Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Tuesday 7 May 2019

Afternoon (Time: 1 hour 15 minutes) | Paper Reference **WCH03/01**

Chemistry

Advanced Subsidiary
Unit 3: Chemistry Laboratory Skills I

Candidates must have: Scientific calculator
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 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- 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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Pearson

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

1 Inorganic compounds **A** and **B** each contain one cation and one anion.

(a) Two tests were carried out on **A**. The observation for each test was recorded in the table.

(i) Complete the statements in the inference column by writing the names or formulae of the ions and the gas.

(3)

Test	Observation	Inference
Test 1 A flame test was carried out on a sample of **A**	A lilac flame was seen	The **cation** in **A** is ....
Test 2 A sample of **A** was heated in a dry test tube	A colourless gas was evolved, which relit a glowing splint	The **gas** evolved is ..... The **anion** in **A** is ....

(ii) Write the equation for the reaction in **Test 2**.
State symbols are **not** required.

(1)

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(b) The cation in compound **B** is formed from a metal in **Group 2** of the Periodic Table.

Three tests were carried out on **B**. The observation for each test was recorded in the table.

(i) Complete the statements in the inference column by writing the names or formulae of the ions and the precipitate.

(3)

Test	Observation	Inference
Test 3 A flame test was carried out on a sample of **B**	A crimson red flame was seen	The **cation** in **B** is ....
Test 4 A few drops of dilute sulfuric acid were added to an aqueous solution of **B**	A white precipitate formed	The **precipitate** is ....
Test 5 Dilute nitric acid and aqueous silver nitrate were added to an aqueous solution of **B**	A cream precipitate formed	The **anion** in **B** is ....

(ii) Write the **ionic** equation for the reaction in **Test 4**. Include state symbols.

(2)

(iii) A student who carried out **Test 5** recorded a white precipitate.
Describe a test on the precipitate that would distinguish between the two possible anions in **B**.
Give the result of the test for each possible anion.

(2)

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(Total for Question 1 = 11 marks)

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2 An organic compound **D** has the molecular formula C_4H_8O.

(a) Two tests were carried out on **D**. The observation and inference for each test were recorded in the table.

Test	Observation	Inference
Test 1 A small amount of reagent **X** was added to a sample of **D**	A gas was given off that produced steamy fumes in air and turned damp blue litmus paper red	**D** contains an —OH group
Test 2 A few drops of reagent **Y** were added to a sample of **D**	The orange-brown reagent **Y** turned colourless when added to **D**	**D** contains C═C

(i) Identify reagent **X** by name or formula.

(1)

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(ii) Identify the steamy fumes produced in **Test 1** by name or formula.

(1)

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(iii) Identify reagent **Y** by name or formula.

(1)

.....

(b) The mass spectrum of **D** includes peaks at $m/e = 15$ and $m/e = 31$.

Identify the ions that give these peaks.

(2)

Formula of the ion giving the peak at $m/e = 15$

Structure of the ion giving the peak at $m/e = 31$

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(c) The molecular formula of compound **D** is C_4H_8O.

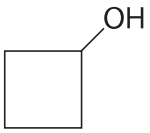
Compound **D** has a **branched** chain structure.

The functional groups identified in **Test 1** and **Test 2** are on **different** carbon atoms.

Use this information and your answer to (b) to deduce the structure of **D**.

(1)

(d) Cyclobutanol also has the molecular formula C_4H_8O.



By considering the bonds in cyclobutanol and **D**, describe how infrared spectroscopy can be used to distinguish between these two compounds. Specific wavenumber ranges are not required.

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(Total for Question 2 = 7 marks)

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3 Iron reacts with copper(II) sulfate solution, $CuSO_4(aq)$, in a redox reaction and solid copper is produced.

Five students carried out an investigation to find out whether iron(II) sulfate or iron(III) sulfate is the other product in this reaction.

Procedure

Step **1** Weigh a given mass of iron filings in a small beaker.

