



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

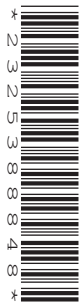
CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

5070/21

Paper 2 Theory

October/November 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.

You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 16.

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 **16** printed pages.



Section A

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

The total mark for this section is 45.

For
Examiner's
Use

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

calcium oxide
carbon dioxide
carbon monoxide
copper(II) sulfate
ethanol
ethene
iron(II) chloride
iron(III) chloride
nitrogen dioxide
silver chloride
silver iodide
sulfur dioxide

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

Which compound is

(a) a solid, which when dissolved in water, gives a green precipitate with aqueous ammonia,

..... [1]

(b) a colourless gas which is formed when limestone is heated strongly,

..... [1]

(c) a gas which is formed in the atmosphere by lightning activity,

..... [1]

(d) a basic oxide,

..... [1]

(e) formed when ethane undergoes complete combustion,

..... [1]

(f) a white salt which is insoluble in water?

..... [1]

[Total: 6]

A2 Alkenes are a homologous series of unsaturated hydrocarbons.

For
Examiner's
Use

(a) Give the general formula of alkenes.

..... [1]

(b) In addition to having a general formula, state two **other** characteristics of a homologous series.

1

2 [2]

(c) Alkenes can be made by cracking alkanes.

(i) Give **one** condition required for cracking.

..... [1]

(ii) Tetradecane, $C_{14}H_{30}$, can be cracked to form an alkene containing eight carbon atoms and an alkane.

Construct an equation for this reaction.

[1]

(d) Ethene reacts with bromine to form 1,2-dibromoethane, CH_2BrCH_2Br .

Name this type of reaction.

..... [1]

(e) Ethene reacts with hydrogen chloride to form the covalent compound chloroethane, CH_3CH_2Cl .

Suggest **two** physical properties of chloroethane.

1

2 [2]

(f) Halogenoalkanes such as CCl_2F_2 are responsible for the depletion of ozone in the upper atmosphere.

Describe the importance of the ozone layer in the upper atmosphere.

.....

.....

..... [2]

[Total: 10]

A3 Calcium, proton number 20, is an element in Group II of the Periodic Table.

For
Examiner's
Use

(a) Give the electronic configuration for calcium.

..... [1]

(b) Calcium has six naturally-occurring isotopes.

(i) State the meaning of the term *isotopes*.

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

(ii) Complete the following table to show the number of sub-atomic particles in two of these isotopes.

isotope	number of protons	number of electrons	number of neutrons
^{42}Ca			
^{48}Ca			

[3]

(c) Calcium chloride can be formed by reacting calcium carbonate with dilute hydrochloric acid.

(i) Construct an equation for this reaction.

[1]

(ii) Write both the formula and the electronic configuration for the ions present in calcium chloride.

[2]

(d) (i) Name the products formed at the anode and cathode when molten calcium chloride is electrolysed.

anode

cathode [1]

(ii) Predict the product formed at the cathode when a dilute aqueous solution of calcium chloride is electrolysed.

..... [1]

(iii) Explain why solid calcium chloride does not conduct electricity.

..... [1]

[Total: 11]

A4 Nitrogen and oxygen are present in dry air.

For
Examiner's
Use

(a) What is the percentage composition by volume of each of these gases in dry air?

nitrogen

oxygen [2]

(b) What method is used to separate these gases from each other?

..... [1]

(c) In a petrol engine, nitrogen and oxygen combine to form oxides of nitrogen such as nitrogen dioxide, NO_2 .

State one harmful effect that nitrogen dioxide has on the environment.

..... [1]

(d) One of the hydrocarbons in petrol is octane, C_8H_{18} .

In a petrol engine, some of the octane reacts to form carbon monoxide and water.

Construct an equation for this reaction.

[2]

(e) Catalytic converters are used to remove carbon monoxide and nitrogen dioxide from the exhaust gases of petrol engines.

A catalyst containing rhodium and platinum or palladium is present in a catalytic converter.

What is the function of a catalyst?

..... [1]

(f) In a catalytic converter, carbon monoxide and nitrogen dioxide undergo redox reactions. These reactions reduce the amount of carbon monoxide and nitrogen dioxide in car exhausts.

(i) What is meant by the term *redox reaction*?

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

(ii) Explain how the redox reactions in the catalytic converter decrease the amounts of carbon monoxide and nitrogen dioxide in car exhausts.

