Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 22 January 2024

Afternoon (Time: 1 hour 20 minutes)

Paper reference **WCH13/01**

Chemistry

International Advanced Level

UNIT 3: Practical Skills in Chemistry I

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.*
- Show all your working in calculations and include units where appropriate.

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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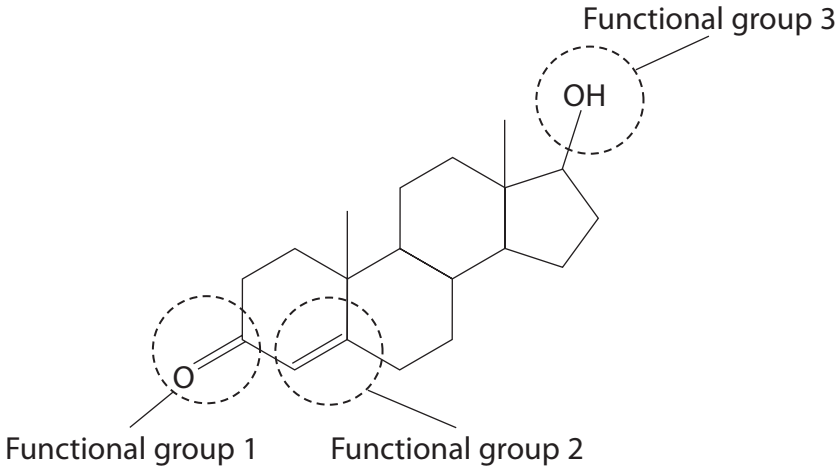
S:1/1/1/

P 7 5 5 9 3 A 0 1 2 0

Pearson

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

1 This question is about the hormone testosterone, the structure of which is shown.



(a) Give the **name** of each of the three circled functional groups.

(3)

Functional group 1

.....

Functional group 2

.....

Functional group 3

.....

(b) Describe a chemical test and the expected positive result for both functional group 2 and functional group 3.

(4)

Functional group 2

Test

.....

.....

Result

.....

.....

Functional group 3

Test

.....

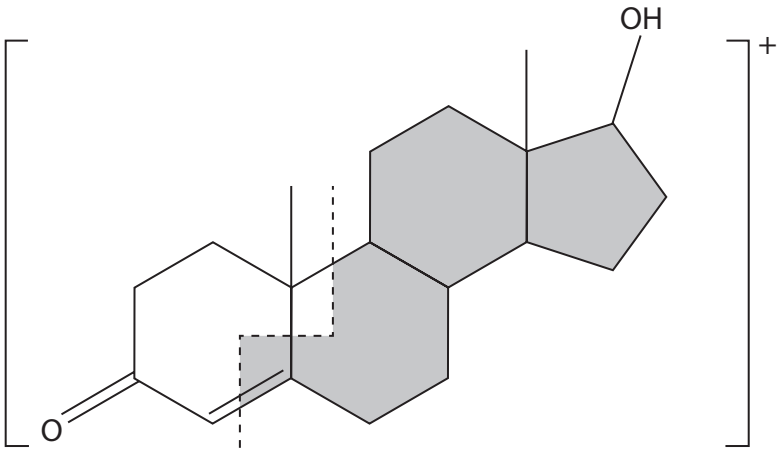
.....

Result

.....

.....

(c) In a mass spectrometer, the molecular ion formed can break apart into smaller fragments. One way the molecular ion can fragment is shown by the dashed line.



(i) Deduce the *m*/*z* ratio of the fragment shown by the **unshaded** area, assuming it forms a singly charged ion.

(1)

.....

(ii) When molecular ions fragment, they form a smaller ion and another type of particle.

State the other type of particle formed.

(1)

.....

(Total for Question 1 = 9 marks)

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2 An experiment was carried out to determine the concentration of citric acid in lemon juice using a titration.

Three students used the following procedure.

Procedure

Step **1** Add 24.0 g of lemon juice to a 250 cm^3 volumetric flask.

Step **2** Make up the volume of the lemon juice to 250 cm^3 using deionised water and mix thoroughly.

Step **3** Pipette 25.0 cm^3 of the diluted lemon juice into a conical flask and add a few drops of phenolphthalein indicator.

Step **4** Titrate the diluted lemon juice with standardised sodium hydroxide of concentration 0.103 mol dm^{-3}.

Student **A** obtained the results shown.

Titration	Rough	1	2	3
Burette reading (final) / cm^3	24.60	48.90	23.80	48.00
Burette reading (initial) / cm^3	0.00	24.60	0.00	23.80
Titre / cm^3	24.60	24.30	23.80	24.20

(a) Draw a circle around the concordant results in the table.

(1)

(b) Calculate the mean titre, using your answer from (a).

