

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel International Advanced Level**Time** 1 hour 20 minutes**Paper****reference****WCH13/01****Chemistry****International Advanced Subsidiary/Advanced Level****UNIT 3: Practical Skills in Chemistry I****You must have:**

Scientific calculator, ruler

January 2022

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

1 This question is about ammonium chloride, NH_4Cl , a soluble ionic compound.

(a) An aqueous solution of NH_4Cl contains both ammonium ions, NH_4^+ , and chloride ions, Cl^- .

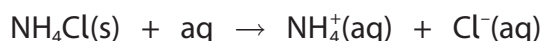
(i) State what would be **seen** on the addition of acidified silver nitrate solution to an aqueous solution of NH_4Cl .

(1)

(ii) Describe a test to confirm the presence of NH_4^+ ions in a solution of NH_4Cl . Include the result of the positive test.

(2)

(b) A student investigated the enthalpy change when dissolving NH_4Cl in excess water.



Procedure

Step 1 Accurately weigh 7.17 g of NH_4Cl into a glass beaker.

Step 2 Fill a 50 cm^3 measuring cylinder with deionised water.
Measure the temperature of the water using a thermometer.

Step 3 Pour the water from the measuring cylinder into the beaker and at the same time start a stopwatch. Stir the solution in the beaker, using the thermometer.

Step 4 Record the temperature at 15 s, 30 s and then at 30 s intervals while continuing to stir the solution.

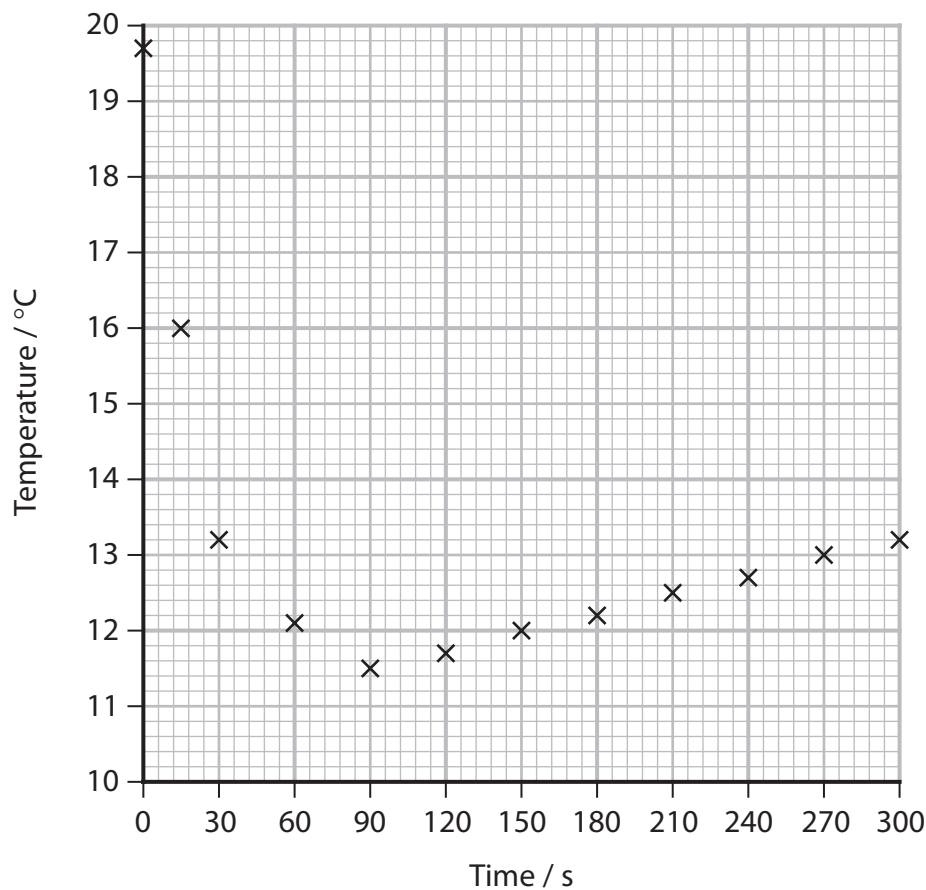
The data from the experiment are shown on the graph.

