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

Friday 22 May 2015 – Morning
Time: 1 hour 30 minutes

Paper Reference
WCH01/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or 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.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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6/6/6/5/1/

P 4 4 8 8 0 A 0 1 2 8

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 In which order do the electrons fill the orbitals of an atom?

☒ **A** 1s 2s 2p 3s 3p 4s 4p 3d

☒ **B** 1s 2s 2p 3s 3d 3p 4s 4p

☒ **C** 1s 2s 2p 3s 3p 3d 4s 4p

☒ **D** 1s 2s 2p 3s 3p 4s 3d 4p

(Total for Question 1 = 1 mark)

2 Ions are separated in the mass spectrometer by

☒ **A** a vacuum pump.

☒ **B** a magnetic field.

☒ **C** an ionization chamber.

☒ **D** electron bombardment.

(Total for Question 2 = 1 mark)

3 Which of the following contains one mole of neutrons?

☒ **A** 1 g of $^{1}_{1}H$

☒ **B** 1 g of $^{12}_{6}C$

☒ **C** 2 g of $^{24}_{12}Mg$

☒ **D** 2 g of $^{22}_{10}Ne$

(Total for Question 3 = 1 mark)

4 Solutions of barium chloride and silver nitrate are mixed together.
The reaction that takes place is an example of

☒ **A** displacement.

☒ **B** neutralization.

☒ **C** oxidation.

☒ **D** precipitation.

(Total for Question 4 = 1 mark)

5 The Avogadro constant is numerically equal to the number of

☒ **A** ions in 1 mol of sodium chloride, NaCl

☒ **B** atoms in 1 mol of hydrogen gas, H_2

☒ **C** electrons in 1 mol of helium gas, He

☒ **D** molecules in 1 mol of oxygen gas, O_2

(Total for Question 5 = 1 mark)

6 10 g of magnesium is added to 1 dm^3 of 1 mol dm^{-3} copper(II) sulfate solution and the mixture is stirred until no further reaction occurs.

Which of the following is a result of this reaction?

☒ **A** The resulting solution is colourless.

☒ **B** 10 g of copper is displaced.

☒ **C** 63.5 g of copper is displaced.

☒ **D** All the magnesium reacts.

(Total for Question 6 = 1 mark)

7 Which of the following gas samples has the same volume as 7.0 g of carbon monoxide?

All volumes are measured at the same temperature and pressure.

☒ **A** 1.0 g of hydrogen

☒ **B** 3.5 g of nitrogen

☒ **C** 10.0 g of argon

☒ **D** 35.5 g of chlorine

(Total for Question 7 = 1 mark)

8 Which of the following aqueous solutions contains the greatest number of **negative** ions?

☒ **A** 500 cm^3 of 0.10 mol dm^{-3} $Na_2SO_4(aq)$

☒ **B** 250 cm^3 of 0.12 mol dm^{-3} $BaCl_2(aq)$

☒ **C** 250 cm^3 of 0.15 mol dm^{-3} $KI(aq)$

☒ **D** 500 cm^3 of 0.10 mol dm^{-3} $Zn(NO_3)_2(aq)$

(Total for Question 8 = 1 mark)

9 In an experiment carried out at 200 °C and 1 atm pressure, 20 cm^3 of ammonia gas reacted with an excess of heated copper(II) oxide.

$$3CuO(s) + 2NH_3(g) \rightarrow 3Cu(s) + 3H_2O(g) + N_2(g)$$

If all measurements were made at 200 °C and 1 atm pressure, what would be the total volume, in cm^3, of gaseous products?

☒ **A** 10

☒ **B** 20

☒ **C** 30

☒ **D** 40

(Total for Question 9 = 1 mark)

10 Ammonia is manufactured from hydrogen and nitrogen in the Haber process.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

If 60 tonnes of hydrogen produces 80 tonnes of ammonia, what is the percentage yield in the reaction?

