Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

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| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | |

**CHEMISTRY** **0620/21**

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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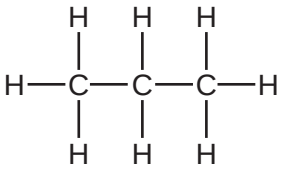
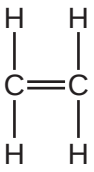
CAMBRIDGE International Examinations

**1** The structures of five carbon compounds are shown below.

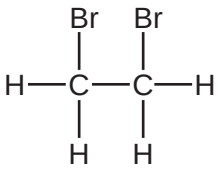
**A**



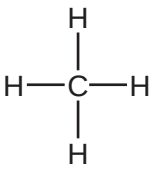
**B**



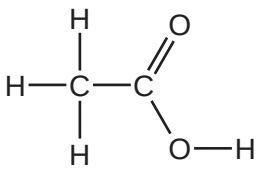
**C**



**D**



**E**



View solution

**(a)** Answer the following questions about these compounds. Each compound may be used once, more than once or not at all.

**(i)** Which compound, **A**, **B**, **C**, **D** or **E**, is ethanoic acid? ..... [1]

**(ii)** Which **two** compounds are saturated hydrocarbons? ..... and ..... [1]

**(iii)** Which compound is the main constituent of natural gas? ..... [1]

**(iv)** Which compound reacts with steam to form ethanol? ..... [1]

**(v)** Which compound is causing concern as a greenhouse gas? ..... [1]

**(vi)** Which **two** compounds are in the same homologous series? ..... and ..... [1]

View solution

**(b)** Deduce the molecular formula for compound **C**.

..... [1]

View solution

**(c)** Complete the symbol equation for the complete combustion of compound **A**.

$$C_3H_8 + .....O_2 \rightarrow 3CO_2 + .....H_2O$$ [2]

[Total: 9]

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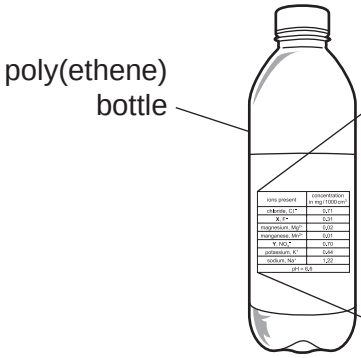
**2** The diagram shows a bottle of mineral water. The concentration of the ions present in the water is shown on the label. The pH of the water is also shown.




| ions present | concentration in mg / 1000 cm$^3$ |
|---|---|
| chloride, $Cl^-$ | 0.71 |
| **X**, $F^-$ | 0.31 |
| magnesium, $Mg^{2+}$ | 0.02 |
| manganese, $Mn^{2+}$ | 0.01 |
| **Y**, $NO_3^-$ | 0.70 |
| potassium, $K^+$ | 0.44 |
| sodium, $Na^+$ | 1.22 |
| pH = 6.6 | |

**(a) (i)** Which positively charged ion is present in the highest concentration?

View solution

..... [1]

**(ii)** State the name of:

View solution

ion **X** .....

ion **Y** .....

[2]

**(iii)** Calculate the mass, in mg, of sodium ions in 200 cm$^3$ of mineral water.

View solution

..... mg [1]

**(iv)** Which **one** of the following phrases best describes the pH of this mineral water?
Tick **one** box.

View solution

| | |
|---|---|
| neutral | ☐ |
| strongly acidic | ☐ |
| strongly alkaline | ☐ |
| weakly acidic | ☐ |
| weakly alkaline | ☐ |

[1]

**(b)** Describe a test for chloride ions.

View solution

test .....

result .....

[2]

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**(c)** The mineral water bottle is made of poly(ethene).

View solution

Complete the following sentence about poly(ethene) using words from the list below.

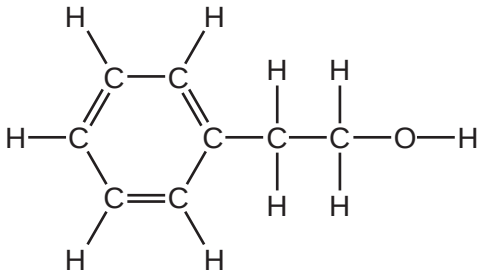
**atom ionic monomer polymer reactant saturated**

Poly(ethene) is a ..... made by the addition of ..... units.

