



Rewarding Learning

General Certificate of Secondary Education
2022

Centre Number

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Candidate Number

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Chemistry

Unit 3: Practical Skills

Practical Booklet B

Higher Tier

MV18

[GCM34]

MONDAY 27 JUNE, AFTERNOON

Time

1 hour, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write on blank pages. Complete in black ink only.

Answer **all five** questions.

Information for Candidates

The total mark for this paper is 70.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **4(b)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is provided.

1 The solubility of many substances increases as temperature increases.

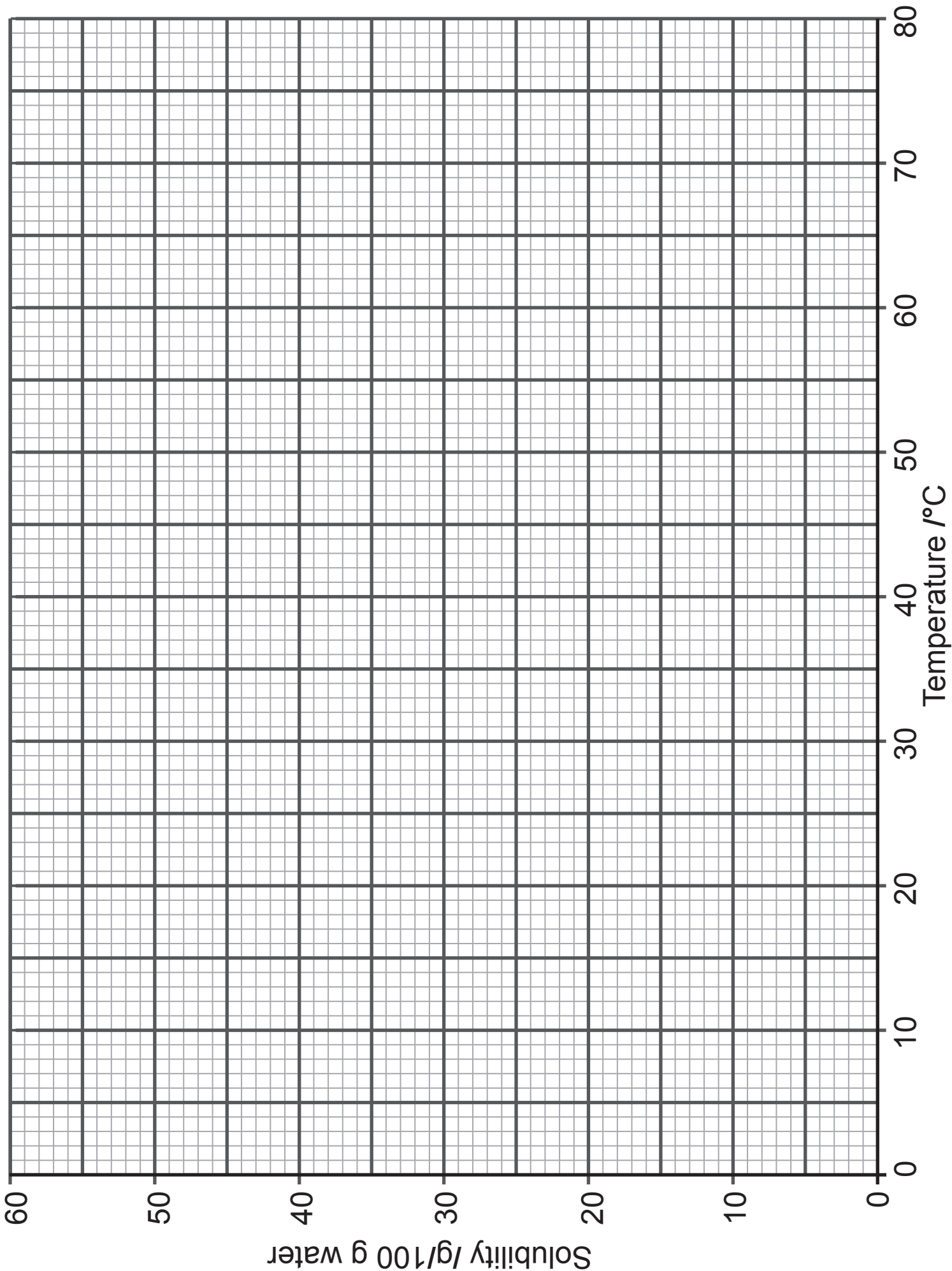
(a) What is meant by the term solubility? [3 marks]

(b) A student carried out a series of experiments to determine the solubility of potassium chloride over a range of temperatures. The results are shown in the table below.

