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 9 October 2018

Morning (Time: 1 hour 30 minutes)	Paper Reference **WCH01/01**

Chemistry
Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

You 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.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over

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 Silicon dioxide reacts with hydrogen fluoride to form water and a compound with the formula H_2SiF_6 .

$$SiO_2 + \ldots\ldots\ldots HF \rightarrow H_2SiF_6 + \ldots\ldots\ldots H_2O$$

The mole ratio of HF to H_2O in the balanced equation is

☐ **A** 1 : 2

☐ **B** 3 : 1

☐ **C** 2 : 1

☐ **D** 6 : 1

(Total for Question 1 = 1 mark)

2 For safety reasons, the concentration of lead in paint should not exceed 600 parts per million (ppm) by mass.

Therefore, the mass of lead in one kilogram of paint should not exceed

☐ **A** 0.06 g

☐ **B** 0.60 g

☐ **C** 6.0 g

☐ **D** 60 g

(Total for Question 2 = 1 mark)

3 The solution containing the greatest number of chloride ions is

☐ **A** 10 cm^3 of 1.00×10^{-2} mol dm^{-3} $AlCl_3$

☐ **B** 20 cm^3 of 1.50×10^{-2} mol dm^{-3} $MgCl_2$

☐ **C** 30 cm^3 of 1.50×10^{-2} mol dm^{-3} HCl

☐ **D** 10 cm^3 of 2.50×10^{-2} mol dm^{-3} $CaCl_2$

(Total for Question 3 = 1 mark)

4 Which statement is true about the ions $^{55}Mn^{2+}$ and $^{56}Fe^{2+}$?

☒ **A** $^{55}Mn^{2+}$ is deflected less in a mass spectrometer than $^{56}Fe^{2+}$.

☒ **B** They have the same number of electrons.

☒ **C** $^{55}Mn^{2+}$ has more protons than $^{56}Fe^{2+}$.

☒ **D** They have the same number of neutrons.

(Total for Question 4 = 1 mark)

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5 10 cm^3 of a 1.00×10^{-2} mol dm^{-3} solution needs to be diluted to make the concentration 5.00×10^{-4} mol dm^{-3}.

What volume of water, in cm^3, should be added?

☒ **A** 20

☒ **B** 40

☒ **C** 190

☒ **D** 200

(Total for Question 5 = 1 mark)

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6 The Avogadro constant is 6.0×10^{23} mol^{-1}.

The number of **atoms** in 15 g of nitrogen monoxide, NO, is

☒ **A** 3.0×10^{23}

☒ **B** 6.0×10^{23}

☒ **C** 2.4×10^{24}

☒ **D** 9.0×10^{24}

(Total for Question 6 = 1 mark)

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

7 Nitrogen monoxide reacts with oxygen to form nitrogen dioxide.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

200 cm^3 of nitrogen monoxide is mixed with 350 cm^3 of oxygen.

What is the total volume, in cm^3, of the gaseous mixture when the reaction is complete?

All volumes are measured at the same temperature and pressure.

- ☒ **A** 200
- ☒ **B** 350
- ☒ **C** 450
- ☒ **D** 550

(Total for Question 7 = 1 mark)

8 The first six successive ionisation energies of an element X are given in the table.

Ionisation energy	1st	2nd	3rd	4th	5th	6th
Value / $kJ\,mol^{-1}$	789	1577	3232	4356	16091	19785

The formula of the oxide of X is most likely to be

- ☒ **A** XO_2
- ☒ **B** XO_3
- ☒ **C** X_2O
- ☒ **D** X_2O_3

(Total for Question 8 = 1 mark)

9 The total number of occupied orbitals in the **third** quantum shell of a silicon atom in its ground state is

- ☒ **A** 2
- ☒ **B** 3
- ☒ **C** 4
- ☒ **D** 5

(Total for Question 9 = 1 mark)

10 Which of these statements is correct?

☒ **A** The ionic radii of the alkali metals increase down the group.

☒ **B** The ionic radii for the ions Na^+, Mg^{2+}, Al^{3+} increase across this series.

☒ **C** The first ionisation energies of the alkali metals increase down the group.

☒ **D** The melting temperatures of successive elements in Period 3 always increase across the period.

