



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



CHEMISTRY
Paper 2 Theory

5070/21
May/June 2013
1 hour 30 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Section A

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B

Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 20.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **17** printed pages and **3** blank pages.

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 Choose from the following compounds to answer the questions below.

- butane
- calcium carbonate
- carbon dioxide
- copper(II) nitrate
- iron(II) hydroxide
- iron(III) hydroxide
- propene
- sodium chloride
- sulfur dioxide
- sulfuric acid

Each compound can be used once, more than once or not at all.

Name a compound which

(a) is a green solid,

..... [1]

(b) is a saturated hydrocarbon,

..... [1]

(c) has a molecule with only 9 atoms,

..... [1]

(d) can be used to reduce the acidity in lakes,

..... [1]

(e) will turn aqueous acidified potassium dichromate(VI) from orange to green,

..... [1]

(f) can be electrolysed in aqueous solution to form two gases.

..... [1]

[Total: 6]

A2 Photosynthesis helps to maintain the percentage of oxygen in air.

(a) What is the percentage, by volume, of oxygen in dry air?

..... [1]

(b) In addition to releasing oxygen, photosynthesis produces glucose, $C_6H_{12}O_6$.

Write the overall equation that represents photosynthesis.

..... [1]

(c) Describe the essential conditions needed for photosynthesis.

.....

 [2]

(d) Photosynthesis is an endothermic reaction.

(i) Explain, in terms of the energy changes that occur during bond breaking and bond making, why photosynthesis is an endothermic reaction.

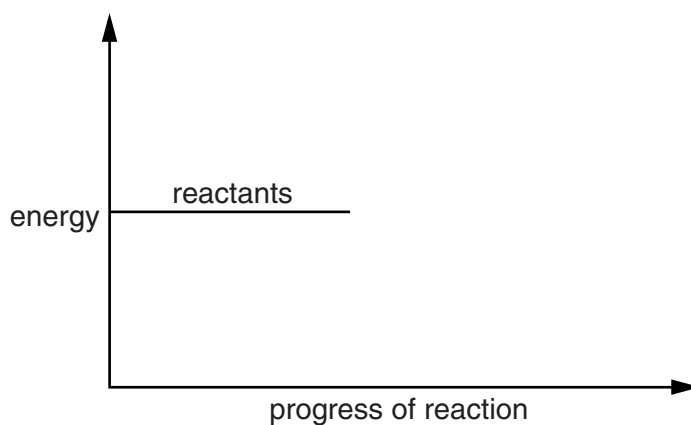
.....

 [2]

(ii) Complete the energy profile diagram for photosynthesis.

On your diagram label the

- products,
- enthalpy change for the reaction, ΔH ,
- activation energy, E_a .