☒ **A** $\frac{80}{170} \times 100\%$

☒ **B** $\frac{80}{340} \times 100\%$

☒ **C** $\frac{30}{80} \times 100\%$

☒ **D** $\frac{60}{80} \times 100\%$

(Total for Question 10 = 1 mark)

11 Which of the following compounds has the greatest ionic character?

☒ **A** Caesium fluoride

☒ **B** Caesium iodide

☒ **C** Potassium fluoride

☒ **D** Potassium iodide

(Total for Question 11 = 1 mark)

12 Which species has a dative covalent bond?

☒ **A** H_3O^+

☒ **B** H_2O

☒ **C** OH^-

☒ **D** O_2

(Total for Question 12 = 1 mark)

13 The atomic radius of potassium is larger than that of sodium because potassium has

☒ **A** a larger nuclear charge.

☒ **B** a larger nucleus.

☒ **C** more occupied electron shells.

☒ **D** a smaller first ionization energy.

(Total for Question 13 = 1 mark)

14 Consider the following data.

$S(s)$	+	$H_2(g)$	→	$H_2S(g)$	$\Delta H^{\ominus} = a$
$H_2(g)$	+	$½O_2(g)$	→	$H_2O(l)$	$\Delta H^{\ominus} = b$
$S(s)$	+	$O_2(g)$	→	$SO_2(g)$	$\Delta H^{\ominus} = c$
$H_2S(g)$	+	$1½O_2(g)$	→	$H_2O(l) + SO_2(g)$	$\Delta H^{\ominus} = d$

What is the relationship between a, b, c and d?

☒ **A** $a = b + c - d$

☒ **B** $a = d - b - c$

☒ **C** $a = b - c - d$

☒ **D** $a = d + c - b$

(Total for Question 14 = 1 mark)

15 In which of the following does **X** represent the mean bond enthalpy for the O–H bond in water?

☒ **A** $H_2O(g) \rightarrow O(g) + H_2(g)$ $\Delta H = 2\mathbf{X}$

☒ **B** $H_2O(g) \rightarrow O(g) + 2H(g)$ $\Delta H = 2\mathbf{X}$

☒ **C** $H_2O(g) \rightarrow O(g) + H_2(g)$ $\Delta H = \mathbf{X}$

☒ **D** $H_2O(g) \rightarrow O(g) + 2H(g)$ $\Delta H = \mathbf{X}$

(Total for Question 15 = 1 mark)

16 Which of the following is a step in the propagation stage of the chlorination of methane?

☒ **A** $Cl_2 \rightarrow Cl^{\bullet} + Cl^{\bullet}$

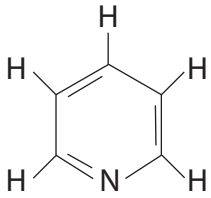
☒ **B** $CH_3^{\bullet} + Cl^{\bullet} \rightarrow CH_3Cl$

☒ **C** $CH_3^{\bullet} + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$

☒ **D** $CH_4 + Cl^{\bullet} \rightarrow CH_3Cl + H^{\bullet}$

(Total for Question 16 = 1 mark)

17 A molecule of **Z** has the following structure:



Molecule of **Z**

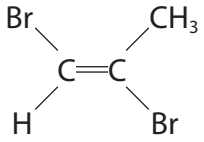
What are the total numbers of σ-bonds and π-bonds in a molecule of **Z**?

	Number of σ-bonds	Number of π-bonds
☒ **A**	3	11
☒ **B**	8	3
☒ **C**	11	3
☒ **D**	14	6

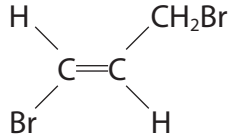
(Total for Question 17 = 1 mark)

18 Which is the structure of *Z*-1,2-dibromoprop-1-ene?

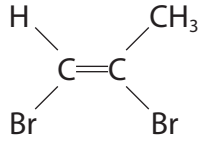
☒ **A**



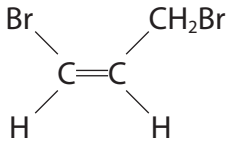
☒ **B**



☒ **C**

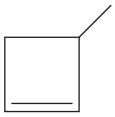


☒ **D**



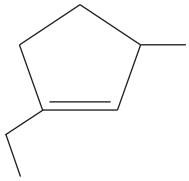
(Total for Question 18 = 1 mark)

19 The skeletal formula of 3-methylcyclobut-1-ene is shown below.

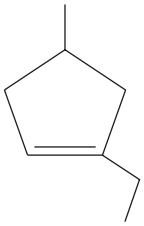


What is the skeletal formula of 1-ethyl-3-methylcyclopent-1-ene?

