



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

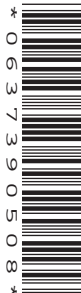
CANDIDATE  
NAME

CENTRE  
NUMBER

--	--	--	--	--

CANDIDATE  
NUMBER

--	--	--	--



**CHEMISTRY**

**5070/22**

Paper 2 Theory

**October/November 2010**

**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.

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.

For Examiner's Use	
<b>Section A</b>	
<b>B6</b>	
<b>B7</b>	
<b>B8</b>	
<b>B9</b>	
<b>Total</b>	

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.

For  
Examiner's  
Use

**A1 (a)** Choose from the following list of metals to answer the questions below.

aluminium  
iron  
lead  
magnesium  
potassium  
silver  
vanadium

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

Which metal

- (i) reacts with cold water to form an alkaline solution,  
..... [1]
- (ii) forms a protective oxide layer on its surface,  
..... [1]
- (iii) is the catalyst used in the industrial manufacture of ammonia,  
..... [1]
- (iv) is a sacrificial metal used to prevent iron pipes from rusting,  
..... [1]
- (v) is in Period 5 of the Periodic Table?  
..... [1]

**(b)** Draw a labelled diagram to show the structure of a typical metal.

[2]

[Total: 7]

**A2** Ethanol can be made both by fermentation and by the addition of steam to ethene.

For  
Examiner's  
Use

**(a) (i)** Name the organic compound required for fermentation.

..... [1]

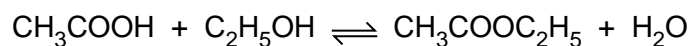
**(ii)** State the conditions under which fermentation most readily takes place.

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

**(b)** Write an equation for the reaction between steam and ethene.

[1]

**(c)** Ethanol, C<sub>2</sub>H<sub>5</sub>OH, reacts with ethanoic acid, CH<sub>3</sub>COOH.



**(i)** Name the compound CH<sub>3</sub>COOC<sub>2</sub>H<sub>5</sub>.

..... [1]

**(ii)** What name is given to this type of chemical reaction?

..... [1]

**(d) (i)** Name the third member of the alcohol homologous series.

..... [1]

**(ii)** Draw the structural formula of this compound, showing all atoms and bonds.

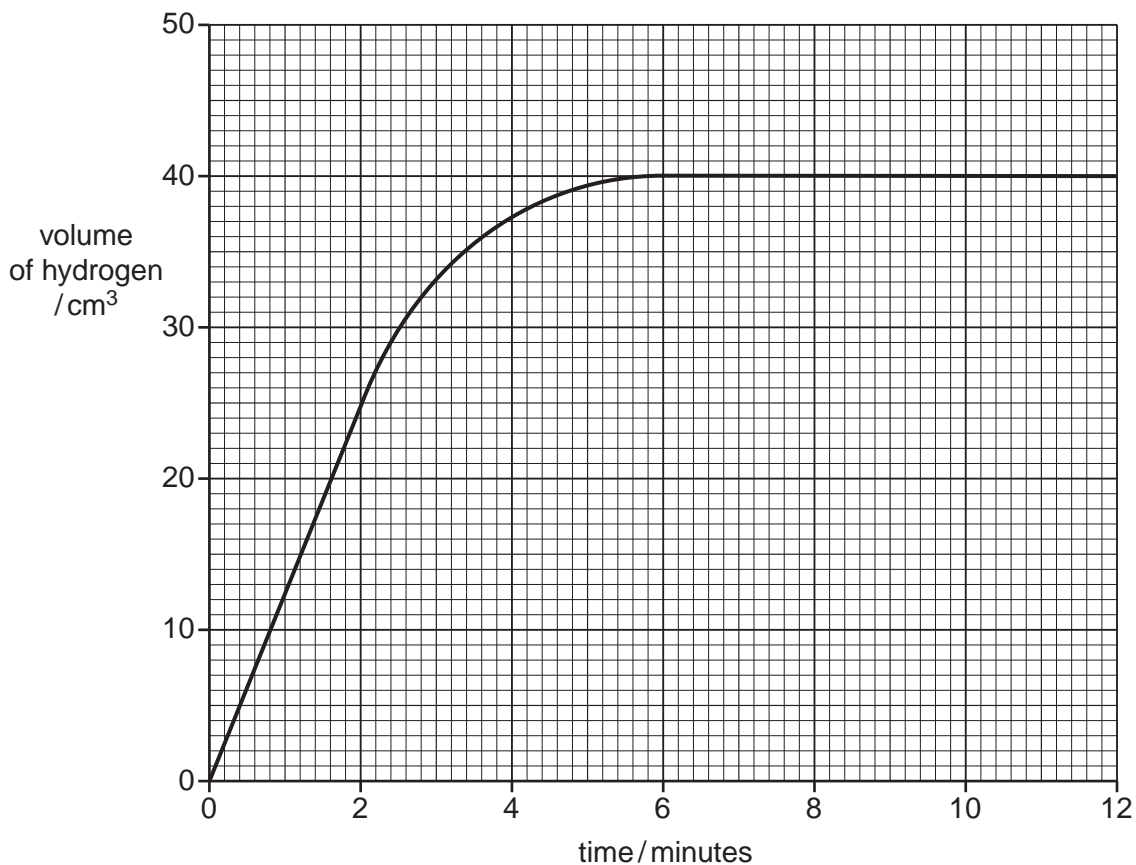
[1]