(Total for Question 10 = 1 mark)

11 Which compound would be expected to show the greatest covalent character?

☒ **A** LiBr

☒ **B** LiI

☒ **C** KF

☒ **D** KCl

(Total for Question 11 = 1 mark)

12 Phosphoric(V) acid, H_3PO_4, can be made from phosphorus in two stages.

$$P_4 + 5O_2 \rightarrow P_4O_{10}$$

$$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$$

Data

Formula	P_4	O_2	P_4O_{10}	H_2O	H_3PO_4
Molar mass / g mol^{-1}	124	32	284	18	98

The percentage atom economy, by mass, for the production of phosphoric(V) acid from phosphorus is

☒ **A** 58.0

☒ **B** 69.0

☒ **C** 72.4

☒ **D** 100

(Total for Question 12 = 1 mark)

13 This question is about the reaction of nickel(II) carbonate and hydrochloric acid.

$$NiCO_3(s) + 2HCl(aq) \rightarrow NiCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) The ionic equation for this reaction is

(1)

☒ **A** $NiCO_3(s) + 2H^+(aq) \rightarrow Ni^{2+}(aq) + CO_2(g) + H_2O(l)$

☒ **B** $Ni^{2+}(s) + 2Cl^-(aq) \rightarrow NiCl_2(aq)$

☒ **C** $Ni^{2+}(s) + 2HCl(aq) \rightarrow NiCl_2(aq) + 2H^+(aq)$

☒ **D** $NiCO_3(s) + 2HCl(aq) \rightarrow Ni^{2+}(aq) + 2Cl^-(aq) + CO_2(g) + H_2O(l)$

(b) Excess hydrochloric acid reacts with 0.20 mol of nickel(II) carbonate.
What is the volume, in dm^3, of gas produced at room temperature and pressure?
(1 mol of any gas occupies 24 dm^3 at room temperature and pressure)

(1)

☒ **A** 1.2

☒ **B** 2.4

☒ **C** 4.8

☒ **D** 9.6

(c) What is the minimum volume of hydrochloric acid with a concentration of 4.0 mol dm^{-3} that reacts with 0.20 mol of nickel carbonate?

(1)

☒ **A** 20 cm^3

☒ **B** 50 cm^3

☒ **C** 100 cm^3

☒ **D** 200 cm^3

(Total for Question 13 = 3 marks)

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14 When 100 cm^3 of 2.0 mol dm^{-3} sodium hydroxide solution is added to 100 cm^3 of 2.0 mol dm^{-3} sulfuric acid (an excess) to form sodium sulfate, the temperature rise is 12.5 °C.

Energy transferred (J) = mass × 4.2 × temperature change

What is the enthalpy change of the reaction in kJ mol^{-1}?

☒ **A** $\Delta H = -\dfrac{200 \times 4.2 \times 12.5}{0.4}$

☒ **B** $\Delta H = -100 \times 4.2 \times 12.5 \times 0.4$

☒ **C** $\Delta H = -\dfrac{200 \times 4.2 \times 12.5}{0.2}$

☒ **D** $\Delta H = -100 \times 4.2 \times 12.5 \times 0.2$

(Total for Question 14 = 1 mark)

15 Hydrogen is manufactured using the reaction

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

The percentage yield of hydrogen in this process is 90%.

The mass of hydrogen, in tonnes, which can be produced from 160 tonnes of methane is

☒ **A** 27

☒ **B** 54

☒ **C** 60

☒ **D** 67

(Total for Question 15 = 1 mark)

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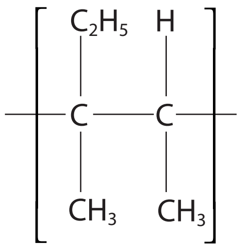
16 The repeat unit of a polymer is shown.



What is the systematic name of the monomer which forms this polymer?

- ☒ **A** 2-ethylbut-2-ene
- ☒ **B** 2,3-dimethylbut-1-ene
- ☒ **C** 2-ethylpent-2-ene
- ☒ **D** 3-methylpent-2-ene

(Total for Question 16 = 1 mark)

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17 A compound contains 31.25% Ca, 18.75% C and 50.00% O.

