Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Monday 18 May 2020

Morning (Time: 1 hour 30 minutes) | Paper Reference **8CH0/01**

Chemistry

Advanced Subsidiary

Paper 1: Core Inorganic and Physical Chemistry

Candidates must have: Scientific calculator
Data Booklet
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.*

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.*
- For the question marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing the points that you make are related or follow on from each other where appropriate.
- 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 ▶

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 This question is about the electronic structure of some Group 5 elements.

(a) Which is the electronic configuration of the arsenide ion, As^{3-}?

(1)

☒ **A** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

☒ **B** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$

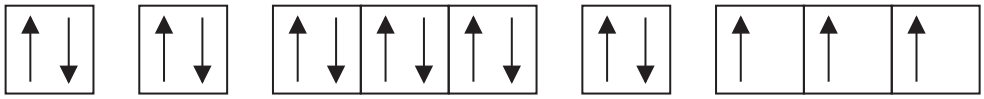
☒ **C** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

☒ **D** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3 4d^3$

(b) The electronic configuration of a phosphorus atom can be written

$$1s^2 2s^2 2p^6 3s^2 3p^3$$

An alternative way to express the electronic configuration is



(i) State what is meant by the two arrows in the first box.

(1)

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(ii) State why the arrows are all pointing in the same direction in the 3p boxes.

(1)

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(Total for Question 1 = 3 marks)

2 This question is about ionisation energies.

(a) (i) Which equation represents the **second** ionisation of bromine?

(1)

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

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

☒ **C** $Br(g) - 2e^- \rightarrow Br^{2+}(g)$

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

(ii) Which set of successive ionisation energies is most likely to be associated with the element boron?

(1)