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

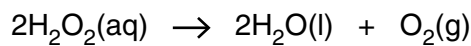
[Total: 10]

A5 Hydrogen peroxide, H₂O₂, is a colourless liquid.

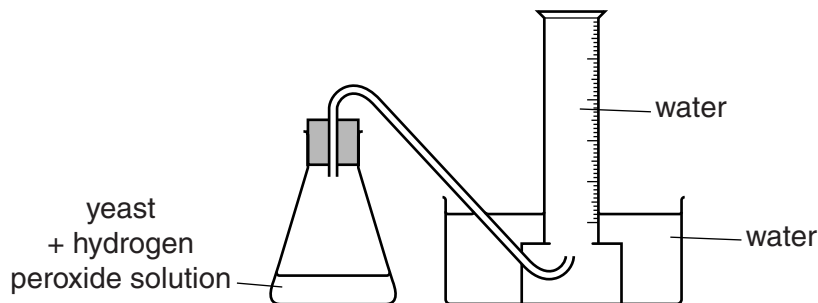
(a) Calculate the percentage by mass of oxygen in hydrogen peroxide.

.....% [2]

(b) The enzyme catalase is present in yeast. The enzyme catalyses the decomposition of aqueous hydrogen peroxide.



The apparatus below is used to monitor this reaction.



What measurements should be taken in order to monitor the rate of this reaction?

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

(c) Describe and explain the effect of increasing the concentration of hydrogen peroxide on the rate of this reaction.

For
Examiner's
Use

.....

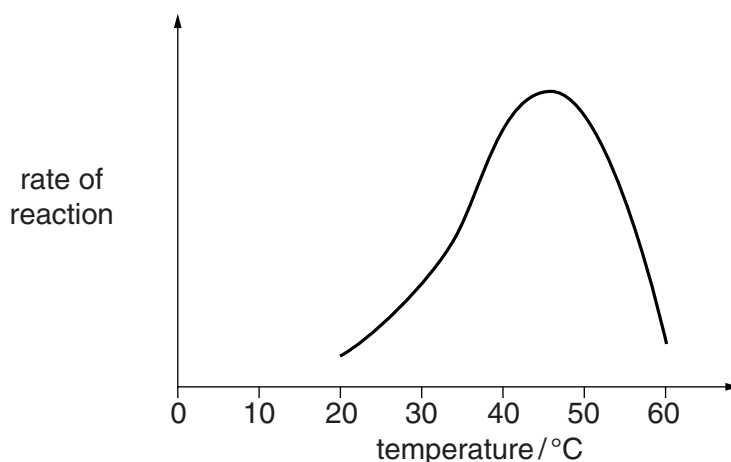
.....

.....

.....

..... [3]

(d) The graph below shows how the rate of decomposition of hydrogen peroxide, catalysed by yeast, varies with temperature. All other conditions are kept constant.



Suggest why the rate of reaction decreases rapidly from 45 °C to 60 °C.

..... [1]

[Total: 8]

Section B

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

The total mark for this section is 30.

For
Examiner's
Use

B6 Iron is extracted from its ore (haematite, Fe_2O_3) in a blast furnace.
Coke (carbon) and limestone (calcium carbonate) are also added to the furnace.

(a) Describe the essential reactions taking place in the blast furnace.

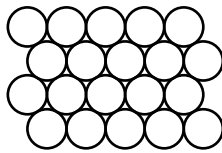
.....
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.....
.....
..... [4]

(b) Steel is an alloy made by the addition of carbon or metals to iron.
Use the diagrams below to explain why an alloy of iron and manganese is less malleable than pure iron.

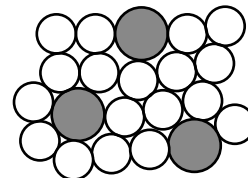
Key

○ iron atoms

● manganese atoms



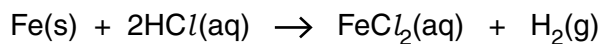
iron



alloy of iron and manganese

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

- (c) Iron reacts with dilute hydrochloric acid to form iron(II) chloride.



A student added 2.1 g of iron to 50 cm³ of 0.10 mol/dm³ hydrochloric acid.

- (i) Calculate the amount, in moles, of iron present.

..... mol [1]

- (ii) Calculate the amount, in moles, of hydrochloric acid present.

..... mol [1]

- (iii) Calculate the volume of hydrogen formed in this reaction, measured at room temperature and pressure.

