Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

3304301344

CHEMISTRY **0620/23**

Paper 2 **October/November 2014**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
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 16.
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 **16** printed pages.

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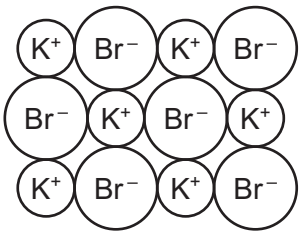
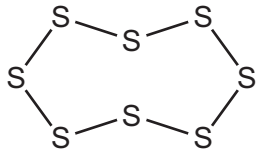
1 **(a)** The structures of five substances, **A**, **B**, **C**, **D** and **E**, are shown below.

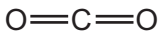
A



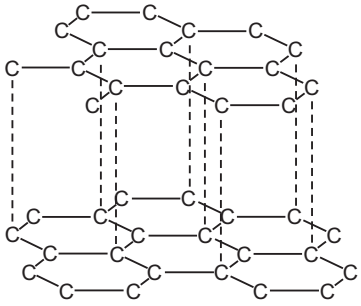
B



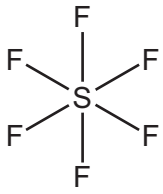
C



D



E



Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

(i) Which **two** substances are elements? ..... and ..... [2]

(ii) Which substance has a giant ionic structure? ..... [1]

(iii) Which substance is a product formed when a hydrocarbon is completely burnt in air?

..... [1]

(iv) Which substance, when molten, produces a brown vapour at the anode when electrolysed?

..... [1]

(v) Which substance is used as a lubricant? ..... [1]

(b) Deduce the simplest formula of substance **A**.

..... [1]

(c) Calculate the relative molecular mass of substance **E**.
You must show your working.

[2]

[Total: 9]

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2 **(a)** Use ideas about the movement and arrangement of particles to explain why:

- solids have a definite volume and shape,
- liquids have a definite volume but no definite shape,
- gases have no definite volume or shape.

.....

.....

.....

.....

.....

..... [4]

(b) The table shows some properties of six substances, **A** to **F**, which are either solids or liquids at room temperature.

substance	melting point / °C	electrical conductivity	solubility in water
A	+3550	does not conduct in any state	insoluble
B	+44	does not conduct in any state	insoluble
C	+1660	conducts when solid or liquid	insoluble
D	+681	only conducts when in aqueous solution or liquid	soluble
E	–39	conducts when solid or liquid	insoluble
F	–11	does not conduct in any state	insoluble

(i) Which substance has a giant covalent structure?

..... [1]

(ii) Which **two** substances are liquids at room temperature?

..... [2]

(iii) Which **two** substances are metals?

..... [2]

(iv) Which **two** substances are simple molecules?

..... [2]

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[Turn over

(c) Dry air contains mainly nitrogen, noble gases and oxygen.

(i) Which **one** of the following shows the correct composition of dry air?
Tick **one** box.

nitrogen 21%, oxygen 78%, noble gases 1%	☐
nitrogen 1%, oxygen 78%, noble gases 21%	☐
nitrogen 69%, oxygen 21%, noble gases 10%	☐
nitrogen 78%, oxygen 21%, noble gases 1%	☐

[1]

(ii) Metals can be joined together by high temperature welding.
This process is sometimes carried out in the presence of argon.
Suggest why welding is carried out in the presence of argon.

.....

..... [2]

[Total: 14]

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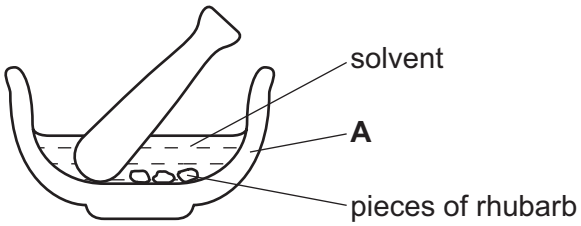
3 Rhubarb is a plant which has a red stem.

(a) A student separated the pigments in the rhubarb stem by chromatography.
He used the apparatus shown below to extract the pigments.



(i) State the name of the piece of apparatus labelled **A**.