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- (i) Give **two** reasons why the student stirred the solution in Steps **3** and **4**.

(2)

- (ii) Use the graph to determine the maximum temperature change, ΔT , in this experiment. You **must** show your working on the graph.

(2)



- (iii) Another student carried out the experiment using a polystyrene cup in place of the glass beaker.

Explain how this student's graph would be different.
You may annotate the graph as part of your answer.

(3)

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- (c) The experimental results of another student were used in the equation shown to calculate the enthalpy change, ΔH , for dissolving one mole of NH_4Cl in excess water.

$$\Delta H = \frac{m \times c \times \Delta T}{n}$$

$$= +14\,500 \text{ J mol}^{-1}$$

In the equation

m = mass of solution = 50 g

c = specific heat capacity of water = $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

ΔT = maximum temperature change of solution

n = moles of NH_4Cl

- (i) State **two** assumptions made in this calculation.
You do **not** need to justify your answers.

(2)



- (ii) The total percentage uncertainty in this experiment was 2.6%.

Show that the enthalpy change of 14.5 kJ mol^{-1} is consistent with a data book value of 14.8 kJ mol^{-1} .

(2)

(Total for Question 1 = 14 marks)

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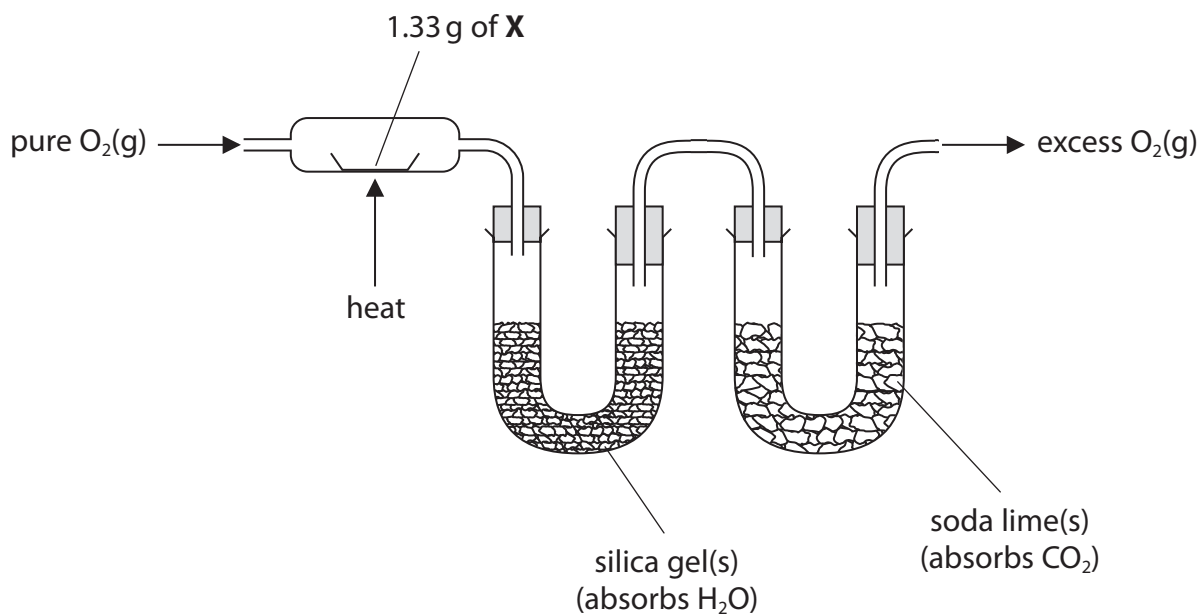
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2 This question is about two organic compounds, **X** and **Y**. Both are liquids which contain carbon, hydrogen and oxygen only.

- (a) The mass of hydrogen and of carbon present in 1.33 g of **X** were determined by passing its combustion products through the apparatus shown.



- (i) State the **measurements** that should be made.