[Total: 8]

**A3** A student measured the volume of hydrogen produced over time when small pieces of zinc reacted with excess sulfuric acid.

The results are shown in the graph below.

For  
Examiner's  
Use



(a) Use the information from the graph to calculate the average speed of reaction in the first two minutes.

[1]

(b) Explain why the reaction stopped after 6 minutes.

..... [1]

(c) Copper catalyses this reaction.

(i) On the axes above, sketch a line to show the expected results for the catalysed reaction. [1]

(ii) Explain how a catalyst changes the speed of reaction.

..... [1]

- (d) Explain, using ideas about colliding particles, what happens to the speed of this reaction when larger particles of zinc are used.

For  
Examiner's  
Use

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

- (e) Explain, using ideas about colliding particles, what happens to the speed of this reaction when the temperature of the reaction mixture is increased.

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

[Total: 8]

**A4** Chlorine, bromine and iodine are non-metals in Group VII of the Periodic Table. Their molecules are diatomic.

For  
Examiner's  
Use

**(a)** What do you understand by the term *diatomic*?

..... [1]

**(b) (i)** Describe the trend in colour of the Group VII elements down the Group.

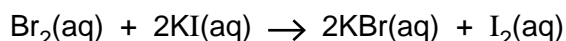
..... [1]

**(ii)** In what physical state do the following elements exist at room temperature and pressure?

bromine .....

iodine ..... [2]

**(c)** Aqueous bromine reacts with aqueous potassium iodide.



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

[1]

**(ii)** Describe a positive test for iodide ions.

test .....

observation ..... [2]

**(iii)** Explain why aqueous bromine does not react with aqueous potassium chloride.

.....

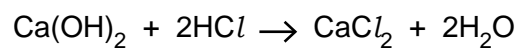
..... [1]

**(d)** Hydrochloric acid can be made by burning hydrogen in chlorine, then dissolving the product in water.

Give the formulae for the ions present in hydrochloric acid.

..... [1]

- (e) An aqueous solution of calcium hydroxide was titrated with  $0.0150 \text{ mol/dm}^3$  hydrochloric acid.



It required  $6.00 \text{ cm}^3$  of this aqueous hydrochloric acid to neutralise  $20.0 \text{ cm}^3$  of the calcium hydroxide solution.

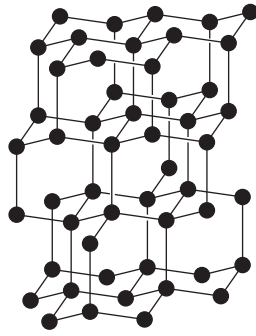
Calculate the concentration, in  $\text{mol/dm}^3$ , of the calcium hydroxide solution.

For  
Examiner's  
Use

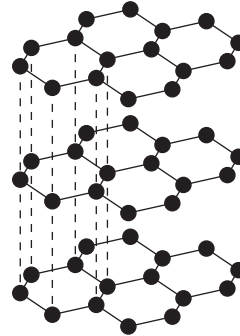
[3]

[Total: 12]

A5 Carbon and graphite are two forms of carbon.



diamond



graphite

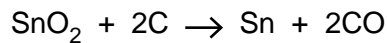
(a) (i) Describe **two** differences in the structure of diamond and graphite.

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

(ii) Explain, in terms of their structure, why graphite is soft but diamond is hard.

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

(b) Tin is extracted by heating tin(IV) oxide, SnO<sub>2</sub>, with carbon in a furnace.