[2]

[Total: 9]

**3** Rose oil contains 2-phenylethanol.
The structure of 2-phenylethanol is shown below.



View solution

**(a)** On the structure above, draw a ring around the alcohol functional group. [1]

**(b)** When heated with an alkali, 2-phenylethanol forms styrene.
Styrene is an unsaturated compound.
Describe a test for an unsaturated compound.

View solution

test .....

result .....

[2]

**(c)** Rose petals contain a variety of different coloured pigments.
A student wants to identify these pigments.

View solution

**(i)** She grinds up rose petals with a solvent.
Explain why.

.....

.....

..... [2]

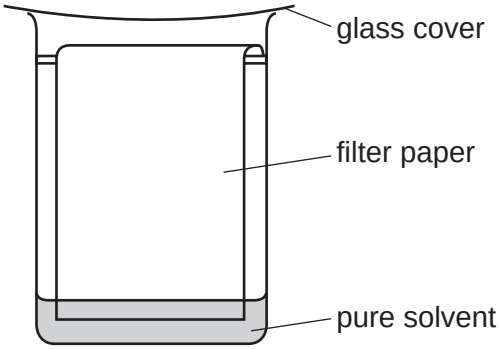
**(ii)** She then filters the solution through some glass wool.
Suggest why she does not use filter paper.

View solution

..... [1]

**(d)** The student uses the apparatus shown below to identify the different pigments in the mixture.

View solution




**(i)** State the name of this method of separating the pigments.

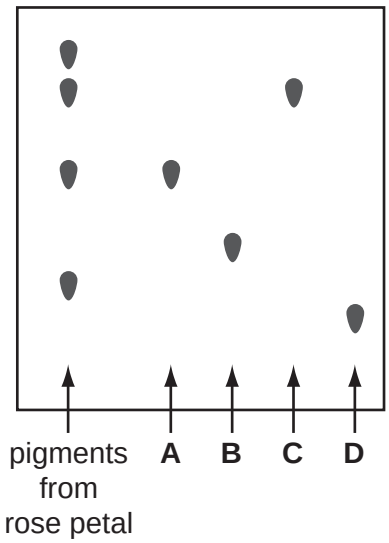
..... [1]

**(ii)** On the diagram above, draw a spot, ●, to show where the mixture of pigments is placed at the start of the experiment. [1]

**(iii)** What is the purpose of the glass cover?

..... [1]

**(iv)** The student also puts four spots of pure pigments, **A**, **B**, **C** and **D**, onto the filter paper. The diagram below shows the results of her experiment.




Which of the pigments, **A**, **B**, **C** and **D**, are present in the rose petals?

..... [1]

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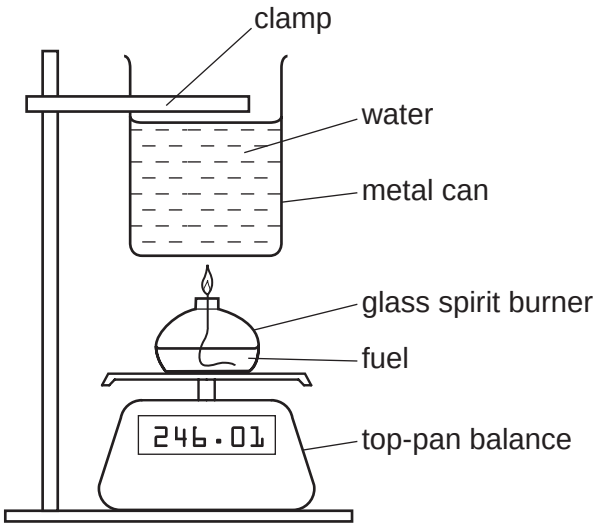
**(e)** The solvent used in the experiment is ethanol.
Draw the structure of a molecule of ethanol showing all atoms and bonds.

View solution

[2]

[Total: 12]

**4** A student wants to compare the energy released when different fuels are burned.
He measures the increase in temperature of the water in a metal can when the fuels are burned.