(2)

- (ii) Give **two** reasons why pure O₂(g), and **not** air, should be used.

(2)

- (iii) The experiment showed that 1.33 g of **X** contains 0.14 g of hydrogen and 0.63 g of carbon.

Calculate the empirical formula of **X**, using these data.
You **must** show your working.

(3)

- (b) When phosphorus(V) chloride is added to **X**, steamy white fumes are seen.

State what can be deduced about compound **X** from this observation only.

(1)



- (c) Compound **X** is converted into compound **Y** when refluxed with **excess** sodium dichromate(VI) in sulfuric acid.

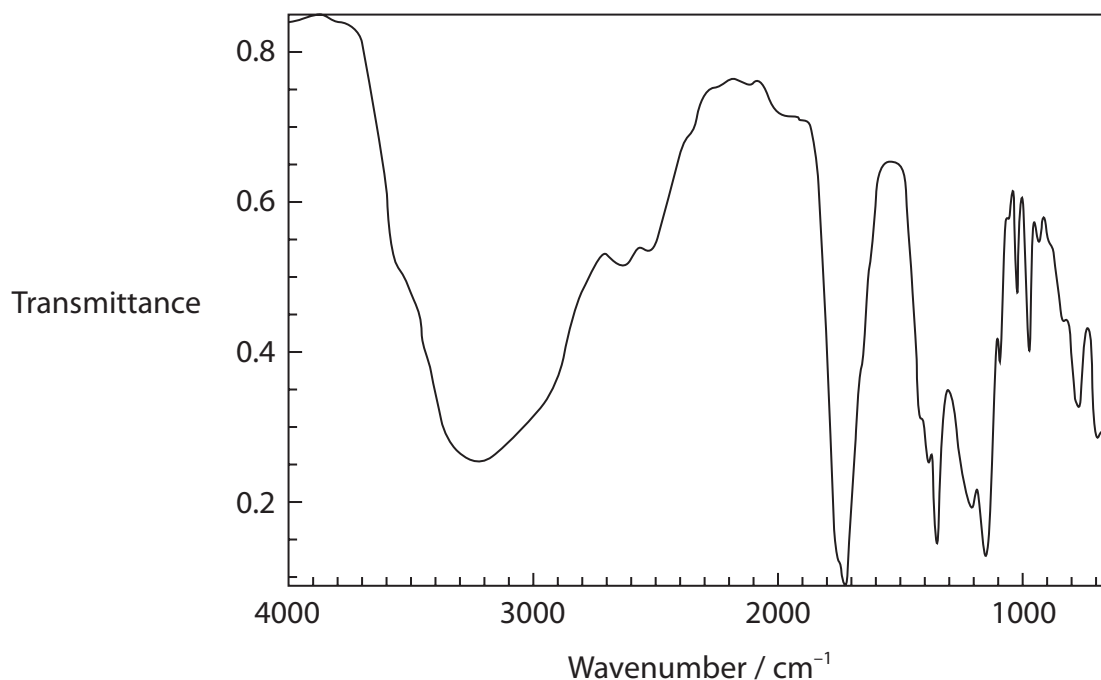
Compound **Y** is a liquid that is soluble in the reaction mixture.

Draw a **labelled** diagram of the apparatus that could be used to separate **Y** from the reaction mixture.

(3)



(d) The infrared spectrum of **Y** is shown.



The table shows some infrared absorption data.

Bond	Wavenumber range / cm^{-1}
C—H (alkane)	2962 – 2853
O—H (alcohols and phenols)	3750 – 3200
O—H (carboxylic acids)	3300 – 2500
C=C (alkene)	1669 – 1645
C=O (aldehydes, ketones, carboxylic acids)	1740 – 1680

Explain how this spectrum shows that **Y** contains a carboxylic acid functional group, quoting data from the table.

