Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 20 minutes

Paper reference **WCH16/01**

Chemistry

International Advanced Level
UNIT 6: Practical Skills in Chemistry II

You must have:
Scientific calculator, ruler

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 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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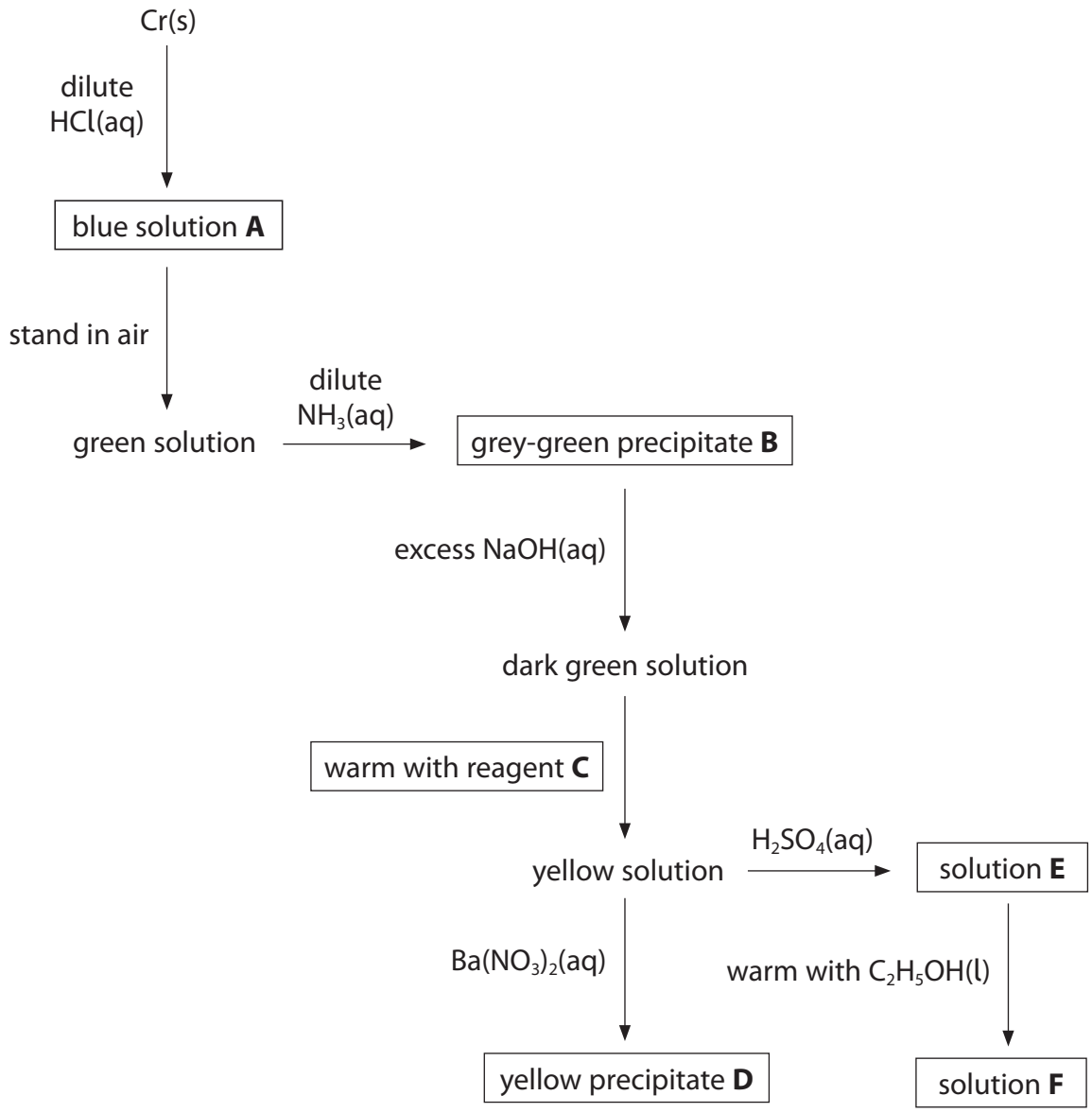
Q:1/1/1/

P 7 0 9 5 7 A 0 1 2 0

Pearson

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

1 A flowchart of a series of reactions of chromium and some of its compounds is shown.



(a) Give the formula of a complex ion of chromium present in solution **A**.