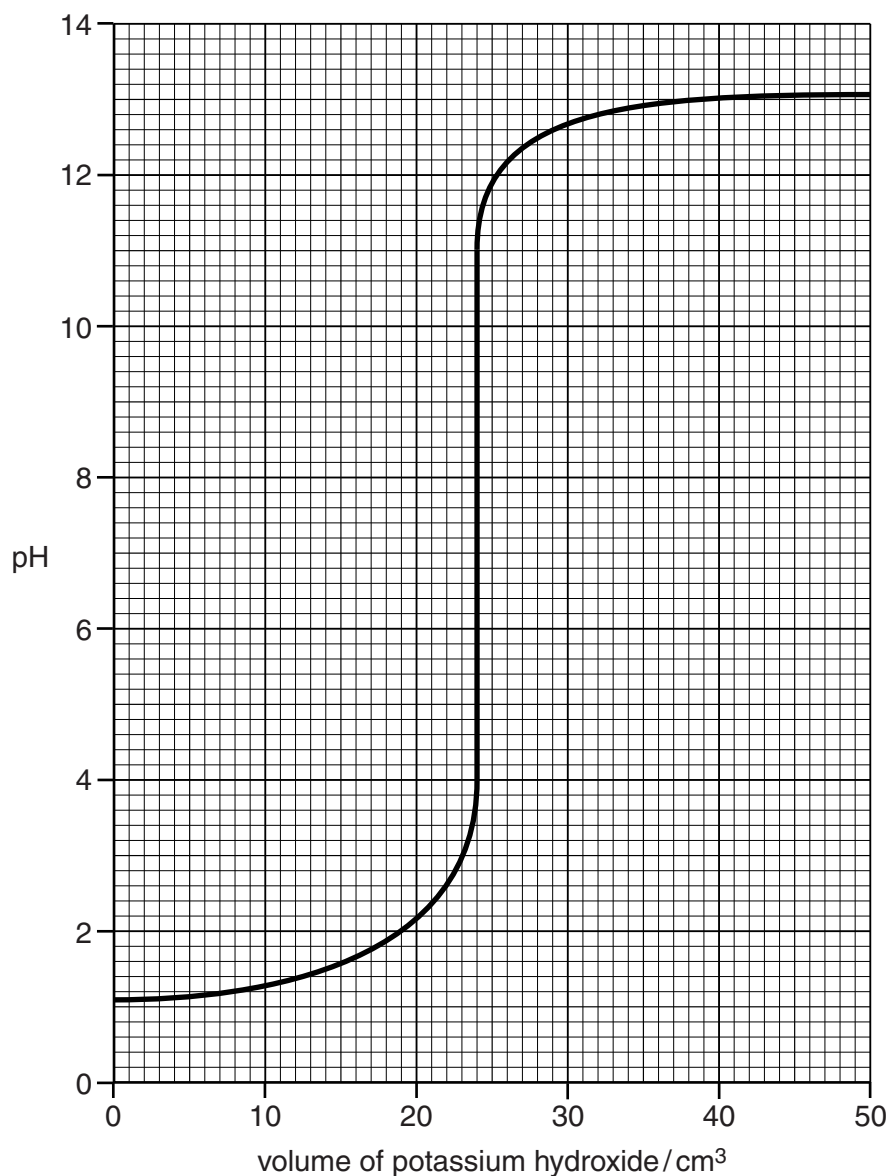
[3]

[Total: 9]

A3 Salts are often made by the neutralisation of bases.

- (a) Aqueous potassium hydroxide, of concentration 0.150 mol/dm^3 , is added to 25.0 cm^3 of sulfuric acid in a flask.

The graph shows how the pH of the liquid in the flask changes as aqueous potassium hydroxide is added to it.



- (i) Construct the equation for the complete neutralisation of sulfuric acid by potassium hydroxide.

..... [1]

- (ii) Use the graph to deduce the volume of aqueous potassium hydroxide required to neutralise 25.0 cm^3 of sulfuric acid.

..... [1]



(iii) Use your answers to (i) and (ii) to calculate the concentration of sulfuric acid

concentration of sulfuric acid = mol/dm³ [3]

(b) Describe the essential experimental details for preparing a pure sample of zinc nitrate crystals from zinc oxide.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [4]

[Total: 9]

A4 The table shows the number of electrons, neutrons and protons in seven different particles.

particle	number of		
	electrons	neutrons	protons
A	12	12	12
B	15	16	15
C	17	18	17
D	17	20	17
E	18	16	16
F	18	22	18
G	18	20	20

(a) What is the nucleon number for **F**?

.....

[1]

(b) Explain why **A** is a neutral particle.

.....

[2]

(c) Which particles are isotopes of the same element?

.....

[1]

(d) What is the charge on **E**?

.....

[1]

(e) Which particles have the same relative mass?

.....

[1]

[Total: 6]

A5 Analysis of compound **X** shows it has the following composition.

element	percentage by mass
nitrogen	11.1
hydrogen	3.20
chromium	41.3
oxygen	44.4

(a) Show that **X** has the formula $\text{N}_2\text{H}_8\text{Cr}_2\text{O}_7$.

[3]

(b) An aqueous solution of **X** is orange.