(1)

(c) The equation for the reaction between citric acid and sodium hydroxide solution is shown.

$$C_6H_8O_7(aq) + 3NaOH(aq) \rightarrow Na_3C_6H_5O_7(aq) + 3H_2O(l)$$

(i) State the colour change that occurs at the end-point of the titration.

(1)

.....

(ii) Calculate the percentage by mass of citric acid in the lemon juice, using your mean titre from (b).
Give your answer to **two** significant figures.

[Concentration of NaOH(aq) = 0.103 mol dm^{-3} M_r of citric acid = 192]

(5)

(d) Suggest a possible reason why the value obtained in (c) is valid, even though lemon juice also contains some ascorbic acid and malic acid.

(1)

.....

.....

(e) Two other students, **B** and **C**, also followed the procedure to find the concentration of citric acid in similar samples of lemon juice.

(i) Student **B** added too much deionised water in Step **2**.

State how Student **B** should correct this mistake.

(1)

.....

.....

.....

(ii) Student **C** used sodium hydroxide solution labelled 0.103 mol dm^{-3} that had been made up several months ago and stored since then.

Explain what effect this would have on the mean titre, compared to Student **A**.

(2)

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(Total for Question 2 = 12 marks)

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3 Seaweeds absorb iodide compounds from seawater. If seaweeds are dried and heated strongly, iodine can be obtained from the ash produced.

Procedure

Step **1** Heat the dried seaweed strongly to burn off any organic material.

Step **2** Add the ash produced in Step **1** to 25 cm^3 of deionised water and boil for 5 minutes.

Step **3** Filter off the remaining solid, collecting the colourless filtrate containing iodide ions.

Step **4** Add 2 cm^3 of dilute sulfuric acid, followed by 10 cm^3 of '20 volume' hydrogen peroxide solution, $H_2O_2(aq)$.

Step **5** Extract the iodine formed in Step **4** using cyclohexane as the solvent.

Step **6** Allow the cyclohexane to evaporate to leave behind iodine crystals.

(a) Suggest why the iodine-containing compounds do not burn off in Step **1**.

(1)

.....

.....

(b) '20 volume' hydrogen peroxide solution means that 1 dm^3 of the solution produces 20 dm^3 of oxygen gas when it decomposes completely.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Calculate the concentration of '20 volume' hydrogen peroxide solution in mol dm^{-3}.

[Molar volume of a gas at room temperature and pressure (r.t.p.) = 24 dm^3 mol^{-1}]

(2)

(c) In Step **4**, the iodide ions in the filtrate are oxidised to form iodine.
The reaction takes place under acidic conditions and the hydrogen peroxide is reduced to form a single product, water.

(i) Write half-equations for each of these changes.
State symbols are not required.

(2)

Oxidation of iodide ions:

Reduction of hydrogen peroxide under acidic conditions:

(ii) Write the overall equation for the reaction between iodide ions and hydrogen peroxide solution under acidic conditions.
State symbols are not required.

(1)

(iii) State the colour of the aqueous iodine solution formed in Step **4**.

(1)

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(d) Describe how to carry out Step **5**, using a separating funnel.

[Density of cyclohexane = 0.78 g cm^{-3}]

(4)

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(e) The hazard symbols for cyclohexane are shown.

Symbol **1** Symbol **2** Symbol **3**

(i) State what is meant by Symbol **3**.

(1)

.....

.....

(ii) Give **two** safety precautions that should be taken to reduce the risk in Step **5**.

Assume eye protection, gloves and a laboratory coat are being worn.

(2)

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.....

.....

.....

(Total for Question 3 = 14 marks)

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4 This question is about experiments involving ethanol.

(a) Ethanol and water mix in all proportions. The percentage of ethanol by volume in ethanol-water mixtures can be found by comparing the density of the mixture to the densities of ethanol-water mixtures of known composition, at a constant temperature.