..... [1]

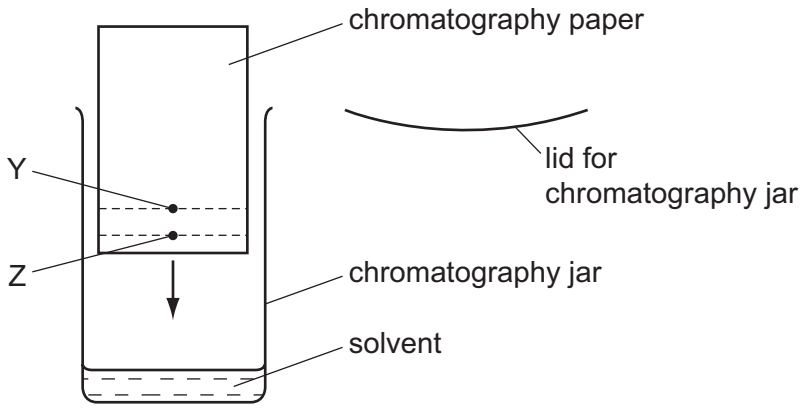
(ii) Suggest a suitable solvent, other than water, that he could use to extract the pigments.

..... [1]

(iii) The solution of pigments was not concentrated enough to use for chromatography.
Suggest how the student could make the solution more concentrated.

..... [1]

(b) The student carried out chromatography using the apparatus shown below.



(i) A spot of the pigment mixture was placed at Y.
Explain why a spot of the mixture was not placed at Z.

..... [1]

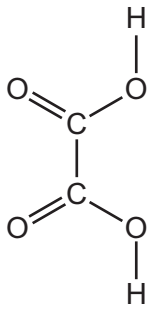
(ii) Describe how the rest of the procedure was carried out.

.....

.....

..... [2]

(c) Rhubarb leaves contain ethanedioic acid.
The structure of ethanedioic acid is shown below.



(i) On the structure above, put a ring around a carboxylic acid group. [1]

(ii) Deduce the molecular formula of ethanedioic acid.

..... [1]

(d) A teacher heated ethanedioic acid with concentrated sulfuric acid.
The equation for the reaction is:

$$\begin{matrix}\text{COOH}\\|\\\text{COOH(s)}\end{matrix} \xrightarrow{H_2SO_4} \text{CO(g)} + \text{CO}_2\text{(g)} + \mathbf{X}$$

(i) Deduce the formula of compound **X**.

..... [1]

(ii) At the end of the reaction, the contents of the test-tube contained diluted sulfuric acid only.
Explain why.

..... [1]

(iii) Carbon dioxide is a product of this reaction.
State **one** common source of the carbon dioxide in the atmosphere.

..... [1]

(iv) Explain why an increase in the concentration of carbon dioxide in the atmosphere is harmful to the environment.

.....

..... [2]

[Total: 13]

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4 A mixture of soil and water was shaken and then filtered.

(a) Draw a labelled diagram of the apparatus you would use for separating the insoluble particles of soil from the solution.

[2]

(b) The filtrate was then evaporated.
The table shows the composition and mass of each compound obtained by evaporating the filtrate.

compound	ions present in the compound	mass of compound / g
calcium carbonate	Ca^{2+} and CO_3^{2-}	4.0
calcium sulfate	Ca^{2+} and SO_4^{2-}	5.0
magnesium sulfate	Mg^{2+} and SO_4^{2-}	2.8
	K^+ and NO_3^-	1.2
potassium sulfate	K^+ and SO_4^{2-}	2.4
sodium carbonate		3.0
sodium chloride	Na^+ and Cl^-	1.6

(i) State the name of the compound which contains K^+ and NO_3^- ions.

..... [1]

(ii) Write the symbols for the ions present in sodium carbonate.

..... [1]

(iii) Which compound with a singly charged negative ion has the highest mass in the mixture?

..... [1]

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[Turn over

The table from page 7 is repeated below:

compound	ions present in the compound	mass of compound / g
calcium carbonate	Ca^{2+} and CO_3^{2-}	4.0
calcium sulfate	Ca^{2+} and SO_4^{2-}	5.0
magnesium sulfate	Mg^{2+} and SO_4^{2-}	2.8
	K^+ and NO_3^-	1.2
potassium sulfate	K^+ and SO_4^{2-}	2.4
sodium carbonate		3.0
sodium chloride	Na^+ and Cl^-	1.6

(iv) Calculate:

the total mass of all the compounds present in the mixture,

..... [1]

the percentage of magnesium sulfate by mass in the mixture.