☒ **A** 738, 1 451, 7 733, 10 541, 13 629

☒ **B** 801, 2 427, 3 660, 25 026, 32 828

☒ **C** 1 086, 2 353, 4 621, 6 223, 37 832

☒ **D** 1 402, 2 856, 4 578, 7 475, 9 445

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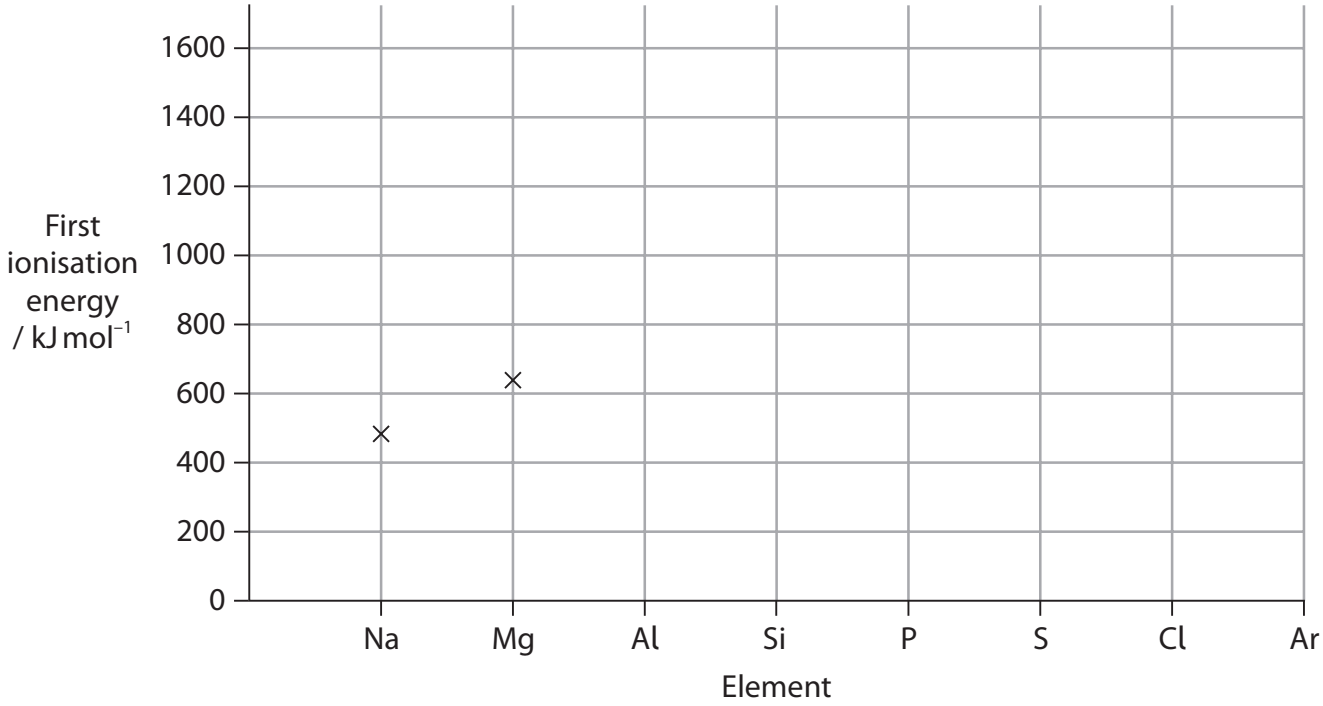
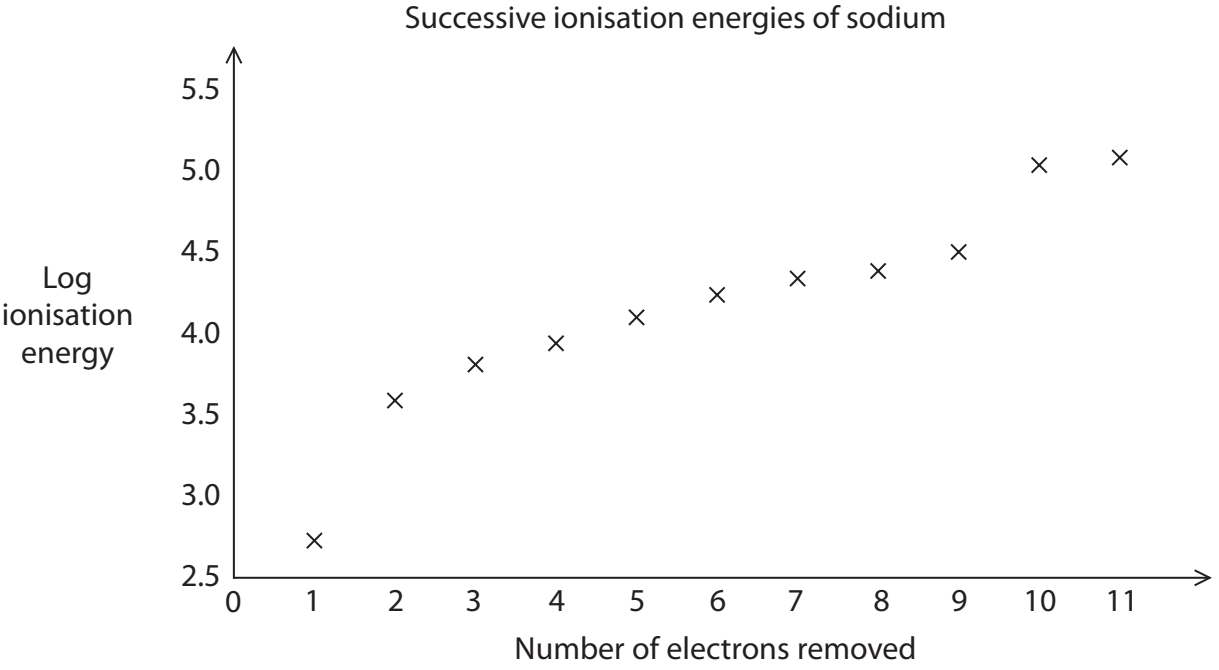
(b) (i) Complete the graph to show how the first ionisation energies of the Period 3 elements change across the period. Precise figures are not required.

(3)

First ionisation energies of the Period 3 elements



(ii) The successive ionisation energies of sodium are shown on the graph.



State what deductions can be made from this graph.

(2)

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(Total for Question 2 = 7 marks)

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3 Nitrogen forms several hydrides. In addition to ammonia, NH_3, it forms hydrazine, N_2H_4, in which the two nitrogen atoms are covalently bonded together.

(a) (i) Explain what is meant by a covalent bond.

(2)

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(ii) Draw a dot-and-cross diagram for hydrazine, showing the outer electrons only.

Use crosses (×) to represent the electrons from nitrogen and dots (•) to represent the electrons from hydrogen.

(1)

(iii) Estimate the H—N—H bond angle in hydrazine.

(1)

Bond angle = ...

(b) Hydrazine is very soluble in water.

Explain, using a labelled diagram and naming the relevant intermolecular interactions, why hydrazine is **very** soluble in water.

(3)

(c) Hydrazine has been used as a rocket fuel.

It is a powerful reducing agent and will react very exothermically with oxidising agents such as hydrogen peroxide.

The equation for the reaction of hydrazine with hydrogen peroxide is

$$N_2H_4(l) + 2H_2O_2(l) \rightarrow N_2(g) + 4H_2O(g)$$

Give **two** reasons why hydrazine is a good rocket fuel when reacted with hydrogen peroxide.

(2)

(Total for Question 3 = 9 marks)

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4 This question is about isotopes.

(a) The table shows data for some isotopes of potassium.

