Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6622432628

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: 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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 20.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

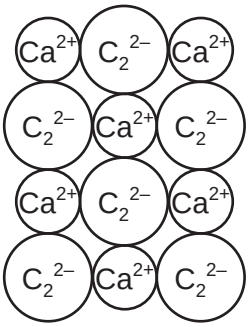
This document consists of **19** printed pages and **1** blank page.

CAMBRIDGE International Examinations

[Turn over

1 The structures of some substances containing carbon are shown.

A



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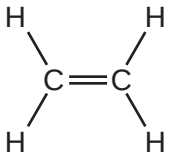

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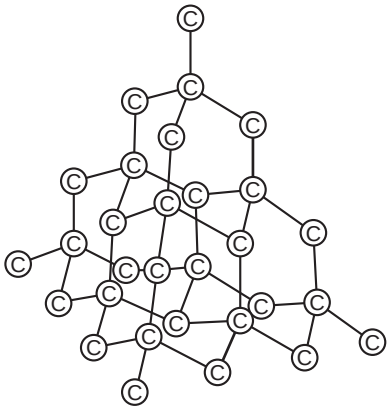

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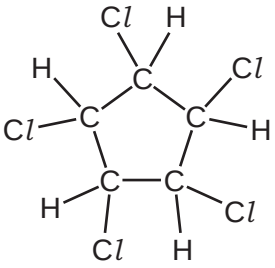

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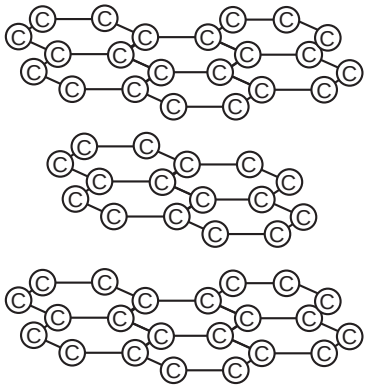


Answer the following questions about these substances.

(a) **(i)** Which **two** substances have giant covalent structures?

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

(ii) Which substance decolourises aqueous bromine?

..... [1]

(iii) Which substance is most likely to be a gas at room temperature and pressure?

..... [1]

(iv) Which substance is a hydrocarbon?

..... [1]

(v) Determine the simplest formula for substance **D**.

..... [1]

(b) Two isotopes of carbon are $^{13}_{6}C$ and $^{14}_{6}C$.

(i) How do these two isotopes differ in their atomic structure?

..... [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{14}_{6}C$.

..... [1]

[Total: 7]

2 This question is about metals.

(a) The table shows some properties of the metals, **R**, **S**, **T** and **U**.

metal	relative electrical conductivity	relative heat conductivity	density in g/cm^3	melting point / °C
R	4.3	11.8	2.7	660
S	1.2	4.2	7.9	1535
T	6.2	22.3	8.9	1083
U	4.1	12.4	7.1	420

Which metal would be best to make the base of a pan for cooking food?

Use the information in the table to explain your answer.

.....

.....

.....

..... [3]

(b) Zinc chloride can be made by reacting excess zinc with hydrochloric acid.

Suggest how the excess zinc can be removed from the reaction mixture.

..... [1]

(c) Zinc can be obtained from molten zinc chloride by electrolysis.

(i) What is meant by the term *electrolysis*?

.....

..... [2]

(ii) Draw a labelled diagram of the apparatus that could be used to electrolyse molten zinc chloride.

[3]

(d) Give **one** advantage of recycling metals.

..... [1]

[Total: 10]

3 The table gives some information about the halogens.

element	colour	melting point / °C	boiling point / °C
chlorine	light green	–101	–35
bromine	red-brown	–7	+59
iodine	grey-black	+114	+184
astatine		+302	+337

(a) **(i)** Predict the colour of astatine.

..... [1]

(ii) Describe the trend in the boiling points of the halogens.

..... [1]

(iii) Deduce the state of chlorine at –50 °C.

Explain your answer.

.....

..... [2]

(b) **(i)** Complete the word equation for the reaction of bromine with aqueous potassium astatide.

bromine + potassium astatide → ..... + ...

