Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Friday 27 May 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

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 ▶

P46656A

3/6/6/3/1/

P 4 6 6 5 6 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 mass of magnesium ions in 1 kg of sea water is 1.3 g.
The concentration in parts per million (ppm) is

☒ **A** 1.3×10^{6}

☒ **B** 1.3×10^{3}

☒ **C** 1.3×10^{-3}

☒ **D** 1.3×10^{-6}

(Total for Question 1 = 1 mark)

2 Calculate the total number of **ions** in 7.41 g of calcium hydroxide, $Ca(OH)_2$.

The molar mass of calcium hydroxide is 74.1 g mol^{-1}.

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

☒ **A** 6.0×10^{22}

☒ **B** 1.2×10^{23}

☒ **C** 1.8×10^{23}

☒ **D** 3.0×10^{23}

(Total for Question 2 = 1 mark)

3 Which of the following has the highest melting temperature?

☒ **A** Hg

☒ **B** K

☒ **C** $C_{10}H_{22}$

☒ **D** SiO_2

(Total for Question 3 = 1 mark)

4 Which of these has a dative covalent bond?

☒ **A** NH_3

☒ **B** OH^-

☒ **C** H_2O

☒ **D** H_3O^+

(Total for Question 4 = 1 mark)

5 What is the equation for the first electron affinity of sulfur?

☒ **A** $S(s) + e^- \rightarrow S^-(g)$

☒ **B** $S(g) + e^- \rightarrow S^-(g)$

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

☒ **D** $S(g) \rightarrow S^+(g) + e^-$

(Total for Question 5 = 1 mark)

6 100 cm^3 of hydrogen is mixed with 25 cm^3 of oxygen at a temperature of 150 °C.
The gases react as shown in the equation below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

The total volume of gas present at the end of the reaction is

☒ **A** 50 cm^3

☒ **B** 100 cm^3

☒ **C** 125 cm^3

☒ **D** 150 cm^3

(Total for Question 6 = 1 mark)

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

7 Sodium nitrate decomposes on heating.

$$2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$$

What is the maximum volume of oxygen, measured in dm^3 at room temperature and pressure, which could be obtained by heating 0.50 mol of sodium nitrate?

[Molar volume of a gas = 24 dm^3 mol^{-1} at room temperature and pressure]

☒ **A** 3

☒ **B** 6

☒ **C** 12

☒ **D** 24

(Total for Question 7 = 1 mark)

8 An excess of copper(II) oxide is mixed with 40.0 cm^3 of 2.50 mol dm^{-3} hydrochloric acid.

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

(a) If the mass of copper(II) chloride produced is 5.50 g, what is the percentage yield of copper(II) chloride?

[Molar mass of copper(II) chloride = 134.4 g mol^{-1}]

(1)

☒ **A** 81.8%

☒ **B** 67.2%

☒ **C** 40.9%

☒ **D** 20.4%

(b) The ionic equation for the reaction is

(1)

☒ **A** $Cu^{2+}(s) + 2Cl^-(aq) \rightarrow CuCl_2(aq)$

☒ **B** $CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$

☒ **C** $CuO(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Cu^{2+}(Cl^-)_2(aq) + H_2O(l)$

☒ **D** $CuO(s) + 2Cl^-(aq) \rightarrow CuCl_2(aq) + O^{2-}(l)$

(c) Some facts about copper(II) chloride are given below.

Which of these gives the **best** evidence that the bonding in copper(II) chloride is ionic?

(1)

☒ **A** It has a melting temperature of 620 °C.

☒ **B** It does not conduct electricity as a solid.

☒ **C** It decomposes before it reaches its boiling temperature.

☒ **D** In the electron density map, there are no contour lines around more than one nucleus.

(Total for Question 8 = 3 marks)

9 The melting temperature of sodium is lower than the melting temperature of magnesium. The **best** explanation for this is

☒ **A** sodium atoms are smaller than magnesium atoms.

☒ **B** sodium ions have a larger charge density than magnesium ions.

☒ **C** the repulsion between the ions in sodium is less than in magnesium.

☒ **D** the number of delocalised electrons per atom is fewer in sodium than in magnesium.

(Total for Question 9 = 1 mark)

10 A trend going down Group 1 is that the

☒ **A** first ionization energy of the element decreases.

☒ **B** lattice energy of the chloride becomes more negative.

☒ **C** radius of the atom decreases.

☒ **D** melting temperature of the element increases.