Temperature /°C	0	20	40	60	80
Solubility /g/100g water	28	34	40	46	52

(i) Plot these results on the axes opposite and draw a suitable line or curve. [3 marks]

(ii) Use the graph to determine the temperature at which the solubility of potassium chloride is 48 g/100 g water. [1 mark]



(iii) Calculate the mass of solid which crystallises out of solution when a saturated solution of potassium chloride containing 80 g of water is cooled from 70°C to 10°C. [4 marks]

mass of crystals = _____ g

(iv) 10 g of potassium chloride were placed in 20 g of water at 50°C. A saturated solution was formed. Calculate the mass of potassium chloride which did not dissolve. [3 marks]

mass of potassium chloride = _____ g

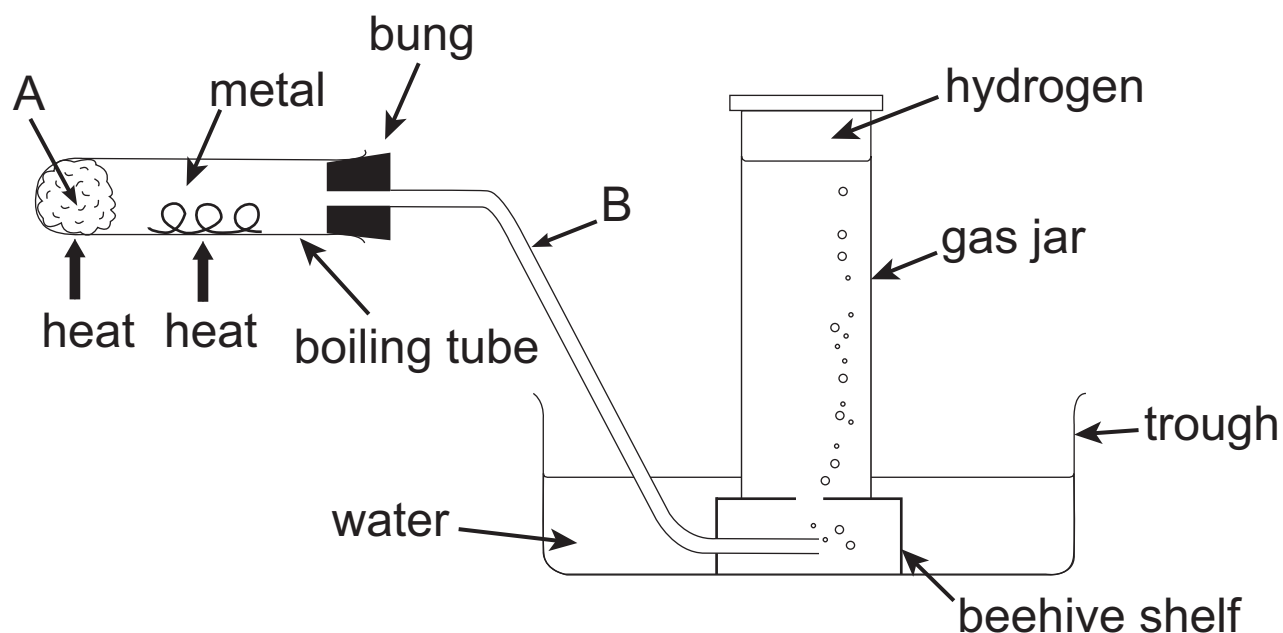
2 The reactivity of metals may be determined using different chemical reactions.

(a) Calcium reacts with water. During the reaction, heat is released and the calcium sinks and then rises in the water.

(i) Write a balanced symbol equation for the reaction of calcium with water. [3 marks]

(ii) State two other observations which would be made when calcium reacts with water. [2 marks]

(b) The apparatus below is used to react metals, such as magnesium or aluminium, with steam.



(i) What labels should be placed at A and B on the diagram? [2 marks]

A _____

B _____

(ii) Write a balanced symbol equation for the reaction of aluminium with steam. Include state symbols. [4 marks]

(iii) Suggest why the bung is removed from the boiling tube as soon as heating is stopped. [1 mark]

(c) The reactivity of four metals was investigated using displacement reactions. Each metal was placed in different metal nitrate solutions. The results are shown in the table below. A tick (✓) indicates that a reaction occurred.

metal \ metal salt solution	magnesium nitrate	copper(II) nitrate	cobalt(II) nitrate	iron(II) nitrate
magnesium		✓	✓	✓
copper	×		×	×
cobalt	×	✓		×
iron	×	✓	✓	

(i) Iron(II) nitrate solution is green. Predict what you would observe when magnesium reacts with iron(II) nitrate solution. [2 marks]

(ii) Arrange the metals in order of reactivity from the most reactive to least reactive. [1 mark]

most reactive: _____

least reactive: _____

- 3 A mixture contains two ionic compounds, each with the same anion. The mixture was analysed to determine the identity of the ions present.

