Cambridge IGCSE

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

CANDIDATE NAME

**SOLVED BY SMART EXAM RESOURCES**

CENTRE NUMBER

CANDIDATE NUMBER

*4049433183*

**CHEMISTRY** **0620/43**

Paper 4 Theory (Extended) **October/November 2019**

**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 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 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.



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

This document consists of **14** printed pages and **2** blank pages.

1 **(a)** Atoms are made of smaller particles called electrons, neutrons and protons.

Complete the table.

| particle | relative charge | relative mass |
|---|---|---|
| electron | **-1** | $\frac{1}{1840}$ |
| neutron | **0** | **1** |
| proton | +1 | **1** |

**Note: You will be able to answer this question if and only if you have learnt by heart your concepts- really well!**

[2]

**(b)** The table gives information about atoms and ions **A**, **B** and **C**.

Complete the table.

| | number of electrons | number of neutrons | number of protons | symbol |
|---|---|---|---|---|
| **A** | **13** | 14 | 13 | $^{27}_{13}Al$ |
| **B** | **10** | **13** | 12 | $^{25}_{12}Mg^{2+}$ |
| **C** | 10 | 10 | 9 | $^{19}_{9}F^{-}$ |

[6]

**Explanation**

**For row A;**
**27-14=13 electrons**

**For row B :**
**If there are 12 protons then there should have been 12 electrons. But the symbol of the ion shows +2. Hence it indicates the loss of 2 electrons**

[Total: 8]

2 The table shows the melting points, boiling points and electrical conductivities of six substances **D**, **E**, **F**, **G**, **H** and **I**.

| substance | melting point / °C | boiling point / °C | electrical conductivity when solid | electrical conductivity when liquid |
|---|---|---|---|---|
| **D** | 1610 | 2230 | non-conductor | non-conductor |
| **E** | 801 | 1413 | non-conductor | good conductor |
| **F** | –119 | 43 | non-conductor | non-conductor |
| **G** | 1535 | 2750 | good conductor | good conductor |
| **H** | 114 | 184 | non-conductor | non-conductor |
| **I** | –210 | –196 | non-conductor | non-conductor |

Choose substances from the table which match the following descriptions. Each substance may be used once, more than once or not at all.

**(a)** Which substance is a liquid at 25 °C? F [1]

**(b)** Which substance is a gas at 25 °C? I [1]

**(c)** Which **three** substances contain simple molecules?

F,H and I [3]

**(d)** Which substance could be a metal? Give a reason for your answer.

substance G

reason It is a good conductor when in the solid state.

[2]

**(e)** Which substance has a macromolecular structure? Give **two** reasons for your answer.

substance D

reason 1 It has a high melting point.

reason 2 It is a non-conductor of elecricity when it is a solid or a liquid.

[3]

**(f)** Which substance is an ionic solid? Give **one** reason for your answer.

substance E

reason It only conducts electricity when it is a liquid

or

It only conducts electricity when it is a liquid but not when it is a solid.

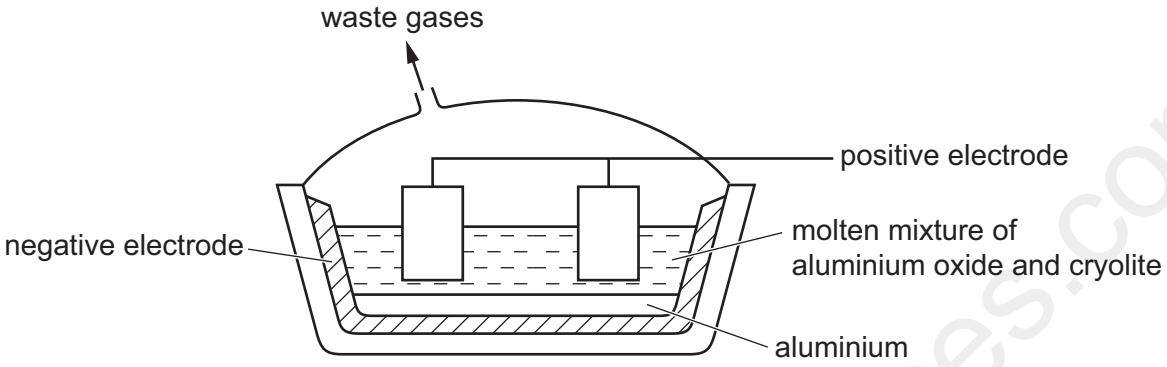
[2]

[Total: 12]

3 **(a)** Name the ore of aluminium which mainly consists of aluminium oxide.