Suggest which element in **X** is responsible for the orange colour.

..... [1]

(c) An acidified aqueous solution of **X** reacts with aqueous potassium iodide to form iodine.

State and explain what you can conclude about the chemical nature of **X**.

.....

 [2]

(d) Aqueous sodium hydroxide is added to solid **X** and the mixture is warmed. A gas that turns moist red litmus blue is evolved.

(i) Give the formula of the positive ion present in **X**.

..... [1]

(ii) Suggest the formula of the other ion present in **X**.

..... [1]

(e) When solid **X** is heated only Cr_2O_3 , water and gas **Z** are formed.

Name gas **Z**.

..... [1]

[Total: 9]

Question A6 starts on page 10.

A6 Potassium is in Group I and chlorine is in Group VII of the Periodic Table.

Potassium forms an oxide with the formula K_2O and chlorine forms an oxide with the formula Cl_2O .

(a) (i) Draw a 'dot-and-cross' diagram for Cl_2O .

You only need to draw the outer shell electrons.

[1]

(ii) Explain, using ideas about structure and bonding, why Cl_2O has a low melting point.

.....

 [2]

(b) Draw diagrams to show the electronic structures and charges of both ions present in potassium oxide.

[2]

(c) Chlorine forms another oxide Cl_2O_7 . One mole of this oxide reacts with one mole of water to make two moles of an acid and no other products.

Construct the equation for this reaction.

..... [1]

[Total: 6]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B7 Malachite is an ore of copper. The formula of malachite is $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$.

Malachite reacts as though it is a mixture of copper(II) carbonate and copper(II) hydroxide.

A small sample of malachite is added to excess dilute hydrochloric acid, $\text{HCl}(\text{aq})$. The carbon dioxide formed is collected and has a volume of 96 cm^3 at room temperature and pressure.

(a) What would you observe when malachite reacts with $\text{HCl}(\text{aq})$?

.....
 [2]

(b) Construct the equation for the reaction between malachite and $\text{HCl}(\text{aq})$.

..... [2]

(c) Calculate the mass of carbonate ion, CO_3^{2-} , in the sample of malachite.

mass of $\text{CO}_3^{2-} = \dots\dots\dots \text{ g}$ [3]

(d) Copper is extracted from malachite by heating with carbon.

(i) Construct an equation for the reduction of malachite by carbon.

..... [2]

(ii) Malachite is a finite resource. Give one **other** reason why copper should be recycled.

.....
 [1]

[Total: 10]

B8 Carboxylic acids are a homologous series of organic compounds.

The table shows information about some carboxylic acids.

carboxylic acid	formula	melting point/°C	boiling point/°C
methanoic acid	HCO ₂ H	8	100
ethanoic acid	CH ₃ CO ₂ H	17	118
	C ₂ H ₅ CO ₂ H	-22	141
butanoic acid	C ₃ H ₇ CO ₂ H		
hexadecanoic acid	C ₁₅ H ₃₁ CO ₂ H	63	269

(a) What is meant by the term *homologous series*?

.....

 [2]

(b) Name the carboxylic acid with the formula C₂H₅CO₂H.

..... [1]

(c) Deduce the general formula for a carboxylic acid.

..... [1]

(d) It is more difficult to estimate the melting point of butanoic acid than its boiling point. Use the data in the table to explain why.

.....
 [1]

(e) When warmed in the presence of concentrated sulfuric acid, butanoic acid reacts with ethanol to make an ester.

Name and draw the structure, showing all the atoms and all the bonds, of this ester.

name

structure

[2]

(f) Hexadecanoic acid, $C_{15}H_{31}CO_2H$, is a weak acid.

(i) Write an equation to show the dissociation of hexadecanoic acid when dissolved in water. Use the equation to explain the meaning of the term weak acid.

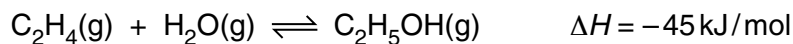
.....
.....
..... [2]

(ii) What is the formula of the salt formed when hexadecanoic acid reacts with aqueous sodium hydroxide?