.....cm³ [2]

[Total: 10]

For
Examiner's
Use

B7 (a) A compound of carbon, hydrogen and chlorine contains 0.48g of carbon, 0.08g of hydrogen and 1.42g of chlorine.

*For
Examiner's
Use*

(i) Deduce the empirical formula of this compound.

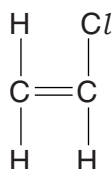
[2]

(ii) The relative molecular mass of this compound is 99.

Deduce the molecular formula of this compound.

[1]

(b) Chloroethene is another compound containing carbon, hydrogen and chlorine. The structure of chloroethene is shown below.



Draw a section of the polymer formed when chloroethene undergoes polymerisation to form poly(chloroethene).

[2]

(c) Poly(chloroethene) is an addition polymer but nylon is a condensation polymer.

Describe the difference between an addition polymer and a condensation polymer in terms of how they are formed from their monomers.

.....

.....

.....

..... [1]

(d) Chloroethene is made by reacting ethene with hydrogen chloride and oxygen in the presence of a catalyst of copper(II) chloride, $CuCl_2$. The other product of the reaction is water.

(i) Construct an equation for this reaction.

[1]

(ii) Copper(II) chloride is made by heating copper(II) oxide, CuO , with hydrochloric acid.

Construct an equation for this reaction.

[1]

(iii) Copper is a transition element.

State **two** physical properties of copper which are different from those of a typical Group I element such as sodium.

1

2 [2]

[Total: 10]

B8 Zinc sulfide is a compound that can be made by heating zinc powder with sulfur powder.

(a) Describe **two** differences between a mixture of zinc and sulfur and a compound of zinc and sulfur.

1

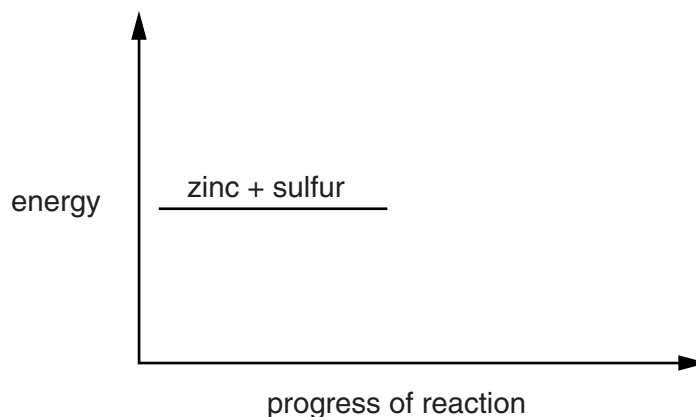
.....

2

..... [2]

(b) The reaction between zinc and sulfur is exothermic.

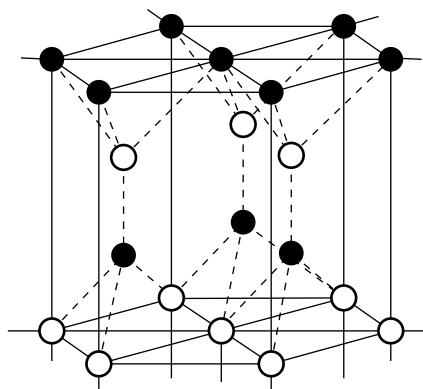
Complete the energy profile diagram for this reaction.
On your diagram label
the product,
the enthalpy change for the reaction, ΔH .



[2]

(c) Part of the structure of zinc sulfide is shown below.

Key
● Zn ions
○ S ions



Deduce the empirical formula of zinc sulfide from this structure.

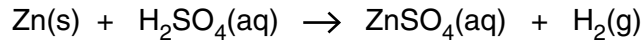
..... [1]

- (d) Zinc sulfide reacts with hydrochloric acid to form hydrogen sulfide.
An aqueous solution of hydrogen sulfide behaves as a weak acid.

Describe what is meant by the term *weak acid*.

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

- (e) Zinc sulfate can be made by reacting zinc with dilute sulfuric acid.



- (i) Write an ionic equation for this reaction.

[1]

- (ii) Describe how you would prepare crystals of pure, dry zinc sulfate using this reaction.

.....
.....
.....
.....
..... [3]

[Total: 10]

B9 Ethanoic acid reacts with sodium hydroxide to form water and a salt.

For
Examiner's
Use

(a) Give the formula of the salt.

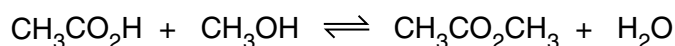
..... [1]

(b) The reaction between ethanoic acid and sodium hydroxide is described as a neutralisation reaction.

