Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary
Unit 2: Application of Core Principles of Chemistry

Friday 9 June 2017 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6CH02/01

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.
- 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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P 5 3 4 9 3 A 0 1 2 0

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 Which molecule is polar?

☒ **A** $BeCl_2$

☒ **B** CO_2

☒ **C** CH_4

☒ **D** H_2S

(Total for Question 1 = 1 mark)

2 Which is **not** a disproportionation reaction?

☒ **A** $3ClO^- \rightarrow 2Cl^- + ClO_3^-$

☒ **B** $I_2 + 5O_3 + H_2O \rightarrow 2HIO_3 + 5O_2$

☒ **C** $Br_2 + 2OH^- \rightarrow BrO^- + Br^- + H_2O$

☒ **D** $I_2 + H_2O \rightarrow HI + HIO$

(Total for Question 2 = 1 mark)

3 Two layers form when the non-polar solvent cyclohexane (density 0.78 g cm^{-3}) is mixed with a dilute solution of aqueous iodine (density 1.03 g cm^{-3}) and left to stand. The colours of the layers are

	Lower layer	Upper layer
☒ **A**	purple	brown
☒ **B**	brown	black
☒ **C**	yellow	purple
☒ **D**	brown	yellow

(Total for Question 3 = 1 mark)

4 A solution of a metal salt produced a white precipitate with barium chloride solution and the mixture fizzed when dilute nitric acid was added. The metal salt could be

☒ **A** Na_2SO_4

☒ **B** $MgSO_4$

☒ **C** Na_2CO_3

☒ **D** $AgNO_3$

(Total for Question 4 = 1 mark)

5 The **least** soluble hydroxide and **least** soluble sulfate of barium and magnesium are

☒ **A** $Mg(OH)_2$ and $MgSO_4$

☒ **B** $Mg(OH)_2$ and $BaSO_4$

☒ **C** $Ba(OH)_2$ and $MgSO_4$

☒ **D** $Ba(OH)_2$ and $BaSO_4$

(Total for Question 5 = 1 mark)

6 The reaction which results in effervescence is

☒ **A** calcium and water.

☒ **B** strontium and chlorine.

☒ **C** magnesium oxide and water.

☒ **D** barium hydroxide and dilute nitric acid.

(Total for Question 6 = 1 mark)

7 Hydrogen can be produced from

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H = -41 \text{ kJ mol}^{-1}$$

Which will shift the equilibrium position to the right?

☒ **A** Raising the temperature

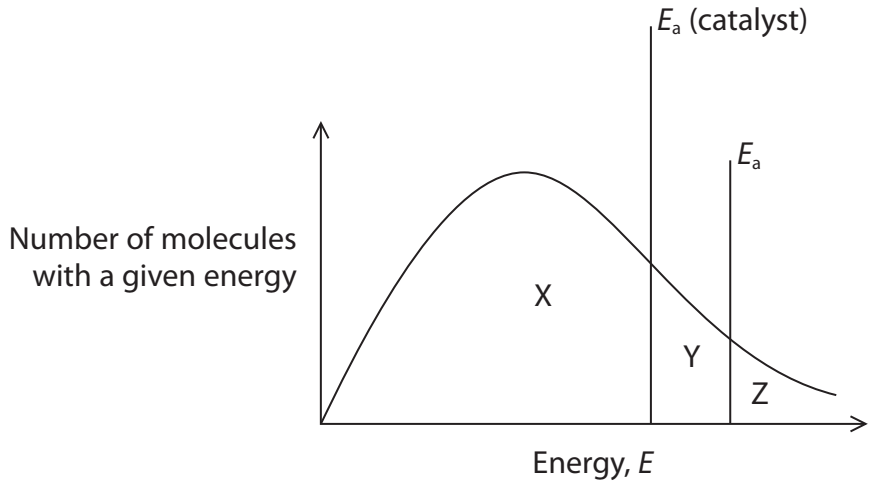
☒ **B** Increasing the pressure

☒ **C** Adding a catalyst

☒ **D** Removing the carbon dioxide

(Total for Question 7 = 1 mark)

8 The Maxwell-Boltzmann diagram shows the distribution of molecular energies for a gaseous system with the activation energy labelled, both with and without a catalyst.