(1)

(b) Give the formula of precipitate **B**.

(1)

(c) Identify reagent **C**, by name or formula.

(1)

(d) Suggest the identity, by name or formula, of precipitate **D**.

(1)

(e) State the colour of solution **E**.

(1)

(f) State the colour of solution **F**.

(1)

(Total for Question 1 = 6 marks)

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2 This question is about the identification of three organic compounds, **X**, **Y** and **Z**.

A molecule of each compound has only one **type** of functional group.
Each compound contains six carbon atoms and two oxygen atoms.

In the mass spectrum of **X**, the molecular ion peak is at $m/z = 114$.

(a) State the molecular formula of **X**.

(1)

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(b) Three chemical tests are carried out on **X**.

Test **1** When Brady's reagent (2,4-dinitrophenylhydrazine solution) is added to **X**, an orange precipitate is observed.

Test **2** When **X** is heated with an acidified solution of potassium dichromate(VI), no change is observed.

Test **3** When **X** is added to an alkaline solution of iodine, the formation of a pale yellow precipitate is observed.

Explain what can be deduced about the functional group present in **X**, by considering the results of each of these tests.

(3)

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(c) The **high** resolution proton NMR spectrum of **X** contains only two singlets with relative peak areas of 3 : 2.

Draw the structure of **X**, identifying the two proton environments.

(2)

(d) The molecular formula of **Y** is $C_6H_{12}O_2$.

(i) When aqueous sodium carbonate is added to **Y**, effervescence is observed.

Identify, by name or formula, the functional group present in **Y**.

(1)

.....

(ii) The ^{13}C NMR spectrum of **Y** contains **four** peaks.

Give **two** possible structures for **Y**.

(2)

Structure 1	Structure 2

(iii) Explain how the **low** resolution **proton** NMR spectrum of **Y** would confirm which of your structures in (d)(ii) is correct.
Chemical shifts are not required.

(2)

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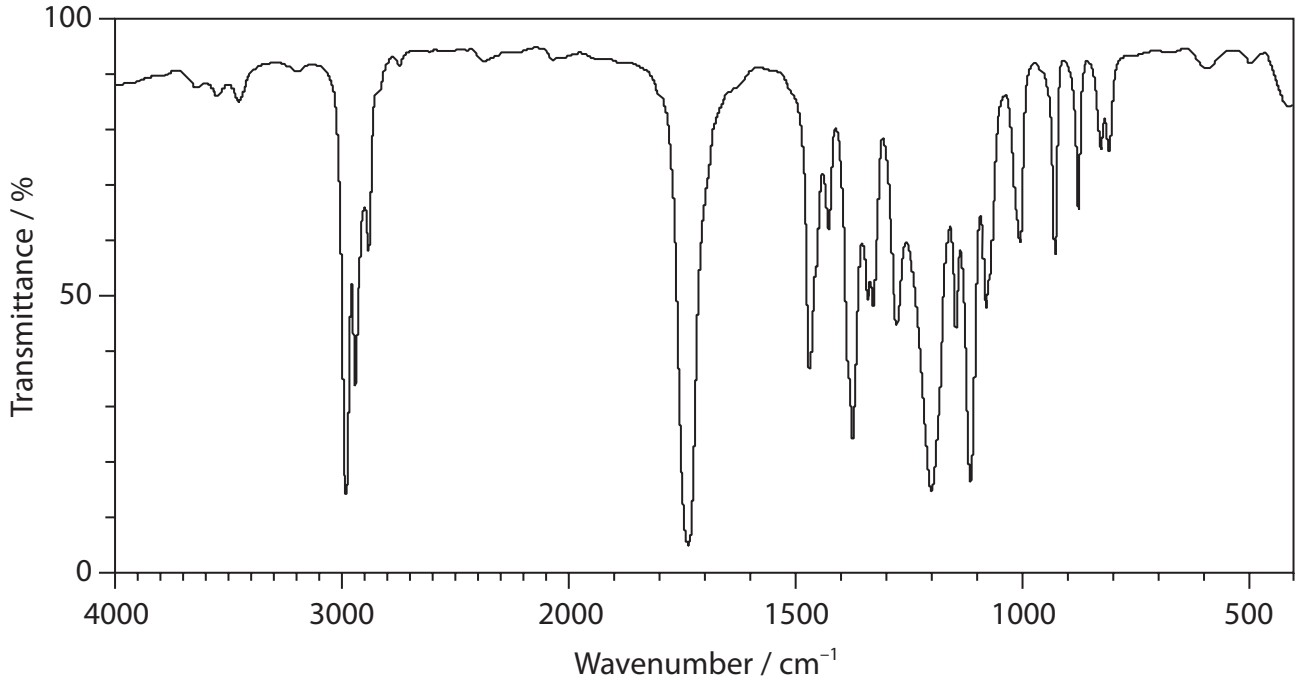
(e) The molecular formula of **Z** is $C_6H_{12}O_2$.