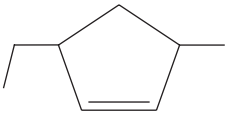
☒ **A**



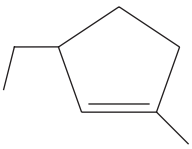
☒ **B**



☒ **C**



☒ **D**



(Total for Question 19 = 1 mark)

20 Which of the following fuels, when burned, would make no significant contribution to climate change?

☒ **A** Hydrogen

☒ **B** Methane

☒ **C** Petrol

☒ **D** Coal

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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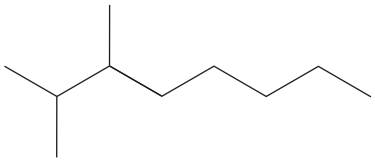
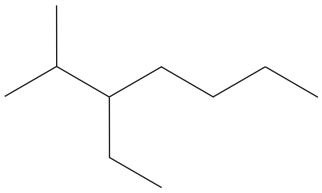
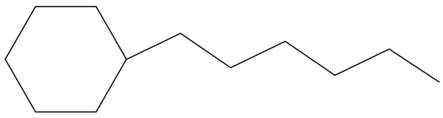
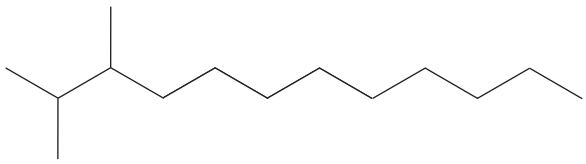
SECTION B

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

21 A propellant for a rocket consists of a fuel, kerosene, and an oxidizer, liquid oxygen.

(a) The formulae of some hydrocarbons present in kerosene are shown in the table below.

Hydrocarbon	Formula
A	
B	$CH_3(CH_2)_{10}CH_3$
C	
D	
E	

(i) Name the homologous series to which the compounds **A**, **B**, **C** and **E** belong.

(1)

.....

(ii) Name the compound **A**.

(1)

.....

(iii) Explain the term **structural isomers**, by reference to two molecules selected from the table in part (a).

(3)

.....

.....

.....

.....

.....

.....

.....

(iv) Give the **molecular** formula of the compound **D**.

(2)

(b) In the petrochemical industry, other fuels are obtained by the cracking and reforming of kerosene.

Using appropriate letters, **A** to **D**, identify a molecule listed in the table that could be formed from **E** by

(i) cracking alone

(1)

.....

(ii) cracking and then reforming

(1)

.....

(c) Suggest how engine performance is improved by using a fuel containing the molecule that you have identified in (b)(ii).

(1)

.....

.....

(d) The **energy density** of a fuel is defined as the energy produced per kilogram of fuel.

Calculate the energy density of dodecane, $C_{12}H_{26}$, in kJ kg^{-1}. Give your answer to **two** significant figures.

The enthalpy change of combustion of dodecane is −8086 kJ mol^{-1}.

[Molar mass: $C_{12}H_{26}$ = 170 g mol^{-1}]

(3)

energy density = ... kJ kg^{-1}

(Total for Question 21 = 13 marks)

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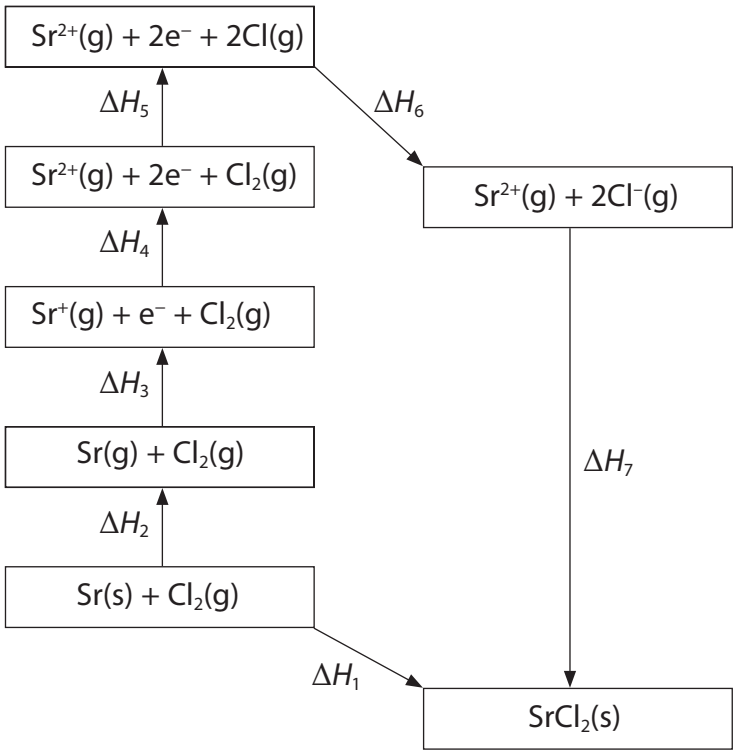
22 Born-Haber cycles can be used to determine experimental values of lattice energies.