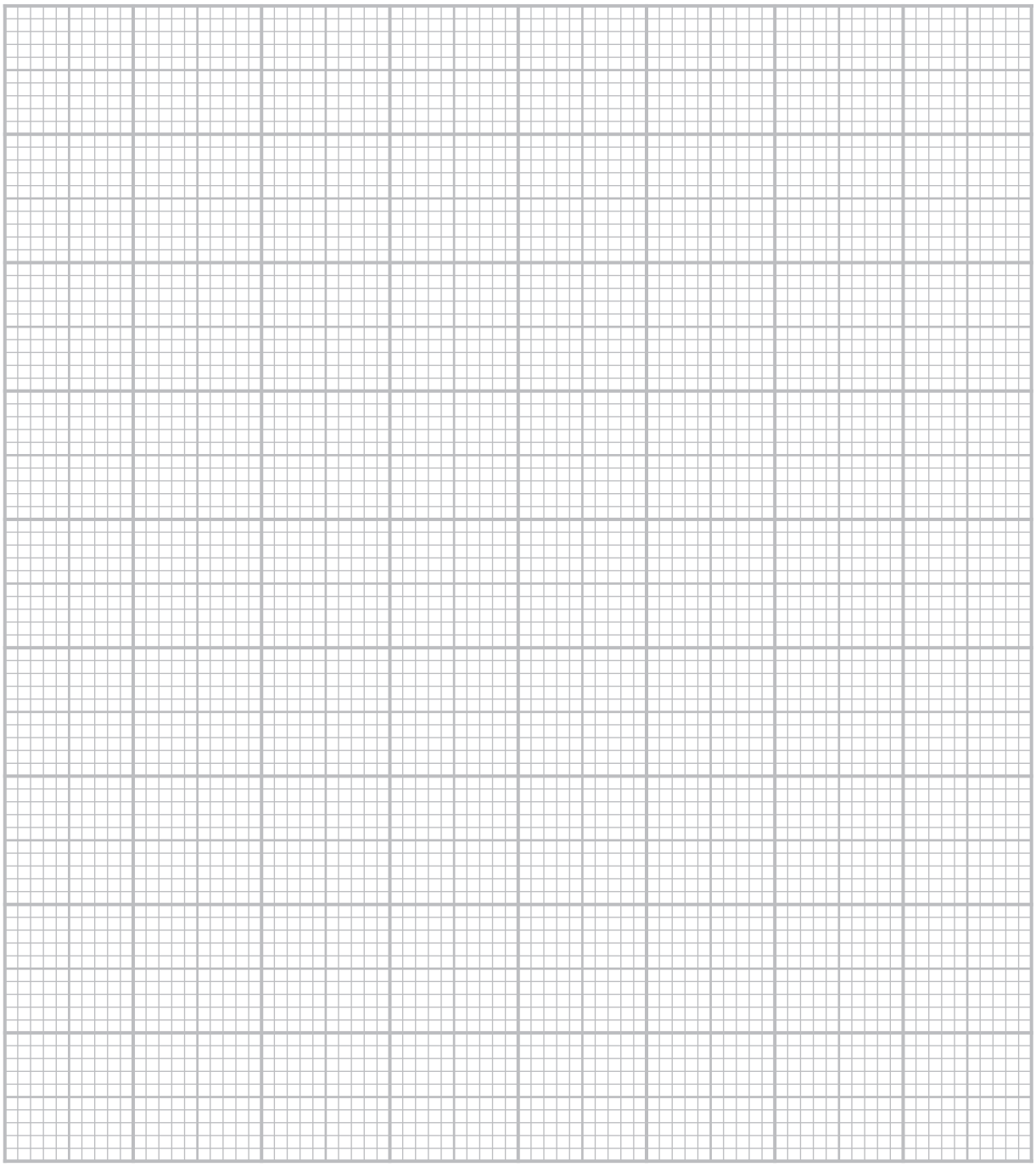
Percentage of ethanol in mixture	Density / g cm^{-3}
30	0.962
45	0.940
55	0.920
70	0.886
85	0.845
95	0.811

(i) Calculate the density of an ethanol-water mixture, sample **A**, 5.00 cm^3 of which has a mass of 4.75 g.

(1)

(ii) Plot a graph of density against the percentage of ethanol by volume.

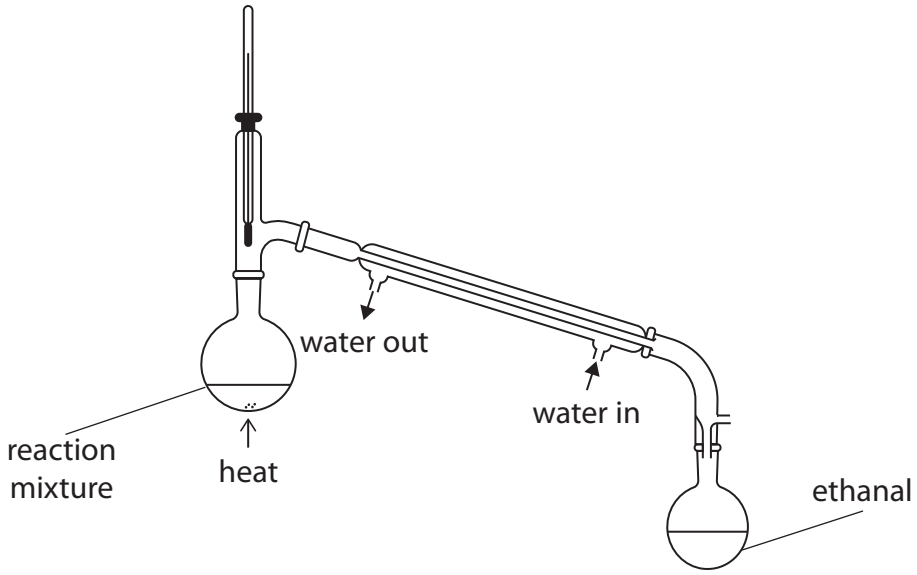
(3)



(iii) Determine the percentage of ethanol by volume in sample **A** using your answer to (a)(i) and the graph in (a)(ii). Show your working on the graph.