Isotope	Relative isotopic mass	Abundance %
^{39}K	38.9637	93.218
^{40}K	39.9340	0.012
^{41}K	40.9618	6.770

(i) State what is meant by the terms 'relative isotopic mass' and 'relative atomic mass'.

(3)

(ii) State what is meant by the term 'isotopes'. Illustrate your answer by referring to the isotopes of potassium.

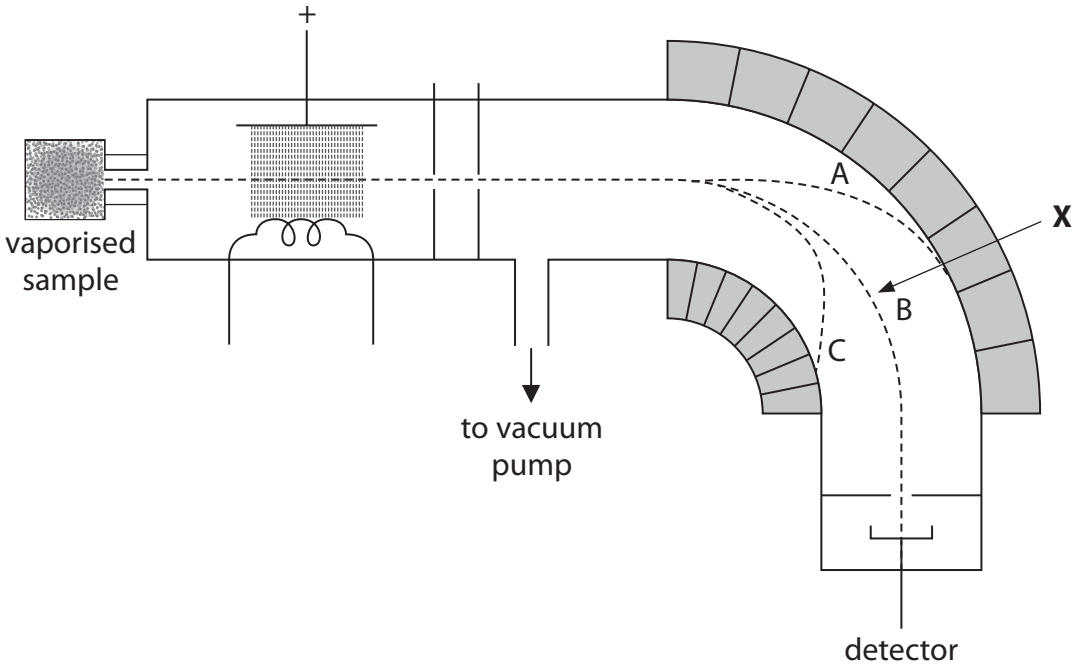
(2)

(iii) Use the data in the table to calculate the relative atomic mass of potassium. Give your answer to 4 significant figures.

(2)

(b) The relative isotopic abundances of an element can be measured using a mass spectrometer.

A simplified and incompletely labelled diagram of a mass spectrometer is shown.



(i) Name the feature of the mass spectrometer responsible for the behaviour of the ions in the region indicated by the arrow **X**.

(1)

(ii) Explain the three ion pathways, A, B and C, shown in the region indicated by the arrow **X**.

(3)

(iii) Give a reason why the mass spectrometer must be operated under vacuum.

(1)

(Total for Question 4 = 12 marks)

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5 This question is about the reactions of the halogens and halide ions.

(a) (i) When chlorine gas is bubbled through an aqueous solution of potassium iodide, the reaction involves

(1)

☒ **A** oxidation only

☒ **B** reduction only

☒ **C** redox

☒ **D** disproportionation

(ii) Cyclohexane was added to the resulting solution from (a)(i). The mixture was shaken and then allowed to stand for a few minutes. Two layers were formed.

[Density: aqueous layer solution = 1.10 g cm^{-3}, cyclohexane layer = 0.78 g cm^{-3}]

The colour of the **lower** layer was

(1)

☒ **A** pale yellow

☒ **B** purple

☒ **C** red

☒ **D** pale green

(b) Concentrated sulfuric acid was added to a small quantity of solid potassium iodide in a test tube.

(i) In this exothermic reaction, which of the following mixtures of gases would be produced?

(1)

☒ **A** hydrogen iodide and sulfur dioxide only

☒ **B** hydrogen iodide and hydrogen sulfide only

☒ **C** hydrogen iodide, sulfur dioxide and hydrogen sulfide

☒ **D** hydrogen iodide, hydrogen sulfide and iodine

(ii) Hydrogen iodide is a gas which reacts in a similar way to hydrogen chloride.

State the observation when the hydrogen iodide gas is passed over the mouth of an open bottle of concentrated ammonia solution.
Write an equation, including state symbols, for the reaction.

(3)

Observation .....

