Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

3293960889

CHEMISTRY **0620/31**

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.

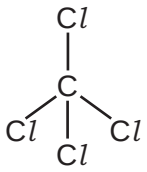
This document consists of **18** printed pages and **2** blank pages.

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1 The structures of some substances containing chlorine are shown.

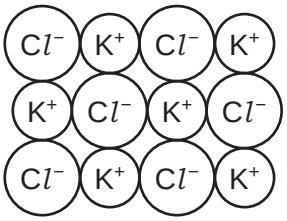
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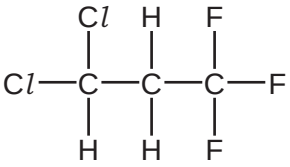
B



C



D



E



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

..... [1]

(ii) Which substance represents part of an ionic structure?

..... [1]

(iii) Which substance is an element?

Explain your answer.

.....

..... [2]

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

..... [1]

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(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

(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 $^{35}_{17}Cl$.

..... [1]

(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.

[2]

[Total: 9]

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2 A bicycle maker wants to choose a suitable material to make bicycle frames.
The table shows the properties of some materials that could be used.

material	relative strength	density in g / cm^3	resistance to corrosion	cost per tonne in $ / tonne
aluminium	8	2.7	very good	1500
iron	21	7.9	poor	450
stainless steel	24	7.9	very good	600
titanium	27	4.5	very good	15000
zinc	14	7.1	good	1300

(a) Which material is the most suitable for making the bicycle frame?

Explain your answer using information from the table.

.....

.....

.....

..... [3]

(b) Aluminium is extracted from aluminium oxide by electrolysis.

(i) State the name of the main ore of aluminium.

..... [1]

(ii) Suggest why aluminium is extracted by electrolysis and **not** by reduction with carbon.

..... [1]

(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). ..... [2]

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(c) The diagram shows the changes of state when zinc vapour is cooled slowly to room temperature.



Explain what happens during these changes in terms of

- the distance between the particles,
- the type of motion shown by the particles.

.....

.....

.....

.....

..... [4]

[Total: 11]

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3 The table shows some properties of the Group I metals.

metal	density in g/cm^3	melting point /°C	boiling point /°C
lithium	0.53	181	1342
sodium		98	883
potassium	0.86	63	760
rubidium	1.53	39	686
caesium		29	669

(a) **(i)** Describe the trend in boiling points of the Group I metals.

..... [1]

(ii) Predict the density of caesium.

..... [1]

(iii) Deduce the state of caesium at 20 °C.

Explain your answer.

.....

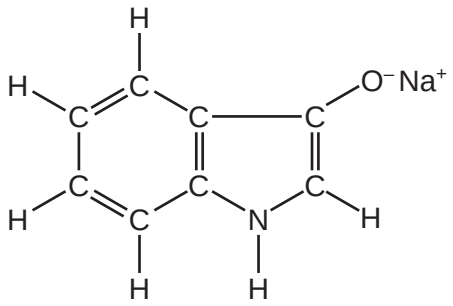
..... [2]

(b) Complete the word equation for the reaction of rubidium with water.

rubidium + water → ..... + ... [2]

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(c) The dye, indigotin, is formed when compound **F** is exposed to air.
The structure of compound **F** is shown below.



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

type of atom	number of atoms	atomic mass	
carbon	8	12	8 × 12 = 96
hydrogen			
nitrogen	1	14	1 × 14 = 14
oxygen	1	16	1 × 16 = 16
sodium			

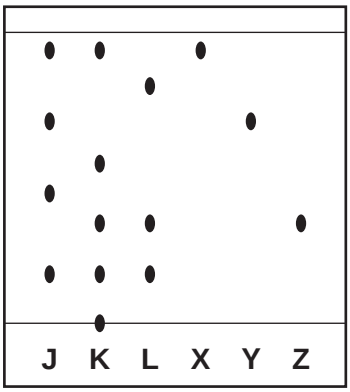
relative molecular mass = ... [2]

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[Turn over

(d) Three dye mixtures, **J**, **K** and **L**, were spotted onto a piece of chromatography paper. Three pure dyes, **X**, **Y** and **Z**, were also spotted onto the same piece of paper.