[2]

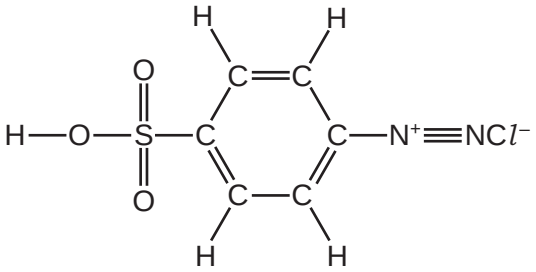
(ii) Suggest why bromine does **not** react with aqueous potassium chloride.

.....

..... [1]

(c) Compound **X** is used to prepare the dye methyl orange.

The structure of compound **X** is shown.



Complete the table and calculate the relative molecular mass of compound **X**.

type of atom	number of atoms	atomic mass	
carbon	6	12	6 × 12 = 72
hydrogen	5	1	5 × 1 = 5
nitrogen	2	14	2 × 14 = 28
sulfur	1	32	1 × 32 = 32
oxygen			
chlorine			

relative molecular mass = ... [2]

(d) Describe how you could use methyl orange to distinguish between solutions of hydrochloric acid and sodium hydroxide.

.....

..... [2]

(e) Methyl orange and Congo red are dyes. A mixture of methyl orange and Congo red can be separated by chromatography.

Draw a labelled diagram to show how the apparatus is arranged to carry out chromatography.

[3]

[Total: 14]

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TURN OVER TO CONTINUE

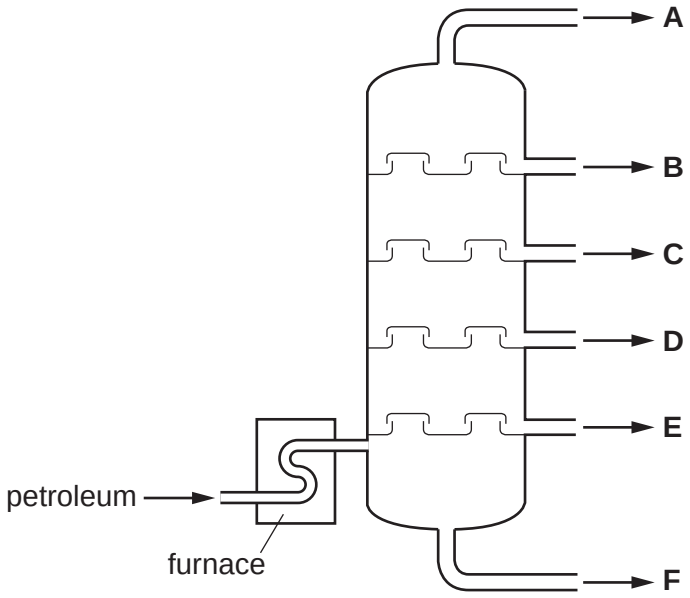
4 Petroleum is a mixture of hydrocarbons.

(a) What is the meaning of the term *hydrocarbon*?

..... [1]

(b) Petroleum can be separated into different fractions by fractional distillation.

The diagram shows a fractionating column. The fractions are shown by letters.



Describe how fractional distillation is used to separate the petroleum into fractions.

In your answer refer to

- changes of state,
- differences in boiling points.

.....

.....

.....

.....

.....

.....

..... [5]

(c) The properties of the fractions are shown in the table.

fraction	number of carbon atoms	percentage by mass of the fraction	boiling range / °C
A	1 – 4	3	less than 40
B	4 – 10	14	40 – 160
C	10 – 16	13	160 – 250
D	16 – 20	9	250 – 300
E	20 – 25	9	300 – 350
F	more than 25		more than 350
		total = 100	

(i) Describe how the number of carbon atoms affects the boiling range.

.....

..... [1]

(ii) Determine the percentage by mass of fraction **F** in this sample of petroleum.

..... [1]

(iii) Which **one** of the fractions is mainly gaseous at 25 °C?

..... [1]

(iv) Fraction **F** is the residue. It contains bitumen.

Give **one** use of bitumen.

..... [1]

(d) Fraction **C** can be cracked to form alkenes.

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

..... [1]

(ii) Complete the chemical equation for the cracking of dodecane, $C_{12}H_{26}$, to form heptane, C_7H_{16}, and one other hydrocarbon.

$$C_{12}H_{26} \rightarrow C_7H_{16} + ...$$

[1]

[Total: 12]

5 Iron is a transition element.

(a) Describe the physical and chemical properties of iron.