The infrared spectrum of **Z** is shown.



Group	Wavenumber range / cm^{-1}
C—H stretching vibrations	
Alkane	2962–2853
Alkene	3095–3010
Aldehyde	2900–2820 and 2775–2700
O—H stretching vibrations	
Alcohols	3750–3200
Carboxylic acids	3300–2500
C═O stretching vibrations	
Aldehydes	1740–1720
Ketones	1720–1700
Carboxylic acids	1725–1700
Esters	1750–1735

(i) **Z** has a fruity smell.

Deduce the identity of the functional group present in **Z**, using all the information given.
Include any relevant wavenumber ranges in your answer.

(2)

(ii) The high resolution proton NMR spectrum of **Z** contains four peaks (J, K, L and M). Peak J has the highest chemical shift, showing that this proton environment is close to an electronegative atom.

The splitting pattern of the peaks is shown.

Peak	J	K	L	M
Splitting pattern	septet	quartet	doublet	triplet

Draw the displayed structure of **Z**, labelling the proton environment responsible for each of the peaks J, K, L and M.

(3)

(Total for Question 2 = 16 marks)

3 A student investigated the kinetics of the reaction between bromide ions, Br^-, and bromate(V) ions, BrO_3^-, in aqueous acid.

$$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

To determine the rate equation for the reaction, the student varied the concentration of bromide ions, bromate(V) ions and acid in turn.

The effect of the concentration of bromide ions was investigated first.

Procedure

Step **1** Add 10.0 cm^3 of 0.0050 mol dm^{-3} potassium bromate(V), 15.0 cm^3 of acidified methyl orange indicator solution and 5.0 cm^3 of 0.00010 mol dm^{-3} aqueous phenol to a beaker labelled **P**.

Step **2** Prepare the contents of beaker **Q** for Run 1 as specified in the table.

Step **3** Pour the contents of beaker **Q** into beaker **P** and start a timer. Pour the contents of beaker **P** back into beaker **Q** and place beaker **Q** on a white tile.

Step **4** Stop the timer as soon as the mixture turns colourless. Record the time, along with the temperature of the solution.

Step **5** Repeat Steps **1** to **4** for the remaining runs.

Contents of beaker **Q**		
Run	Volume of 0.01 mol dm^{-3} KBr / cm^3	Volume of H_2O / cm^3
1	10.0	0
2	8.0	2.0
3	6.0	4.0
4	5.0	5.0
5	4.0	6.0
6	3.0	7.0

(a) Give **one** reason why the contents of beaker **P** are poured back into beaker **Q** in Step **3**.

(1)

(b) Methyl orange indicator is bleached colourless by bromine.
Under the experimental conditions, the reciprocal of the time taken for the methyl orange to be bleached ($1/t$) is proportional to the initial rate.

(i) Explain why phenol is added to the reaction mixture.

(2)

(ii) Give the colour of the reaction mixture before it turns colourless.

(1)

(iii) Give the reason why the temperature is measured in Step **4**.

(1)

(c) The student's results are shown.

