Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Time 1 hour 30 minutes

Paper reference **8CH0/01**

Chemistry

Advanced Subsidiary
PAPER 1: Core Inorganic and Physical Chemistry

You must have:
Scientific calculator, Data Booklet

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.*
- 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 ▶

Q:1/1/1/1/

P 7 0 8 0 1 A 0 1 2 8

Pearson

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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 Which is the electronic configuration for the S^{2-} ion?

☒ **A** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

☒ **B** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

☒ **C** $1s^2\ 2s^2\ 2p^6\ 3p^6$

☒ **D** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

(Total for Question 1 = 1 mark)

2 Which is the most likely sequence of values, in $kJ\,mol^{-1}$, for the first four ionisation energies of barium?

☒ **A** 1000 2251 3361 4564

☒ **B** 496 4563 6913 9544

☒ **C** 503 965 3458 4530

☒ **D** 578 1817 2745 11578

(Total for Question 2 = 1 mark)

3 This question is about tests for ions.

(a) A student wrote the following answer to a question about the processes that can give rise to a flame colour during a flame test of an inorganic compound.

"When an inorganic compound is heated, energy is emitted as ions move up energy levels. Electrons return to lower energy levels and release energy as light which is always in the visible region of the electromagnetic spectrum."

Identify **three** errors in this account. Include in your answers a correct word or phrase that should be used instead.

(3)

First error

.....

Correct word or phrase

.....

.....

Second error

.....

Correct word or phrase

.....

.....

Third error

.....

Correct word or phrase

.....

.....

(b) Which compound does **not** give a red colour in a flame test?

(1)

- ☒ **A** calcium chloride
- ☒ **B** lithium carbonate
- ☒ **C** sodium iodide
- ☒ **D** strontium bromide

(c) A wire is used for a flame test.

Which material would be most suitable for a flame test wire?

(1)

- ☒ **A** copper
- ☒ **B** iron
- ☒ **C** magnesium
- ☒ **D** platinum

(d) An aqueous solution is suspected to be potassium bromide and is tested for the presence of the anion.

(i) Write the **name** of the reagent used to test for the anion.

(1)

.....

(ii) State the expected result of this test and the **formula** of the product.

(2)

Result of test

.....

.....

Formula of the product

.....

(Total for Question 3 = 8 marks)

4 This question is about isotopes, mass spectra and hydrocarbons.

(a) Hydrogen has three isotopes, ^{1}H, ^{2}H and ^{3}H.

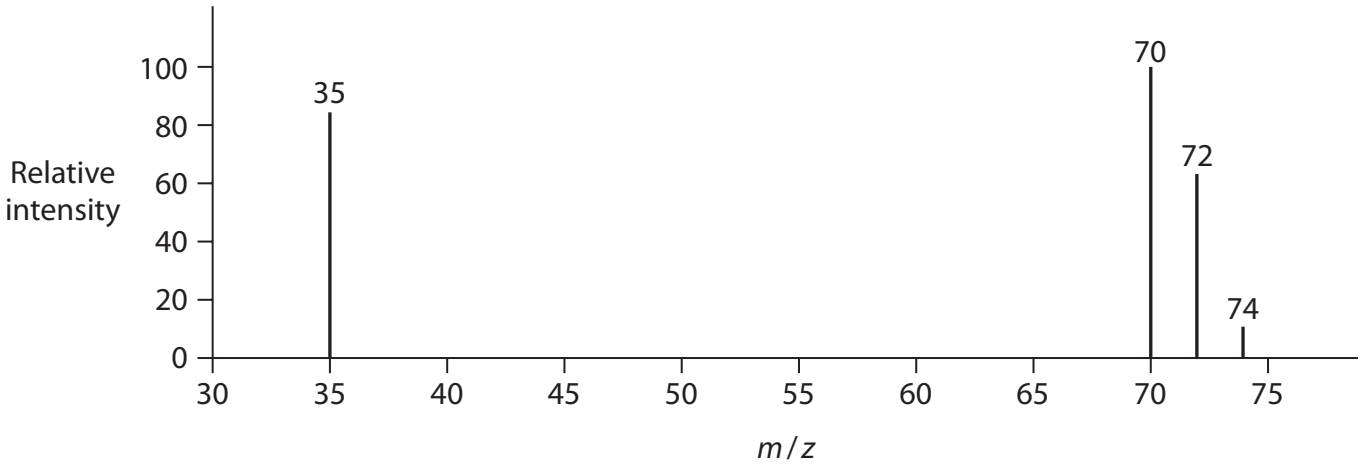
Which is the correct number of subatomic particles in ^{3}H?

