **C** a structural formula.

☒ **D** a displayed formula.

(Total for Question 1 = 1 mark)

2 The concentration of potassium ions in human blood is in the range 3.5×10^{-3} to 5.0×10^{-3} mol dm^{-3}.

An average person has 5 dm^3 of blood.

What is the minimum mass of potassium ions in the blood of an average person?

[Molar mass of potassium = 39.1 g mol^{-1}]

☒ **A** 0.137 g

☒ **B** 0.684 g

☒ **C** 0.978 g

☒ **D** 684.0 g

(Total for Question 2 = 1 mark)

3 What is the number of **atoms** present in 3.06 dm^3 of carbon dioxide, at 373 K?

[Molar volume of a gas at 373 K is 30.6 dm^3 mol^{-1}, Avogadro constant = 6.0×10^{23} mol^{-1}]

☒ **A** 1.8×10^{22}

☒ **B** 6.0×10^{22}

☒ **C** 1.8×10^{23}

☒ **D** 6.0×10^{23}

(Total for Question 3 = 1 mark)

4 A sample of seawater contains 3.54% sodium chloride by mass.

What is the concentration of sodium chloride in parts per million?

☒ **A** 3.54×10^{-6}

☒ **B** 3.54×10^{-4}

☒ **C** 3.54×10^{4}

☒ **D** 3.54×10^{6}

(Total for Question 4 = 1 mark)

5 Hot packs and cold packs are used to heat and cool parts of the body.

What are the signs of the standard enthalpy changes of reaction used in hot packs and cold packs?

	Hot packs	Cold packs
☒ **A**	negative	negative
☒ **B**	positive	negative
☒ **C**	negative	positive
☒ **D**	positive	positive

(Total for Question 5 = 1 mark)

6 For reactions with the ionic equation

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

the type of enthalpy change is

☒ **A** $\Delta H_{atomisation}$

☒ **B** $\Delta H_{combustion}$

☒ **C** $\Delta H_{formation}$

☒ **D** $\Delta H_{neutralisation}$

(Total for Question 6 = 1 mark)

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

7 An excess of zinc powder is added to a solution of copper(II) sulfate and the maximum change in temperature of the solution is measured.

The energy transferred is calculated using

Energy transferred in joules = mass × specific heat capacity × temperature change

In this calculation, it is usual to assume that the

☒ **A** mass is equal to the mass of zinc added to the mass of copper(II) sulfate solution.

☒ **B** mass is equal to the volume of copper(II) sulfate solution.

☒ **C** specific heat capacity is the average of the specific heat capacities of the solution and zinc.

☒ **D** specific heat capacity is the specific heat capacity of zinc.

(Total for Question 7 = 1 mark)

8 When 10 cm^3 of 1 mol dm^{-3} nitric acid is mixed with 20 cm^3 of 1 mol dm^{-3} sodium hydroxide solution, there is a temperature rise of ΔT.

If the reaction is repeated with 20 cm^3 of nitric acid of 1 mol dm^{-3} and 20 cm^3 of 1 mol dm^{-3} sodium hydroxide solution, the temperature rise is

☒ **A** $2\Delta T$

☒ **B** $1.5\Delta T$

☒ **C** ΔT

☒ **D** $0.75\Delta T$

(Total for Question 8 = 1 mark)

9 Which of the following equations shows the process occurring when the **second** ionisation energy of magnesium is measured?

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

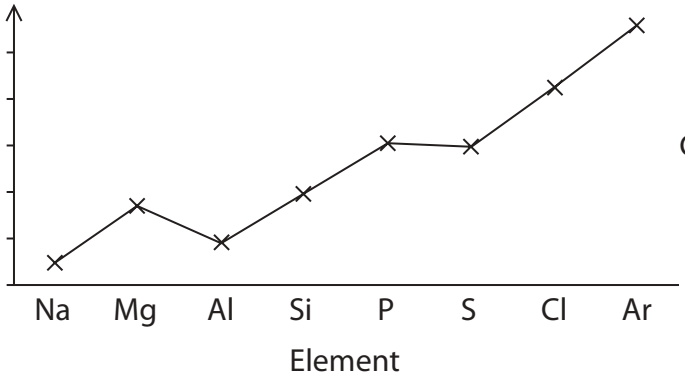
☒ **B** $Mg(g) - 2e^- \rightarrow Mg^{2+}(g)$