(i) How does this equation show that tin(IV) oxide gets reduced?

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

(ii) Explain why carbon monoxide must not be allowed to escape from the furnace.

..... [1]

(c) Carbon monoxide can be formed by the reduction of carbon dioxide with red-hot carbon.

(i) Write an equation for this reaction.

[1]

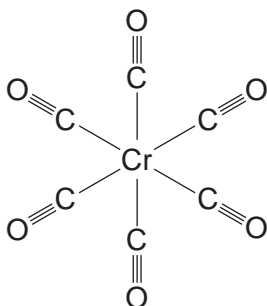


- (ii) Carbon monoxide has a triple covalent bond.  
Draw the electronic structure of carbon monoxide. Show only the outer electrons.

For  
Examiner's  
Use

[2]

- (iii) Carbon monoxide reacts with chromium to form chromium carbonyl.  
The structure of chromium carbonyl is shown below.



Write the empirical formula for chromium carbonyl.

..... [1]

[Total: 10]

Section B

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

The total mark for this section is 30.

**B6** The carbon cycle regulates the amount of carbon dioxide in the atmosphere.

**(a)** Explain how the processes of photosynthesis and respiration help to regulate the amount of carbon dioxide in the atmosphere.

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

**(b)** Methane is an atmospheric pollutant which contributes to global warming.

**(i)** Suggest **two** possible consequences of an increase in global warming.

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

**(ii)** Write an equation for the complete combustion of methane.

[1]

**(iii)** Methane is generally unreactive. Apart from combustion, state one other chemical reaction of methane.

..... [1]

(c) Methane is a member of the alkane homologous series.

For  
Examiner's  
Use

(i) Describe how the boiling points of unbranched alkanes vary with the size of their molecules.

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

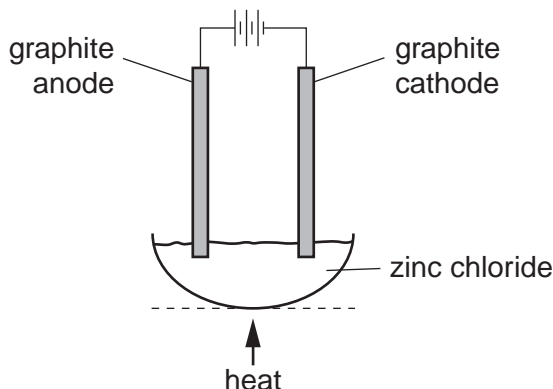
(ii) Alkanes can be cracked to form alkenes.  
State the conditions required for cracking alkanes.

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

[Total: 10]

**B7** Zinc chloride is an ionic solid. It can be electrolysed using the apparatus shown below.

For  
Examiner's  
Use



**(a)** Explain why zinc chloride conducts electricity when molten, but not when solid.

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

**(b)** Predict the products of this electrolysis at

the anode, .....

the cathode. .... [1]

**(c)** When a dilute aqueous solution of zinc chloride is electrolysed, hydroxide ions are converted to oxygen at the anode. Write the ionic equation for this reaction.

[2]

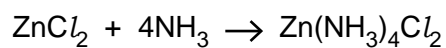
**(d)** Describe a positive test for zinc ions.

test .....

observations .....

..... [3]

- (e) Solid zinc chloride absorbs ammonia to form tetrammine zinc chloride,  $\text{Zn}(\text{NH}_3)_4\text{Cl}_2$ .



Calculate the maximum yield, in grams, of tetrammine zinc chloride formed when 3.4 g of zinc chloride reacts with excess ammonia.

For  
Examiner's  
Use

[2]

[Total:10]

**B8** Magnesium is a reactive metal.

For  
Examiner's  
Use

- (a) (i) Name the products formed when magnesium reacts with steam.

..... [1]

- (ii) Write the equation for the reaction of magnesium with ethanoic acid,  $\text{CH}_3\text{COOH}$ .

[2]

- (b) Magnesium chloride is a soluble salt.

Describe how you can make pure dry crystals of magnesium chloride from magnesium carbonate.

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

- (c) The equation shows the reaction which occurs when magnesium carbonate is heated.