**(a)** What piece of apparatus is missing from the diagram above?

View solution

..... [1]

**(b)** State **two** things the student should keep the same when burning each fuel.

View solution

.....

.....

..... [2]

**(c)** Suggest why the water in the can should be stirred.

View solution

.....

..... [1]

**(d)** What happens to the reading on the top-pan balance as the fuel burns?
Give a reason for your answer.

View solution

.....

..... [2]

**(e)** The results of burning four fuels, **D**, **E**, **F** and **G**, are shown in the table below.

View solution

| fuel | temperature of water at start of experiment / °C | temperature of water at end of experiment / °C |
|---|---|---|
| **D** | 20 | 45 |
| **E** | 19 | 43 |
| **F** | 16 | 44 |
| **G** | 21 | 46 |

Which fuel produced the greatest temperature rise in the water?

..... [1]

**(f)** The metal can is made of mild steel coated with tin.

View solution

**(i)** Steel is an alloy.
What is meant by the term *alloy*?

.....

..... [1]

**(ii)** Why does the tin prevent the steel can from rusting?

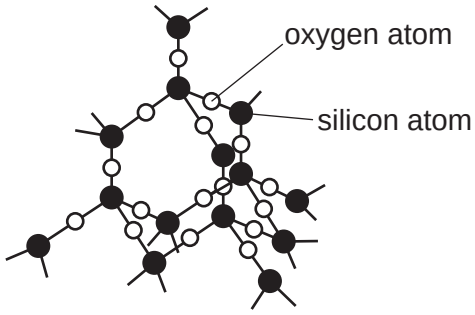
View solution

.....

..... [2]

**(g)** Glass is made from silicon(IV) oxide.
Part of the structure of silicon dioxide is shown below.

View solution




Which **one** of the following best describes the structure of silicon dioxide?
Tick **one** box.

giant covalent ☐
giant ionic ☐
simple atomic ☐
simple molecular ☐

[1]

[Total: 11]

**5** **(a)** Describe how acids react with metals and with metal oxides.

View solution

In your answer:
- refer to a particular metal and metal oxide,
- illustrate your answer with at least one word equation.

.....

.....

.....

.....

..... [4]

**(b)** When metals react with hydrochloric acid, the temperature of the reaction mixture increases.
Which **one** of the following words best describes this reaction?
Draw a ring around the correct answer.

View solution

**endothermic** **exothermic** **isotopic** **radioactive**

[1]

**(c)** Uranium is a metal which has several radioactive isotopes. Some of these are used as sources of energy.
State **one** other use of radioactive isotopes.

View solution

..... [1]