Its empirical formula is

- ☒ **A** CaC_2O_4
- ☒ **B** Ca_2CO_3
- ☒ **C** Ca_2CO_2
- ☒ **D** $CaCO_3$

(Total for Question 17 = 1 mark)

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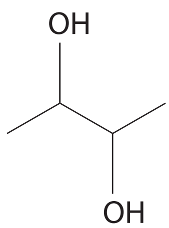
18 Which reagent reacts with but-2-ene to form the compound with the formula shown?



- ☒ **A** Water
- ☒ **B** Sodium hydroxide
- ☒ **C** Hydrogen peroxide
- ☒ **D** Acidified potassium manganate(VII)

(Total for Question 18 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

19 A sample of zinc has the relative atomic mass 65.44. The sample contains four isotopes.

The abundance of three of these isotopes is shown.

Relative isotopic mass	64	66	67
Abundance (%)	49.00	27.90	4.50

(a) (i) Use these data to calculate the relative isotopic mass of the fourth isotope.

Show your working, and give your answer to an appropriate number of significant figures.

(3)

(ii) State and explain what difference, if any, you would expect between the **chemical** properties of the lightest and heaviest isotopes of zinc.

(1)

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(b) Isotopic masses are determined using a mass spectrometer. The sample under investigation is first converted into gaseous ions.

(i) Ions then pass through slits in a series of electrically charged plates.

Give **two** reasons for this procedure.

(2)

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(ii) State how ions of different mass are separated.

(1)

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(iii) The ions eventually produce a current in the detector. Data from the detector are used to produce a mass spectrum.

State how the horizontal axis of a mass spectrum is labelled.
Give your answer in **words**, not symbols.

(1)

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(c) Complete the electronic configuration of an atom of zinc using s p d notation.

(1)

$1s^2$...

(d) Describe, with the aid of a diagram, the bonding in a sample of zinc. You should state the attractions which hold the particles together in the solid.

(3)

(Total for Question 19 = 12 marks)

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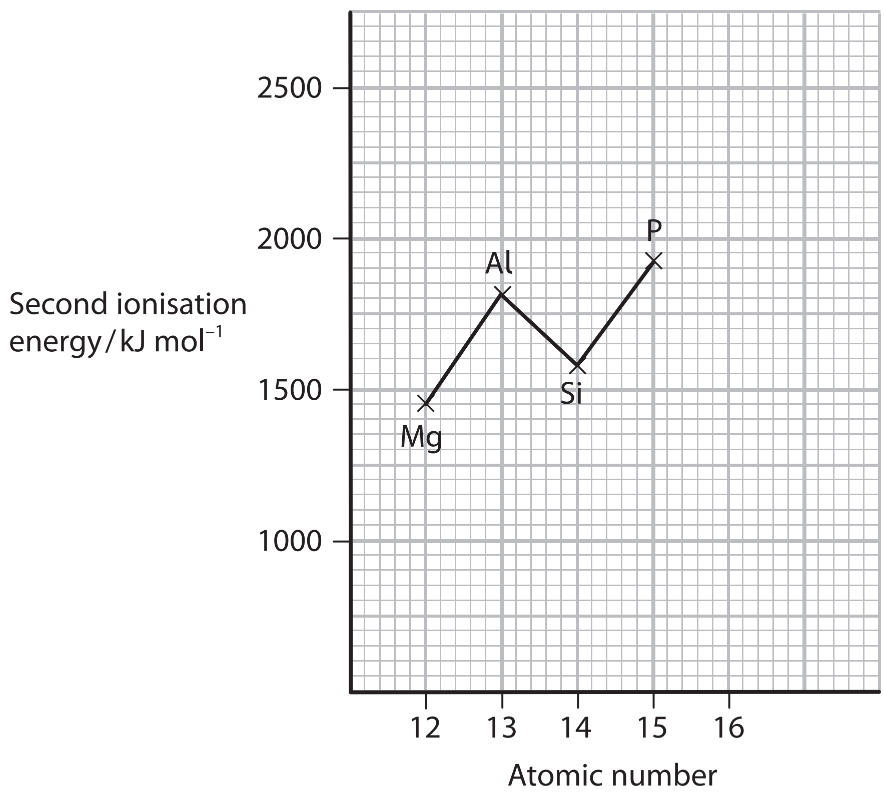
20 (a) The **second** ionisation energies of some elements in Period 3 are shown on the grid.