☒ **C** $Mg^+(g) + e^- \rightarrow Mg(s)$

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

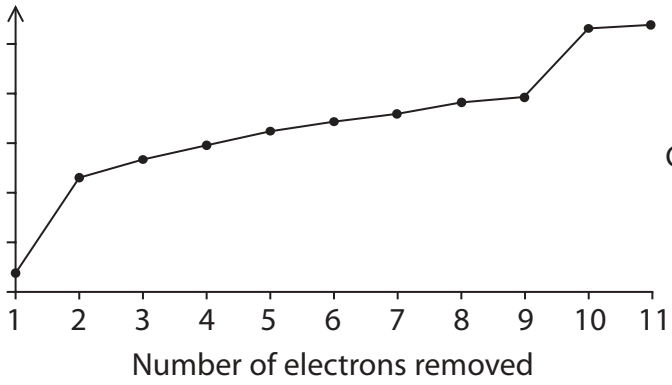
(Total for Question 9 = 1 mark)

10 Graph 1 shows the variation in first ionisation energy with increasing atomic number.



Graph 1

Graph 2 shows the variation in successive ionisation energies for sodium.



Graph 2

(a) What quantities were plotted on the *y*-axes to produce these graphs?

(1)

	Graph 1 First ionisation energy of successive elements	Graph 2 Successive ionisation energies of sodium
☒ **A**	actual value	log of value
☒ **B**	log of value	log of value
☒ **C**	log of value	actual value
☒ **D**	actual value	actual value

(b) What is the number of **quantum** shells in a sodium atom suggested by Graph 2?

(1)

☒ **A** Two

☒ **B** Three

☒ **C** Four

☒ **D** Six

(Total for Question 10 = 2 marks)

11 The smallest ion which is isoelectronic with the sodium ion, Na^+, is

☒ **A** hydride ion, H^-.

☒ **B** nitride ion, N^{3-}.

☒ **C** oxide ion, O^{2-}.

☒ **D** fluoride ion, F^-.

(Total for Question 11 = 1 mark)

12 The electronic configuration of a metal **ion** with a charge of +3 could be

☒ **A** $1s^2 2s^2 2p^6$

☒ **B** $1s^2 2s^2 2p^6 3s^1$

☒ **C** $1s^2 2s^2 2p^6 3s^2 3p^1$

☒ **D** $1s^2 2s^2 2p^6 3s^2 3p^3$

(Total for Question 12 = 1 mark)

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

13 Two pieces of filter paper are soaked in water and attached to microscope slides.

A few crystals of purple potassium manganate(VII) are placed on the filter paper attached to the first slide.

A few crystals of blue copper(II) sulfate are placed on the filter paper attached to the second slide.

Both are connected to a DC supply of 20 V for a few minutes.

Which electrodes do the colours on the filter papers move towards?

	Filter paper with potassium manganate(VII)	Filter paper with copper(II) sulfate
☒ **A**	positive	positive
☒ **B**	positive	negative
☒ **C**	negative	positive
☒ **D**	negative	negative

(Total for Question 13 = 1 mark)

14 The similarity between metallic elements and ionic compounds is that both

☒ **A** are held together by forces of attraction between positive and negative ions.

☒ **B** are held together by electrostatic forces.

☒ **C** consist of lattices containing only positive ions.

☒ **D** consist of giant structures of atoms.

(Total for Question 14 = 1 mark)

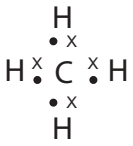
Use this space for any rough working. Anything you write in this space will gain no credit.

15 In what states do sodium and sodium chloride conduct electricity?

	Sodium	Sodium chloride
☒ **A**	solid and liquid	liquid
☒ **B**	solid and liquid	solid and liquid
☒ **C**	solid	solid
☒ **D**	liquid	solid

(Total for Question 15 = 1 mark)

16 Four dot-and-cross electron diagrams are shown.



W

X

Y

Z

Which diagrams are correct?