(a) The area indicating the number of molecules with energy exceeding the activation energy in the presence of a catalyst is

(1)

☒ **A** X + Y + Z

☒ **B** Y + Z

☒ **C** Y

☒ **D** Z

(b) When the temperature is **increased**, the peak in the Maxwell-Boltzmann diagram

(1)

☒ **A** moves to the left and the height stays the same.

☒ **B** moves to the left and the height increases.

☒ **C** moves to the right and the height stays the same.

☒ **D** moves to the right and the height decreases.

(Total for Question 8 = 2 marks)

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

9 The molecule with the strongest London forces is

☒ **A** CF_4

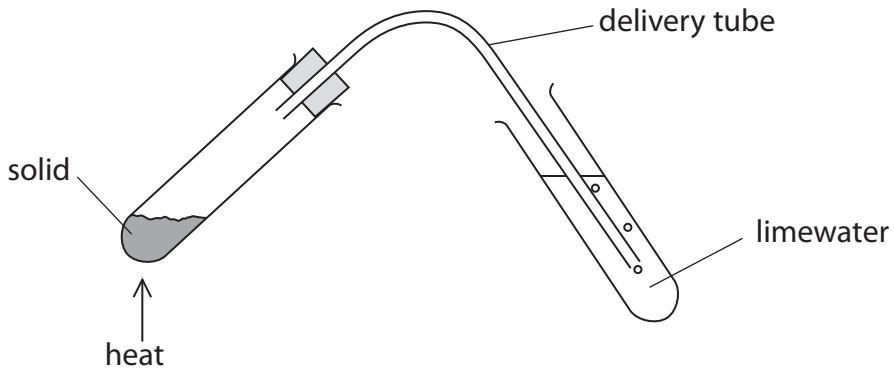
☒ **B** CHF_2Cl

☒ **C** CH_2Cl_2

☒ **D** CH_3I

(Total for Question 9 = 1 mark)

10 Separate samples of lithium carbonate and magnesium carbonate were heated using the apparatus shown.



(a) The limewater went cloudy for

(1)

☒ **A** both carbonates.

☒ **B** only lithium carbonate.

☒ **C** only magnesium carbonate.

☒ **D** neither carbonate.

(b) In a test with limewater, the cloudiness is due to the formation of a precipitate of

(1)

☒ **A** calcium carbonate.

☒ **B** calcium hydrogencarbonate.

☒ **C** calcium hydroxide.

☒ **D** calcium oxide.

(Total for Question 10 = 2 marks)

11 Anhydrous calcium nitrate decomposes on heating.

(a) This action of heat produces a white solid and

(1)

☒ **A** only a brown gas.

☒ **B** only a gas that relights a glowing splint.

☒ **C** both a brown gas and a gas that relights a glowing splint.

☒ **D** only a colourless, inert gas.

(b) Decomposition occurs quite easily because of the

(1)

☒ **A** polarisation of the calcium ion by the nitrate ion.

☒ **B** polarisation of the nitrate ion by the calcium ion.

☒ **C** distortion of the calcium electron cloud by the nitrate ion.

☒ **D** repulsion of the nitrate electron cloud by the calcium ion.

(Total for Question 11 = 2 marks)

12 Given the following boiling temperatures, select the likely boiling temperature for hydrogen fluoride, HF.

Hydrogen halide	Boiling temperature / K
HCl	188
HBr	206
HI	238

☒ **A** 156 K

☒ **B** 172 K

☒ **C** 184 K

☒ **D** 293 K

(Total for Question 12 = 1 mark)

13 The fragment with a peak of *m/e* = 43 is present in the mass spectrum of

☒ **A** $CH_3CH(CH_3)CH_2Br$ and $CH_3CBr(CH_3)_2$

☒ **B** $CH_3CH_2CH_2CH_2Br$ and $CH_3CHBrCH_2CH_3$

☒ **C** $CH_3CH_2CH_2CH_2Br$ and $CH_3CH(CH_3)CH_2Br$

☒ **D** $CH_3CH(CH_3)CH_2Br$ and $CH_3CHBrCH_2CH_3$

(Total for Question 13 = 1 mark)

14 Depending on the conditions, ethanol, CH_3CH_2OH, can be oxidized to ethanal, CH_3CHO, ethanoic acid, CH_3COOH or mixture of the two.