(1)

(b) Ethanal can be prepared by heating ethanol with acidified sodium dichromate(VI) in the apparatus shown.



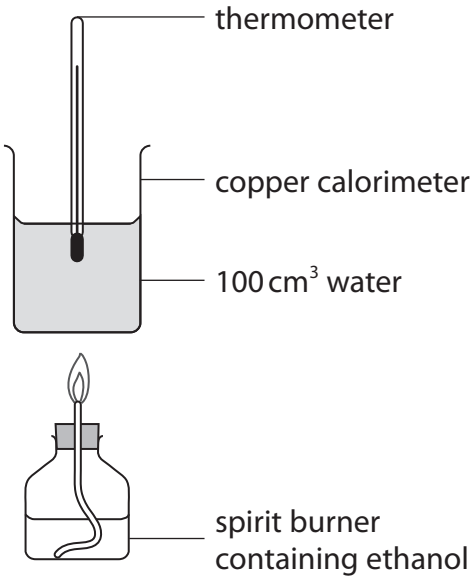
(i) Explain why the reaction mixture is heated as shown, instead of heating under reflux.

(2)

(ii) Explain why the water is passed through the condenser in the direction shown.

(2)

(c) A student determined a value for the enthalpy change of combustion of ethanol, using the apparatus shown.



Data

M_r of ethanol = 46.0

Density of water = 1.00 g cm^{-3}

Specific heat capacity of water = 4.18 J g^{-1} °C^{-1}

Mass of ethanol burnt = 0.650 g

Temperature of water before heating = 20.0°C

Temperature of water after heating = 57.9°C

(i) Calculate the energy transferred to the water.

(1)

(ii) Calculate the amount of ethanol burnt in moles.

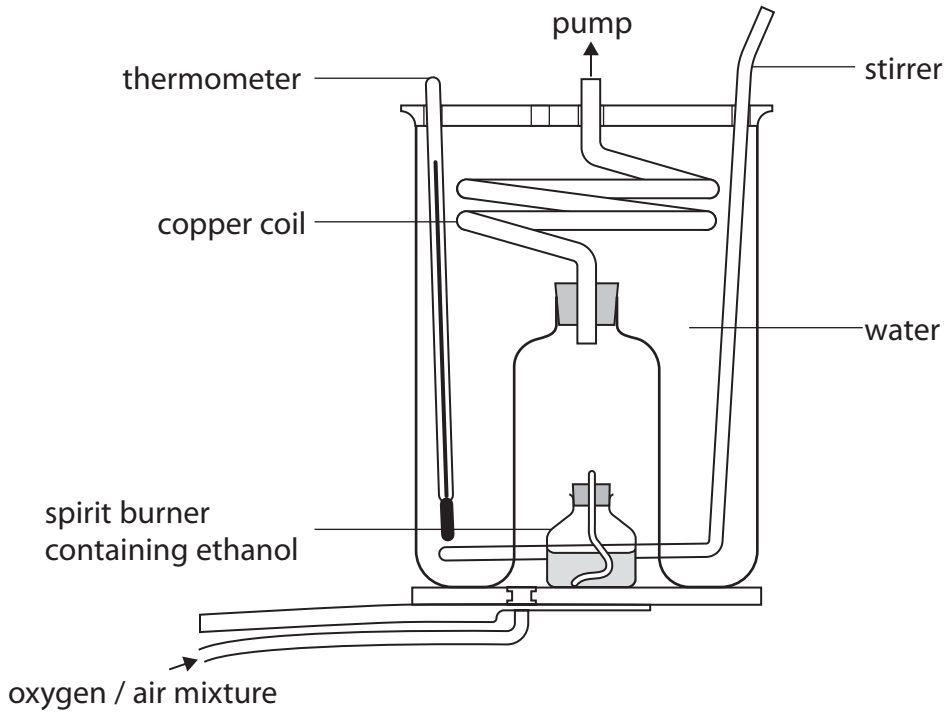
(1)

(iii) Calculate the enthalpy change of combustion of ethanol in kJ mol^{-1}, using your answers to (c)(i) and (c)(ii).

Give your answer to an appropriate number of significant figures.

(1)

(d) Whilst evaluating the method used in (c), the student found a diagram of an alternative apparatus as shown.



Explain two reasons why this apparatus is likely to give a more accurate value for the enthalpy change of combustion of ethanol.

(3)

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 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