(a) Three tests were carried out on the mixture and the observations recorded in the table below.

Test	Observations
1. A flame test was carried out on a solid sample of the mixture.	lilac flame
2. A sample of the mixture was dissolved in deionised water and 5 drops of sodium hydroxide solution were added. An excess of sodium hydroxide solution was added.	white precipitate formed white precipitate disappeared to form a colourless solution
3. A sample of the mixture was dissolved in deionised water and 5 drops of silver nitrate solution were added.	white precipitate formed

Use the information in the table to answer the following questions.

- (i) Using the evidence from Test 1, identify a cation present in the mixture. [1 mark]
-

(ii) Using the evidence from Test 2, identify two other cations which may be present in the mixture. [2 marks]

(iii) Using the evidence from Test 3, write the formula of the anion present in the mixture. [1 mark]

(iv) Write an ionic equation for the formation of the white precipitate in Test 3. Include state symbols. [3 marks]

(v) Suggest the name of a compound which may be present in the mixture. [1 mark]

(b) Describe how you would carry out a flame test on the solid sample of the mixture. [4 marks]

4 The value of x in hydrated compounds such as $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ or $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ may be determined by heating a known mass of the solid to remove all of the water of crystallisation.

(a) What is meant by the term water of crystallisation?
[1 mark]

(b) Describe the method used to determine the value of x in the formula $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ by heating a known mass of the solid. [6 marks]

Your answer should include:

- the apparatus used
- the mass measurements made
- the procedure used to ensure all of the water of crystallisation has been removed
- how the mass of the water of crystallisation is calculated.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

(d) Calculate the loss in mass when a sample of 1.23 g of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ was heated to remove all of the water of crystallisation. [3 marks]

loss in mass = _____ g

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(Questions continue overleaf)

5 A titration was carried out to find the identity of an unknown metal hydroxide $M(OH)_2$. 6.84 g of the unknown metal hydroxide were dissolved in 1 dm^3 of deionised water. 25.0 cm^3 of this solution were transferred to a conical flask using a pipette and titrated against 0.16 mol/dm^3 hydrochloric acid using methyl orange indicator.

(a) Describe how you would prepare and use a pipette to transfer 25.0 cm^3 of the unknown metal hydroxide solution to the conical flask. [4 marks]

(b) State the colour change observed at the end point. [2 marks]

(c) State two ways you would ensure that the end point of the titration is determined accurately. [2 marks]

1.

2.

(d) The results obtained in the titration are recorded in the table below.

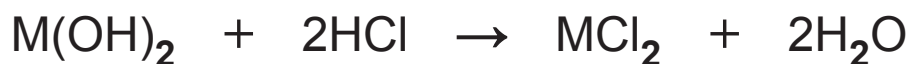
	Initial burette reading /cm³	Final burette reading /cm³	Titre /cm³
Rough titration	0.0	13.2	13.2
First accurate titration	13.2	25.6	12.4
Second accurate titration	25.6	38.2	12.6

(i) Calculate the average titre. [2 marks]

(ii) Calculate the number of moles of hydrochloric acid used. [1 mark]

moles of hydrochloric acid = _____

The balanced symbol equation for the reaction may be represented as:



(iii) Calculate the number of moles of M(OH)_2 present in 25.0 cm^3 of the solution. [1 mark]

moles of $\text{M(OH)}_2 = \underline{\hspace{2cm}}$

(iv) Calculate the number of moles of M(OH)_2 present in 1 dm^3 of the solution. [1 mark]

moles of $\text{M(OH)}_2 = \underline{\hspace{2cm}}$

- (v) Using the initial mass used to prepare the solution and the answer to (iv) calculate the relative formula mass (M_r) of $M(OH)_2$. [1 mark]

relative formula mass (M_r) = _____

- (vi) Calculate the relative atomic mass (A_r) of M and identify M. [2 marks]

relative atomic mass (A_r) = _____

identity of M: _____

This is the end of the question paper

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	

Total Marks	
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Examiner Number

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SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	CO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	HCOO^-
Nitrate	NO_3^-
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}



Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
 Science: Chemistry,
 Science: Double Award
 or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble
Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

												1 H Hydrogen 1							4 He Helium 2
		1	2											3	4	5	6	7	0
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10		
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18		
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36		
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54		
133 Cs Caesium 55	137 Ba Barium 56	139 La [*] Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 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	285 Cn Copernicium 112								

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series



a = relative atomic mass (approx)
x = atomic symbol
b = atomic number

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 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