..... [1]

[Total: 10]

B9 Ethanol is manufactured by the hydration of ethene.



This reaction is exothermic.

The reaction is normally carried out at a pressure of 70 atmospheres and a temperature of 300 °C.

(a) The reaction is carried out at 70 atmospheres pressure and at **600 °C** rather than 300 °C.

Predict and explain the effect of raising the temperature on

(i) the rate of reaction,

.....

 [2]

(ii) the position of equilibrium.

.....

 [2]

(b) The reaction is carried out at **20 atmospheres** rather than 70 atmospheres, and at 300 °C.

Predict and explain the effect of decreasing the pressure on

(i) the rate of reaction,

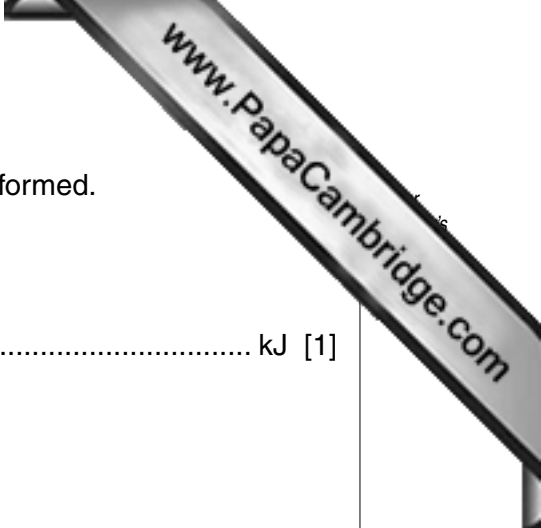
.....

 [2]

(ii) the position of equilibrium.

.....

 [2]



(c) Calculate the energy released when 10 moles of ethanol are formed.

energy released = kJ [1]

(d) The hydration of ethene uses an acid catalyst.

Explain how a catalyst can increase the rate of reaction.

.....
..... [1]

[Total: 10]

B10 Aqueous silver nitrate can be electrolysed using inert electrodes.
Solid silver is formed on the cathode (negative electrode).

The table shows how the mass of silver formed is affected by four factors.

temperature of solution /°C	duration of electrolysis /seconds	current passed through solution/amps	concentration of solution /mol/dm ³	mass of silver formed /g
25	100	9.65	1.0	0.108
30	100	9.65	1.0	0.108
25	100	9.65	0.5	0.108
25	200	9.65	0.5	0.216
25	100	19.3	1.0	0.216

(a) The electrode reaction at the cathode is reduction.

(i) Construct the equation for the reaction which occurs at the cathode.

..... [1]

(ii) Explain why this reaction is reduction.

.....
..... [1]

(b) State how each of the following factors affects the mass of silver formed at the cathode.

temperature of solution

.....
.....

duration of electrolysis

.....
.....

current used

.....
.....

concentration of solution

.....
.....

[4]

- (c) Explain why aqueous silver nitrate can be electrolysed but solid silver nitrate cannot.

.....
.....
..... [2]

- (d) Aqueous silver nitrate reacts with dilute hydrochloric acid to form a white precipitate.

Construct the ionic equation, including state symbols, for the formation of this white precipitate.

..... [2]