☒ **A** W, X, Y and Z only

☒ **B** W, Y and Z only

☒ **C** W and Z only

☒ **D** X and Z only

(Total for Question 16 = 1 mark)

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

17 Which molecule contains the greatest number of π bonds?

☒ **A** CO_2

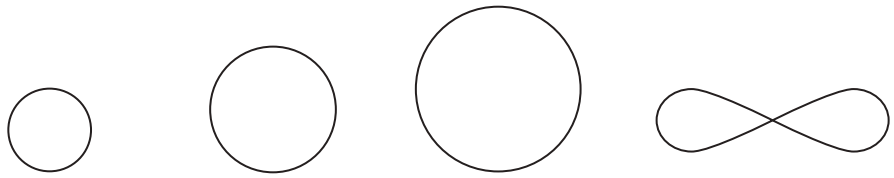
☒ **B** C_2H_4

☒ **C** C_2H_6

☒ **D** C_4H_8

(Total for Question 17 = 1 mark)

18 The diagrams show the shape and relative size of four of the atomic orbitals occupied in a magnesium atom.



E **F** **G** **H**

Which diagram shows a 2s orbital?

☒ **A** **E**

☒ **B** **F**

☒ **C** **G**

☒ **D** **H**

(Total for Question 18 = 1 mark)

19 The number of structural isomers with formula C_6H_{14} is

☒ **A** 3

☒ **B** 4

☒ **C** 5

☒ **D** 6

(Total for Question 19 = 1 mark)

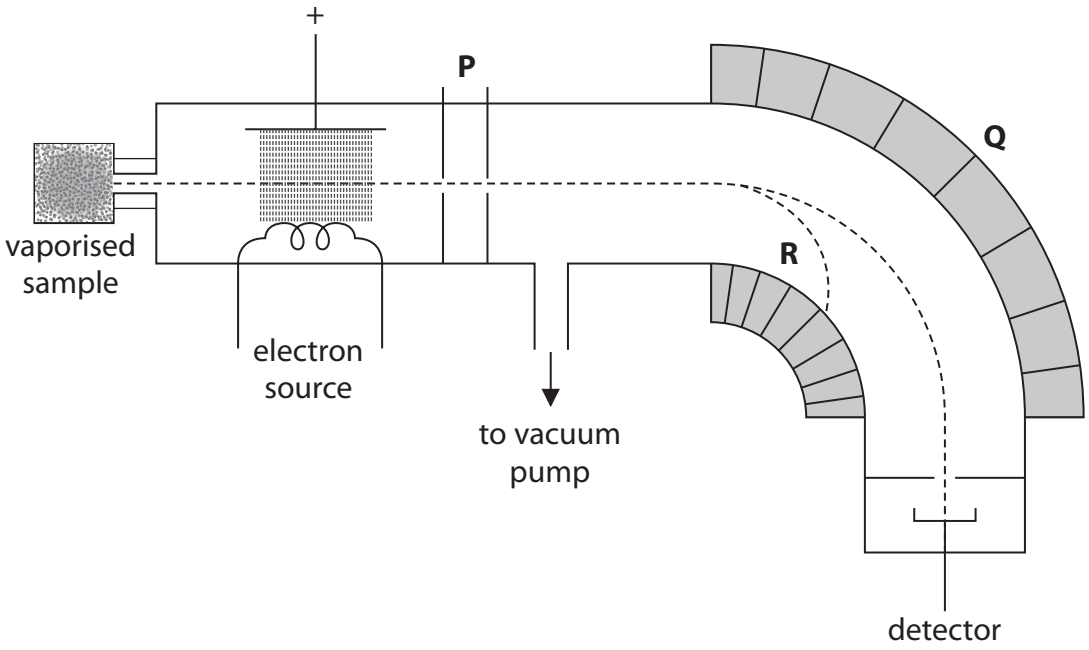
TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

20 This question is about mass spectrometery.

(a) A diagram of a mass spectrometer is shown.



(i) Identify **P** and state its purpose.

(2)

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.....

.....

.....

(ii) Identify **Q**.