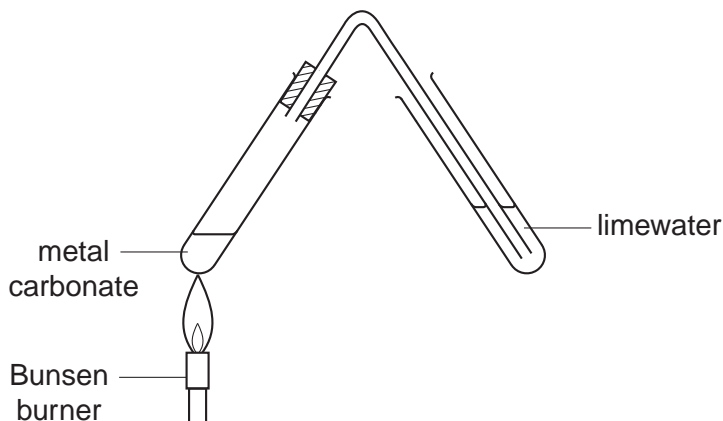


State the name given to this type of chemical reaction.

..... [1]

- (d) A student compared the action of heat on three solid metal carbonates. She heated each carbonate using the apparatus shown below. In each case, she recorded the length of time taken for the limewater to turn milky.

For  
Examiner's  
Use



- (i) State one factor that must be kept constant if the speeds of reaction are to be compared in a fair way.  
 ..... [1]
- (ii) The time taken for the limewater to turn milky for each metal carbonate is shown in the table.

metal carbonate	time taken for the limewater to turn milky / s
copper carbonate	10
magnesium carbonate	40
zinc carbonate	24

Describe and explain these results in terms of the reactivity of the metals.

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

[Total: 10]

**B9** Sulfur dioxide is a gas which contributes to acid rain.

For  
Examiner's  
Use

- (a) (i) State one source of sulfur dioxide in the atmosphere.

.....[1]

- (ii) Acid rain can cause lakes to become acidic. This may cause fish and plants in the water to die.

Describe one **other** environmental problem caused by acid rain.

.....[1]

- (b) Acid rain is a solution of dilute sulfuric acid.

The acidity in lakes can be neutralised by adding powdered calcium carbonate.

- (i) Write an equation, including state symbols, for the reaction of calcium carbonate with sulfuric acid.

[2]

- (ii) State one industrial use of sulfuric acid.

.....[1]

- (iii) Sulfuric acid is a strong acid.

What do you understand by the term *strong acid*?

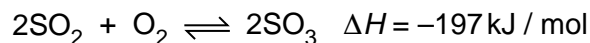
.....  
.....[1]

- (c) Sulfuric acid is manufactured by the Contact process.

Name the raw materials used in the first stage of the Contact process.

.....[1]

- (d) The equation shows the second stage of the Contact process.



- (i) State the meaning of the symbol  $\Delta H$ .

.....[1]

- (ii) Predict and explain the effect of increasing the temperature on the position of equilibrium in this reaction.