(1)

		Number of subatomic particles		
		Protons	Neutrons	Electrons
☒	**A**	2	1	2
☒	**B**	1	2	0
☒	**C**	1	2	1
☒	**D**	2	1	3

(b) The diagram shows the mass spectrum of a sample of chlorine with one peak missing.

Chlorine has two isotopes, ^{35}Cl and ^{37}Cl, and a relative atomic mass of 35.5



(i) The relative abundance of the isotope ^{35}Cl is 75.5 %.
The relative peak height of this isotope is 82.5 in the mass spectrum.

Calculate the relative peak height of the missing peak caused by the isotope ^{37}Cl.

(2)

(ii) Give a reason for the presence of the three peaks at 70, 72 and 74.

(1)

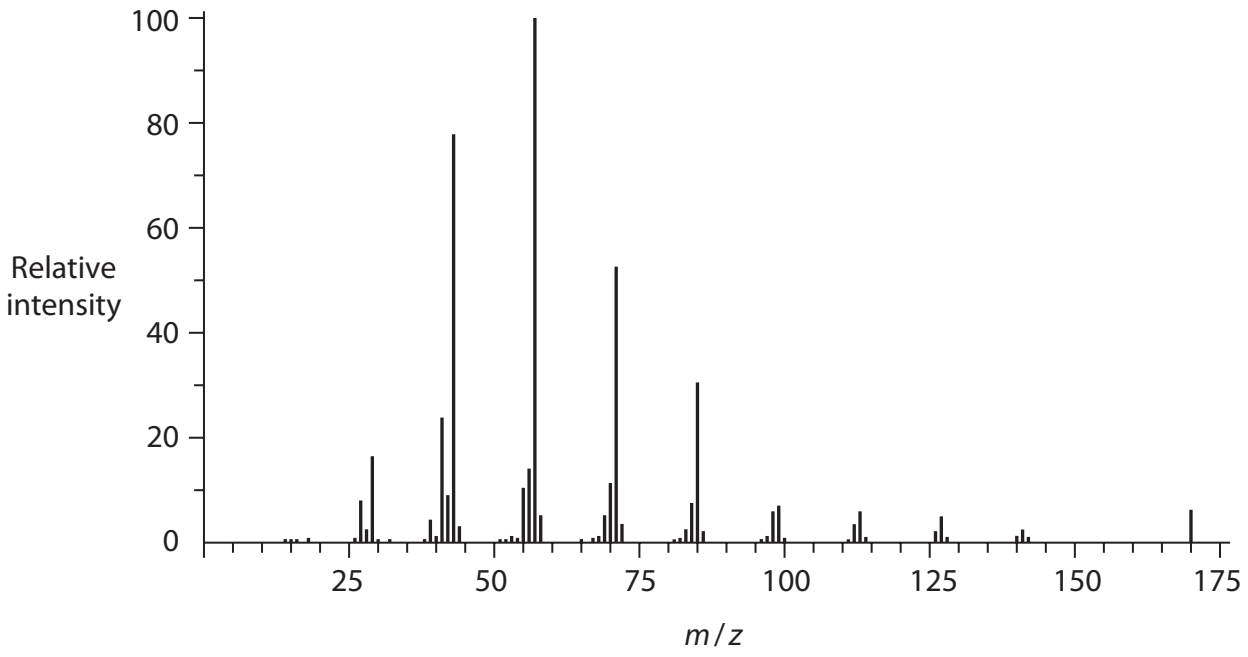
(iii) Explain, using calculations, why there is an approximate ratio of 9 : 6 : 1 for the peak heights corresponding to the *m* / *z* values of 70, 72 and 74.