(a) The diagram below shows a Born-Haber cycle for the formation of strontium chloride from strontium and chlorine.



Using symbols from ΔH_1 to ΔH_7 as appropriate, identify the

(i) enthalpy change of atomization of strontium

(1)

.....

(ii) bond enthalpy of chlorine

(1)

.....

(iii) first electron affinity of chlorine

(1)

.....

(iv) enthalpy change of formation of strontium chloride

(1)

.....

(b) The table below shows the energy changes that are needed to determine the lattice energy of strontium chloride, $SrCl_2$.

Energy change	ΔH / kJ mol^{-1}
enthalpy change of atomization of strontium	+164
first ionization energy of strontium	+550
second ionization energy of strontium	+1064
enthalpy change of atomization of chlorine, $\frac{1}{2}Cl_2$	+122
first electron affinity of chlorine	−349
enthalpy change of formation of strontium chloride	−829

(i) Define the term **lattice energy**.

(2)

.....

.....

.....

.....

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

(2)

lattice energy = ... kJ mol^{-1}

*(c) The lattice energies of sodium fluoride and magnesium fluoride are shown in the table below.

Compound	Lattice energy / kJ mol^{-1}
Sodium fluoride, NaF	–918
Magnesium fluoride, MgF_2	–2957

Explain, in terms of the sizes and charges of the ions involved, why the lattice energy of MgF_2 is more negative than that of NaF.

(3)

(Total for Question 22 = 11 marks)

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23 This question is about alkenes.

(a) Give the general formula for the homologous series of alkenes.

(1)

.....

(b) Give the **structural** formula of the organic product formed when **ethene**, $CH_2=CH_2$, reacts with

(i) hydrogen

(1)

(ii) chlorine

(1)

(iii) acidified aqueous potassium manganate(VII)

(1)

(iv) bromine **water**

(1)

(c) When **propene**, $CH_3CH=CH_2$, reacts with hydrogen chloride, there are **two** possible products, a major product and a minor product.

(i) Draw the **displayed** formulae of these products.

(2)

Major product	Minor product

(ii) Give the mechanism for the reaction of **propene** with hydrogen chloride which forms the major product.

(3)

(d) Propene can be polymerized.

(i) Write a balanced equation for the polymerization of propene to form poly(propene), drawing the **displayed** formula of the repeat unit of poly(propene).

(3)

(ii) State a problem associated with the disposal of waste poly(propene).

(1)

(e) Standard enthalpy changes of combustion can be used to calculate the standard enthalpy change of formation of propene.

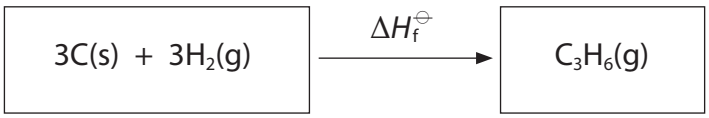
$$3C(s) + 3H_2(g) \longrightarrow C_3H_6(g)$$

Values for some standard enthalpy changes of combustion, $\Delta H_c^{\ominus}$, are shown in the table below.

Substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
C(s)	−394
$H_2(g)$	−286
$C_3H_6(g)$	−2058

(i) Complete the Hess cycle below to enable you to calculate $\Delta H_f^{\ominus}$ from combustion data.