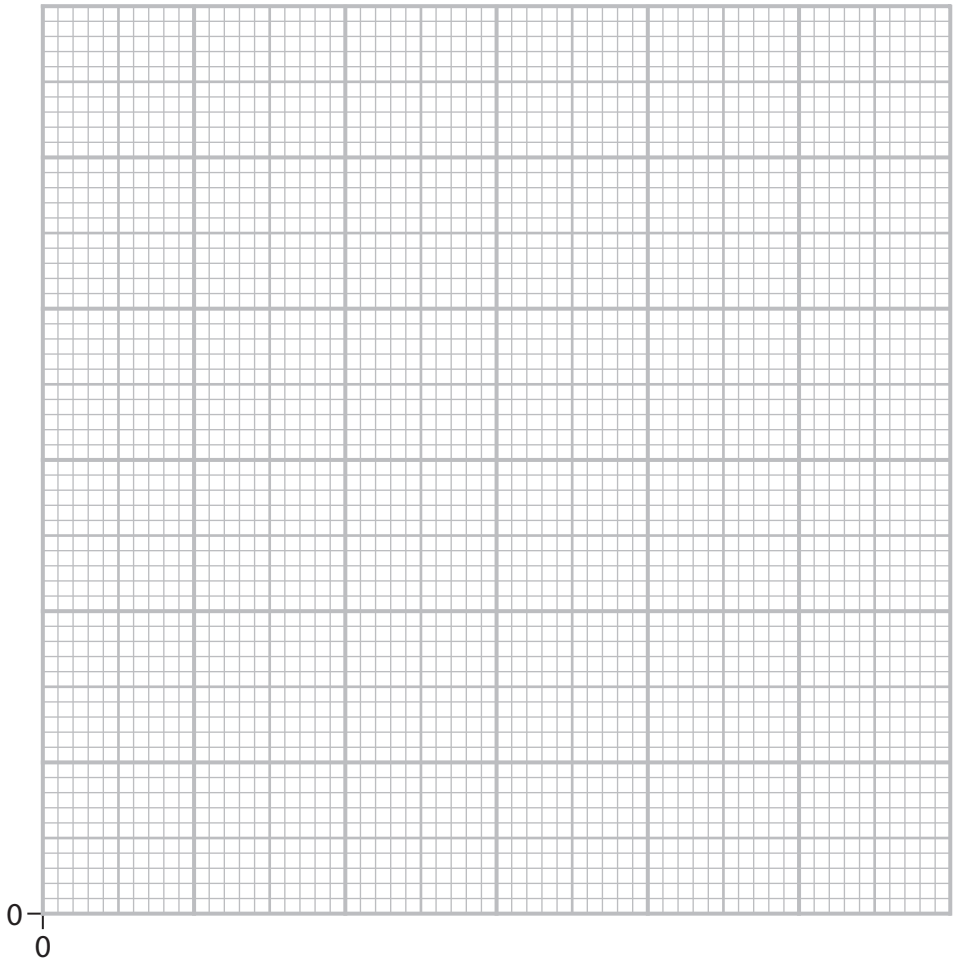
Volume of KBr / cm^3	10.0	8.0	6.0	5.0	4.0	3.0
Time, t / s	23	24	32	39	48	64
$(1/t)$ / s^{-1}	0.043	0.042	0.031	0.026		
Temperature / °C	18	22	22	22	22	22

(i) Complete the table by calculating the remaining values of $1/t$.

(1)

(ii) Plot a graph of $1/t$ against the volume of KBr.
Include a line of best fit.

(3)



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(iii) State why the volume of KBr is proportional to the concentration of bromide ions in the reaction mixture.

(1)

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.....

(iv) State the order of reaction with respect to bromide ions, using your graph.