Write the simplest ionic equation for this reaction.

..... [1]

(c) Ethanoic acid reacts with methanol to form an ester and water.



The reaction is endothermic.

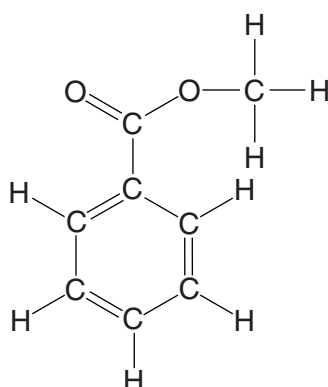
(i) Describe what happens to the position of this equilibrium when the concentration of methanol is **increased**. Explain your answer.

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

(ii) Describe what happens to the position of this equilibrium when the temperature of the reaction mixture is **decreased**. Explain your answer.

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

(d) The structure of the ester methyl benzoate is shown below.



Deduce the molecular formula for methyl benzoate.

..... [1]

- (e) Sodium hydroxide is an alkali.

Give the formula of the ion present in sodium hydroxide which causes it to be alkaline.

..... [1]

- (f) A student titrated a metal hydroxide with 0.200 mol/dm^3 hydrochloric acid. It required 12.5 cm^3 of hydrochloric acid to neutralise 25.0 cm^3 of 0.0500 mol/dm^3 metal hydroxide solution.

- (i) Calculate the amount, in moles, of hydrochloric acid used.

..... mol [1]

- (ii) Calculate the amount, in moles, of metal hydroxide present.

..... mol [1]

- (iii) Construct an equation for this reaction.
Use the letter **M** to represent the metal in the metal hydroxide solution.

[1]

- (g) Name a metal hydroxide which can be used to treat excess acidity in soils.

..... [1]

[Total: 10]