(i) Mark on the grid, with a cross, the value you would expect for sulfur.

(1)

(ii) Write an equation, including state symbols, for the **second** ionisation of aluminium.

(2)

*(iii) Explain why the **second** ionisation energy of aluminium is greater than both the second ionisation energy of magnesium and the second ionisation energy of silicon.

(4)

(iv) Predict, with a reason, which element in Period 3 has the highest **second** ionisation energy.

(1)

(b) Magnesium and sulfur both react with chlorine to form chlorides with a formula XCl_2.

Magnesium chloride, $MgCl_2$, is ionic. Sulfur dichloride, SCl_2, consists of covalently bonded molecules.

(i) Describe how the electrical conductivity of these two compounds differs.

(1)

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(ii) Draw a dot and cross diagram for sulfur dichloride.

Use crosses (×) for electrons in sulfur and dots (•) for electrons in chlorine. Only show outer shell electrons.

(2)

(iii) Sketch an electron density map of sulfur dichloride.

(1)

(iv) State how the electron density map of magnesium chloride differs from that of sulfur dichloride.

(1)

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(c) The Born-Haber cycle can be used to determine the lattice energy of magnesium chloride.

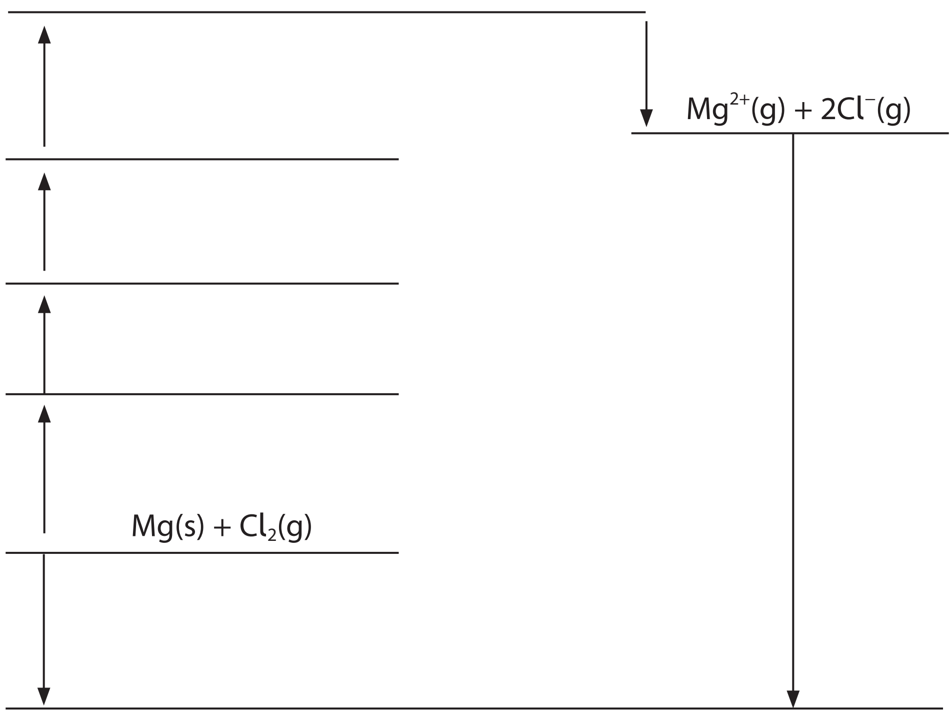
The table below shows the enthalpy changes that are needed.

Energy change	ΔH / kJ mol^{-1}
Enthalpy change of atomisation of magnesium	+147.7
First ionisation energy of magnesium	+738
Second ionisation energy of magnesium	+1451
Enthalpy change of atomisation of chlorine (½Cl_2)	+121.7
First electron affinity of chlorine	−348.8
Enthalpy change of formation of magnesium chloride	−641.3

(i) The diagram shows an incomplete Born-Haber cycle for the formation of magnesium chloride from magnesium and chlorine.