Bauxite ..... [1]

**(b)** Aluminium is produced by the electrolysis of aluminium oxide dissolved in molten cryolite.




**(i)** Give **two** reasons why the electrolysis is done using a molten mixture of aluminium oxide and cryolite instead of molten aluminium oxide only.

1 It improves conductivity or It is a better conductor .....

2 It has a lower operating temperature. .....

[2]

**(ii)** Write ionic half-equations for the reactions occurring at the electrodes.

positive electrode $2O^{2-} \rightarrow O_2 + 4e^-$ .....

negative electrode $Al^{3+} + 3e^- \rightarrow Al$ .....

[2]

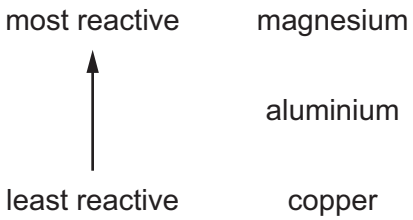
**(iii)** The anodes are made of carbon and have to be replaced regularly.

Explain why the carbon anodes have to be replaced regularly.

Anodes(or carbon) react with oxygen to form carbondioxide.Hence they need to be replaced. .....

..... [2]

**(c)** The positions of some common metals in the reactivity series are shown.




**(i)** When magnesium is placed in aqueous copper(II) sulfate a displacement reaction occurs immediately. ********You lose one mark if you do not write the state symbols********

Write an ionic equation for the reaction. Include state symbols.

$Mg(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Mg^{2+}(aq)$

..... [2]

[1]mark->Writing correct ionis equation and another [1] mark for writing the state symbols.

**(ii)** State **two** observations you would make when magnesium is placed in aqueous copper(II) sulfate.

1 The solid dissolves [ or] The solid disappears .....

2 The blue colour of the solution fades [or] The solution becomes paler .....

Other accepted options: 1)Solution becomes colourless 2) Pink/Orange/Brown solid is formed [2]

**(iii)** When aluminium foil is added to aqueous copper(II) sulfate no immediate reaction takes place.

Explain why.

Beacuse an unreactive coating of aluminium oxide is formed.

..... [1]

**(d)** Aluminium powder reacts with iron(III) oxide to produce aluminium oxide and iron.

Write a chemical equation for this reaction.

Note: As per the marking scheme, even if your complete equation is not correct, still you get [1] mark for simply mentioning $Fe_2O_3$ and $Al_2O_3$

$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

..... [2]

[Total: 14]

**4** This question is about phosphorus and compounds of phosphorus.

**(a)** A phosphorus molecule contains four phosphorus atoms **only**.

What is the formula of a phosphorus molecule?

$P_4$

..... [1]

**(b)** Phosphorus reacts with chlorine gas to produce phosphorus(III) chloride, $PCl_3$.

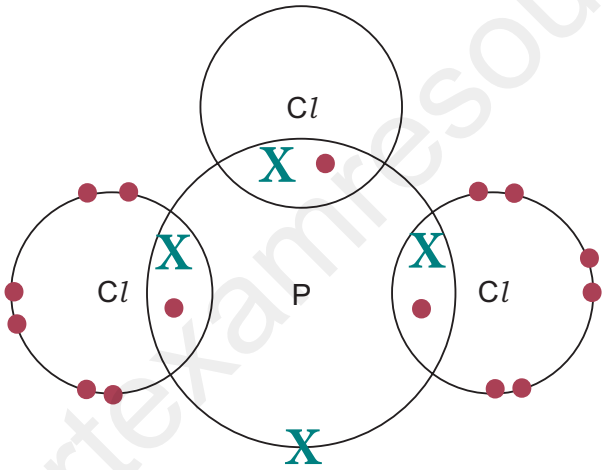
**(i)** Write a chemical equation for the reaction between phosphorus and chlorine to produce phosphorus(III) chloride, $PCl_3$.