.....

.....

.....

.....

..... [5]

(b) Iron carbonyl, $Fe(CO)_5$, is a covalent liquid.

(i) Suggest **two** physical properties of iron carbonyl.

.....

..... [2]

(ii) When heated above 200 °C, iron carbonyl undergoes thermal decomposition.

$$Fe(CO)_5(l) \rightarrow Fe(s) + 5CO(g)$$

Explain why this reaction could have an adverse effect on health if not carried out in a fume cupboard.

.....

..... [2]

[Total: 9]

6 Ethanol can be manufactured by reacting ethene with steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(a) What is the meaning of the symbol $\rightleftharpoons$?

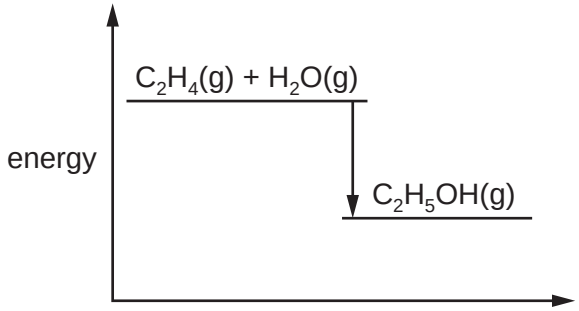
..... [1]

(b) State **two** conditions needed for this reaction.

.....

..... [2]

(c) The energy level diagram for this reaction is shown.



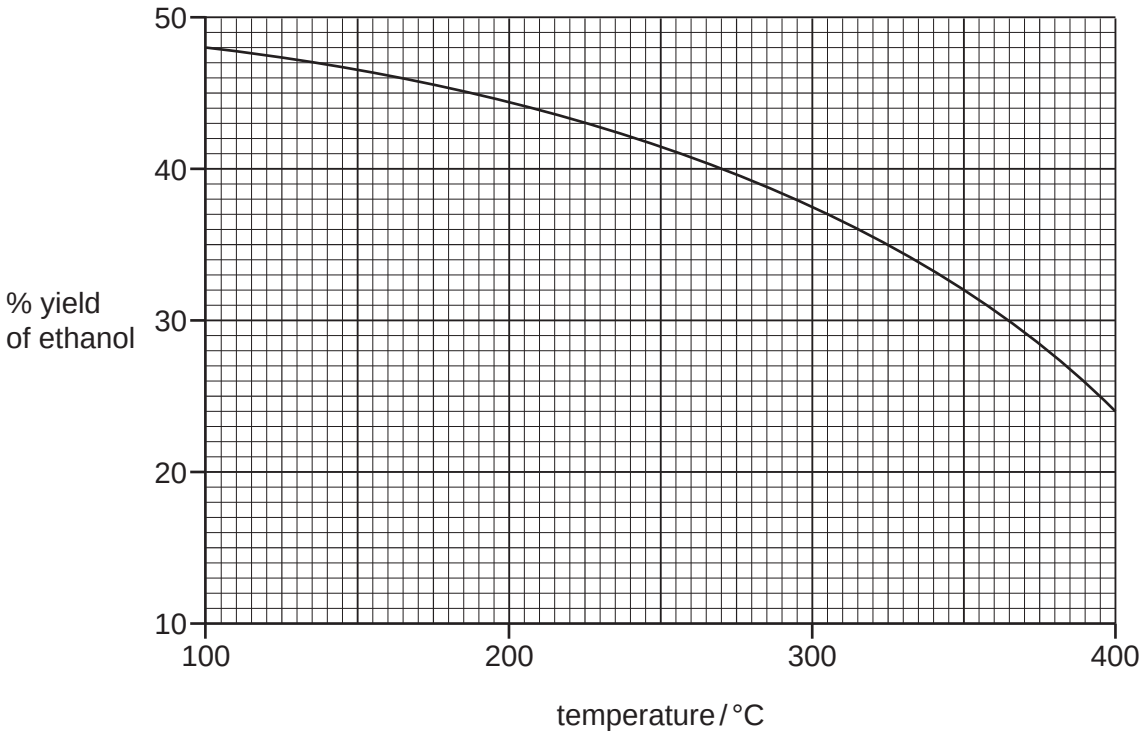
Is this reaction exothermic or endothermic?

Give a reason for your answer.

