



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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CENTRE
NUMBER

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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.

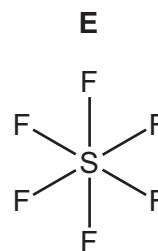
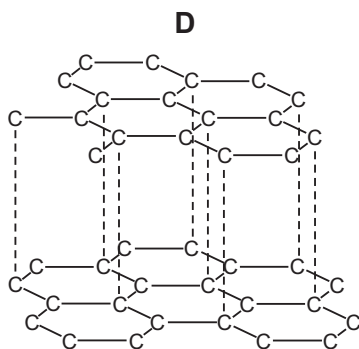
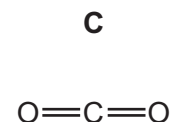
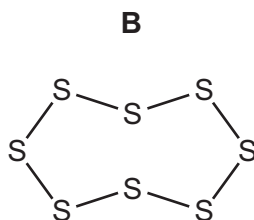
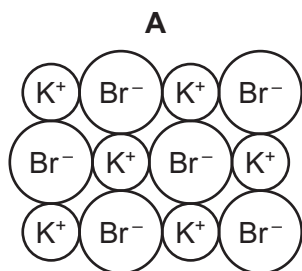
At the end of the examination, fasten all your work securely together.

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.

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



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]

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]

(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.

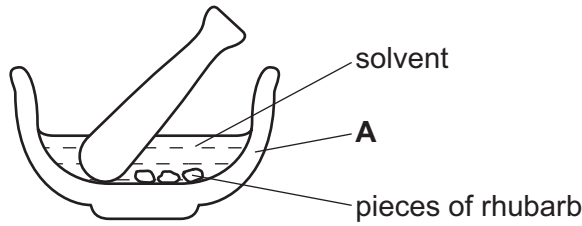
.....

..... [2]

[Total: 14]

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]

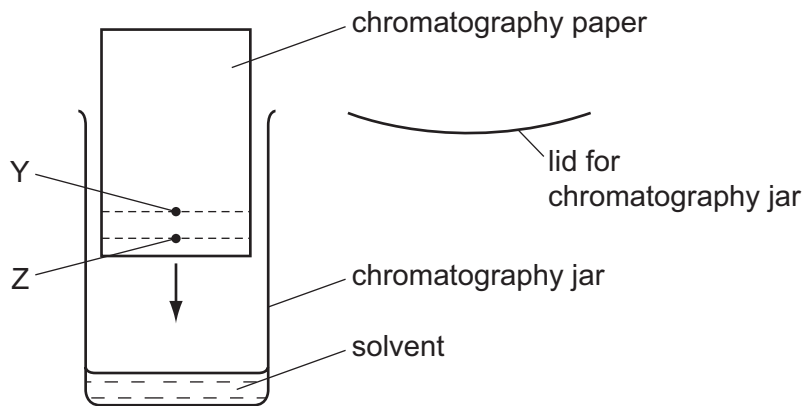
(ii) Suggest a suitable solvent, other than water, that he could use to extract the pigments.

..... [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.

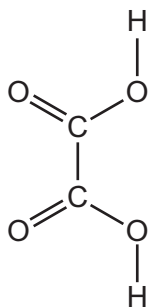
..... [1]

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

.....

 [2]

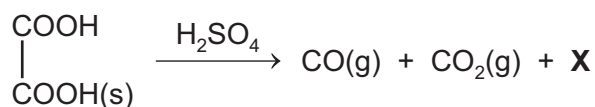
- (c) Rhubarb leaves contain ethanedioic acid.
The structure of ethanedioic acid is shown below.



- (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:



- (i) Deduce the formula of compound **X**. [1]
- [1]

- (ii) At the end of the reaction, the contents of the test-tube contained diluted sulfuric acid only.
Explain why. [1]
- [1]

- (iii) Carbon dioxide is a product of this reaction.
State **one** common source of the carbon dioxide in the atmosphere. [1]
- [1]

- (iv) Explain why an increase in the concentration of carbon dioxide in the atmosphere is harmful to the environment. [2]
- [2]
- [2]

[Total: 13]

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]

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.



[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]

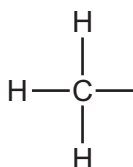
5 Methanol reacts with excess hydrochloric acid to form chloromethane and water.



(a) To which homologous series does methanol belong?

..... [1]

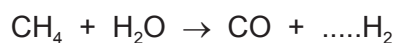
(b) Complete the structure of methanol below to show its functional group.



[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.