Step **2** Add 25 cm^3 (an excess) of copper(II) sulfate solution to the iron filings.

Step **3** Warm the beaker and contents. The copper produced settles at the bottom of the beaker.

Step **4** Pour off as much of the solution as possible and wash the copper with distilled water.

Step **5** Weigh a piece of filter paper and use it to filter off the copper.

Step **6** Dry the filter paper and copper in a warm oven.

Step **7** Allow the filter paper and copper to cool and then reweigh them to find the mass of copper produced.

Results

Student	Mass of iron used / g	Mass of copper produced / g
1	0.21	0.20
2	0.39	0.48
3	0.60	0.94
4	0.82	0.88
5	0.98	1.12

(a) Name a suitable piece of apparatus to measure 25 cm^3 of copper(II) sulfate in Step **2**.

(1)

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(b) The mass of copper recorded by student 3 is anomalous.
Suggest an error made by this student that would explain this anomalous result other than the incorrect use of the weighing balance.

(1)

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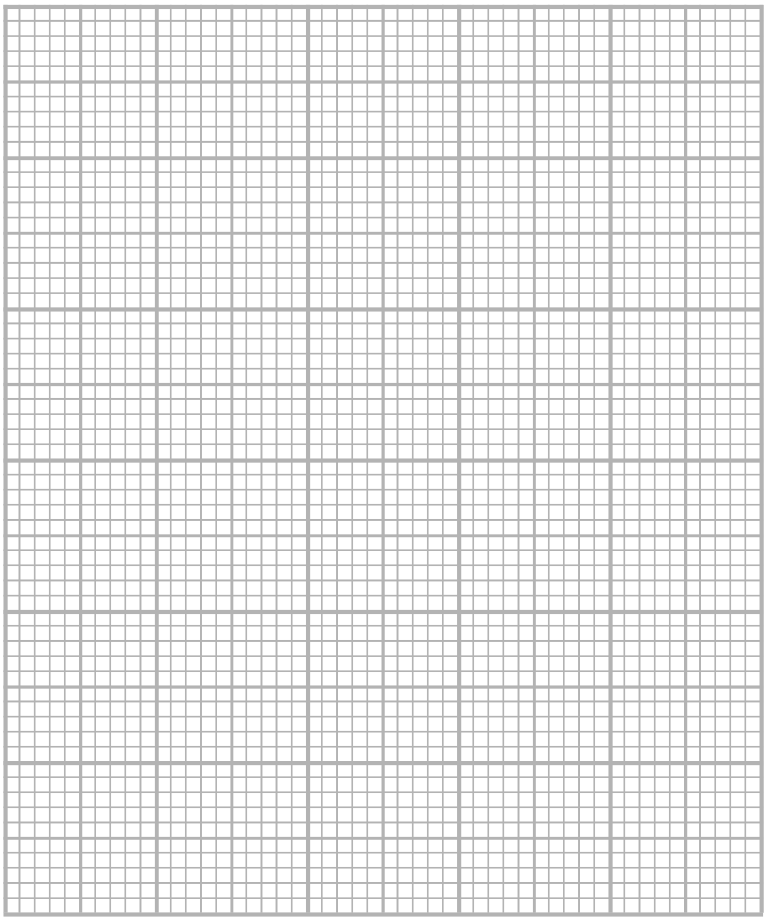
(c) Plot a graph of mass of copper (*y*-axis) against mass of iron (*x*-axis).

Draw a straight line of best fit on the graph.

(3)



(d) Use the graph to determine the mass of copper that would be produced from 0.56 g of iron.

(1)

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(e) Deduce the balanced equation for the reaction between iron and copper(II) sulfate.

State symbols are not required.
You **must** show your working.

Use the following relative atomic masses: Cu = 64, Fe = 56

(2)

(f) Give a reason why it is acceptable to use the relative atomic masses as 64 and 56 in (e) rather than the values of 63.5 and 55.8 given in the Periodic Table.