(1)

.....

(iii) Suggest **two** ways in which the ions following path **R** could differ from the ions that reach the detector.

(2)

.....

.....

(b) The mass spectrum of magnesium shows the presence of three isotopes.

(i) Complete the table to show the numbers of subatomic particles in the atom of each isotope.

(2)

Isotope mass number	Number of protons	Number of neutrons	Number of electrons
24			
25			
26			

(ii) Explain, with reference to the subatomic particles of the isotopes of magnesium, the meaning of the term isotope.

Quote data from the table in (b)(i).

(2)

(iii) Data obtained using the mass spectrum of magnesium are given in the table.

Isotope mass number	Relative abundance
24	0.786
25	0.101
26	0.113

Calculate the relative atomic mass of magnesium in the sample.

Give your answer to **two** decimal places.

(2)

(c) State **two** further uses of mass spectrometers.

(2)

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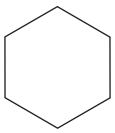
(Total for Question 20 = 13 marks)

21 Cyclohexane, C_6H_{12}, is a colourless liquid which shows the typical reactions of alkanes.



cyclohexane

Data: Boiling temperature = 81°C Density = 0.779 g cm^{-3}

(a) Cyclohexane is carefully added to bromine water in a test tube.

The test tube is shaken, allowed to settle and then the mixture is allowed to stand in sunlight.

(i) Describe what you **see** in the test tube before it is shaken.

(2)

.....

.....

.....

.....

(ii) Describe what you would **see** in the test tube after it is shaken and allowed to settle.

(1)

.....

.....

(iii) Describe the change you would **see** in the test tube after it is allowed to stand in sunlight.

(1)

.....

.....

(b) The reaction that occurs in (a)(iii) is a free radical substitution.

(i) Draw the **skeletal** formula and give the name of the monosubstitution product of this reaction.

(2)

Name .....

(ii) Write the equation for the initiation step of the reaction. Include appropriate curly arrows.

(2)

(iii) Draw the **skeletal** formula for the product of a termination step of the reaction between two cyclohexyl free radicals, $\cdot C_6H_{11}$.

(1)

(c) Write the equation for the reaction when cyclohexane burns **completely** in air.

Use molecular formulae and give the state symbols for the reactants and products at room temperature.

(2)

(d) Suggest why cyclohexane is often added to petrol for use in internal combustion engines.

(1)

.....

.....

(e) (i) Complete the equation, including state symbols, for the atomisation of gaseous cyclohexane.

(1)

$C_6H_{12}(g) \rightarrow$

(ii) Calculate the enthalpy change of atomisation of gaseous cyclohexane, using the bond energies in the table. Include a sign and units in your answer.

Bond	Mean bond energy / kJ mol^{-1}
C—C	347
C—H	415

(2)

(iii) Suggest how the enthalpy change of atomisation for liquid cyclohexane would differ from the value for gaseous cyclohexane calculated in (e)(ii).

Justify your answer.

(1)

.....

.....

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.....

(Total for Question 21 = 16 marks)

22 This question is about alkenes.

(a) But-2-ene has two geometric isomers.

(i) Draw the skeletal formulae of these two isomers and give their names.

(2)

*(ii) Explain how geometric isomerism arises in but-2-ene.

(2)

(b) (i) Give the mechanism for the reaction between hydrogen bromide and but-2-ene.
Use appropriate curly arrows and include relevant dipoles and lone pairs.

(4)

*(ii) 2-bromobutane is formed by the addition of hydrogen bromide to both but-1-ene and but-2-ene.

Explain why the atom economy, by mass, for the formation of 2-bromobutane is different for each reaction.

(2)

(c) **Name** the product of the reaction between but-2-ene and acidified potassium manganate(VII).

(1)

(d) (i) Draw the structure of poly(but-2-ene). Show **two** repeat units.

(2)

(ii) State a problem associated with the disposal of used polymer products such as poly(but-2-ene).