[1]

(c) Calcium carbonate decomposes when heated.

(i) Complete the symbol equation for this reaction.

$$CaCO_3 \rightarrow CaO + ...$$

[1]

(ii) Calcium oxide, CaO, reacts with water to form a strongly alkaline solution.
Which **one** of the following pH values is strongly alkaline?
Put a ring around the correct answer.

pH 3 **pH 7** **pH 8** **pH 12**

[1]

[Total: 9]

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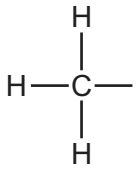
5 Methanol reacts with excess hydrochloric acid to form chloromethane and water.

methanol + hydrochloric acid $\rightarrow$ chloromethane + water

(a) To which homologous series does methanol belong?

..... [1]

(b) Complete the structure of methanol below to show its functional group.



[1]

(c) Methanol can be made from synthesis gas which contains carbon monoxide and hydrogen. Synthesis gas is made from methane.

(i) Complete the symbol equation for this reaction.

$$CH_4 + H_2O \rightarrow CO + ...H_2$$

[1]

(ii) Suggest **two** hazards associated with the products of this reaction.

.....

..... [2]

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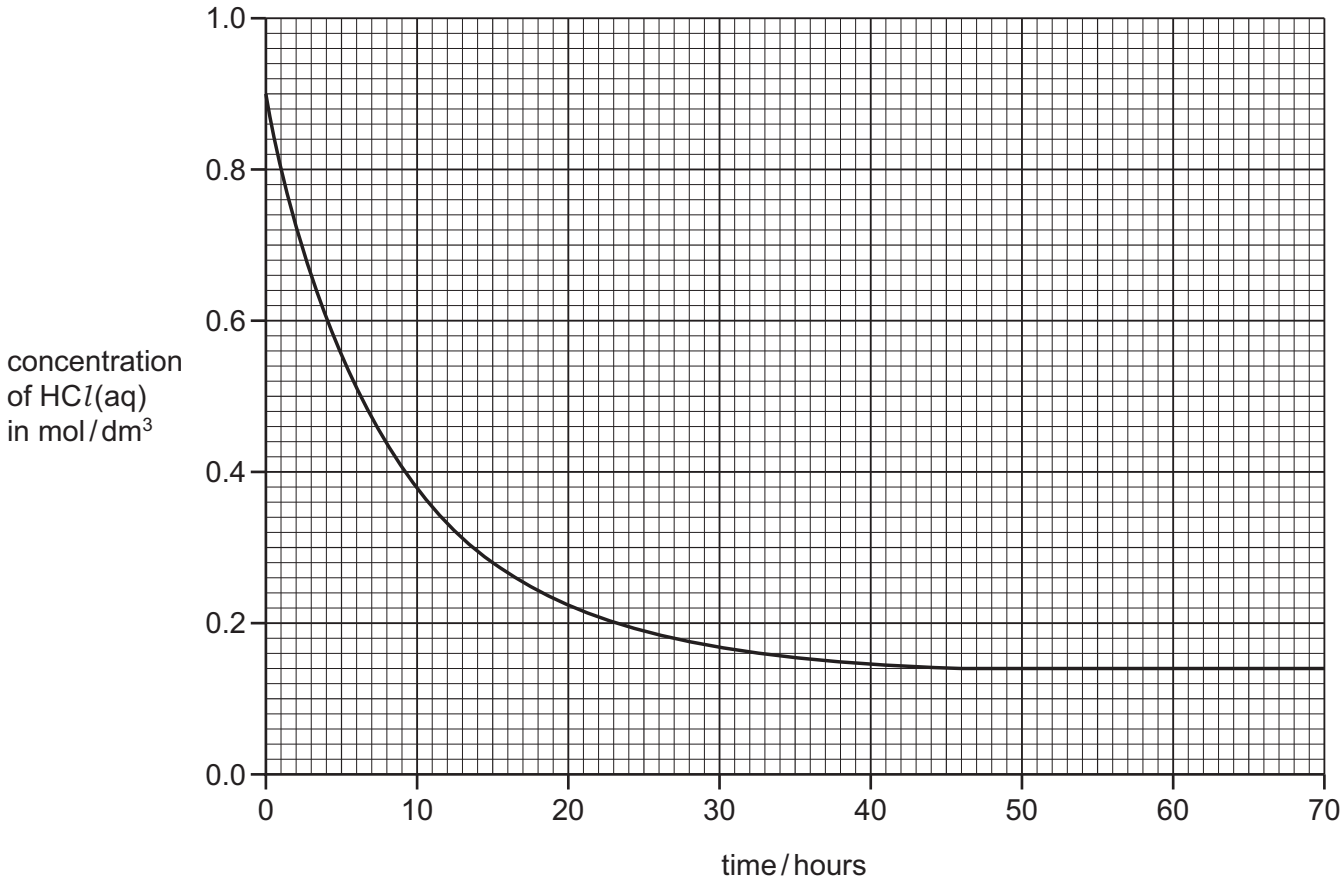
[Turn over