(Total for Question 10 = 1 mark)

11 Which of the following ions has the biggest radius?

☒ **A** S^{2-}

☒ **B** Cl^{-}

☒ **C** K^{+}

☒ **D** Ca^{2+}

(Total for Question 11 = 1 mark)

12 When 0.1 mol of aqueous potassium hydroxide was added to 0.1 mol of nitric acid, 5200 J were transferred to the surroundings. What is the enthalpy change, in kJ mol^{-1}, for this reaction?

$$KOH(aq) + HNO_3(aq) \rightarrow KNO_3(aq) + H_2O(l)$$

☒ **A** –52

☒ **B** –26

☒ **C** +26

☒ **D** +52

(Total for Question 12 = 1 mark)

13 A compound has the composition 62.1% C, 10.3% H and 27.6% O.

What is its empirical formula?

☒ **A** CH_2O

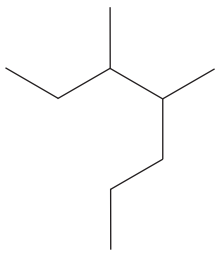
☒ **B** C_6H_2O

☒ **C** C_6H_3O

☒ **D** C_3H_6O

(Total for Question 13 = 1 mark)

14 What is the systematic name of the following?



☒ **A** 3-methyl-2-propylpentane

☒ **B** 3-methyl-4-propylpentane

☒ **C** 3,4-dimethylheptane

☒ **D** 4,5-dimethylheptane

(Total for Question 14 = 1 mark)

15 Which of the following shows geometric isomerism?

☒ **A** prop-1-ene

☒ **B** but-1-ene

☒ **C** 1,1-dichloroethene

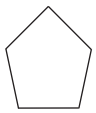
☒ **D** 1,2-dichloroethene

(Total for Question 15 = 1 mark)

16 This question is about the organic compounds with skeletal formulae as shown.

1

2



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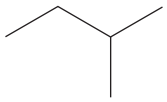
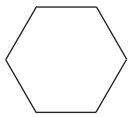


4



(a) Which compounds are isomers?

(1)

☒ **A** 1 and 2

☒ **B** 1 and 3

☒ **C** 1 and 4

☒ **D** 2 and 3

(b) Which compound has the same molecular formula and empirical formula?

(1)

☒ **A** 1

☒ **B** 2

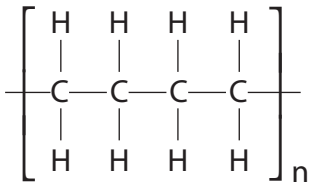
☒ **C** 3

☒ **D** 4

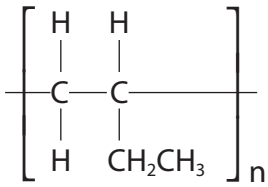
(Total for Question 16 = 2 marks)

17 What is the formula of poly(but-1-ene)?

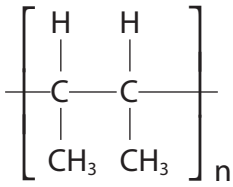
☒ **A**



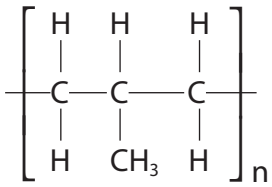
☒ **B**



☒ **C**



☒ **D**



(Total for Question 17 = 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.

18 A mass spectrometer was used to analyse a sample of oxygen gas in which the most abundant isotope was ^{16}O. The oxygen was ionized and the ions were accelerated by an electric field.

(a) (i) Suggest the formulae of **two** different ions containing only the ^{16}O isotope, which might be formed in the mass spectrometer.

(2)

.....

.....

(ii) Which part of the mass spectrometer separates ions of different mass?

(1)

.....

(iii) For the two ions you have chosen in (a)(i), sketch their paths in the mass spectrometer after leaving the electric field and as they approach the detector region. Label each path with the formula of the ion.

(2)

(b) The following results were obtained for the atoms of oxygen in the sample.

Relative isotopic mass	Relative abundance
16	99.759
17	0.037
18	0.204

Calculate the relative atomic mass of oxygen atoms. Show your working and give your answer to **three** decimal places.

(2)

(c) In the first half of the twentieth century, oxygen was used as the standard for relative atomic mass. The unit of atomic mass was defined as 1/16 the mass of an oxygen atom. This was based on samples of oxygen obtained from the air which consisted of a mixture of oxygen isotopes.

Suggest **one** reason why the use of this standard was discontinued.

(1)

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(d) Would you expect the first electron affinities of ^{16}O and ^{18}O to differ? Justify your answer.