**(d)** Complete the table below to show the number of protons, neutrons and electrons in two isotopes of uranium.

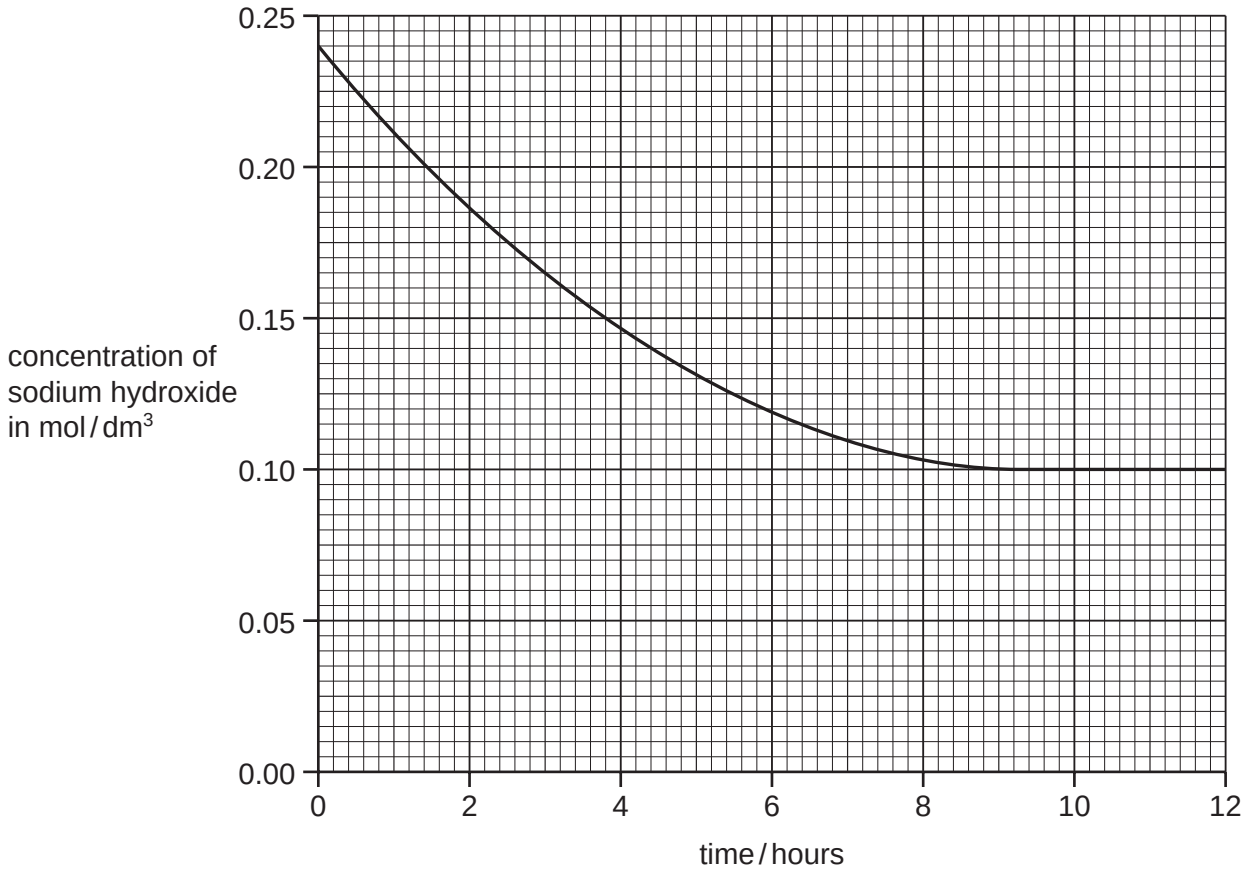
View solution

| isotope | $^{235}_{92}U$ | $^{238}_{92}U$ |
|---|---|---|
| protons | | |
| neutrons | | |
| electrons | | |

[3]

[Total: 9]

**6** The organic compound 1-bromobutane reacts with excess sodium hydroxide to form butan-1-ol.
A scientist studied the rate of this reaction by finding out how the concentration of sodium hydroxide changed with time.
The graph below shows the results.




**(a) (i)** Describe how the concentration of sodium hydroxide changes with time.

View solution

.....

..... [2]

**(ii)** Determine the time it took for the concentration of sodium hydroxide to fall to 0.15 mol / $dm^3$.

..... [1]

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

..... [1]

**(iv)** On the grid above, draw a line to show how the concentration of sodium hydroxide changes when the concentration of 1-bromobutane in the reaction mixture is increased.
All other conditions remain the same.

[2]

**(v)** Increasing the concentration of 1-bromobutane increases the rate of this reaction.
Suggest **one** other way of increasing the rate of this reaction.

..... [1]

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**(b)** The concentration of aqueous sodium hydroxide can be found by titrating samples of the reaction mixture with hydrochloric acid.
Describe how you would carry out this titration.

View solution

In your answer, refer to:
- a burette,
- a volumetric pipette,
- an acid-base indicator solution.

.....

.....

.....

.....

..... [4]

**(c)** Hydrochloric acid is made by dissolving hydrogen chloride gas, HC*l*, in water.
Draw a dot-and-cross diagram to show a molecule of hydrogen chloride.
Show hydrogen electrons as x.
Show chlorine electrons as ●.

View solution

[2]

[Total: 13]

**7** Fertilisers usually contain compounds of nitrogen, phosphorus and potassium.

**(a)** Why do farmers use fertilisers?

View solution

..... [1]

**(b)** Many fertilisers contain ammonium sulfate.
Ammonium sulfate is made by reacting aqueous ammonia with sulfuric acid.
What type of chemical reaction is this?