.....  
.....  
.....[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	O																																																																																																																																																																																																																																																																																																																																																																																																																																																									
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>N</b> Nitrogen 7	15 <b>O</b> Oxygen 8	16 <b>F</b> Fluorine 9	17 <b>Ne</b> Neon 10	18 <b>Ar</b> Argon 18	19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36	37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54	55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	58 <b>Ce</b> Cerium 58	59 <b>Pr</b> Praseodymium 59	60 <b>Nd</b> Neodymium 60	61 <b>Pm</b> Promethium 61	62 <b>Sm</b> Samarium 62	63 <b>Eu</b> Europium 63	64 <b>Gd</b> Gadolinium 64	65 <b>Tb</b> Terbium 65	66 <b>Dy</b> Dysprosium 66	67 <b>Ho</b> Holmium 67	68 <b>Er</b> Erbium 68	69 <b>Tm</b> Thulium 69	70 <b>Yb</b> Ytterbium 70	71 <b>Lu</b> Lutetium 71	72 <b>Fr</b> Francium 87	73 <b>Ra</b> Radium 88	74 <b>Ac</b> Actinium 89	75 <b>Th</b> Thorium 90	76 <b>Pa</b> Protactinium 91	77 <b>U</b> Uranium 92	78 <b>Np</b> Neptunium 93	79 <b>Pu</b> Plutonium 94	80 <b>Am</b> Americium 95	81 <b>Cm</b> Curium 96	82 <b>Bk</b> Berkelium 97	83 <b>Cf</b> Californium 98	84 <b>Es</b> Einsteinium 99	85 <b>Fm</b> Fermium 100	86 <b>Md</b> Mendelevium 101	87 <b>No</b> Nobelium 102	88 <b>Lr</b> Lawrencium 103	89 <b>Fr</b> Francium 87	90 <b>Ra</b> Radium 88	91 <b>Ac</b> Actinium 89	92 <b>Th</b> Thorium 90	93 <b>Pa</b> Protactinium 91	94 <b>U</b> Uranium 92	95 <b>Np</b> Neptunium 93	96 <b>Pu</b> Plutonium 94	97 <b>Am</b> Americium 95	98 <b>Cm</b> Curium 96	99 <b>Bk</b> Berkelium 97	100 <b>Cf</b> Californium 98	101 <b>Es</b> Einsteinium 99	102 <b>Fm</b> Fermium 100	103 <b>Md</b> Mendelevium 101	104 <b>No</b> Nobelium 102	105 <b>Lr</b> Lawrencium 103	106 <b>Lu</b> Lutetium 71	107 <b>Yb</b> Ytterbium 70	108 <b>Er</b> Erbium 68	109 <b>Tm</b> Thulium 69	110 <b>Dy</b> Dysprosium 66	111 <b>Ho</b> Holmium 67	112 <b>Er</b> Erbium 68	113 <b>Lu</b> Lutetium 71	114 <b>Yb</b> Ytterbium 70	115 <b>Lu</b> Lutetium 71	116 <b>Yb</b> Ytterbium 70	117 <b>Lu</b> Lutetium 71	118 <b>Yb</b> Ytterbium 70	119 <b>Lu</b> Lutetium 71	120 <b>Yb</b> Ytterbium 70	121 <b>Lu</b> Lutetium 71	122 <b>Yb</b> Ytterbium 70	123 <b>Lu</b> Lutetium 71	124 <b>Yb</b> Ytterbium 70	125 <b>Lu</b> Lutetium 71	126 <b>Yb</b> Ytterbium 70	127 <b>Lu</b> Lutetium 71	128 <b>Yb</b> Ytterbium 70	129 <b>Lu</b> Lutetium 71	130 <b>Yb</b> Ytterbium 70	131 <b>Lu</b> Lutetium 71	132 <b>Yb</b> Ytterbium 70	133 <b>Lu</b> Lutetium 71	134 <b>Yb</b> Ytterbium 