Even if you do incorrect balancing, you still score a mark for writing correct symbols of reactants and products.

$P_4 + 6Cl_2 \rightarrow 4\ PCl_3$

..... [2]

**(ii)** Complete the dot-and-cross diagram to show the electron arrangement in a molecule of phosphorus(III) chloride, $PCl_3$. Show outer shell electrons only.

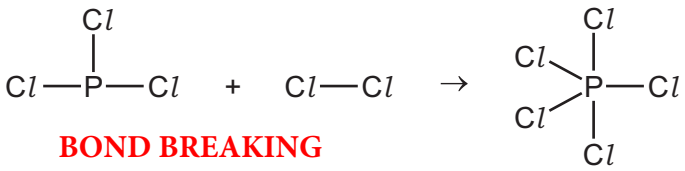



[2]

**(c)** Gaseous phosphorus(III) chloride, $PCl_3$, reacts with gaseous chlorine to form gaseous phosphorus(V) chloride, $PCl_5$.

$$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$$

The chemical equation for this reaction can be represented as shown.



BOND BREAKING

BOND MAKING

**(i)** Use the bond energies in the table to calculate the energy change, in kJ/mol, of the reaction.

| bond | bond energy in kJ/mol |
|---|---|
| P–Cl | 326 |
| Cl–Cl | 243 |

- Energy needed to break bonds.

**Bond breaking=3(P-Cl) + 1(Cl-Cl)= (3 x 326) + (243)=1221**

1221 ..... kJ

- Energy released when bonds are formed.

**Bond forming = 5( P-Cl)= 5 X (326) = 1630**

1630 ..... kJ

- Energy change of reaction.

**Energy Chnage=-409 kJ**

-409
energy change = ..... kJ/mol

**Note: Negative sign in the final answer is essential** [3]

**(ii)** Deduce whether the energy change for this reaction is exothermic or endothermic. Explain your answer.

**Exothermic and the energy released when bonds are formed is greater than the energy absorbed to break the bonds.**

..... [1]

**(d)** Under certain conditions the reaction reaches equilibrium.

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$$

State and explain the effect, if any, on the **position of equilibrium** if the pressure is increased. All other conditions are unchanged.

There are fewer moles on the right. Hence the equilibrium shifts to the right.

..... [2]

**(e)** Phosphine, $PH_3$, is produced by the reaction between water and calcium phosphide, $Ca_3P_2$.

Balance the chemical equation for this reaction.

$$Ca_3P_2 + \ldots 6 \ldots H_2O \rightarrow \ldots\ldots 3 \ldots Ca(OH)_2 + \ldots 2 \ldots PH_3$$ [2]

**(f)** The phosphonium ion, $PH_4^+$, is similar to the ammonium ion.

**(i)** State the formula of the ammonium ion. $NH_4^+$ [1]

**(ii)** Suggest the formula of phosphonium iodide. $PH_4I$ [1]


Hence the formula is :$PH_4I$

**(g)** Calcium phosphate contains the phosphate ion, $PO_4^{3-}$.

What is the formula of calcium phosphate?

$Ca_3(PO_4)_2$ [1]


Hence the formula is :$Ca_3(PO_4)_2$

**(h)** Phosphorus forms another compound with hydrogen with the following composition by mass: P, 93.94%; H, 6.06%.

**(i)** Calculate the empirical formula of the compound.

| | P | H |
|---|---|---|
| | 93.94 /31=3.03 | 6.06/1=6.06 |
| Moles=Mass/$M_r$=> | 3.03/3.03=1 | 6.06/3.03=2 |


Hence the formula is :$PH_2$

empirical formula = $PH_2$ [2]

**(ii)** The compound has a relative molecular mass of 66.
Deduce the molecular formula of the compound.

$A_r$ of hydrogen = 1;
Hence: 66 = x ($M_r$ of $PH_2$)
66 = x ( 31 +2(1)
x = 66/33=2
Hence Molecular formula = 2 x ($PH_2$)= $P_2H_4$

molecular formula = $P_2H_2$ [1]

[Total: 19]

**5** Nitrates such as ammonium nitrate are used as fertilisers.

The final stage in the production of ammonium nitrate is shown in the equation.

$$Ca(NO_3)_2 + 2NH_3 + CO_2 + H_2O \rightarrow 2NH_4NO_3 + CaCO_3$$

Calculate the maximum mass of ammonium nitrate that can be produced from 820 g of calcium nitrate, $Ca(NO_3)_2$, using the following steps.