View solution

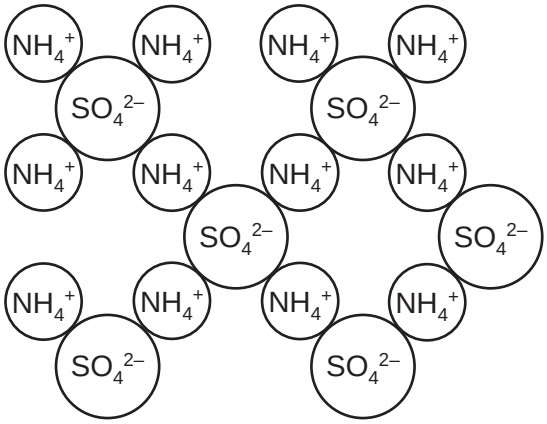
..... [1]

**(c)** Aqueous ammonia reacts with nitric acid to make another compound often found in fertilisers.
State the name of this compound.

..... [1]

**(d)** The structure of ammonium sulfate is shown below.

View solution




Deduce the simplest ratio of ammonium and sulfate ions in ammonium sulfate.

..... [1]

**(e)** Ammonium salts react with alkalis. For example:

View solution

$$\text{ammonium sulfate} + \text{sodium hydroxide} \rightarrow \text{sodium sulfate} + \text{ammonia} + \text{water}$$

Use this information to explain why adding slaked lime to fields which have fertilisers spread on them may result in loss of nitrogen.

.....

.....

..... [2]

**(f)** Many fertilisers contain potassium chloride.
When molten potassium chloride is electrolysed, two products are formed.
Complete the table below to show the name of the electrodes and the products formed.

View solution

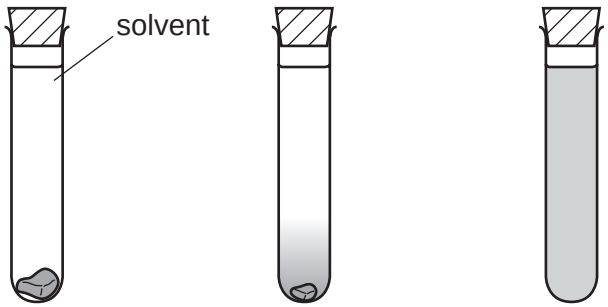
| charge on the electrode | name of the electrode | product formed at the electrode |
|---|---|---|
| positive | | |
| negative | | |

[3]

[Total: 9]

**8** **(a)** A student placed a crystal of iodine in a test tube of solvent.
After two minutes, a dense violet colour was observed at the bottom of the test-tube. After three hours, the violet colour had spread throughout the solvent.

View solution




at the start | after 2 minutes | after 3 hours

Use the kinetic particle theory to explain these observations.

In your answer, refer to:
- the arrangement and motion of the molecules in the iodine crystal,
- the arrangement and motion of the molecules in the solution,
- the names of the processes which are occurring.

.....

.....

.....

.....

..... [4]

View solution

**(b)** Astatine, At, is below iodine in Group VII of the Periodic Table.

**(i)** The table shows the states of the Group VII elements at room temperature.

| element | state |
|---|---|
| fluorine | gas |
| chlorine | gas |
| bromine | liquid |
| iodine | solid |

Use this information to deduce the state of astatine at room temperature.

..... [1]

**(ii)** Astatine is radioactive. A lot of heat is given off due to this radioactivity.
The small samples of astatine that have been isolated are often liquid.
Suggest why they are often liquid.

View solution

..... [1]

**(iii)** Although few compounds of astatine have been made, scientists think that sodium astatide will react with iodine.
Complete the equation for this reaction.

View solution

$$I_2 + .....NaAt \rightarrow 2NaI + .....$$

[2]

[Total: 8]

**DATA SHEET**
**The Periodic Table of the Elements**

| | Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | | | | | | | | | III | IV | V | VI | VII | 0 |
| | | | | | | | | | | | | | | | | 4 He Helium 2 |
| | | | | | 1 H Hydrogen 1 | | | | | | | | | | | |
| | 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 | Po Polonium 84 | At Astatine 85 | Rn Radon 86 |
| | 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 | a = relative atomic mass |
| X | X = atomic symbol |
| b | 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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