(1)

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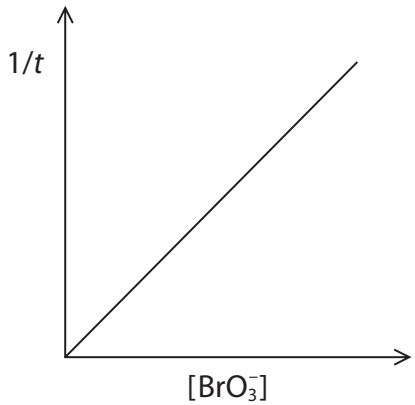
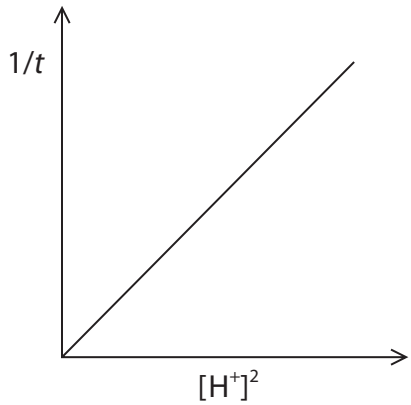
(d) After investigating the effect on the rate of the concentration of bromate(V) ions and the concentration of hydrogen ions, the student obtained the graphs shown.



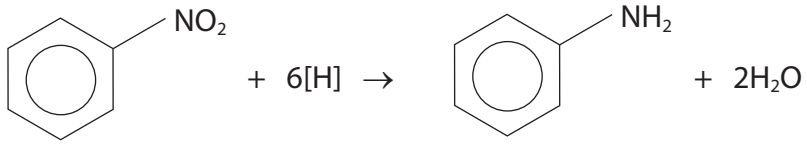


Deduce the rate equation for the reaction, using these data and your answer to (c)(iv).

(1)

(Total for Question 3 = 12 marks)

4 This question is about the preparation of phenylamine by the reduction of nitrobenzene.



nitrobenzene phenylamine

Outline procedure

Step **1** Add 2.1 cm^3 of nitrobenzene, 5 g of granulated tin and 10 cm^3 of concentrated hydrochloric acid to a round-bottomed flask.

Step **2** Add a few anti-bumping granules to the flask and heat the contents under reflux for 15 minutes. Leave to cool.

Step **3** Dissolve 7.5 g of sodium hydroxide in 10 cm^3 of distilled water and add to the flask. An initial precipitate forms before redissolving.

Step **4** Add 15 cm^3 of distilled water to the flask and steam distil the contents, collecting the cloudy distillate in a conical flask.

Step **5** Add 3 g of powdered sodium chloride to the distillate and swirl to dissolve, before transferring the contents to a separating funnel.
Add 8 cm^3 of ether to the funnel and shake, occasionally relieving the pressure. Allow the layers to separate.

Step **6** Discard the aqueous layer before transferring the ether layer to a clean flask containing a few pellets of potassium hydroxide.

Step **7** Decant the contents of the flask from Step **6** into a pear-shaped flask and distil off all the ether.

Step **8** Distil the remaining contents of the pear-shaped flask, collecting the fraction boiling between 180 °C and 185 °C.

Some data relating to the organic chemicals involved in the preparation are shown.

Chemical	Hazard	M_r	Density / g cm^{-3}	Boiling temperature / °C
Nitrobenzene	Toxic by inhalation and skin absorption	123.0	1.20	211
Phenylamine	Toxic by inhalation and skin absorption	93.0	1.03	184
Ether	Highly flammable	74.0	0.71	35

(a) Give **two** reasons why gloves should be worn in Step **1**.

(2)

(b) (i) State the role of tin in the preparation.

(1)

(ii) Suggest, by name or formula, the identity of the initial precipitate formed in Step **3**.

(1)

(c) State why the distillate in Step **4** is cloudy.

(1)

(d) Suggest why sodium chloride is added to the distillate in Step **5**.

(1)

(e) (i) Draw a **labelled** diagram of the separating funnel **at the end** of Step **5**.

(2)

(ii) State how you would relieve the pressure in the separating funnel in Step **5**.

(1)

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(f) Suggest **one** reason for adding pellets of potassium hydroxide in Step **6**.

(1)

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(g) State how the mixture would be heated to distil off the ether in Step **7**.
Justify your answer.

(2)

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(h) Calculate the mass of phenylamine formed in this preparation.

The limiting reagent is nitrobenzene and the overall yield by mass is 43 %.

Refer to all the information at the start of the question.

(4)

(Total for Question 4 = 16 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

* Lanthanide series

* Actinide 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
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