[Total: 10]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

DATA SHEET
The Periodic Table of the Elements

Group																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
I	II	III	IV	V	VI	VII	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18	19 F Fluorine 9	20 Ne Neon 10	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Ca Calcium 20	41 Zr Zirconium 40	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	58 Ce Cerium 58	59 Pr Praseodymium 59	60 Nd Neodymium 60	61 Pm Promethium 61	62 Sm Samarium 62	63 Eu Europium 63	64 Gd Gadolinium 64	65 Tb Terbium 65	66 Dy Dysprosium 66	67 Ho Holmium 67	68 Er Erbium 68	69 Tm Thulium 69	70 Yb Ytterbium 70	71 Lu Lutetium 71	72 Fr Francium 87	73 Ra Radium 88	74 Ac Actinium 89	75 Th Thorium 90	76 Pa Protactinium 91	77 U Uranium 92	78 Np Neptunium 93	79 Pu Plutonium 94	80 Am Americium 95	81 Cm Curium 96	82 Bk Berkelium 97	83 Cf Californium 98	84 Es Einsteinium 99	85 Fm Fermium 100	86 Md Mendelevium 101	87 No Nobelium 102	88 Lr Lawrencium 103	89 Fr Francium 87	90 Ra Radium 88	91 Ac Actinium 89	92 Th Thorium 90	93 Pa Protactinium 91	94 U Uranium 92	95 Np Neptunium 93	96 Pu Plutonium 94	97 Am Americium 95	98 Cm Curium 96	99 Bk Berkelium 97	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Fr Francium 87	105 Ra Radium 88	106 Ac Actinium 89	107 Th Thorium 90	108 Pa Protactinium 91	109 U Uranium 92	110 Np Neptunium 93	111 Pu Plutonium 94	112 Am Americium 95	113 Cm Curium 96	114 Bk Berkelium 97	115 Cf Californium 98	116 Es Einsteinium 99	117 Fm Fermium 100	118 Md Mendelevium 101	119 No Nobelium 102	120 Lr Lawrencium 103	121 Fr Francium 87	122 Ra Radium 88	123 Ac Actinium 89	124 Th Thorium 90	125 Pa Protactinium 91	126 U Uranium 92	127 Np Neptunium 93	128 Pu Plutonium 94	129 Am Americium 95	130 Cm Curium 96	131 Bk Berkelium 97	132 Cf Californium 98	133 Es Einsteinium 99	134 Fm Fermium 100	135 Md Mendelevium 101	136 No Nobelium 102	137 Lr Lawrencium 103	138 Fr Francium 87	139 Ra Radium 88	140 Ac Actinium 89	141 Th Thorium 90	142 Pa Protactinium 91	143 U Uranium 92	144 Np Neptunium 93	145 Pu Plutonium 94	146 Am Americium 95	147 Cm Curium 96	148 Bk Berkelium 97	149 Cf Californium 98	150 Es Einsteinium 99	151 Fm Fermium 100	152 Md Mendelevium 101	153 No Nobelium 102	154 Lr Lawrencium 103	155 Fr Francium 87	156 Ra Radium 88	157 Ac Actinium 89	158 Th Thorium 90	159 Pa Protactinium 91	160 U Uranium 92	161 Np Neptunium 93	162 Pu Plutonium 94	163 Am Americium 95	164 Cm Curium 96	165 Bk Berkelium 97	166 Cf Californium 98	167 Es Einsteinium 99	168 Fm Fermium 100	169 Md Mendelevium 101	170 No Nobelium 102	171 Lr Lawrencium 103	172 Fr Francium 87	173 Ra Radium 88	174 Ac Actinium 89	175 Th Thorium 90	176 Pa Protactinium 91	177 U Uranium 92	178 Np Neptunium 93	179 Pu Plutonium 94	180 Am Americium 95	181 Cm Curium 96	182 Bk Berkelium 97	183 Cf Californium 98	184 Es Einsteinium 99	185 Fm Fermium 100	186 Md Mendelevium 