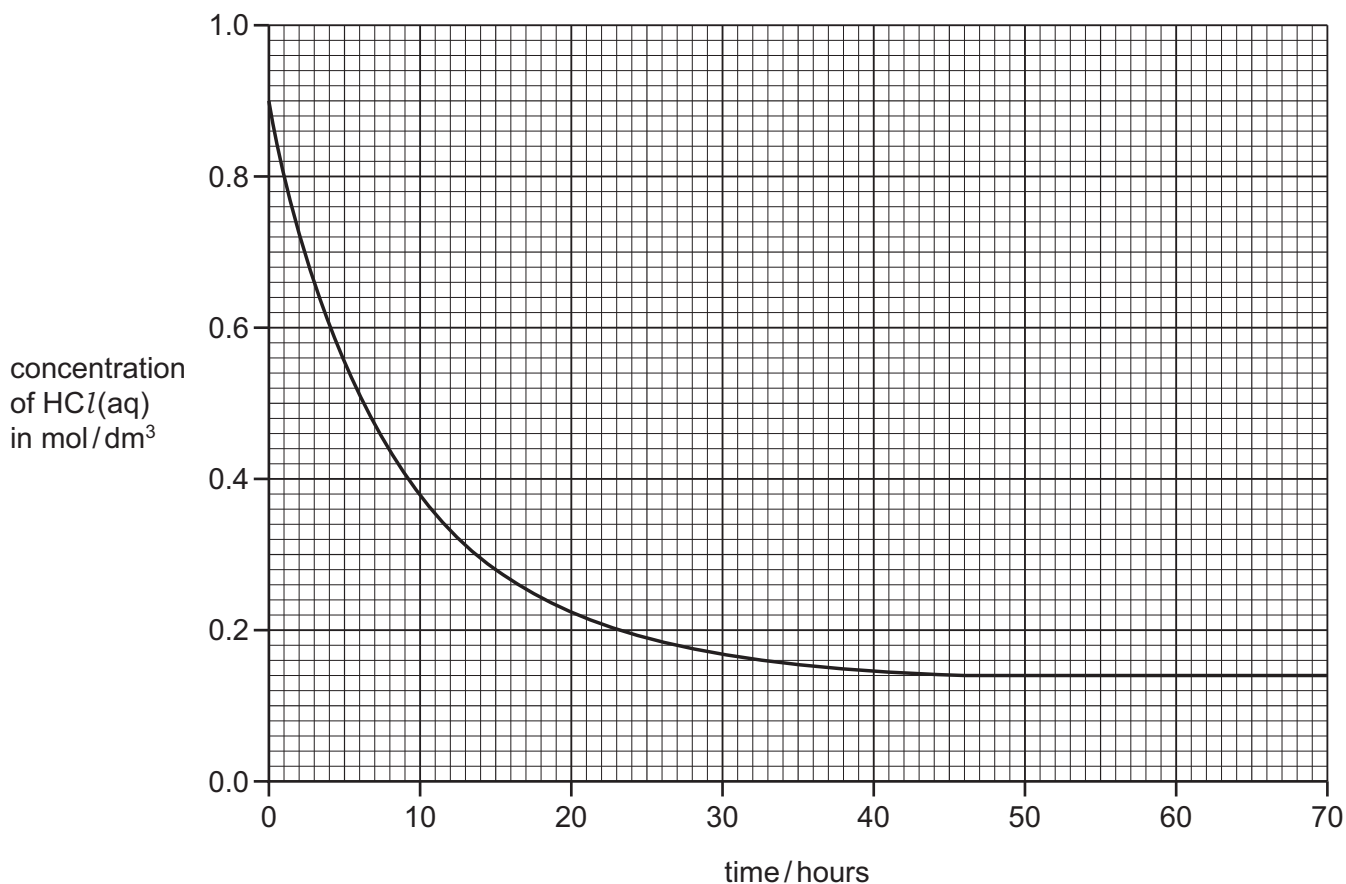


[1]

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

.....
 [2]

- (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]

- (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.