(3)

(c) The mass spectrum of a hydrocarbon, **B**, which has a molecular formula C_xH_y, is shown.

(i) Determine the relative molecular mass of compound **B**.

(1)



Relative molecular mass of compound **B** is .....

(ii) Deduce the molecular formula of hydrocarbon **B**.

(1)

(d) 1.00 g of a **different** hydrocarbon, **W**, was burnt in oxygen.
Analysis of the combustion products showed that complete combustion produced 3.14 g of carbon dioxide and 1.29 g of water.

Water and carbon dioxide were the only products of combustion.

Calculate the **empirical** formula of hydrocarbon **W**.
You **must** show your working.

(4)

(Total for Question 4 = 13 marks)

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5 Intermolecular forces affect melting temperatures, boiling temperatures and solubility.

(a) The table gives the melting temperatures of some Group 7 hydrogen halides.

Compound	Melting temperature / K
HF	190
HCl	158
HBr	185

Predict the melting temperature, in K, of hydrogen iodide, HI, using the information in the table.

(1)

Melting temperature of HI ..... K

(b) The compounds in the table are isomers.

Compound	Structural formula	Boiling temperature / °C
hexane	$CH_3CH_2CH_2CH_2CH_2CH_3$	69
2-methylpentane	$CH_3CH_2CH_2CH(CH_3)$	61
3-methylpentane	$CH_3CH_2CH(CH_3)CH_2CH_3$	63

Which is most likely to be the boiling temperature of another isomer, 2,2-dimethylbutane?

The structure of 2,2-dimethylbutane is

$$CH_3C(CH_3)_2CH_2CH_3$$

(1)

- ☒ **A** 40 °C
- ☒ **B** 50 °C
- ☒ **C** 60 °C
- ☒ **D** 70 °C

*(c) Methanol, CH_3OH, is miscible with water in all proportions.
Sodium chloride is much less soluble in methanol than in water.

Explain these statements using your knowledge of the interactions between solutes and solvents.
You **must** use diagrams to illustrate your answers.

(6)

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(Total for Question 5 = 8 marks)

6 The table shows some information about the structure and bonding in four substances.

(a) Complete the table.

(2)

Substance	Structure	Bonding	Melting temperature / K
silicon(IV) oxide	giant	covalent	1883
potassium chloride			1043
iron		metallic	1808
iodine		covalent	387

(b) Explain why the melting temperature of silicon(IV) oxide is much higher than that of iodine, even though the bonding in both is covalent.

(3)

(c) Iron and potassium chloride both conduct electricity when molten. However, only iron conducts electricity when solid.

Explain these observations.

(3)

(Total for Question 6 = 8 marks)

7 This question is about s-block elements and some of their compounds.

(a) Which list contains only s-block elements?

(1)

- ☒ **A** Li, Na, Mg and Cl
- ☒ **B** K, Ca, Co and Rb
- ☒ **C** Mg, Al, Sr and Ba
- ☒ **D** Be, Rb, Ba and Ra

(b) Which pair of statements describes the trends **down** Group 2?