(1)

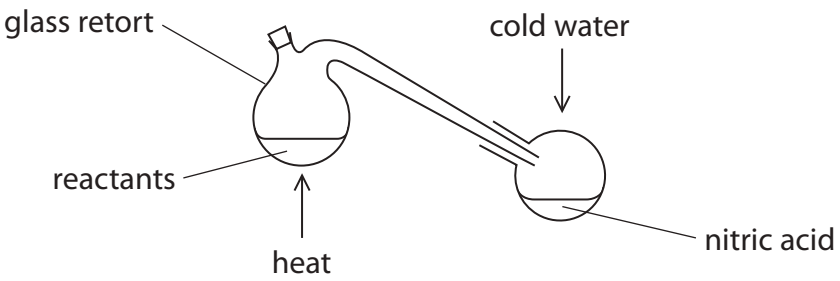
(iii) State **one** way in which the use of polymers can be made more sustainable.

(1)

(Total for Question 22 = 15 marks)

23 This is a question about nitric acid, HNO_3, and nitrates.

(a) Nitric acid can be prepared in the laboratory by heating concentrated sulfuric acid with sodium nitrate in a glass retort.



(i) Write the chemical equation for this reaction in which nitric acid and sodium hydrogensulfate are the only products.

State symbols are not required.

(1)

(ii) The nitric acid obtained by this method is coloured by dissolved oxides of nitrogen. Pure nitric acid is colourless, and normally stored in brown glass bottles.

Suggest why nitric acid needs to be stored in brown glass bottles.

(1)

(iii) Complete the table by giving the meanings of the three hazard symbols associated with concentrated nitric acid.

(2)

*(iv) Silver and copper react with concentrated nitric acid to form soluble salts but pure gold does not react. Gold is often alloyed with silver and/or copper.
Use this information to outline the steps required to determine the percentage of gold in an alloy of gold, silver and copper.
Do **not** include practical details or an explanation of the calculation.

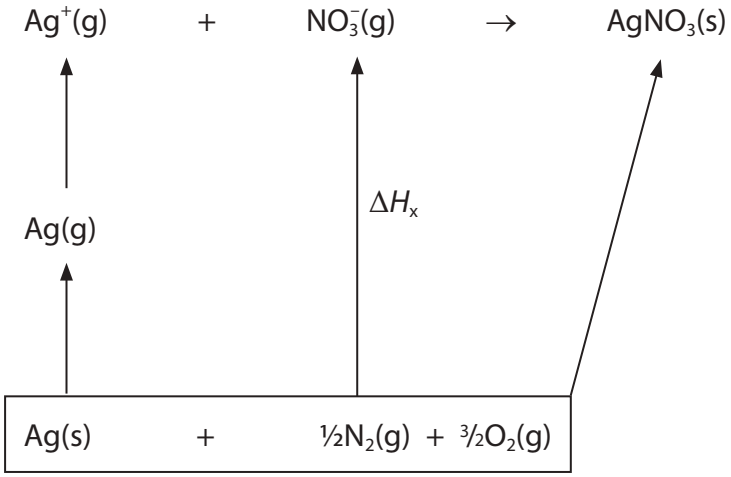
(3)

(v) Magnesium reacts with very dilute nitric acid to form a solution of magnesium nitrate and hydrogen.

Write the **ionic** equation for this reaction, including state symbols.

(2)

(b) (i) The lattice energy of silver nitrate is found to be –832 kJ mol^{-1} using the energy cycle.



Calculate ΔH_x.

Enthalpy change	Value / kJ mol^{-1}
ΔH_f[AgNO$_3$(s)]	–124
ΔH_{at}[Ag(s)]	+285
First ionisation energy [Ag(g)]	+731

(2)

*(ii) The theoretical lattice energy for silver nitrate is –820 kJ mol^{-1}.

What can you deduce about the bonding in silver nitrate? Justify your answer.

(2)

(c) Silver nitrate sticks are used for the treatment of warts. The affected area is moistened and rubbed with the stick.

(i) Suggest why the skin is moistened.

(1)

(ii) A stick weighing 20.0 g contains 95% silver nitrate by mass.

Calculate the number of moles of silver nitrate in the stick.

[molar mass of silver nitrate = 169.9 g mol^{-1}]

(2)

(Total for Question 23 = 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)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)											(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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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