For
Examiner's
Use

DATA SHEET
The Periodic Table of the Elements

Group																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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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 Nb Niobium 41	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 Cf Californium 98	101 Es Einsteinium 99	102 Fm Fermium 100	103 Md Mendelevium 101	104 No Nobelium 102	105 Lr Lawrencium 103	106 Fr Francium 87	107 Ra Radium 88	108 Ac Actinium 89	109 Th Thorium 90	110 Pa Protactinium 91	111 U Uranium 92	112 Np Neptunium 93	113 Pu Plutonium 94	114 Am Americium 95	115 Cm Curium 96	116 Bk Berkelium 97	117 Cf Californium 98	118 Es Einsteinium 99	119 Fm Fermium 100	120 Md Mendelevium 101	121 No Nobelium 102	122 Lr Lawrencium 103	123 Fr Francium 87	124 Ra Radium 88	125 Ac Actinium 89	126 Th Thorium 90	127 Pa Protactinium 91	128 U Uranium 92	129 Np Neptunium 93	130 Pu Plutonium 94	131 Am Americium 95	132 Cm Curium 96	133 Bk Berkelium 97	134 Cf Californium 98	135 Es Einsteinium 99	136 Fm Fermium 100	137 Md Mendelevium 101	138 No Nobelium 102	139 Lr Lawrencium 103	140 Ce Cerium 58	141 Pr Praseodymium 59	142 Nd Neodymium 60	143 Pm Promethium 61	144 Nd Neodymium 60	145 Sm Samarium 62	146 Eu Europium 63	147 Pm Promethium 61	148 Sm Samarium 62	149 Eu Europium 63	150 Sm Samarium 62	151 Gd Gadolinium 64	152 Eu Europium 63	153 Tb Terbium 65	154 Dy Dysprosium 66	155 Ho Holmium 67	156 Er Erbium 68	157 Tm Thulium 69	158 Yb Ytterbium 70	159 Lu Lutetium 71	160 Fr Francium 87	161 Ra Radium 88	162 Ac Actinium 89	163 Th Thorium 90	164 Pa Protactinium 91	165 U Uranium 92	166 Np Neptunium 93	167 Pu Plutonium 94	168 Am Americium 95	169 Cm Curium 96	170 Bk Berkelium 97	171 Cf Californium 98	172 Es Einsteinium 99	173 Fm Fermium 100	174 Md Mendelevium 101	175 No Nobelium 102	176 Lr Lawrencium 103	177 Fr Francium 87	178 Ra Radium 88	179 Ac Actinium 89	180 Th Thorium 90	181 Pa Protactinium 91	182 U Uranium 92	183 Np Neptunium 93	184 Pu Plutonium 94	185 Am Americium 95	186 Cm Curium 96	187 Bk Berkelium 97	188 Cf Californium 98	189 Es Einsteinium 99	190 Fm Fermium 100	191 Md Mendelevium 101	192 No Nobelium 102	193 Lr Lawrencium 103	194 Fr Francium 87	195 Ra Radium 88	196 Ac Actinium 89	197 Th Thorium 90	198 Pa Protactinium 91	199 U Uranium 92	200 Np Neptunium 93	201 Pu Plutonium 94	202 Am Americium 95	203 Cm Curium 96	204 Bk Berkelium 97	205 Cf Californium 98	206 Es Einsteinium 99	207 Fm Fermium 100	208 Md Mendelevium 101	209 No Nobelium 102	210 Lr Lawrencium 103	211 Fr Francium 87	212 Ra Radium 88	213 Ac Actinium 89	214 Th Thorium 90	215 Pa Protactinium 91	216 U Uranium 92	217 Np Neptunium 93	218 Pu Plutonium 94	219 Am Americium 95	220 Cm Curium 96	221 Bk Berkelium 97	222 Cf Californium 98	223 Es Einsteinium 99	224 Fm Fermium 100	225 Md Mendelevium 101	226 No Nobelium 102	227 Lr Lawrencium 103	228 Fr Francium 87	229 Ra Radium 88	230 Ac Actinium 89	231 Th Thorium 90	232 Pa Protactinium 91	233 U Uranium 92	234 Np Neptunium 93	235 Pu Plutonium 94	236 Am Americium 95	237 Cm Curium 96	238 Bk Berkelium 97	239 Cf Californium 98	240 Es Einsteinium 99	241 Fm Fermium 100	242 Md Mendelevium 101	243 No Nobelium 102	244 Lr Lawrencium 103	245 Fr Francium 87	246 Ra Radium 88	247 Ac Actinium 89	248 Th Thorium 90	249 Pa Protactinium 91	250 U Uranium 92	251 Np Neptunium 93	252 Pu Plutonium 94	253 Am Americium 95	254 Cm Curium 96	255 Bk Berkelium 97	256 Cf Californium 98	257 Es Einsteinium 99	258 Fm Fermium 100	259 Md Mendelevium 101	260 No Nobelium 102	261 Lr Lawrencium 103	262 Fr Francium 87	263 Ra Radium 88	264 Ac Actinium 89	265 Th Thorium 90	266 Pa Protactinium 91	267 U Uranium 92	268 Np Neptunium 93	269 Pu Plutonium 94	270 Am Americium 95	271 Cm Curium 96	272 Bk Berkelium 97	273 Cf Californium 98	274 Es Einsteinium 99	275 Fm Fermium 100	276 Md Mendelevium 101	277 No Nobelium 102	278 Lr Lawrencium 103	279 Fr Francium 87	280 Ra Radium 88	281 Ac Actinium 