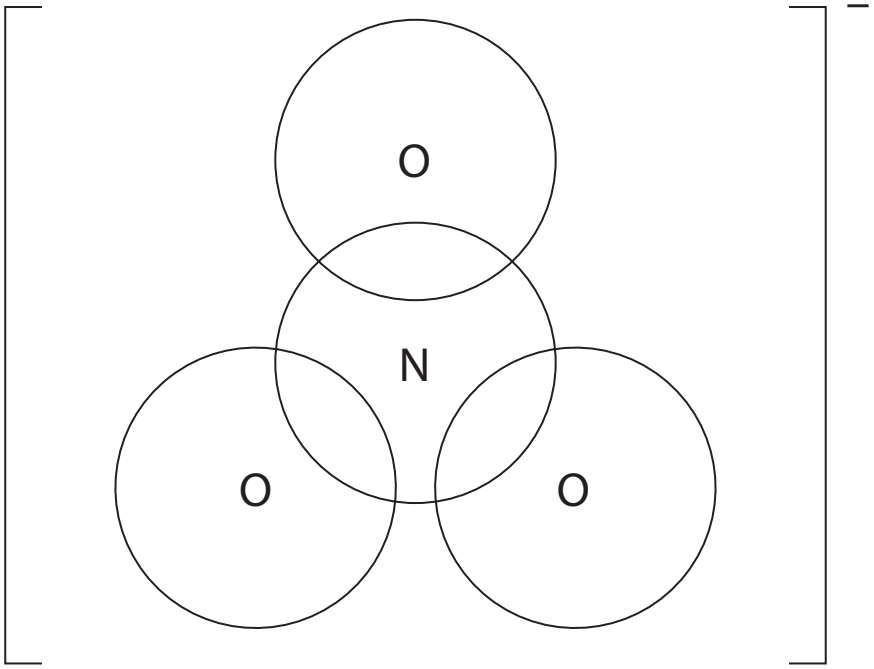
(1)

	Solubility of sulfates	Solubility of hydroxides
☒ **A**	increases	increases
☒ **B**	decreases	increases
☒ **C**	decreases	decreases
☒ **D**	increases	decreases

(c) The s-block nitrates undergo thermal decomposition.

(i) Draw a dot-and-cross diagram for the nitrate(V) ion, NO_3^-, showing outer electrons only.

(1)



(ii) Write an equation for the thermal decomposition of lithium nitrate.

State symbols are **not** required.

(1)

(iii) The equation for the thermal decomposition of sodium nitrate is different from that for lithium nitrate.

$$NaNO_3(s) \rightarrow NaNO_2(s) + \tfrac{1}{2}O_2(g)$$

The gas produced is collected in a gas syringe.

Calculate the theoretical volume of gas, in **cm^3**, that could be collected at 298 K and 101 kPa by the decomposition of 0.500 g of pure sodium nitrate. Give your answer to 2 significant figures.

[$pV = nRT$, $R = 8.31\ J\,mol^{-1}\,K^{-1}$]

(4)

(iv) State one reason why the experimental gas volume may differ from the calculated theoretical volume.
Assume that no gas escapes and measurements have been made accurately.

(1)

.....

.....

(d) A textbook states, 'The thermal stability of Group 1 carbonates is generally higher than the thermal stability of Group 2 carbonates in the same period'.

Explain why Group 1 carbonates are more thermally stable than Group 2 carbonates.

(3)

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(Total for Question 7 = 12 marks)

8 This question is about some reactions of chlorine and hydrogen chloride.

(a) When hydrogen gas and chlorine gas are mixed and passed over a hot platinum catalyst, hydrogen chloride gas is formed.

The equation for this reaction is

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

In an experiment, 20 cm^3 of dry hydrogen gas was reacted with 20 cm^3 of dry chlorine gas.
All gas volumes were measured at room temperature and pressure (r.t.p.).

Calculate the number of gas molecules in the product at r.t.p.

[Molar volume of a gas at r.t.p. = 24 000 $cm^3\,mol^{-1}$
Avogadro constant (L) = $6.02 \times 10^{23}\,mol^{-1}$]

(2)

(b) Hydrogen chloride gas dissolves in water to form hydrochloric acid.

(i) Hydrogen chloride gas does not conduct electricity.
Hydrochloric acid is a good conductor of electricity.

Give a reason for this change in conductivity.

(1)

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.....

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(ii) When concentrated hydrochloric acid on a glass rod is held above a concentrated ammonia solution, a white smoke is observed.

Write an equation, including state symbols, for the reaction that produces the white smoke.