(2)

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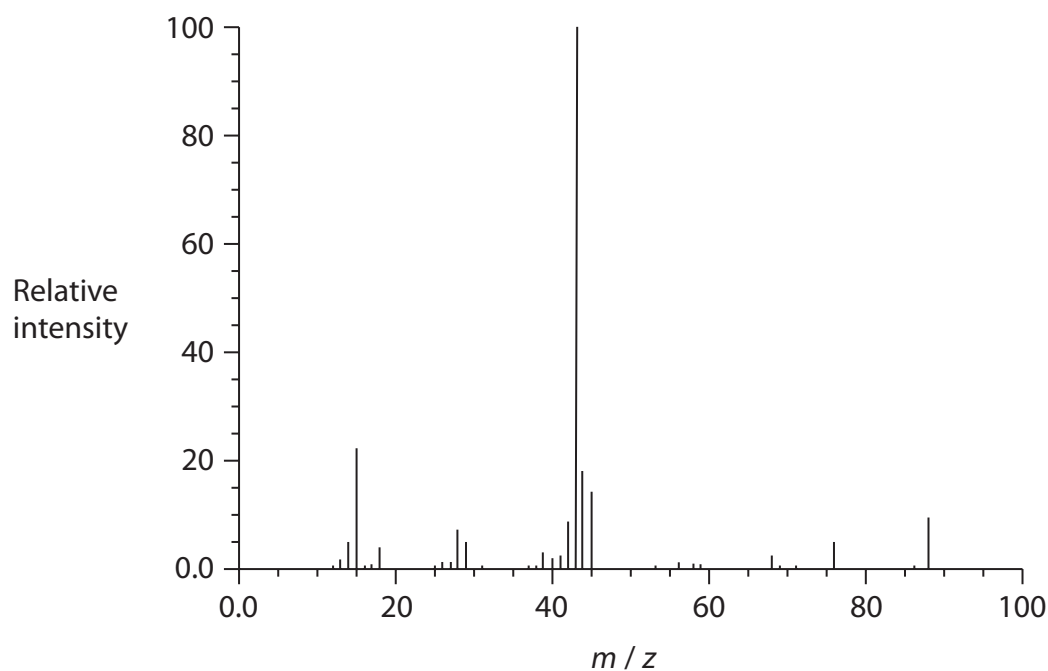
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(e) The mass spectrum of **Y** is shown.



(i) Show that the mass spectrum is consistent with **Y** having the molecular formula $C_3H_4O_3$.

(1)

(ii) Suggest the structure of the ion causing the peak at $m/z = 43$ in the mass spectrum of **Y**.

(1)

(f) Compound **X** contains one type of functional group.

Compound **Y** contains two different functional groups.

Use the information in the question to deduce the structures of **X** and **Y**.

(2)

Compound **X**

Compound **Y**

(Total for Question 2 = 17 marks)



- 3 A student used a precipitation titration to determine the value of x in the formula of a sample of hydrated barium chloride, $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$.

Procedure

Step 1 Prepare a solution by dissolving 1.57 g of $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$ in deionised water, making the solution up to the mark in a 250.0 cm^3 volumetric flask and then mixing thoroughly.

Step 2 Use a pipette to transfer 10.0 cm^3 of the barium chloride solution into a conical flask.
Add excess sodium sulfate solution and swirl the mixture.

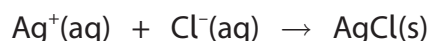
Step 3 Fill a burette with $0.0324\text{ mol dm}^{-3}$ silver nitrate solution.

Step 4 Add three drops of potassium chromate(VI) solution to the conical flask and titrate the contents, while swirling, with the silver nitrate solution.
The end-point is shown by the appearance of a permanent pale red precipitate.

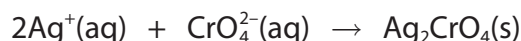
Step 5 Repeat Steps 2 to 4 until concordant results are obtained.

During the titration, two precipitation reactions occur.

Reaction 1 Silver ions react with chloride ions forming silver chloride.



Reaction 2 Once all chloride ions have reacted, silver ions react with chromate(VI) ions to form a red precipitate of silver chromate(VI).



- (a) (i) Give the **ionic** equation for the reaction that occurs when sodium sulfate solution is added to the conical flask in Step 2.
Include state symbols.

(1)

- (ii) Give a possible reason why it is necessary to add sodium sulfate solution.
Justify your answer.