89	282 Th Thorium 90	283 Pa Protactinium 91	284 U Uranium 92	285 Np Neptunium 93	286 Pu Plutonium 94	287 Am Americium 95	288 Cm Curium 96	289 Bk Berkelium 97	290 Cf Californium 98	291 Es Einsteinium 99	292 Fm Fermium 100	293 Md Mendelevium 101	294 No Nobelium 102	295 Lr Lawrencium 103	296 Fr Francium 87	297 Ra Radium 88	298 Ac Actinium 89	299 Th Thorium 90	300 Pa Protactinium 91	301 U Uranium 92	302 Np Neptunium 93	303 Pu Plutonium 94	304 Am Americium 95	305 Cm Curium 96	306 Bk Berkelium 97	307 Cf Californium 98	308 Es Einsteinium 99	309 Fm Fermium 100	310 Md Mendelevium 101	311 No Nobelium 102	312 Lr Lawrencium 103	313 Fr Francium 87	314 Ra Radium 88	315 Ac Actinium 89	316 Th Thorium 90	317 Pa Protactinium 91	318 U Uranium 92	319 Np Neptunium 93	320 Pu Plutonium 94	321 Am Americium 95	322 Cm Curium 96	323 Bk Berkelium 97	324 Cf Californium 98	325 Es Einsteinium 99	326 Fm Fermium 100	327 Md Mendelevium 101	328 No Nobelium 102	329 Lr Lawrencium 103	330 Fr Francium 87	331 Ra Radium 88	332 Ac Actinium 89	333 Th Thorium 90	334 Pa Protactinium 91	335 U Uranium 92	336 Np Neptunium 93	337 Pu Plutonium 94	338 Am Americium 95	339 Cm Curium 96	340 Bk Berkelium 97	341 Cf Californium 98	342 Es Einsteinium 99	343 Fm Fermium 100	344 Md Mendelevium 101	345 No Nobelium 102	346 Lr Lawrencium 103	347 Fr Francium 87	348 Ra Radium 88	349 Ac Actinium 89	350 Th Thorium 90	351 Pa Protactinium 91	352 U Uranium 92	353 Np Neptunium 93	354 Pu Plutonium 94	355 Am Americium 95	356 Cm Curium 96	357 Bk Berkelium 97	358 Cf Californium 98	359 Es Einsteinium 99	360 Fm Fermium 100	361 Md Mendelevium 101	362 No Nobelium 102	363 Lr Lawrencium 103	364 Fr Francium 87	365 Ra Radium 88	366 Ac Actinium 89	367 Th Thorium 90	368 Pa Protactinium 91	369 U Uranium 92	370 Np Neptunium 93	371 Pu Plutonium 94	372 Am Americium 95	373 Cm Curium 96	374 Bk Berkelium 97	375 Cf Californium 98	376 Es Einsteinium 99	377 Fm Fermium 100	378 Md Mendelevium 101	379 No Nobelium 102	380 Lr Lawrencium 103	381 Fr Francium 87	382 Ra Radium 88	383 Ac Actinium 89	384 Th Thorium 90	385 Pa Protactinium 91	386 U Uranium 92	387 Np Neptunium 93	388 Pu Plutonium 94	389 Am Americium 95	390 Cm Curium 96	391 Bk Berkelium 97	392 Cf Californium 98	393 Es Einsteinium 99	394 Fm Fermium 100	395 Md Mendelevium 101	396 No Nobelium 102	397 Lr Lawrencium 103	398 Fr Francium 87	399 Ra Radium 88	400 Ac Actinium 89	401 Th Thorium 90	402 Pa Protactinium 91	403 U Uranium 92	404 Np Neptunium 93	405 Pu Plutonium 94	406 Am Americium 95	407 Cm Curium 96	408 Bk Berkelium 97	409 Cf Californium 98	410 Es Einsteinium 99	411 Fm Fermium 100	412 Md Mendelevium 101	413 No Nobelium 102	414 Lr Lawrencium 103	415 Fr Francium 87	416 Ra Radium 88	417 Ac Actinium 89	418 Th Thorium 90	419 Pa Protactinium 91	420 U Uranium 92	421 Np Neptunium 93	422 Pu Plutonium 94	423 Am Americium 95	424 Cm Curium 96	425 Bk Berkelium 97	426 Cf Californium 98	427 Es Einsteinium 99	428 Fm Fermium 100	429 Md Mendelevium 101	430 No Nobelium 102	431 Lr Lawrencium 103	432 Fr Francium 87	433 Ra Radium 88	434 Ac Actinium 89	435 Th Thorium 90	436 Pa Protactinium 91	437 U Uranium 92	438 Np Neptunium 93	439 Pu Plutonium 94	440 Am Americium 95	441 Cm Curium 96	442 Bk Berkelium 97	443 Cf Californium 98	444 Es Einsteinium 99	445 Fm Fermium 100	446 Md Mendelevium 101	447 No Nobelium 102	448 Lr Lawrencium 103	449 Fr Francium 87	450 Ra Radium 88	451 Ac Actinium 89	452 Th Thorium 90	453 Pa Protactinium 91	454 U Uranium 92	455 Np Neptunium 93	456 Pu Plutonium 94	457 Am Americium 95	458 Cm Curium 96	459 Bk Berkelium 97	460 Cf Californium 98	461 Es Einsteinium 99	462 Fm Fermium 100	463 Md Mendelevium 101	464 No Nobelium 102	465 Lr Lawrencium 103	466 Fr Francium 87	467 Ra Radium 88	468 Ac Actinium 89	469 Th Thorium 90	470 Pa Protactinium 91	471 U Uranium 92	472 Np Neptunium 93	473 Pu Plutonium 94	474 Am Americium 95	475 Cm Curium 96	476 Bk Berkelium 97	477 Cf Californium 98	478 Es Einsteinium 99