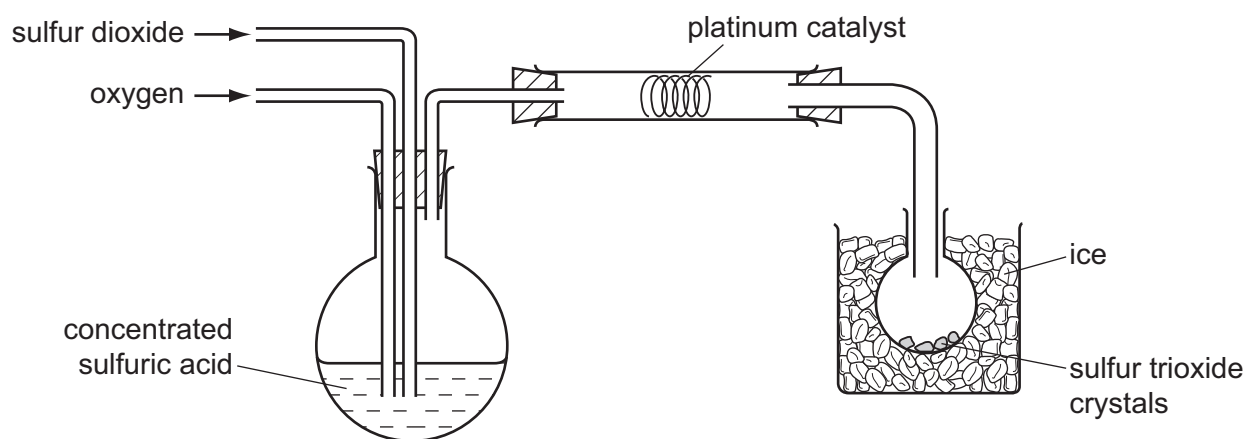
.....

 [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.



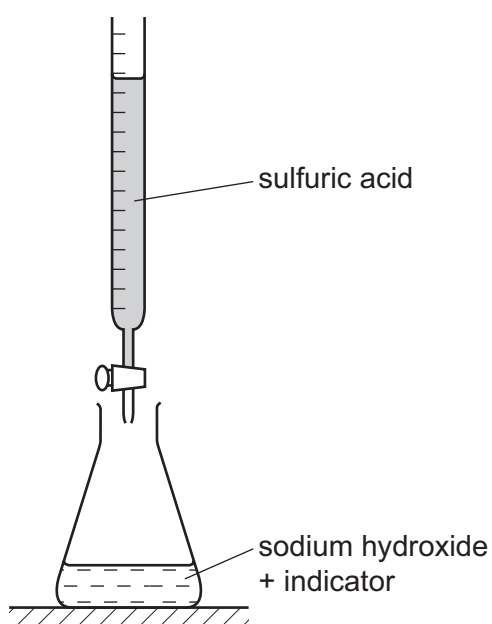
(iv) Suggest why the sulfur trioxide is collected in a flask surrounded by ice.

..... [1]

- (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 cm³ of sodium hydroxide into the flask.
Tick **one** box.

beaker

measuring cylinder

test-tube

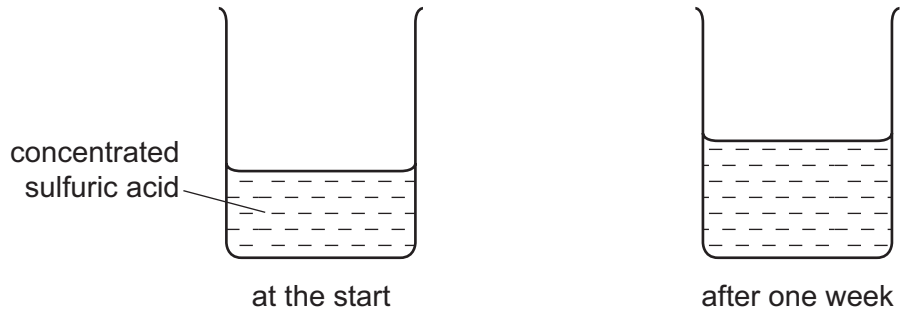
volumetric pipette

[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.



Write a word equation for this reaction.

[2]

[Total: 9]

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 | 96 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 | 210 Po Polonium 84 | 210 At Astatine 85 | 210 Rn Radon 86 | |
| 87 Fr Francium | 226 Ra Radium 88 | 227 Ac Actinium 89 | | | | | | | | | | | | | | | | |

*58-71 Lanthanoid series

†90-103 Actinoid series

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

| | | | | | | | | | | | | | |
|-----------------------------------|--|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|
| 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 147 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 | 232 Pa Protactinium 91 | 238 U Uranium 92 | 238 Np Neptunium 93 | 244 Pu Plutonium 94 | 247 Am Americium 95 | 251 Cm Curium 96 | 257 Bk Berkelium 97 | 261 Cf Californium 98 | 265 Es Einsteinium 99 | 267 Fm Fermium 100 | 268 Md Mendelevium 101 | 269 No Nobelium 102 | 277 Lr Lawrencium 103 |

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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