101	187 No Nobelium 102	188 Lr Lawrencium 103	189 Fr Francium 87	190 Ra Radium 88	191 Ac Actinium 89	192 Th Thorium 90	193 Pa Protactinium 91	194 U Uranium 92	195 Np Neptunium 93	196 Pu Plutonium 94	197 Am Americium 95	198 Cm Curium 96	199 Bk Berkelium 97	200 Cf Californium 98	201 Es Einsteinium 99	202 Fm Fermium 100	203 Md Mendelevium 101	204 No Nobelium 102	205 Lr Lawrencium 103	206 Fr Francium 87	207 Ra Radium 88	208 Ac Actinium 89	209 Th Thorium 90	210 Pa Protactinium 91	211 U Uranium 92	212 Np Neptunium 93	213 Pu Plutonium 94	214 Am Americium 95	215 Cm Curium 96	216 Bk Berkelium 97	217 Cf Californium 98	218 Es Einsteinium 99	219 Fm Fermium 100	220 Md Mendelevium 101	221 No Nobelium 102	222 Lr Lawrencium 103	223 Fr Francium 87	224 Ra Radium 88	225 Ac Actinium 89	226 Th Thorium 90	227 Pa Protactinium 91	228 U Uranium 92	229 Np Neptunium 93	230 Pu Plutonium 94	231 Am Americium 95	232 Cm Curium 96	233 Bk Berkelium 97	234 Cf Californium 98	235 Es Einsteinium 99	236 Fm Fermium 100	237 Md Mendelevium 101	238 No Nobelium 102	239 Lr Lawrencium 103	240 Fr Francium 87	241 Ra Radium 88	242 Ac Actinium 89	243 Th Thorium 90	244 Pa Protactinium 91	245 U Uranium 92	246 Np Neptunium 93	247 Pu Plutonium 94	248 Am Americium 95	249 Cm Curium 96	250 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	253 Fm Fermium 100	254 Md Mendelevium 101	255 No Nobelium 102	256 Lr Lawrencium 103	257 Fr Francium 87	258 Ra Radium 88	259 Ac Actinium 89	260 Th Thorium 90	261 Pa Protactinium 91	262 U Uranium 92	263 Np Neptunium 93	264 Pu Plutonium 94	265 Am Americium 95	266 Cm Curium 96	267 Bk Berkelium 97	268 Cf Californium 98	269 Es Einsteinium 99	270 Fm Fermium 100	271 Md Mendelevium 101	272 No Nobelium 102	273 Lr Lawrencium 103	274 Fr Francium 87	275 Ra Radium 88	276 Ac Actinium 89	277 Th Thorium 90	278 Pa Protactinium 91	279 U Uranium 92	280 Np Neptunium 93	281 Pu Plutonium 94	282 Am Americium 95	283 Cm Curium 96	284 Bk Berkelium 97	285 Cf Californium 98	286 Es Einsteinium 99	287 Fm Fermium 100	288 Md Mendelevium 101	289 No Nobelium 102	290 Lr Lawrencium 103	291 Fr Francium 87	292 Ra Radium 88	293 Ac Actinium 89	294 Th Thorium 90	295 Pa Protactinium 91	296 U Uranium 92	297 Np Neptunium 93	298 Pu Plutonium 94	299 Am Americium 95	300 Cm Curium 96	301 Bk Berkelium 97	302 Cf Californium 98	303 Es Einsteinium 99	304 Fm Fermium 100	305 Md Mendelevium 101	306 No Nobelium 102	307 Lr Lawrencium 103	308 Fr Francium 87	309 Ra Radium 88	310 Ac Actinium 89	311 Th Thorium 90	312 Pa Protactinium 91	313 U Uranium 92	314 Np Neptunium 93	315 Pu Plutonium 94	316 Am Americium 95	317 Cm Curium 96	318 Bk Berkelium 97	319 Cf Californium 98	320 Es Einsteinium 99	321 Fm Fermium 100	322 Md Mendelevium 101	323 No Nobelium 102	324 Lr Lawrencium 103	325 Fr Francium 87	326 Ra Radium 88	327 Ac Actinium 89	328 Th Thorium 90	329 Pa Protactinium 91	330 U Uranium 92	331 Np Neptunium 93	332 Pu Plutonium 94	