.....

..... [2]

(d) The graph below shows how the percentage yield of ethanol changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield changes with temperature.

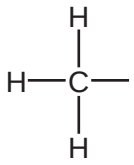
.....

..... [1]

(ii) Determine the percentage yield when the temperature is 350 °C.

..... [1]

(e) **(i)** Complete the structure of ethanol, C_2H_5OH, to show all atoms and all bonds.



[1]

(ii) Give **one** use of ethanol.

..... [1]

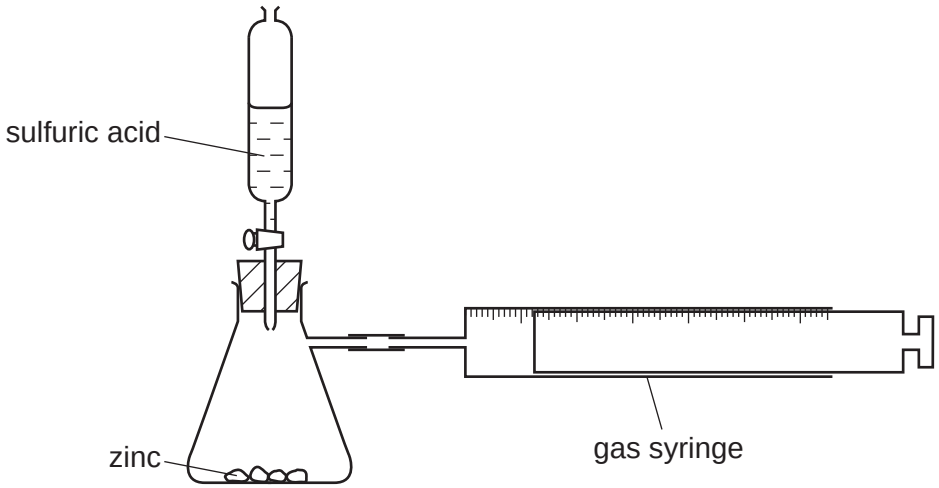
(iii) Complete the chemical equation for the complete combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow ....CO_2 + ...H_2O$$

[2]

[Total: 11]

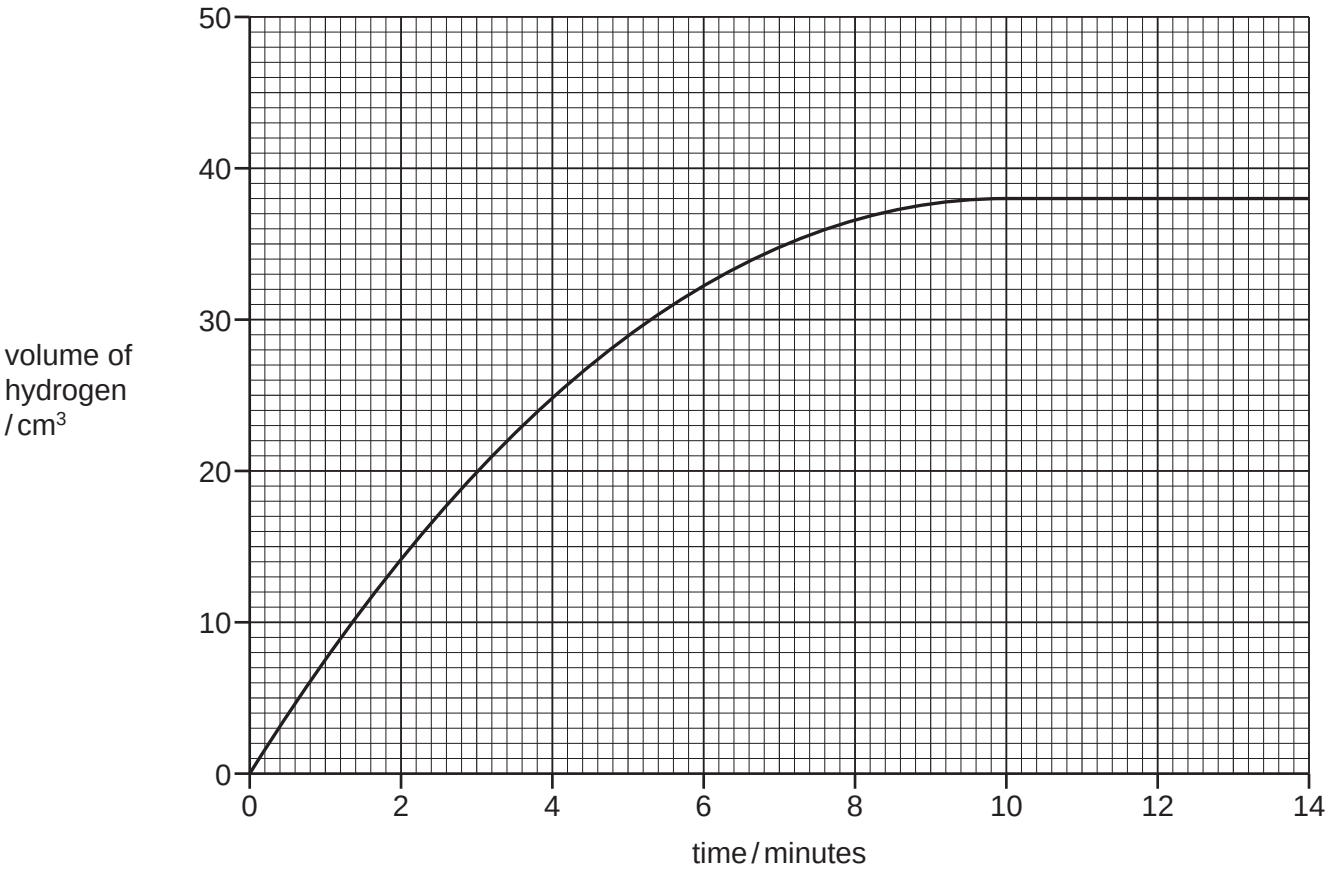
7 A student investigated the reaction between zinc and sulfuric acid at 20 °C using the apparatus shown. The zinc was in excess.