(1)

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.....

(Total for Question 18 = 9 marks)

19 This question is about elements in Period 3 of the Periodic Table.

(a) Write the equation, including state symbols, which represents the first ionization energy of magnesium.

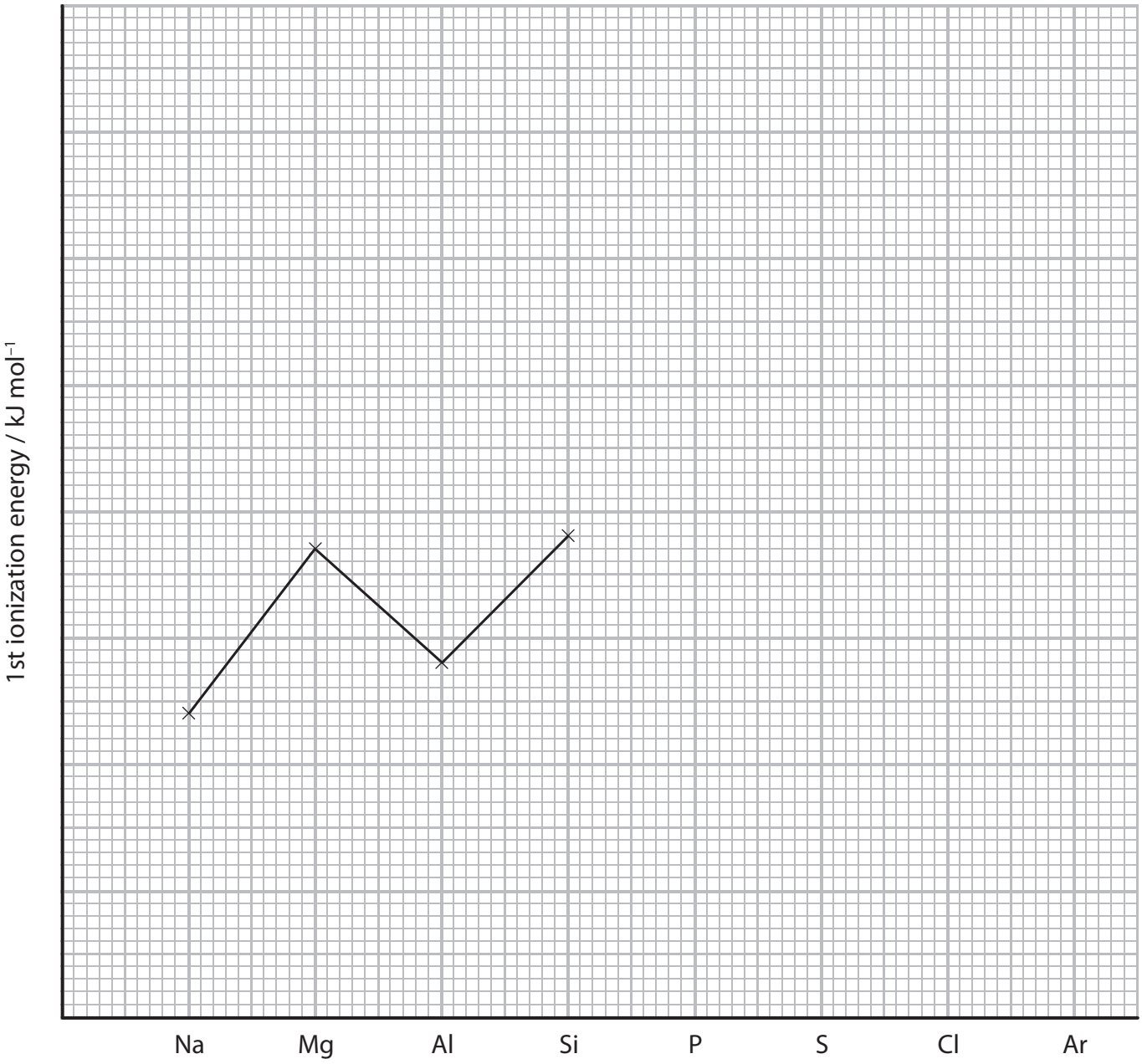
(2)

(b) Complete the electronic configuration for aluminium using s, p notation.

(1)

$1s^2$.....

(c) The sketch graph below shows the first ionization energies of some of the elements in Period 3.



*(i) Explain why the values shown on the graph go down from magnesium to aluminium, and then rise again going from aluminium to silicon.