Mass spectrometry can be used to identify the products.

The **absence** of a fragment ion peak m/e = 45 indicates that

☒ **A** all the product is ethanoic acid.

☒ **B** all the product is ethanal.

☒ **C** none of the ethanol has been oxidized.

☒ **D** the product is a mixture of ethanal and ethanoic acid.

(Total for Question 14 = 1 mark)

15 Trichlorofluoromethane, $CFCl_3$, is a greenhouse gas because it

☒ **A** absorbs infrared radiation and forms chlorine free radicals.

☒ **B** absorbs infrared radiation and re-radiates it back to Earth.

☒ **C** absorbs ultraviolet radiation and forms chlorine free radicals.

☒ **D** absorbs ultraviolet radiation and re-radiates it back to Earth.

(Total for Question 15 = 1 mark)

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

16 A 0.990 g sample of 1,2-dichloroethane was completely hydrolysed and silver nitrate was then added to produce a white precipitate. The maximum mass of precipitate possible is

[Molar masses: 1,2-dichloroethane = 99 g mol^{-1}, silver chloride = 143.4 g mol^{-1}]

☒ **A** 0.990 g

☒ **B** 1.434 g

☒ **C** 2.424 g

☒ **D** 2.868 g

(Total for Question 16 = 1 mark)

17 Which observations about silver chloride and silver bromide are correct?

	Action of sunlight	Action of dilute ammonia
☒ **A**	both turn grey	only silver chloride dissolves
☒ **B**	only silver chloride turns grey	both silver halides dissolve
☒ **C**	only silver bromide turns grey	only silver chloride dissolves
☒ **D**	no effect on either silver halide	both silver halides dissolve

(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

18 This is a question about the structure of substances.

(a) Predict the H—N—H bond angle in NH_4^+ and the H—O—H bond angle in H_3O^+.

(2)

NH_4^+ .....

H_3O^+ .....

(b) Name the shapes of the BF_3 and PH_3 molecules and explain why they are different.

(4)

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*(c) Explain, with reference to the structure and bonding of each substance, why the electrical conductivity of graphite is 1.0×10^{5} S m^{-1} but that of diamond is 1.0×10^{-2} S m^{-1}.

(4)

(d) Explain why the Cl—Cl bond length is 0.199 nm, but the I—I bond length is 0.267 nm.

(3)

(Total for Question 18 = 13 marks)

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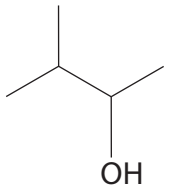
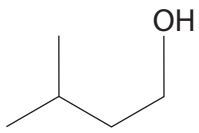
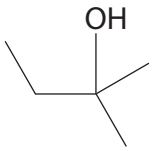
19 This is a question about alcohols and compounds made from them.

(a) (i) Complete the table about some of the structural isomers with the molecular formula $C_5H_{12}O$.

(3)

Name	Skeletal Formula	Classification
2,2-dimethylpropan-1-ol		Primary
		Secondary
3-methylbutan-1-ol		
2-methylbutan-2-ol		

(ii) Identify, by name or formula, the alcohol which is the **branched** structural isomer with molecular formula $C_5H_{12}O$ that is **not** in the table.

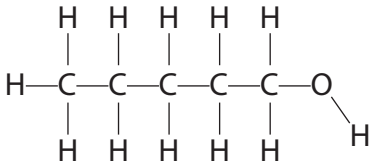
(1)

(iii) Explain why 2,2-dimethylpropan-1-ol has a significantly lower boiling temperature than the isomer pentan-1-ol.