(a) What should the student do to start the reaction?

..... [1]

(b) The graph shows the volume of hydrogen released as the reaction proceeds.



(i) Explain why the volume of gas stays the same after 10 minutes.

..... [1]

(ii) How long did it take for the first 20 cm^3 of gas to be collected?

..... [1]

(iii) The student repeated the experiment at 30 °C. All other conditions remained the same.

Draw the shape of the line **on the grid on page 16** when the reaction was carried out at 30 °C.

[2]

(c) The student repeated the experiment using zinc powder instead of small pieces of zinc.

Describe and explain how the rate of reaction differs when zinc powder is used.

.....

..... [2]

(d) Sulfuric acid is a compound.

(i) What is the meaning of the term *compound*?

.....

..... [1]

(ii) Sulfur is used to make sulfuric acid.

Give **one** source of sulfur.

..... [1]

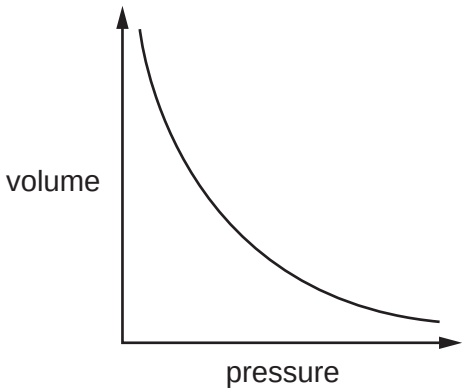
(iii) Sulfur is oxidised by air to form sulfur dioxide.

Give **one** use of sulfur dioxide.

..... [1]

[Total: 10]

8 The graph shows how increasing the pressure at constant temperature changes the volume of a fixed mass of carbon dioxide gas.



(a) Describe how the volume of gas changes with pressure.

.....

.....

..... [2]

(b) What happens to the average distance of the molecules from each other when the pressure is decreased?

..... [1]

(c) Carbon dioxide can be reduced by magnesium.

$$2Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$$

(i) Use the information in the equation to show that carbon dioxide gets reduced.

..... [1]

(ii) Which one of these processes does **not** produce carbon dioxide?

Tick **one** box.

respiration ☐

reaction of an acid with a metal oxide ☐

reaction of an acid with a carbonate ☐

thermal decomposition of limestone ☐

[1]

(iii) Give **two** problems caused by increasing the amount of carbon dioxide in the atmosphere.

.....

.....

..... [2]

[Total: 7]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)