Equation

(c) Potassium iodate(V) can be prepared by adding solid iodine to a **hot** aqueous solution of potassium hydroxide.

The equation for the reaction is

$$3I_2 + 6KOH \rightarrow KIO_3 + 5KI + 3H_2O$$

Potassium iodate(V) can be separated from the other reaction product using their differing solubilities in water.

	Solubility in water at 25 °C / mol dm^{-3}
KI	8.92
KIO_3	0.43

(i) Outline a procedure that you could use to obtain a sample of dry, solid potassium iodate(V) from the reaction mixture.

(3)

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(ii) Describe how you would show that iodide ions are present in an aqueous solution of potassium iodide.

(2)

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(d) Fluorine is an element in Group 7.

Group 7 includes the elements chlorine, bromine and iodine.

Some information about the melting and boiling temperatures of Group 7 elements is shown in the table.

Element	Melting temperature / K	Boiling temperature / K
chlorine	172	238
bromine	266	332
iodine	387	457

Which is the expected boiling temperature of fluorine, in kelvin, K?

(1)

☒ **A** 4

☒ **B** 85

☒ **C** 575

☒ **D** 610

(Total for Question 5 = 12 marks)

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6 Malachite is a green mineral with the formula $Cu_2CO_3(OH)_2$. It has a molar mass of 221 g mol^{-1}.

(a) What is the percentage by mass of copper in pure malachite?

(1)

☒ **A** 40.3%

☒ **B** 51.4%

☒ **C** 57.5%

☒ **D** 67.9%

(b) Describe what you would expect to **see** when an excess of dilute hydrochloric acid is added to a sample of pure solid malachite.

(3)

(c) (i) Describe how you would carry out a flame test on a sample of powdered malachite.

(3)

(ii) When the atoms of some elements are heated, they produce a characteristic flame colour. For example, the copper in malachite gives a blue-green colour. Explain how atoms of different elements can produce different characteristic flame colours when heated.

(4)

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(d) (i) When malachite is heated to approximately 300 °C, water, carbon dioxide and copper(II) oxide are formed.

The equation for this decomposition is

$$Cu_2CO_3(OH)_2 \rightarrow 2CuO + CO_2 + H_2O$$

Calculate the maximum volume of carbon dioxide that could be produced when 0.810 g of malachite is thermally decomposed.
Assume that the gas is collected at a temperature of 25 °C and 101 kPa pressure.

Give your answer to an appropriate number of significant figures and state the units.
[The ideal gas equation is $pV = nRT$. Gas constant (R) = 8.31 J mol^{-1} K^{-1}]

(5)

(ii) The gas was collected in a gas syringe with a stated accuracy of ± 0.5 cm^3.

Calculate the percentage uncertainty in the volume of gas collected.

(1)

(iii) Malachite ore is a mixture of malachite and rock. A 0.810 g sample of malachite ore was thermally decomposed, producing 0.571 g of copper(II) oxide.

Calculate the percentage purity of this malachite ore sample.
Give your answer to an appropriate number of significant figures.

(3)

(Total for Question 6 = 20 marks)

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7 (a) Give the meaning of the term 'periodicity'.
Illustrate your answer by referring to the atomic radii of the Period 2 and Period 3 elements.
Specific values of atomic radii are not required.

(3)

*(b) The melting temperatures of the Period 2 elements are shown.

Symbol of the element	Li	Be	B	$C_{(diamond)}$	N	O	F	Ne
Melting temperature / K	454	1551	2573	3970	63	55	53	25

Explain the trend in melting temperatures across the elements of Period 2 in terms of their structure and bonding.

(6)

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(Total for Question 7 = 9 marks)

8 This question is about the thermal stability of Group 1 and Group 2 nitrates and carbonates.

(a) Complete the equations for the thermal decomposition of sodium nitrate, $NaNO_3$, and for the thermal decomposition of calcium nitrate, $Ca(NO_3)_2$.
State symbols are not required.

(2)

$NaNO_3 \rightarrow$

$Ca(NO_3)_2 \rightarrow$

(b) The thermal stability of Group 1 nitrates increases down the group.
The decomposition temperatures of some Group 1 nitrates are shown.

Name	Formula	Decomposition temperature / K
sodium nitrate	$NaNO_3$	653
potassium nitrate	KNO_3	673
caesium nitrate	$CsNO_3$	687

Explain why the thermal stability of caesium nitrate is greater than that of sodium nitrate.

(3)

(c) Calcium carbonate is thermally decomposed during the manufacture of cement.

(i) Write an equation, including state symbols, for the thermal decomposition of calcium carbonate.

(1)

(ii) Name all the types of bond present in calcium carbonate.

(1)

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(iii) Give a reason, in terms of the bonding, why a high decomposition temperature is required.

(1)

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(Total for Question 8 = 8 marks)

TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 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