(1)

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(g) Student 2 used 50 cm^3 of copper(II) sulfate instead of 25 cm^3.
Give a reason why this will **not** affect the mass of copper produced.

(1)

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(Total for Question 3 = 10 marks)

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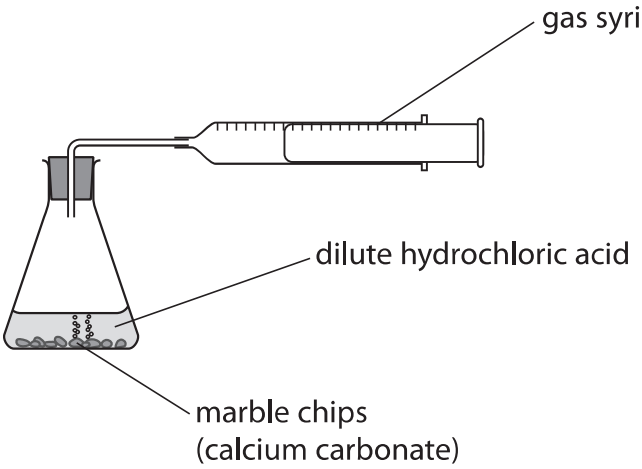
4 Marble chips react with dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

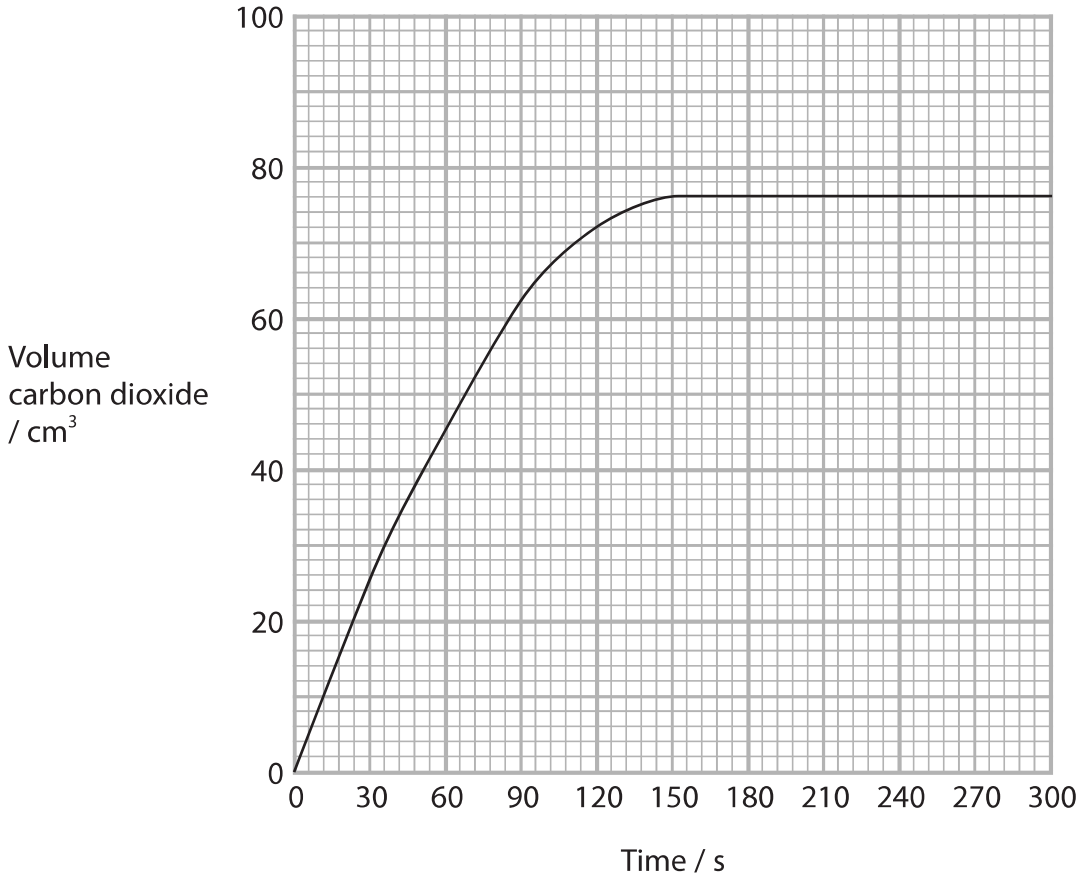
The rate of this reaction can be investigated by measuring the volume of carbon dioxide produced at regular time intervals using the apparatus shown.