Complete the diagram by writing the **formulae** of the correct species, including state symbols, on the five empty horizontal lines.

(4)

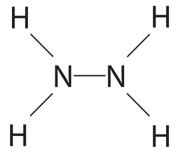


(ii) Calculate the lattice energy of magnesium chloride in $kJ\,mol^{-1}$.

(2)

(Total for Question 20 = 19 marks)

21 The compound hydrazine, N_2H_4, is a liquid which is used as a rocket fuel.

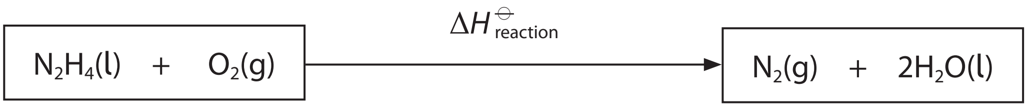


It reacts with oxygen to form nitrogen and water.

(a) Complete the Hess cycle and, using data in the table, calculate the enthalpy change for the oxidation of hydrazine, $\Delta H^{\ominus}_{\text{reaction}}$.

Species	Standard enthalpy change of formation / kJ mol^{-1}
$N_2H_4(l)$	+50.6
$H_2O(l)$	−285.8

(2)



(b) Some bond enthalpies are given in the table.

Bond	Bond enthalpy / kJ mol^{-1}
N—N	158
O═O	498
N≡N	945
H—O	464
N—H	391

(i) Calculate the enthalpy change for the oxidation of hydrazine, using the bond enthalpy values in the table.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(l)$$

(3)

(ii) Give **two** reasons why the enthalpy change calculated using bond enthalpies differs from $\Delta H^{\ominus}_{reaction}$ calculated from the Hess cycle.

(2)

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(Total for Question 21 = 7 marks)

22 One component of petrol is decane, $C_{10}H_{22}$.

(a) Decane reacts with chlorine in the presence of ultraviolet light to form a mixture of products.

(i) Complete the equation for the initiation step, including appropriate curly arrows.

(2)

$$Cl—Cl \longrightarrow$$

(ii) Write equations, using molecular formulae, for **two** propagation steps.

(2)

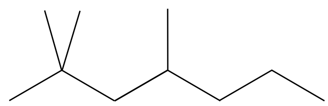
(iii) Write equations, using molecular formulae, for **two** termination steps, other than the one in which chlorine forms.

(2)

(b) The structure of decane can be changed by the process called reforming.

Name the compound shown, which can be produced in this process.

(1)



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(c) Write an equation, using molecular formulae, for the incomplete combustion reaction in which decane reacts to form carbon monoxide and **one** other product.

State symbols are not required.

(1)

(d) Decane can be cracked to form a mixture of butane, and two different alkenes which have different molecular formulae.

(i) Write an equation for this reaction, using molecular formulae. State symbols are not required.

(1)

*(ii) Explain why geometric isomerism can occur in alkenes and why alkenes produced by this cracking reaction may **not** have geometric isomers.

(2)

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(iii) Draw the structure of the *trans*, (*E*), isomer of an alkene produced by the cracking reaction in (d)(i).

(1)

(Total for Question 22 = 12 marks)

23 This question is about alkenes.

*(a) Describe in detail the structure of the C═C double bond in alkenes and hence explain why alkenes are more reactive than alkanes.

(3)

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(b) Hydrogen bromide reacts with propene to form a mixture of 1-bromopropane and 2-bromopropane.

(i) Draw the mechanism for the formation of the **major** product in the reaction of propene with hydrogen bromide. You should show relevant dipoles and curly arrows.

(4)

(ii) State why the amounts of each product are **not** equal.

(1)

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(c) A derivative of propene called allyl bromide, or 3-bromoprop-1-ene, is used to make polymers. The formula of allyl bromide is $CH_2{=}CHCH_2Br$.

Write the equation for the polymerisation of allyl bromide, showing the structure of the polymer.

(2)

(Total for Question 23 = 10 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0 (8)
							1.0 **H** hydrogen 1										(18)
(1)	(2)											(13)	(14)	(15)	(16)	(17)	4.0 **He** helium 2
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