(1)

.....

.....

.....



- (b) Suggest why the red precipitate of silver chromate(VI) only forms after all the chloride ions have reacted.

(1)

- (c) Some data obtained in the experiment are shown.

Titration number	1	2	3	4
Burette reading (final) / cm ³	16.15	32.05	48.30	47.40
Burette reading (initial) / cm ³	0.00	16.15	32.50	31.55
Titre / cm ³	16.15			

- (i) Complete the table and use the concordant results to calculate the mean titre.

(2)



- (ii) Determine the value of x in the formula of the hydrated salt, $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$.
Use information from the procedure and your mean titre from (c)(i).
You **must** show your working.

(5)

(Total for Question 3 = 10 marks)

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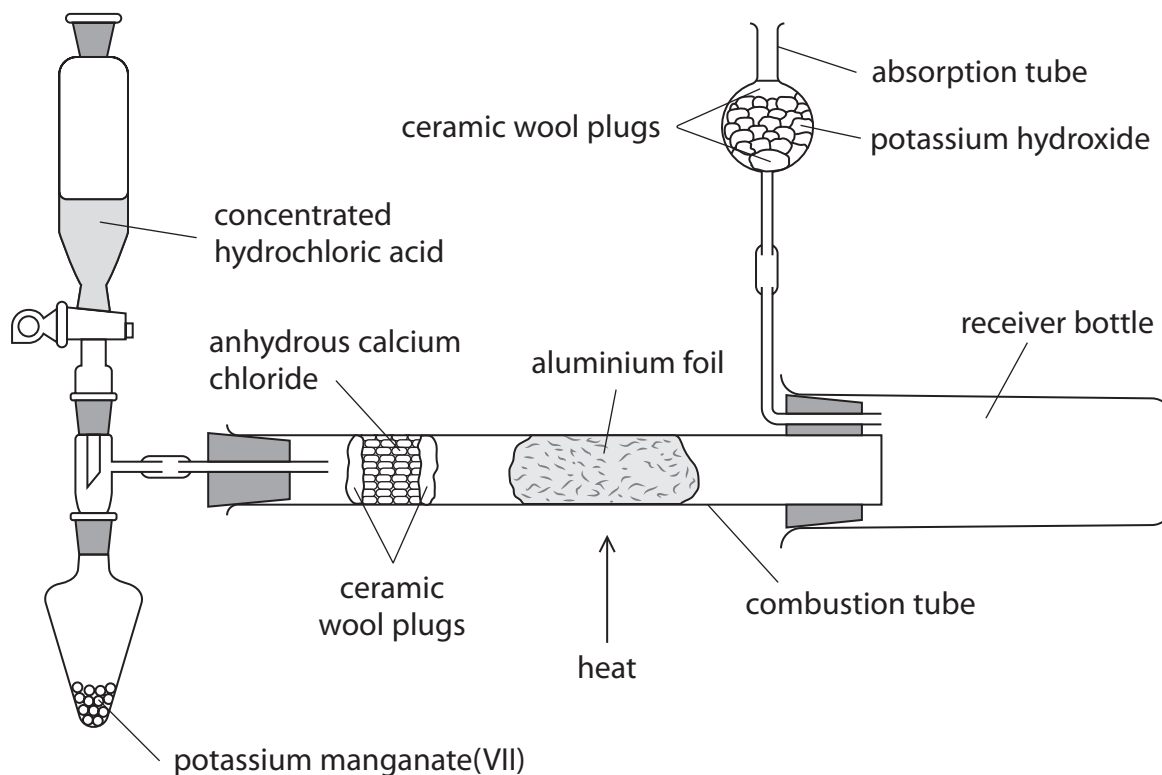
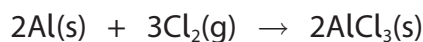
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- 4 This question is about the preparation of anhydrous aluminium chloride, AlCl_3 , which reacts vigorously with water and must be stored in tightly sealed containers.

A sample of anhydrous AlCl_3 was prepared by passing chlorine gas over hot aluminium foil using the apparatus shown.