333 Am Americium 95	334 Cm Curium 96	335 Bk Berkelium 97	336 Cf Californium 98	337 Es Einsteinium 99	338 Fm Fermium 100	339 Md Mendelevium 101	340 No Nobelium 102	341 Lr Lawrencium 103	342 Fr Francium 87	343 Ra Radium 88	344 Ac Actinium 89	345 Th Thorium 90	346 Pa Protactinium 91	347 U Uranium 92	348 Np Neptunium 93	349 Pu Plutonium 94	350 Am Americium 95	351 Cm Curium 96	352 Bk Berkelium 97	353 Cf Californium 98	354 Es Einsteinium 99	355 Fm Fermium 100	356 Md Mendelevium 101	357 No Nobelium 102	358 Lr Lawrencium 103	359 Fr Francium 87	360 Ra Radium 88	361 Ac Actinium 89	362 Th Thorium 90	363 Pa Protactinium 91	364 U Uranium 92	365 Np Neptunium 93	366 Pu Plutonium 94	367 Am Americium 95	368 Cm Curium 96	369 Bk Berkelium 97	370 Cf Californium 98	371 Es Einsteinium 99	372 Fm Fermium 100	373 Md Mendelevium 101	374 No Nobelium 102	375 Lr Lawrencium 103	376 Fr Francium 87	377 Ra Radium 88	378 Ac Actinium 89	379 Th Thorium 90	380 Pa Protactinium 91	381 U Uranium 92	382 Np Neptunium 93	383 Pu Plutonium 94	384 Am Americium 95	385 Cm Curium 96	386 Bk Berkelium 97	387 Cf Californium 98	388 Es Einsteinium 99	389 Fm Fermium 100	390 Md Mendelevium 101	391 No Nobelium 102	392 Lr Lawrencium 103	393 Fr Francium 87	394 Ra Radium 88	395 Ac Actinium 89	396 Th Thorium 90	397 Pa Protactinium 91	398 U Uranium 92	399 Np Neptunium 93	400 Pu Plutonium 94	401 Am Americium 95	402 Cm Curium 96	403 Bk Berkelium 97	404 Cf Californium 98	405 Es Einsteinium 99	406 Fm Fermium 100	407 Md Mendelevium 101	408 No Nobelium 102	409 Lr Lawrencium 103	410 Fr Francium 87	411 Ra Radium 88	412 Ac Actinium 89	413 Th Thorium 90	414 Pa Protactinium 91	415 U Uranium 92	416 Np Neptunium 93	417 Pu Plutonium 94	418 Am Americium 95	419 Cm Curium 96	420 Bk Berkelium 97	421 Cf Californium 98	422 Es Einsteinium 99	423 Fm Fermium 100	424 Md Mendelevium 101	425 No Nobelium 102	426 Lr Lawrencium 103	427 Fr Francium 87	428 Ra Radium 88	429 Ac Actinium 89	430 Th Thorium 90	431 Pa Protactinium 91	432 U Uranium 92	433 Np Neptunium 93	434 Pu Plutonium 94	435 Am Americium 95	436 Cm Curium 96	437 Bk Berkelium 97	438 Cf Californium 98	439 Es Einsteinium 99	440 Fm Fermium 100	441 Md Mendelevium 101	442 No Nobelium 102	443 Lr Lawrencium 103	444 Fr Francium 87	445 Ra Radium 88	446 Ac Actinium 89	447 Th Thorium 90	448 Pa Protactinium 91	449 U Uranium 92	450 Np Neptunium 93	451 Pu Plutonium 94	452 Am Americium 95	453 Cm Curium 96	454 Bk Berkelium 97	455 Cf Californium 98	456 Es Einsteinium 99	457 Fm Fermium 100	458 Md Mendelevium 101	459 No Nobelium 102	460 Lr Lawrencium 103	461 Fr Francium 87	462 Ra Radium 88	463 Ac Actinium 89	464 Th Thorium 90	465 Pa Protactinium 91	466 U Uranium 92	467 Np Neptunium 93	468 Pu Plutonium 94	469 Am Americium 95	470 Cm Curium 96	471 Bk Berkelium 97	472 Cf Californium 98	473 Es Einsteinium 99	474 Fm Fermium 100	475 Md Mendelevium 101	476 No Nobelium 102	477 Lr Lawrencium 103	478 Fr Francium