70	135 <b>Lu</b> Lutetium 71	136 <b>Yb</b> Ytterbium 70	137 <b>Lu</b> Lutetium 71	138 <b>Yb</b> Ytterbium 70	139 <b>Lu</b> Lutetium 71	140 <b>Yb</b> Ytterbium 70	141 <b>Lu</b> Lutetium 71	142 <b>Yb</b> Ytterbium 70	143 <b>Lu</b> Lutetium 71	144 <b>Yb</b> Ytterbium 70	145 <b>Lu</b> Lutetium 71	146 <b>Yb</b> Ytterbium 70	147 <b>Lu</b> Lutetium 71	148 <b>Yb</b> Ytterbium 70	149 <b>Lu</b> Lutetium 71	150 <b>Yb</b> Ytterbium 70	151 <b>Lu</b> Lutetium 71	152 <b>Yb</b> Ytterbium 70	153 <b>Lu</b> Lutetium 71	154 <b>Yb</b> Ytterbium 70	155 <b>Lu</b> Lutetium 71	156 <b>Yb</b> Ytterbium 70	157 <b>Lu</b> Lutetium 71	158 <b>Yb</b> Ytterbium 70	159 <b>Lu</b> Lutetium 71	160 <b>Yb</b> Ytterbium 70	161 <b>Lu</b> Lutetium 71	162 <b>Yb</b> Ytterbium 70	163 <b>Lu</b> Lutetium 71	164 <b>Yb</b> Ytterbium 70	165 <b>Lu</b> Lutetium 71	166 <b>Yb</b> Ytterbium 70	167 <b>Lu</b> Lutetium 71	168 <b>Yb</b> Ytterbium 70	169 <b>Lu</b> Lutetium 71	170 <b>Yb</b> Ytterbium 70	171 <b>Lu</b> Lutetium 71	172 <b>Yb</b> Ytterbium 70	173 <b>Lu</b> Lutetium 71	174 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	176 <b>Yb</b> Ytterbium 70	177 <b>Lu</b> Lutetium 71	178 <b>Yb</b> Ytterbium 70	179 <b>Lu</b> Lutetium 71	180 <b>Yb</b> Ytterbium 70	181 <b>Lu</b> Lutetium 71	182 <b>Yb</b> Ytterbium 70	183 <b>Lu</b> Lutetium 71	184 <b>Yb</b> Ytterbium 70	185 <b>Lu</b> Lutetium 71	186 <b>Yb</b> Ytterbium 70	187 <b>Lu</b> Lutetium 71	188 <b>Yb</b> Ytterbium 70	189 <b>Lu</b> Lutetium 71	190 <b>Yb</b> Ytterbium 70	191 <b>Lu</b> Lutetium 71	192 <b>Yb</b> Ytterbium 70	193 <b>Lu</b> Lutetium 71	194 <b>Yb</b> Ytterbium 70	195 <b>Lu</b> Lutetium 71	196 <b>Yb</b> Ytterbium 70	197 <b>Lu</b> Lutetium 71	198 <b>Yb</b> Ytterbium 70	199 <b>Lu</b> Lutetium 71	200 <b>Yb</b> Ytterbium 70	201 <b>Lu</b> Lutetium 71	202 <b>Yb</b> Ytterbium 70	203 <b>Lu</b> Lutetium 71	204 <b>Yb</b> Ytterbium 70	205 <b>Lu</b> Lutetium 71	206 <b>Yb</b> Ytterbium 70	207 <b>Lu</b> Lutetium 71	208 <b>Yb</b> Ytterbium 70	209 <b>Lu</b> Lutetium 71	210 <b>Yb</b> Ytterbium 70	211 <b>Lu</b> Lutetium 71	212 <b>Yb</b> Ytterbium 70	213 <b>Lu</b> Lutetium 71	214 <b>Yb</b> Ytterbium 70	215 <b>Lu</b> Lutetium 71	216 <b>Yb</b> Ytterbium 70	217 <b>Lu</b> Lutetium 71	218 <b>Yb</b> Ytterbium 70	219 <b>Lu</b> Lutetium 71	220 <b>Yb</b> Ytterbium 70	221 <b>Lu</b> Lutetium 71	222 <b>Yb</b> Ytterbium 70	223 <b>Lu</b> Lutetium 71	224 <b>Yb</b> Ytterbium 70	225 <b>Lu</b> Lutetium 71	226 <b>Yb</b> Ytterbium 70	227 <b>Lu</b> Lutetium 71	228 <b>Yb</b> Ytterbium 70	229 <b>Lu</b> Lutetium 71	230 <b>Yb</b> Ytterbium 70	231 <b>Lu</b> Lutetium 71	232 <b>Yb</b> Ytterbium 70	233 <b>Lu</b> Lutetium 71	234 <b>Yb</b> Ytterbium 70	235 <b>Lu</b> Lutetium 71	236 <b>Yb</b> Ytterbium 70	237 <b>Lu</b> Lutetium 71	238 <b>Yb</b> Ytterbium 70	239 <b>Lu</b> Lutetium 71	240 <b>Yb</b> Ytterbium 70	241 <b>Lu</b> Lutetium 71	