Procedure

- Step 1** Assemble the apparatus with about 5 g of potassium manganate(VII) in the pear-shaped flask, 10 cm^3 of concentrated hydrochloric acid in the tap funnel and a known mass of aluminium foil in the combustion tube.
- Step 2** Carefully open the tap of the funnel, allowing the acid to enter the pear-shaped flask drop by drop. Wait for twenty seconds.
- Step 3** Heat the aluminium foil until it glows brightly. Continue heating until the reaction is complete. Allow the apparatus to cool before closing the tap of the funnel.
- Step 4** Remove the receiver bottle, quickly scrape the product into a sample tube and seal with a lid.

(a) Granules of anhydrous calcium chloride are held between two ceramic wool plugs in the combustion tube.

(i) Explain the purpose of the anhydrous calcium chloride.

(2)

(ii) Give the reason why granules of anhydrous calcium chloride are used rather than powder.

(1)

(b) The reaction occurring in Step 2 produces chlorine gas.

(i) Identify the main hazard related to chlorine gas, giving the **best** way of minimising the risk when using this gas.

(2)

(ii) Give a reason why the concentrated hydrochloric acid is added 'drop by drop' to the pear-shaped flask.

(1)



- (c) Suggest why the heating of the aluminium in Step 3 is delayed by 20 s after the initial production of chlorine gas.

(1)

- (d) State how you would know the reaction is complete in Step 3.

(1)

- (e) Suggest the purpose of the potassium hydroxide in the absorption tube.

(1)

(Total for Question 4 = 9 marks)

TOTAL FOR PAPER = 50 MARKS



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The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)
1.0 H hydrogen 1							
Key relative atomic mass atomic symbol name atomic (proton) number							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
6.9 Li lithium 3	9.0 Be beryllium 4	23.0 Na sodium 11	24.3 Mg magnesium 12	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16
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	39.9 Ar argon 18	33.8 Kr krypton 36
112.4 Cd cadmium 48	118.7 Sn tin 50	121.8 Sb antimony 51	126.9 Te tellurium 52	127.6 I iodine 53	126.9 Br bromine 35	131.3 Xe xenon 54	[222] Rn radon 86
106.4 Pd palladium 46	107.9 Ag silver 47	108.1 Cu copper 29	63.5 Zn zinc 30	65.4 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34
101.1 Ru ruthenium 44	102.9 Rh rhodium 45	102.9 Ir iridium 77	192.2 Pt platinum 78	195.1 Au gold 79	197.0 Hg mercury 80	200.6 Tl thallium 81	204.4 Pb lead 82
186.2 Re rhenium 75	187.2 Os osmium 76	190.2 Ir iridium 77	192.2 Pt platinum 78	195.1 Au gold 79	197.0 Hg mercury 80	200.6 Tl thallium 81	204.4 Pb lead 82
180.9 Ta tantalum 73	180.9 Nb niobium 41	92.9 Zr zirconium 40	91.2 Hf hafnium 72	178.5 La* lanthanum 57	138.9 Ba barium 56	137.3 Fr francium 87	226 Ra radium 88
140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	163 Dy dysprosium 66	165 Ho holmium 67
232 Th thorium 90	231 Pa protactinium 91	238 U uranium 92	237 Np neptunium 93	243 Am americium 95	247 Cm curium 96	251 Cf californium 98	254 Es einsteinium 99
238 U uranium 92	237 Np neptunium 93	234 Th thorium 90	231 Pa protactinium 91	227 Ac* actinium 89	226 Ra radium 88	223 Fr francium 87	222 Rn radon 86
* Lanthanide series * Actinide series							
Elements with atomic numbers 112-116 have been reported but not fully authenticated							
112 Cn copernicium 112	113 Nh nihonium 113	114 Fl flerovium 114	115 Mc moscovium 115	116 Lv livermorium 116	117 Ts tennessine 117	118 Og oganesson 118	119 Uue unbinilium 119

* Lanthanide series

* Actinide series

Elements with atomic numbers 112-116 have been reported but not fully authenticated