The diagram shows the results of this chromatography.



(i) Suggest why the base line was drawn in pencil and **not** in ink.

..... [1]

(ii) Which dye mixture, **J**, **K** or **L**, contains a dye which did **not** move during this chromatography?

..... [1]

(iii) Which dye mixture, **J**, **K** or **L**, contains both dye **X** and dye **Y**?

..... [1]

(iv) Which dye mixture, **J**, **K** or **L**, does **not** contain dye **Z**?

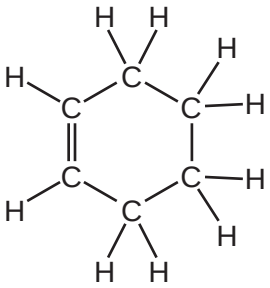
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[Total: 12]

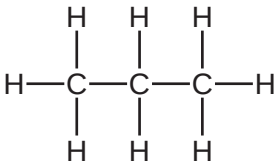
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4 The structures of some organic compounds are shown.

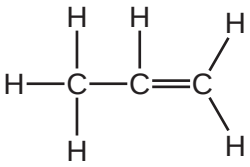
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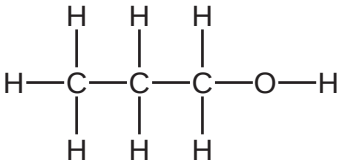
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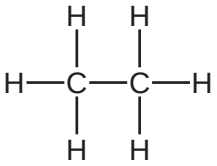
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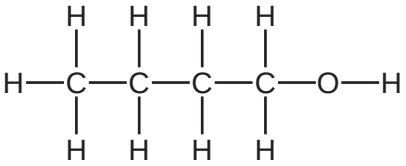
S



T



U



(a) **(i)** Which **two** of these compounds are alcohols?

Explain your answer.

.....

..... [2]

(ii) Which **two** of these compounds are saturated hydrocarbons?

..... [1]

(b) Methanol and ethanol are alcohols in the same homologous series.

Complete the following sentence about a homologous series using words from the list.

alcohols	**chemical**	**compounds**	**elements**
functional	**mixtures**	**physical**	

A homologous series is a family of similar ..... with similar

..... properties due to the same ..... group. [3]

(c) Ethene is an alkene.

(i) Draw the structure of ethene showing all atoms and all bonds.

[1]

(ii) Describe how aqueous bromine is used to show that ethene is an unsaturated compound.

.....

..... [2]

(iii) Ethene is manufactured by cracking.

State the conditions needed for cracking.

..... [1]

(iv) Complete the chemical equation for the cracking of hexadecane, $C_{16}H_{34}$, to form propene and one other hydrocarbon.

$$C_{16}H_{34} \rightarrow C_3H_6 + ...$$

[1]

[Total: 11]

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5 The Group VII elements are called the halogens.

(a) Describe the trends in

- the physical properties of the halogens,
- the reactivity of halogens with other halide ions.

Include a relevant word equation in your answer.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Iodine reacts with hot concentrated nitric acid.

$$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 4H_2O + 10NO_2$$

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

.....

..... [2]

(ii) Nitric acid is strongly acidic.

Which one of the following pH values represents a strongly acidic solution?

Put a ring around the correct answer.

pH 1 pH 7 pH 9 pH 13

[1]

(iii) Nitric acid reacts with zinc oxide.

State the names of the products of this reaction.

..... and .....

[2]

[Total: 10]

6 Ammonia is manufactured by the reaction of nitrogen with hydrogen in the presence of a catalyst.

(a) What is the purpose of a catalyst?

..... [1]

(b) The reaction is reversible.

Complete the equation below by adding the sign for a reversible reaction.