A student followed this procedure:

- place 25 cm^3 of dilute hydrochloric acid in a conical flask
- set up the apparatus as shown and ensure the gas syringe reads 0 cm^3
- remove the bung, add 5 g of large marble chips (an excess) to the acid in the flask and replace the bung immediately
- record the volume of gas in the gas syringe every 30 seconds.

The results of the experiment with large marble chips are shown on the graph.



(a) Give the time when the reaction is **just** complete.

(1)

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(b) Draw a tangent to the curve at time = 0.
Calculate the gradient of the tangent to determine the initial rate of reaction.
Include units in your answer.

(3)

initial rate of reaction = ... units .....

(c) To investigate the effect of particle size on the rate of the reaction, the student carried out another experiment using smaller marble chips.
The same mass of marble chips was used.

(i) State **two** factors, other than the mass of marble chips, that must be controlled so that the results of the two experiments may be compared.

(2)

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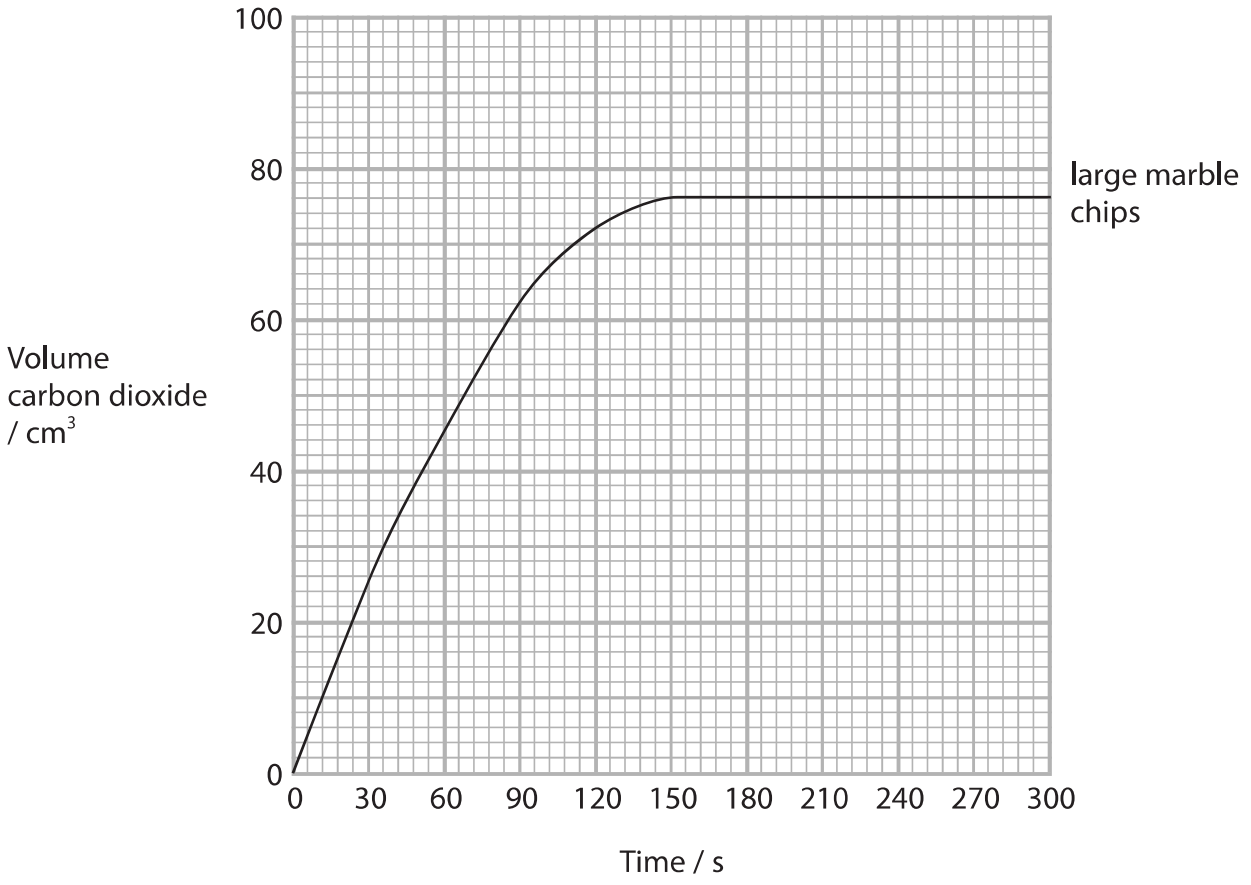
(ii) Add a curve to the graph below to show the expected results for repeating the experiment with the smaller marble chips.