(d) A student investigated the rate of reaction of methanol with hydrochloric acid.
The graph below shows how the concentration of hydrochloric acid changes with time.



(i) Describe how the concentration of hydrochloric acid changes with time.

.....

..... [2]

(ii) Deduce the concentration of hydrochloric acid when the reaction had proceeded for 15 hours.

..... [1]

(iii) At what time was the reaction just complete?

..... [1]

(iv) On the grid above, draw a line to show how the concentration of hydrochloric acid changes with time when the reaction takes place at a higher temperature. [2]

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(e) Hydrochloric acid is formed when hydrogen chloride gas is dissolved in water.
Draw a dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen chloride.
Show only the outer electron shells.
Show hydrogen electrons as x.
Show chlorine electrons as ●.

[2]

[Total: 13]

6 Sulfur burns in air to form sulfur dioxide.

(a) (i) Is sulfur dioxide an acidic or basic oxide?
Give a reason for your answer.

.....

..... [1]

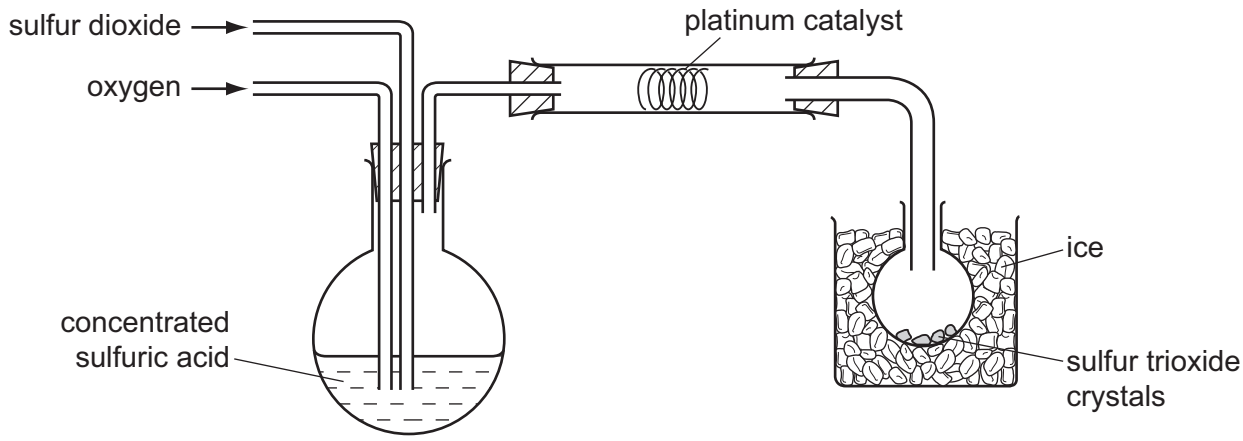
(ii) Sulfur dioxide is an atmospheric pollutant.
Explain why sulfur dioxide in the atmosphere can erode buildings made of limestone.

.....

.....

..... [3]

(b) Sulfur dioxide reacts with oxygen to form sulfur trioxide.
Sulfur trioxide can be made in the laboratory using the apparatus shown below.
Sulfur trioxide has a melting point of 17 °C and a boiling point of 45 °C.



(i) Suggest **one** safety precaution when carrying out this experiment.

..... [1]

(ii) What is the purpose of the platinum catalyst?

..... [1]

(iii) Complete the symbol equation for the reaction.

$$2SO_2 + \text{.....} \rightarrow \text{.....}SO_3$$

[2]

(iv) Suggest why the sulfur trioxide is collected in a flask surrounded by ice.