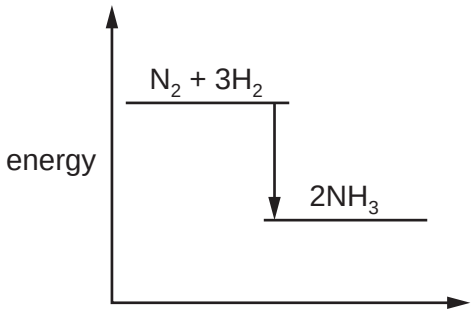
$$N_2 + 3H_2 \quad \quad 2NH_3$$

[1]

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

Is this reaction exothermic or endothermic?

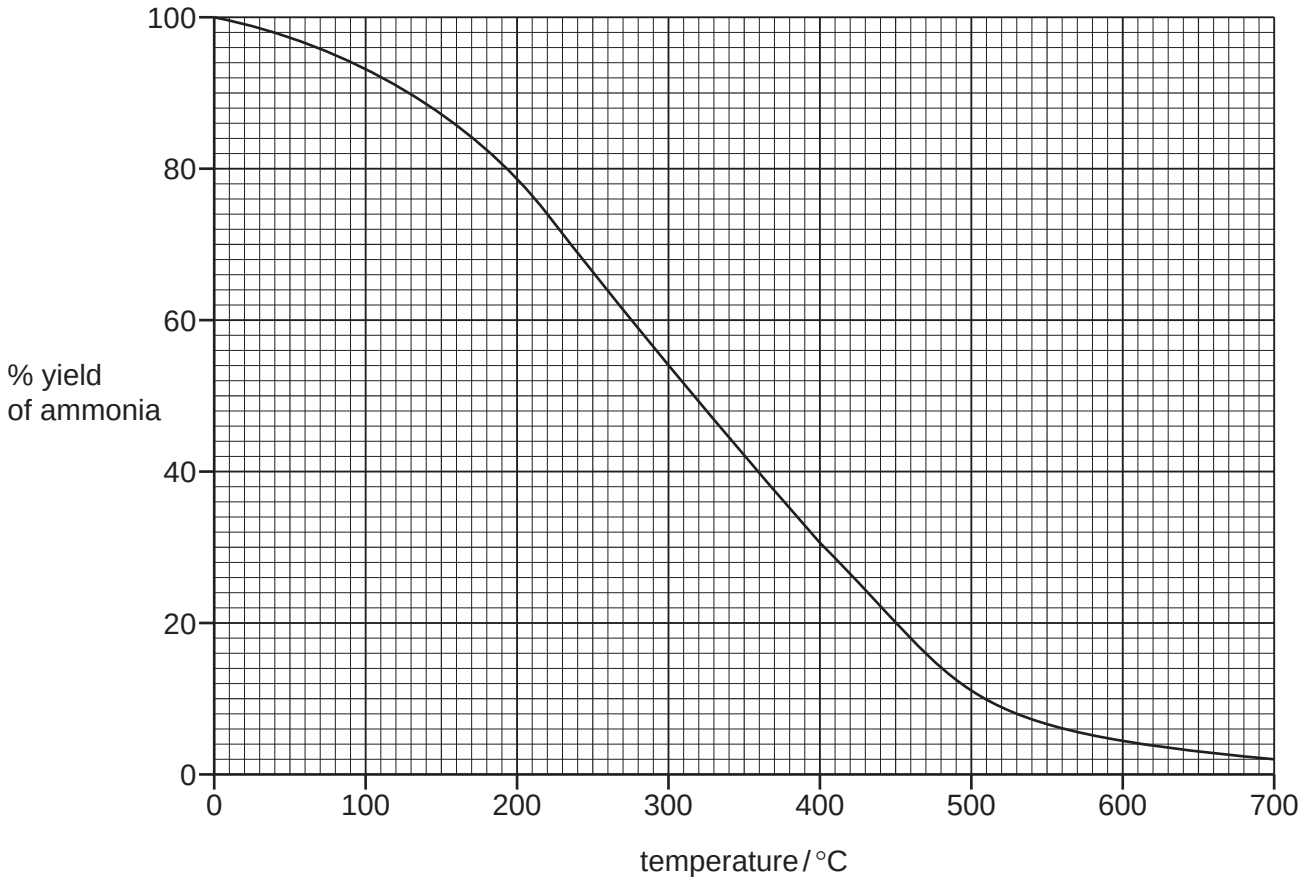
Give a reason for your answer.