(2)

(iv) Draw a hydrogen bond between a water molecule and the pentan-1-ol molecule. Clearly label the bond angle about the hydrogen involved in the hydrogen bond.

(2)



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(b) Ethanol, C_2H_5OH, can be oxidized to ethanoic acid, CH_3COOH.

(i) Give the formula of a suitable oxidizing agent and the conditions required.

(2)

Oxidizing agent .....

Conditions .....

(ii) Using the symbol, [O], for the oxidizing agent, write the equation for the oxidation of ethanol to ethanoic acid. State symbols are not required.

(1)

(iii) Draw, and fully label, the apparatus that would be used to carry out the complete oxidation of ethanol to ethanoic acid. Include any material that would be used to ensure that boiling is controlled and not violent.

(3)

(c) A sample of ethanol was oxidized completely. After separation, 5.00 g of a mixture of ethanoic acid and water was obtained.

The mixture was added to a 500 cm^3 volumetric flask, made up to the mark with deionized water and shaken thoroughly. The concentration of this diluted solution was determined by titration with sodium hydroxide solution, of concentration 0.200 mol dm^{-3}. The following results were obtained using 25.0 cm^3 pipetted aliquots of this diluted ethanoic acid solution.

Titration	Trial	1	2	3
Final volume /cm^3	14.20	19.50	34.45	49.00
Initial volume /cm^3	0.00	5.00	20.00	34.45
Volume added /cm^3	14.20	14.50	14.45	14.55

Mean titre = 14.50 cm^3

(i) State what is unusual about the value of the trial titre.

Suggest a possible fault with the use of a pipette that could explain this value.

You may assume that the bottom of the meniscus was correctly aligned to the mark on the pipette.

(2)

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(ii) The reaction between ethanoic acid and sodium hydroxide has a 1:1 mole ratio.

Calculate the concentration of the diluted ethanoic acid solution in mol dm^{-3}.

(2)

(iii) Calculate the mass of ethanoic acid in 500 cm^3 of the diluted solution.

(2)

(d) Alcohols can undergo complete or incomplete combustion.

(i) Write the equation for the complete combustion of hexan-1-ol, $C_6H_{13}OH$.
State symbols are not required.

(1)

(ii) Write the equation for the incomplete combustion of hexan-1-ol which produces **only** carbon and water. State symbols are not required.

(1)

(iii) Calculate the volume of oxygen, measured at room temperature and pressure, required for the complete combustion of one mole of hexan-1-ol.

State the likely observation if 500 dm^3 of air containing 20% of oxygen was present for the combustion of one mole of hexan-1-ol.
Justify your answer.

[Molar volume = 24.0 dm^3 mol^{-1} at room temperature and pressure]

(3)

Volume =

Observation and justification .....

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(Total for Question 19 = 25 marks)

TOTAL FOR SECTION B = 38 MARKS

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SECTION C

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

20 Fireworks are designed to explode in a controlled manner with bursts of brightly coloured light and loud bangs. It is believed that fireworks originated in China, after the discovery of gunpowder over 1000 years ago. Fireworks essentially consist of:

- colour-producing compounds (often metal salts)
- fuel
- oxidizer
- binders (often a type of starch)
- fuse.

In addition, there may be substances known as chlorine donors to strengthen the colour, regulators to control the rate of reaction and reducing agents to produce hot gases. Inside the firework are small globules, called stars, which give fireworks their colour when they explode, for example calcium carbonate is used to produce an orange-red colour. If these stars are arranged randomly, then they will spread out in the sky on explosion. However, if the stars are packed in a regular pattern, then, on explosion, a particular shape can be created in the sky.

(a) Give the **formulae** of two metal carbonates that could be used to produce a bright red colour from an exploding firework.

(2)

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*(b) Explain, by reference to electronic transitions, how the metal ions produce the colours of the firework.