242 <b>Yb</b> Ytterbium 70	243 <b>Lu</b> Lutetium 71	244 <b>Yb</b> Ytterbium 70	245 <b>Lu</b> Lutetium 71	246 <b>Yb</b> Ytterbium 70	247 <b>Lu</b> Lutetium 71	248 <b>Yb</b> Ytterbium 70	249 <b>Lu</b> Lutetium 71	250 <b>Yb</b> Ytterbium 70	251 <b>Lu</b> Lutetium 71	252 <b>Yb</b> Ytterbium 70	253 <b>Lu</b> Lutetium 71	254 <b>Yb</b> Ytterbium 70	255 <b>Lu</b> Lutetium 71	256 <b>Yb</b> Ytterbium 70	257 <b>Lu</b> Lutetium 71	258 <b>Yb</b> Ytterbium 70	259 <b>Lu</b> Lutetium 71	260 <b>Yb</b> Ytterbium 70	261 <b>Lu</b> Lutetium 71	262 <b>Yb</b> Ytterbium 70	263 <b>Lu</b> Lutetium 71	264 <b>Yb</b> Ytterbium 70	265 <b>Lu</b> Lutetium 71	266 <b>Yb</b> Ytterbium 70	267 <b>Lu</b> Lutetium 71	268 <b>Yb</b> Ytterbium 70	269 <b>Lu</b> Lutetium 71	270 <b>Yb</b> Ytterbium 70	271 <b>Lu</b> Lutetium 71	272 <b>Yb</b> Ytterbium 70	273 <b>Lu</b> Lutetium 71	274 <b>Yb</b> Ytterbium 70	275 <b>Lu</b> Lutetium 71	276 <b>Yb</b> Ytterbium 70	277 <b>Lu</b> Lutetium 71	278 <b>Yb</b> Ytterbium 70	279 <b>Lu</b> Lutetium 71	280 <b>Yb</b> Ytterbium 70	281 <b>Lu</b> Lutetium 71	282 <b>Yb</b> Ytterbium 70	283 <b>Lu</b> Lutetium 71	284 <b>Yb</b> Ytterbium 70	285 <b>Lu</b> Lutetium 71	286 <b>Yb</b> Ytterbium 70	287 <b>Lu</b> Lutetium 71	288 <b>Yb</b> Ytterbium 70	289 <b>Lu</b> Lutetium 71	290 <b>Yb</b> Ytterbium 70	291 <b>Lu</b> Lutetium 71	292 <b>Yb</b> Ytterbium 70	293 <b>Lu</b> Lutetium 71	294 <b>Yb</b> Ytterbium 70	295 <b>Lu</b> Lutetium 71	296 <b>Yb</b> Ytterbium 70	297 <b>Lu</b> Lutetium 71	298 <b>Yb</b> Ytterbium 70	299 <b>Lu</b> Lutetium 71	300 <b>Yb</b> Ytterbium 70	301 <b>Lu</b> Lutetium 71	302 <b>Yb</b> Ytterbium 70	303 <b>Lu</b> Lutetium 71	304 <b>Yb</b> Ytterbium 70	305 <b>Lu</b> Lutetium 71	306 <b>Yb</b> Ytterbium 70	307 <b>Lu</b> Lutetium 71	308 <b>Yb</b> Ytterbium 70	309 <b>Lu</b> Lutetium 71	310 <b>Yb</b> Ytterbium 70	311 <b>Lu</b> Lutetium 71	312 <b>Yb</b> Ytterbium 70	313 <b>Lu</b> Lutetium 71	314 <b>Yb</b> Ytterbium 70	315 <b>Lu</b> Lutetium 71	316 <b>Yb</b> Ytterbium 70	317 <b>Lu</b> Lutetium 71	318 <b>Yb</b> Ytterbium 70	319 <b>Lu</b> Lutetium 71	320 <b>Yb</b> Ytterbium 70	321 <b>Lu</b> Lutetium 71	322 <b>Yb</b> Ytterbium 70	323 <b>Lu</b> Lutetium 71	324 <b>Yb</b> Ytterbium 70	325 <b>Lu</b> Lutetium 71	326 <b>Yb</b> Ytterbium 70	327 <b>Lu</b> Lutetium 71	328 <b>Yb</b> Ytterbium 70	329 <b>Lu</b> Lutetium 71	330 <b>Yb</b> Ytterbium 70	331 <b>Lu</b> Lutetium 71	332 <b>Yb</b> Ytterbium 70	333 <b>Lu</b> Lutetium 71	334 <b>Yb</b> Ytterbium 70	335 <b>Lu</b> Lutetium 71	336 <b>Yb</b> Ytterbium 70	337 <b>Lu</b> Lutetium 71	338 <b>Yb</b> Ytterbium 70	339 <b>Lu</b> Lutetium 71	340 <b>Yb</b> Ytterbium 70	341 <b>Lu</b> Lutetium 71	342 <b>Yb</b> Ytterbium 70	343 <b>Lu</b> Lutetium 71	344 <b>Yb</b> Ytterbium 70	345 <b>Lu</b> Lutetium 71	346 <b>Yb</b> Ytterbium 70	347 <b>Lu</b> Lutetium 71	348 <b>Yb</b> Ytterbium 70	349 <b>Lu</b> Lutetium 71	350 <b>Yb</b> Ytterbium 70	351 <b>Lu</b> Lutetium 71	352 <b>Yb</b> Ytterbium 70	353 <b>Lu</b> Lutetium 71	354 <b>Yb</b> Ytterbium 70	355 <b>Lu</b> Lutetium 71	356 <b>Yb</b> Ytterbium 70	357 <b>Lu</b> Lutetium 71	358 <b>Yb</b> Ytterbium 70	359 <b>Lu</b> Lutetium 71	360 <b>Yb</b> Ytterbium 70	361 <b>Lu</b> Lutetium 71	362 <b>Yb</b> Ytterbium 70	363 <b>Lu</b> Lutetium 71	364 <b>Yb</b> Ytterbium 70	365 <b>Lu</b> Lutetium 71	366 <b>Yb</b> Ytterbium 70	367 <b>Lu</b> Lutetium 71	368 <b>Yb</b> Ytterbium 70	369 <b>Lu</b> Lutetium 71	370 <b>Yb</b> Ytterbium 70	371 <b>Lu</b> Lutetium 71	372 <b>Yb</b> Ytterbium 70	373 <b>Lu</b> Lutetium 71	374 <b>Yb</b> Ytterbium 70	375 <b>Lu</b> Lutetium 71	376 <b>Yb</b> Ytterbium 70	377 <b>Lu</b> Lutetium 71	378 <b>Yb</b> Ytterbium 70	379 <b>Lu</b> Lutetium 71	380 <b>Yb</b> Ytterbium 70	381 <b>Lu</b> Lutetium 71	382 <b>Yb</b> Ytterbium 70	383 <b>Lu</b> Lutetium 71	384 <b>Yb</b> Ytterbium 70	385 <b>Lu</b> Lutetium 71	386 <b>Yb</b> Ytterbium 70	387 <b>Lu</b> Lutetium 71	388 <b>Yb</b> Ytterbium 70	389 <b>Lu</b> Lutetium 71	390 <b>Yb</b> Ytterbium 70	391 <b>Lu</b> Lutetium 71	392 <b>Yb</b> Ytterbium 70	393 <b>Lu</b> Lutetium 71	394 <b>Yb</b> Ytterbium 70	395 <b>Lu</b> Lutetium 71	396 <b>Yb</b> Ytterbium 70	397 <b>Lu</b> Lutetium 71	398 <b>Yb</b> Ytterbium 70	399 <b>Lu</b> Lutetium 71	400 <b>Yb</b> Ytterbium 70	401 <b>Lu</b> Lutetium 71	402 <b>Yb</b> Ytterbium 70	403 <b>Lu</b> Lutetium 71	404 <b>Yb</b> Ytterbium 70	405 <b>Lu</b> Lutetium 71	406 <b>Yb</b> Ytterbium 70	407 <b>Lu</b> Lutetium 71	408 <b>Yb</b> Ytterbium 70	409 <b>Lu</b> Lutetium 71	410 <b>Yb</b> Ytterbium 70	411 <b>Lu</b> Lutetium 71	412 <b>Yb</b> Ytterbium 70	413 <b>Lu</b> Lutetium 71	414 <b>Yb</b> Ytterbium 70	415 <b>Lu</b> Lutetium 71	416 <b>Yb</b> Ytterbium 70	417 <b>Lu</b> Lutetium 71	418 <b>Yb</b> Ytterbium 70	419 <b>Lu</b> Lutetium 71	420 <b>Yb</b> Ytterbium 70	421 <b>Lu</b> Lutetium 71	422 <b>Yb</b> Ytterbium 70	423 <b>Lu</b> Lutetium 71	424 <b>Yb</b> Ytterbium 70	425 <b>Lu</b> Lutetium 71	426 <b>Yb</b> Ytterbium 70	427 <b>Lu</b> Lutetium 71	428 <b>Yb</b> Ytterbium 70	429 <b>Lu</b> Lutetium 71	430 <b>Yb</b> Ytterbium 70	431 <b>Lu</b> Lutetium 71	432 <b>Yb</b> Ytterbium 70	433 <b>Lu</b> Lutetium 71	434 <b>Yb</b> Ytterbium 70	435 <b>Lu</b> Lutetium 71	436 <b>Yb</b> Ytterbium 70	437 <b>Lu</b> Lutetium 71	438 <b>Yb</b> Ytterbium 70	439 <b>Lu</b> Lutetium 71	440 <b>Yb</b> Ytterbium 70	441 <b>Lu</b> Lutetium 71	442 <b>Yb</b> Ytterbium 70	443 <b>Lu</b> Lutetium 71	444 <b>Yb</b> Ytterbium 70	445 <b>Lu</b> Lutetium 71	446 <b>Yb</b> Ytterbium 70	447 <b>Lu</b> Lutetium 71	448 <b>Yb</b> Ytterbium 70	449 <b>Lu</b> Lutetium 71	450 <b>Yb</b> Ytterbium 70	451 <b>Lu</b> Lutetium 71	452 <b>Yb</b> Ytterbium 70	453 <b>Lu</b> Lutetium 71	454 <b>Yb</b> Ytterbium 70	455 <b>Lu</b> Lutetium 71	456 <b>Yb</b> Ytterbium