.....

..... [1]

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



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

..... [1]

(ii) Determine the percentage yield of ammonia at 350 °C.

..... [1]

(e) Describe a test for ammonia.

test.....

result..... [2]

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(f) Ammonia is a weak base.

Describe how you would measure the pH of an aqueous solution of a weak base using Universal Indicator.

.....

..... [2]

(g) Complete the chemical equation for the reaction of ammonia with chlorine.

$$.....NH_3 + 3Cl_2 \rightarrow N_2 + ...HCl$$

[2]

[Total: 11]

7 Calcium carbonate reacts with dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

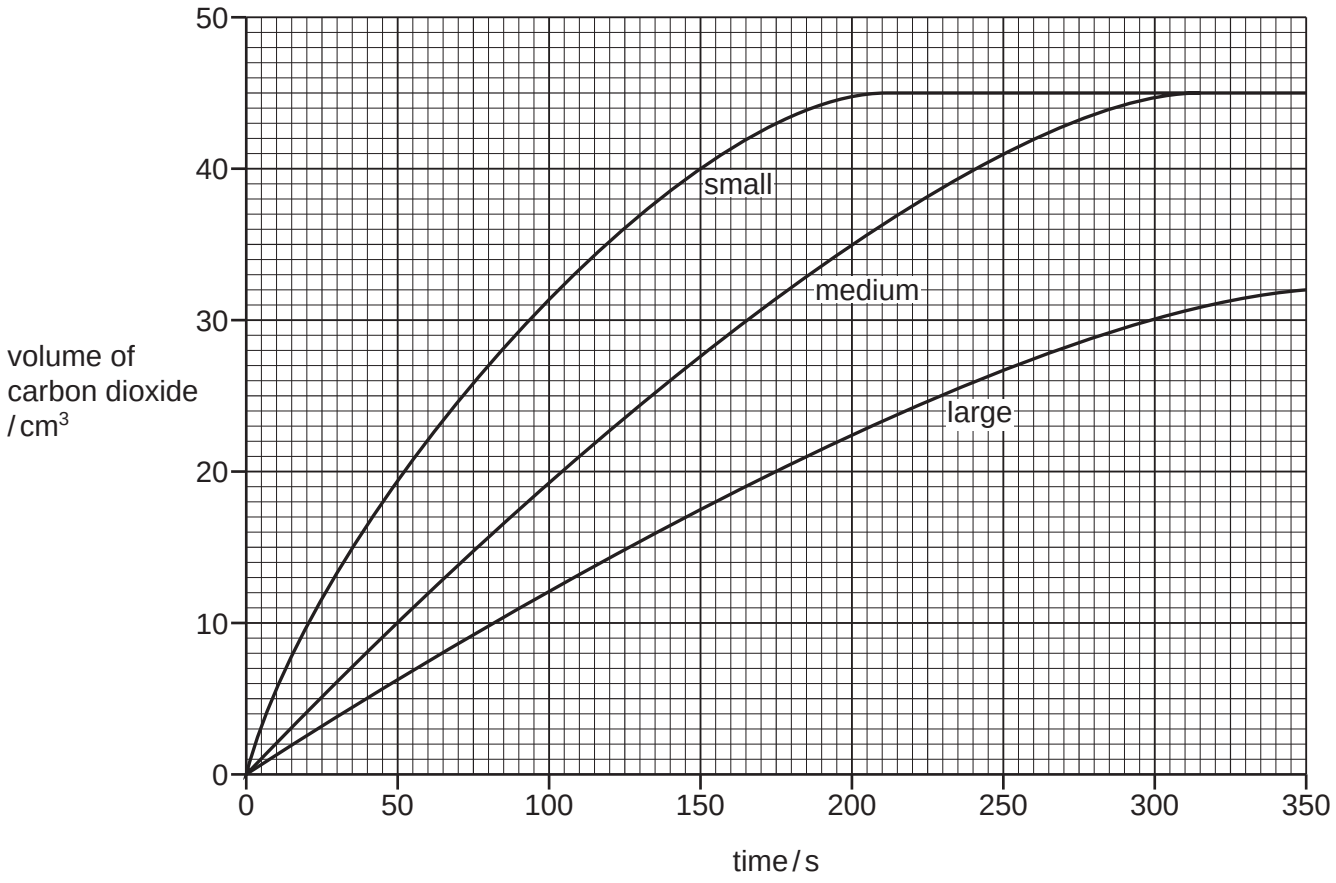
A student investigated this reaction by measuring the volume of carbon dioxide released every minute at constant temperature.