(2)



(iii) Explain the difference in the rate of reaction when smaller marble chips are used instead of the large marble chips.

(2)

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(d) A calculation shows that reacting 25 cm^3 of hydrochloric acid with excess marble chips should form 90 cm^3 of carbon dioxide.

Give a reason why the volume of carbon dioxide collected in the experiment is less than 90 cm^3.

(1)

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(Total for Question 4 = 11 marks)

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5 This question is about propanoic acid, CH_3CH_2COOH.

(a) An aqueous solution of propanoic acid is prepared by the oxidation of propan-1-ol.

Outline procedure

Step **1** Place 3 cm^3 of propan-1-ol in a round-bottom flask and add a few anti-bumping granules.

Step **2** Set up the apparatus for reflux, with the round-bottom flask partially immersed in an ice-water bath.

Step **3** Add 20 cm^3 of acidified potassium dichromate(VI) slowly through the top of the condenser.

Step **4** Remove the ice-water bath and heat the mixture under reflux for 30 minutes.

Step **5** Allow the apparatus to cool and then rearrange it for distillation. Collect all the distillate up to 143 °C.

(i) Suggest a reason why the mixture in the round-bottom flask is cooled as the acidified potassium dichromate(VI) is added in Step **3**.

(1)

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(ii) Give a reason why the mixture is heated under reflux rather than in an open flask in Step **4**.

(1)

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(iii) Draw a labelled diagram of the apparatus, with its contents, arranged for heating under reflux in Step **4**.

(4)

(iv) The boiling temperature of propanoic acid is 141 °C.

Suggest the identity of **one** impurity, other than water, that might be present in the distillate collected in Step **5**.

(1)

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(b) A titration was carried out to find the concentration of an aqueous solution of propanoic acid.

25.0 cm^3 of 0.102 mol dm^{-3} sodium hydroxide was placed in a conical flask and titrated with the aqueous solution of propanoic acid using phenolphthalein as indicator.

The mean titre was 18.60 cm^3.

The equation for the reaction is

$$CH_3CH_2COOH + NaOH \rightarrow CH_3CH_2COONa + H_2O$$

(i) Calculate the concentration of propanoic acid in g dm^{-3}.

(3)

(ii) The pipette used to measure the 25.0 cm^3 of sodium hydroxide had an uncertainty of ±0.06 cm^3.

Calculate the percentage uncertainty in this measurement.

(1)

(Total for Question 5 = 11 marks)

TOTAL FOR PAPER = 50 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									(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