(1)



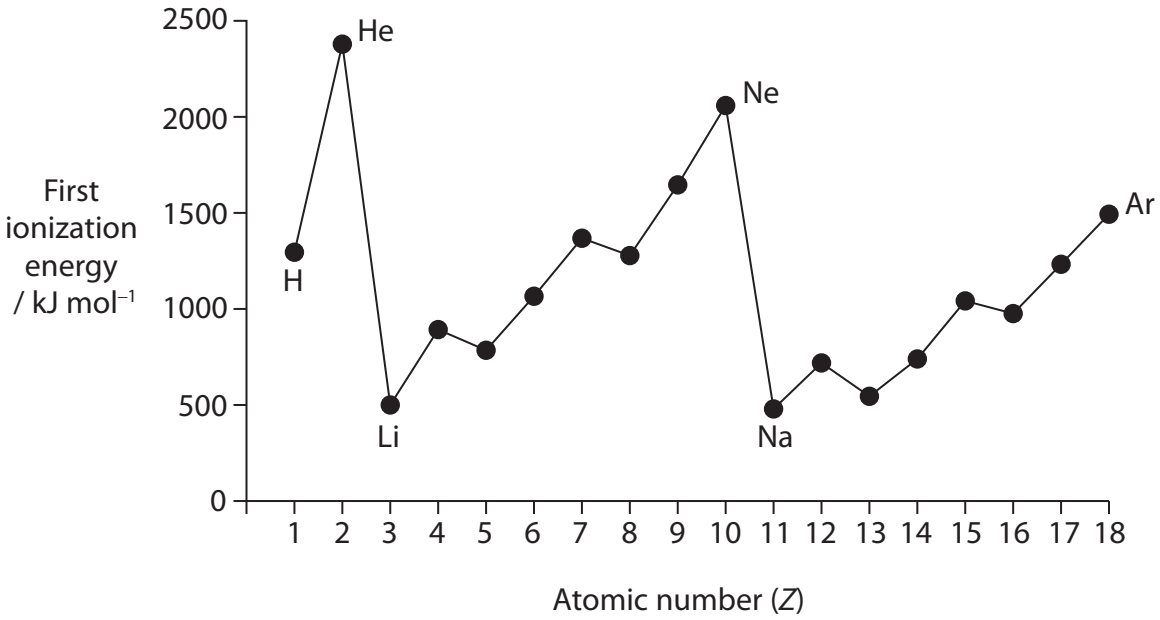
(ii) Calculate $\Delta H_f^{\ominus}$, in kJ mol^{-1}.

(2)

standard enthalpy change of formation of propene = ... kJ mol^{-1}

(Total for Question 23 = 17 marks)

24 The diagram below shows the pattern in the first ionization energies of the first 18 elements.



(a) Give the equation, including state symbols, for the first ionization energy of fluorine.

(2)

*(b) Explain why there is a **general** increase in the first ionization energies from sodium to argon.

(3)

(c) *(i) Explain why the first ionization energy of aluminium ($Z = 13$) is less than that of magnesium ($Z = 12$).

(2)

.....

.....

.....

.....

*(ii) Explain why the first ionization energy of sulfur ($Z = 16$) is less than that of phosphorus ($Z = 15$).

(2)

.....

.....

.....

.....

(d) The table below, which is incomplete, refers to the elements sodium to sulfur.

Element	Na	Mg	Al	Si	P	S
Melting temperature	low	high				
Structure		giant				
Electrical conductivity		high				

(i) Complete the **melting temperature** row by using only the words 'high' or 'low'.

(2)

(ii) Complete the **structure** row by using only the words 'giant' or 'molecular'.

(2)

(iii) Complete the **electrical conductivity** row by using only the words 'high' or 'low'.

(1)

(e) In an experiment, 2.76 g of sodium completely reacted with water to form 500 cm^3 of aqueous sodium hydroxide.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

(i) Calculate the number of moles of sodium that reacted.

(1)

(ii) Calculate the maximum volume, in dm^3, of hydrogen that can be formed at room temperature and pressure.

[1 mol of any gas occupies 24 dm^3 at room temperature and pressure.]

(2)

(iii) Calculate the concentration, in mol dm^{-3}, of the sodium hydroxide solution, NaOH(aq), formed in the experiment.

(2)

(Total for Question 24 = 19 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: 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