(a) Draw a diagram of the apparatus that the student could use to investigate this reaction.

[2]

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(b) The graph shows the results of this reaction using three samples of calcium carbonate of the same mass: large pieces, medium-sized pieces and small pieces.



(i) Which sample, large, medium or small pieces, gave the fastest initial rate of reaction?

Use the graph to explain your answer.

.....

..... [2]

(ii) The experiment was repeated using powdered calcium carbonate of the same mass. Draw a line **on the grid above** to show how the volume of carbon dioxide changes with time for this experiment. [2]

(iii) At what time was the reaction just complete when small pieces of calcium carbonate were used?

..... [1]

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(c) When calcium carbonate is heated strongly, calcium oxide is formed.

(i) Give **one** use of calcium oxide.

..... [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

.....

..... [2]

[Total: 10]

8 A teacher passed hydrogen gas over hot copper(II) oxide.

$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

(a) Which substance is reduced in this reaction?

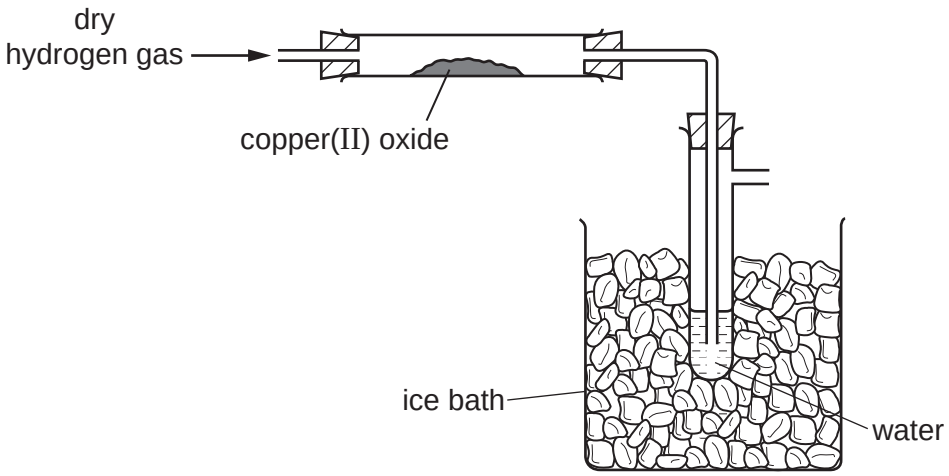
Explain your answer.

.....

..... [2]

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(b) The diagram shows the apparatus used.



The hydrogen was passed over the hot copper(II) oxide until the reaction was complete.

(i) As the experiment proceeds, suggest what happens to the mass of copper(II) oxide.

..... [1]

(ii) Suggest why electrical heating is used in this experiment and **not** a Bunsen burner.

..... [1]

(iii) Describe the chemical test for the presence of water.

test.....

result..... [2]

[Total: 6]

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The Periodic Table of Elements

	Group																	
	I	II										III	IV	V	VI	VII	VIII
								1 H hydrogen 1									2 He helium 4
Key atomic number / atomic symbol / name / relative atomic mass	3 Li lithium 7	4 Be beryllium 9										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 –	113	114 Fl flerovium –	115	116 Lv livermorium –	117	118

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.)

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