The relative formula mass, $M_r$, of calcium nitrate, $Ca(NO_3)_2$, = 164.

- Calculate the number of moles of $Ca(NO_3)_2$ in 820 g.

**Moles= Mass/$M_r$**
**= 820/ 164 =5**

**5**
..... mol

- Deduce the number of moles of $NH_4NO_3$ produced.

**$Ca(NO_3)_2 + 2NH_3 + CO_2 + H_2O \rightarrow 2NH_4NO_3 + CaCO_3$**

**According to the above ideal equation:**
**For every 1 mole of $Ca(NO_3)_2$, there exist 2 moles of $NH_4NO_3$**
**Hence for 5 " " " " " " 2x5=10moles " "**

**10**
..... mol

- Calculate the $M_r$ of $NH_4NO_3$.

**$M_r$ of $NH_4NO_3$= 14 + 4(1) + 14 + 3(16)=80**

**80**
$M_r$ of $NH_4NO_3$ = .....

- Calculate the maximum mass of ammonium nitrate produced.

**Mass= Moles X $M_r$**
**= 10 X 80**
**= 800g**

**800**
..... g
[4]

**6** This question is about sulfuric acid and substances that can be made from sulfuric acid.

**(a)** Sulfuric acid is a strong acid.

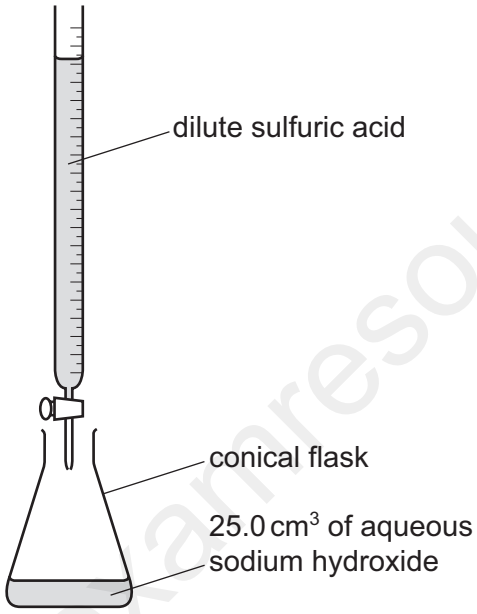
What is meant by the term *strong acid*?

strong A strong acid exists entirely as ions in the solution

acid Acid is a proton donor

[2]

**(b)** Dilute sulfuric acid and aqueous sodium hydroxide are used to make aqueous sodium sulfate, $Na_2SO_4(aq)$, or aqueous sodium hydrogen sulfate, $NaHSO_4(aq)$. The method includes use of the following apparatus.




25.0 $cm^3$ of aqueous sodium hydroxide of concentration 0.100 $mol/dm^3$ was neutralised by 25.0 $cm^3$ of dilute sulfuric acid of concentration 0.0500 $mol/dm^3$. The equation for the reaction is shown. This is **reaction 1**.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) \qquad \textbf{reaction 1}$$

The same technique and the same solutions can be used to make aqueous sodium hydrogen sulfate. The equation for the reaction is shown. This is **reaction 2**.

$$NaOH(aq) + H_2SO_4(aq) \rightarrow NaHSO_4(aq) + H_2O(l) \qquad \textbf{reaction 2}$$

Complete the table to calculate the volume of dilute sulfuric acid that reacts with 25.0 $cm^3$ of aqueous sodium hydroxide in **reaction 2**.

| | volume of 0.0500 $mol/dm^3$ dilute sulfuric acid in $cm^3$ | volume of 0.100 $mol/dm^3$ aqueous sodium hydroxide in $cm^3$ |
|---|---|---|
| **reaction 1** | 25.0 | 25.0 |
| **reaction 2** | 50.0 | 25.0 |

[1]

**(c)** Aqueous sodium hydrogen sulfate, $NaHSO_4(aq)$, contains the ions $Na^+(aq)$, $H^+(aq)$ and $SO_4^{2-}(aq)$.

Describe what you would **see** if the following experiments were done.