..... [1]

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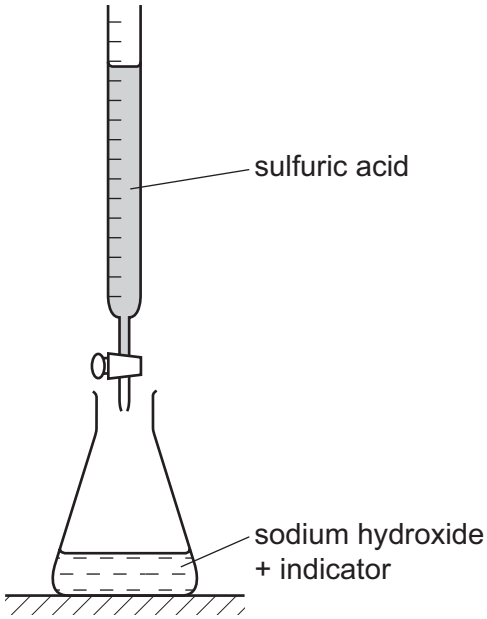
(v) When 64 g of sulfur dioxide react with excess oxygen, 80 g of sulfur trioxide is formed.
Calculate the mass of sulfur trioxide formed from 160 g of sulfur dioxide.

mass = ... g [1]

(c) Sulfur trioxide reacts with water to form sulfuric acid.
A student used the apparatus shown below to determine the concentration of a solution of sodium hydroxide.



(i) Which **one** of these pieces of apparatus should the student use to put 25.0 cm^3 of sodium hydroxide into the flask.
Tick **one** box.

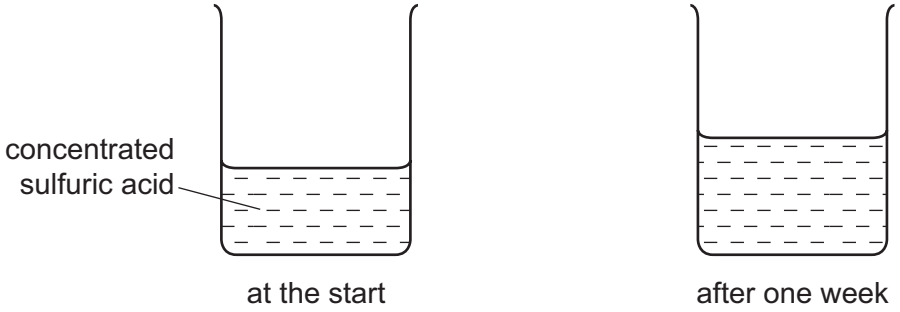
beaker	☐
measuring cylinder	☐
test-tube	☐
volumetric pipette	☐

[1]

(ii) How would the student know when the sulfuric acid had neutralised the sodium hydroxide?

..... [1]

(d) Clean air contains mainly nitrogen, noble gases, oxygen and water vapour.
A teacher left a beaker of concentrated sulfuric acid open to the air for a week.
After a week, the concentration of sulfuric acid in the beaker had decreased.



Explain these results by referring to one or more of the substances present in the air.

.....

..... [1]

[Total: 13]

7 **(a)** Describe the properties of chlorine, bromine and iodine.

In your answer, include the trends in:
- their state,
- their colour,
- their reactivity.

.....

.....

.....

.....

..... [4]

(b) A molecule of chlorine can be written as $Cl–Cl$.
Which **one** of the following words describes this molecule?
Put a ring around the correct answer.

diatomic **giant** **ionic** **monatomic**

[1]

(c) Draw the electronic structure of a fluorine atom.

[2]

(d) The equation below describes the reaction of a halogen with a halide.

$$Br_2 + 2KI \rightarrow I_2 + 2KBr$$

Write a word equation for this reaction.

[2]

[Total: 9]

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DATA SHEET
The Periodic Table of the Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
							1 **H** Hydrogen 1									4 **He** Helium 2
	7 **Li** Lithium 3	9 **Be** Beryllium 4									11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
	23 **Na** Sodium 11	24 **Mg** Magnesium 12									27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
	39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
	85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	101 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
	133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83		209 **At** Astatine 85	222 **Rn** Radon 86
	223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

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