(3)

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(c) Suggest a metal which may be used to produce a white colour in a firework and give the name of the compound produced.

(2)

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(d) Gunpowder is often used in fireworks. It is a mixture of charcoal, sulfur and potassium nitrate.

(i) Complete the equation for one of the chemical reactions that occurs when gunpowder burns.

(2)

.....KNO_3 + ...S + ...C → .....K_2S + ...N_2 + ...

(ii) Identify two different atoms that have been reduced and state the change in their oxidation numbers.

(3)

Atom..... Oxidation number change from ..... to .....

Atom..... Oxidation number change from ..... to .....

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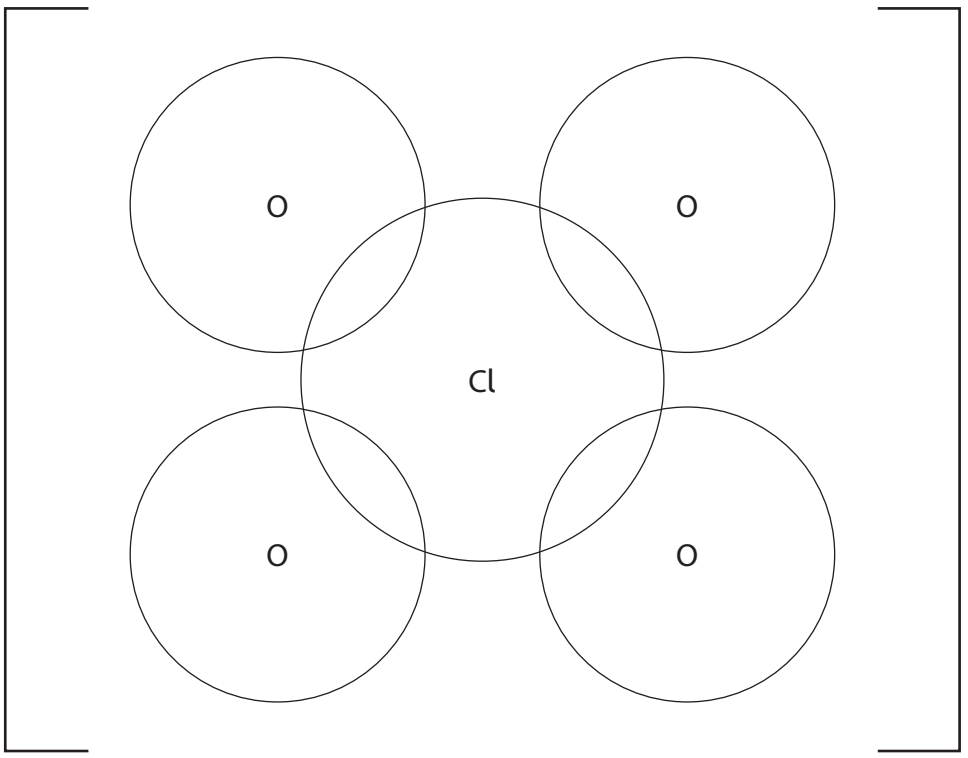
(e) In the 1830s, the more explosive oxidizers called chlorates were discovered.
One of these is potassium chlorate(VII), $KClO_4$.

(i) Suggest how the dot-and-cross diagram for the chlorate(VII) ion may be completed.

Use dots (•) for the chlorine electrons, crosses (×) for the oxygen electrons and an asterisk(*) for the extra electron on one of the oxygen atoms.

(2)



(ii) Environmentalists have raised concerns about the use of potassium chlorate(VII) so alternatives are being investigated.

Suggest **one** possible impact on the environment that potassium chlorate(VII) may have.

(2)

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*(f) Describe fully how the fuse in a firework starts the chemical reaction and why it is not a catalyst.

(3)

*(g) Use your knowledge of reaction kinetics to suggest **two** factors that could affect the rate of reaction of the solids in a firework. Justify your answer.

(3)

(Total for Question 20 = 22 marks)

TOTAL FOR SECTION C = 22 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

* 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