**(i)** A flame test was done on aqueous sodium hydrogen sulfate.

Yellow flame

..... [1]

**(ii)** Solid copper(II) oxide was added to aqueous sodium hydrogen sulfate and the mixture was warmed.

The solid dissolves and a blue colour solution is obtained

..... [2]

**(d)** A test can be done to show the presence of $SO_4^{2-}(aq)$ by adding acidified aqueous barium chloride **or** acidified aqueous barium nitrate.

**(i)** State the observation that would show that $SO_4^{2-}$ is present.

White precipitate

..... [1]

**(ii)** Write an ionic equation for the reaction that occurs if $SO_4^{2-}$ is present. Include state symbols.

$Ba^{2+}(aq) + SO_4^{2-}(aq) \dashrightarrow BaSO_4(s)$

..... [2]

[Total: 9]

**Note: Halide ion test**

Halide ions in solutions are detected using silver nitrate solutions. The test solution is acidified using a few drops of dilute nitric acid, and then a few drops of silver nitrate solution are added. Different coloured silver halide precipitates form, depending on the halide ions present:

- chloride ions give a **white precipitate** of silver chloride
- bromide ions give a **cream precipitate** of silver bromide
- iodide ions give a **yellow precipitate** of silver iodide

**Note: Flame test results:**

| Ion present | Flame test colour |
|---|---|
| Lithium, $Li^+$ | Crimson |
| Sodium, $Na^+$ | Yellow |
| Potassium, $K^+$ | Lilac |
| Calcium, $Ca^{2+}$ | Orange-red |
| Copper, $Cu^{2+}$ | Green |

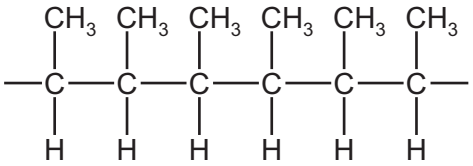
7 Addition polymerisation and condensation polymerisation are two types of polymerisation.

**(a)** Which functional group is present in all the monomers which are used to make addition polymers?

C=C

..... [1]

**(b)** Part of an addition polymer is shown.



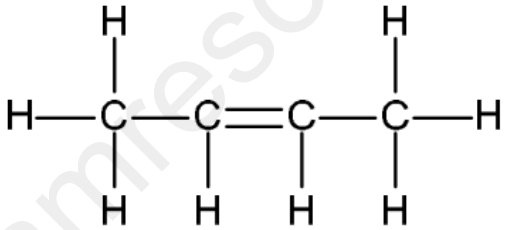
**(i)** How many monomer units are needed to make the part of the addition polymer shown?

3

..... [1]

**(ii)** Draw the structure of the monomer that is used to make this addition polymer. Show all of the atoms and all of the bonds

Name the monomer.



name but-2-ene

[2]

**(iii)** State the empirical formula of:

the monomer $CH_2$ Empirical formula is the same as it is the reduced formula

the polymer. $CH_2$

[2]

**(c)** Complex carbohydrates are natural condensation polymers. They can be broken down into colourless monomers which can then be separated and identified.

**X** is a complex carbohydrate.

Starting with a sample of **X**, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include:

- the name of the process used to break down **X** into its monomers
- **two** types of substance that can be used to break down **X**
- the name of the process used to **separate** the monomers
- the method used to **detect** the monomers after they have been separated
- the method used to **identify** the monomers after they have been separated and detected.

**The complex carbohydrates are broken down by the hydrolysis reaction.Acid and enzymes are used in the process of breaking doen the carbohydrate.The complex carbohydrates get broken down into colourless monomers. The monomers are separated through chromatography. As the monomers are colourless,a suitable locating agent is used to make them visible. The $R_f$ values of the monomers are calculated and compared against standard $R_f$ values to identify the mom=nomers.**

..... [6]

**(d)** Synthetic polyamides are condensation polymers.

**(i)** Name a synthetic polyamide.

**nylon**

..... [1]

**(ii)** Synthetic polyamides can be made by reacting carboxylic acids with amines.

Name the other substance that is produced in this reaction.

**water**

..... [1]

[Total: 14]

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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 |
| 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 – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

atomic number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.).