(2)

(iii) Hydrochloric acid is added to a test tube containing a sample of solid sodium carbonate.

Give **two** observations.

(2)

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(iv) Describe an experiment to enable you to accurately determine the concentration of an approximately 1 mol dm^{-3} solution of hydrochloric acid, using a solution of sodium hydroxide of concentration 1.00 mol dm^{-3}. Details of the calculation are not required.

(5)

(c) Chlorine can be produced by reacting concentrated hydrochloric acid with manganese(IV) oxide.

The equation for this reaction is

$$4HCl(aq) + MnO_2(s) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

(i) Deduce the half-equation for the formation of chlorine.

(1)

(ii) A student reacted 5.0 cm^3 of 5.0 mol dm^{-3} hydrochloric acid with an excess of manganese(IV) oxide. 70 cm^3 of chlorine gas was produced.

The teacher said the expected percentage yield of the experiment is 75%.

Determine whether the student achieved the expected percentage yield.

[Molar volume of a gas at r.t.p. = 24 000 cm^3 mol^{-1}]

(4)

(d) Chlorine reacts with hot concentrated aqueous sodium hydroxide to produce sodium chlorate(V) as one of the products.

The equation for this reaction is

$$3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$$

(i) Explain, using oxidation numbers, why this is a disproportionation reaction.

(2)

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(ii) Calculate the atom economy, by mass, of sodium chlorate(V) in this reaction.

(3)

(Total for Question 8 = 22 marks)

9 Water gas is a fuel gas consisting of a mixture of carbon monoxide and hydrogen.

(a) Water gas is produced by passing steam over white hot coke.

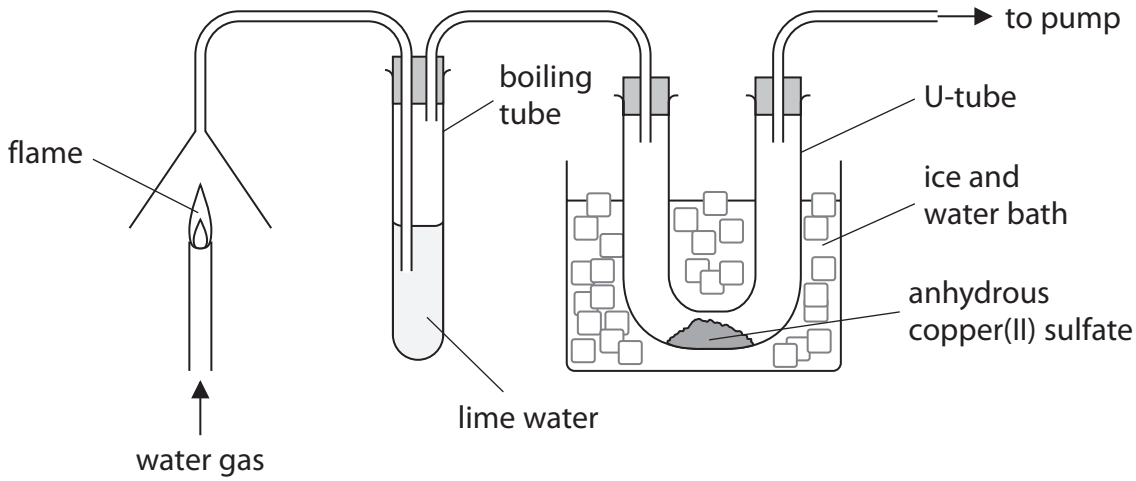
The equation for the reaction is shown.

$$H_2O(g) + C(s) \rightarrow CO(g) + H_2(g)$$

Calculate the total mass of products when 1000 **kg** of steam reacts completely.

(2)

(b) The complete combustion of water gas produces carbon dioxide and water.
A student drew a diagram of the apparatus to attempt to identify the combustion products.



Evaluate whether the student's apparatus is suitable for identifying both of the combustion products. Include any improvements needed.

(5)

(Total for Question 9 = 7 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)						(8)					(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)		(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

* 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