(3)

(ii) Complete the sketch graph for the elements from phosphorus to argon. Explain why one of these elements does not follow the general trend.

(3)

(d) Draw a dot and cross diagram for silicon tetrachloride, $SiCl_4$, showing outer shell electrons only. Use a cross (×) for silicon electrons and a dot (●) for chlorine electrons.

(2)

(e) Sodium and magnesium are both in Period 3. In sodium iodide, the ions are not polarized but in magnesium iodide some polarization occurs.

*(i) Explain the term **polarization** as it applies to magnesium iodide, and state how it arises.

(3)

(ii) State how thermochemical data could be used to show that there is polarization in magnesium iodide.

(1)

(Total for Question 19 = 15 marks)

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20 Fractional distillation is used in industry to obtain alkanes from crude oil.

(a) (i) On what physical property of alkanes does this process depend?

(1)

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(ii) The alkanes are then processed by **cracking** or **reforming** to produce other hydrocarbons.

Explain the meaning of these terms.

(2)

Cracking

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.....

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Reforming

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(iii) The equation for a cracking reaction of butane is

$$C_4H_{10} \rightarrow C_3H_6 + CH_4$$

Use the following standard enthalpy changes of combustion to calculate the enthalpy change of this cracking reaction. Show your method, which may involve the use of a Hess cycle. Include a sign and units in your answer.

Compound	Standard enthalpy change of combustion / kJ mol^{-1}
butane	–2877
propene	–2058
methane	–890

(3)

(iv) Butane can also be cracked to form products other than propene and methane. Write an equation for this reaction.

(1)

(b) (i) The enthalpy change of combustion of a liquid hydrocarbon, pentane, was determined in an experiment.

A sample of pentane was burned in a spirit burner and the energy produced used to heat water in a calorimeter.

The results of the experiment are as follows:

Mass of spirit burner and pentane at start	85.6 g
Mass of spirit burner and pentane after burning	84.6 g
Mass of water in calorimeter	200 g
Initial temperature of water	22.0 °C
Final temperature of water	56.0 °C
Mass of 1 mole of pentane	72.0 g

Heat energy transferred (J) = mass of water $\times$ temperature change $\times$ 4.18

Calculate the enthalpy change of combustion of pentane. Include a sign and units in your answer.

(3)

(ii) Give **one** reason, other than heat loss, why the enthalpy change determined in this experiment differs substantially from the Data Booklet value.

(1)

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(iii) Suggest a reason why this experiment would be too hazardous to carry out in a school laboratory.

(1)

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(c) (i) Write an equation for the complete combustion of pentane. State symbols are not required.

(1)

(ii) Identify the type and number of bonds broken and formed during the combustion of a molecule of pentane.

(2)

(iii) Explain why the enthalpy change of combustion of pentane is exothermic.

(1)

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(Total for Question 20 = 16 marks)

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21 This question is about ethane and ethene.

(a) Ethane reacts with chlorine by a free radical mechanism.

(i) Explain what is meant by the term **free radical**.

(1)

.....

.....

(ii) Complete the equation for the formation of free radicals from one molecule of chlorine. Use appropriate curly arrows to show electron movements.

(1)

Cl—Cl →

(iii) Write an equation for the reaction between ethane and a chlorine free radical, and name the type of step in the mechanism where this occurs. Curly arrows are not required.

(2)

Type of step .....

(iv) Give an equation for a termination step in this mechanism in which an **organic** compound other than chloroethane is formed.

(1)

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(b) Ethene contains a carbon-carbon double bond.

(i) Complete the diagram below showing the σ and π bonds in the carbon-carbon double bond in ethene.

(2)

C C

*(ii) Describe and explain what happens to the σ and π bonds in ethene in an addition reaction.

(3)

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(iii) One test for a carbon-carbon double bond is the reaction with acidified potassium manganate(VII), $KMnO_4$.

Give the colour change if this reaction was carried out with ethene. Draw the **displayed** formula of the product.

(2)

From ..... to .....

Displayed formula

(iv) Describe another test for a carbon-carbon double bond and give the colour change for the positive result.

(2)

Test.....

From ..... to .....

(v) Ethene reacts with hydrogen bromide. Write the mechanism for this reaction, showing any relevant dipoles.

(4)

Mechanism:

(c) But-1-ene is an alkene with properties similar to ethene.

Write an equation, using **skeletal** formulae for the organic compounds, showing the conversion of but-1-ene to butane. State the essential condition needed.

(2)

Condition.....

(Total for Question 21 = 20 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									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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