



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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CENTRE
NUMBER

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CHEMISTRY

0620/21

Paper 2

October/November 2015

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.

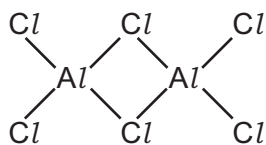
The number of marks is given in brackets [] at the end of each question or part question.

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

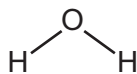
This document consists of **16** printed pages.

1 The structures of six compounds are shown below.

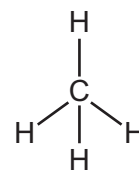
A



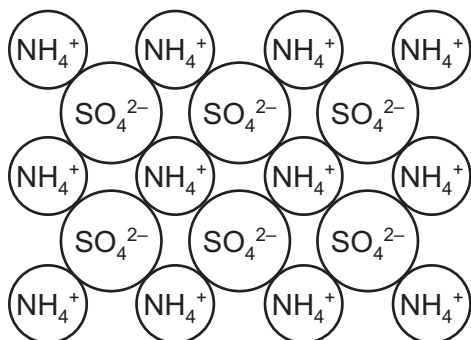
B



C



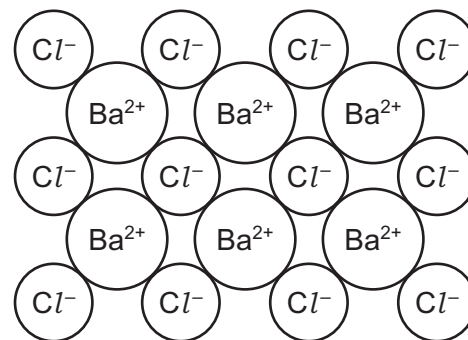
D



E



F

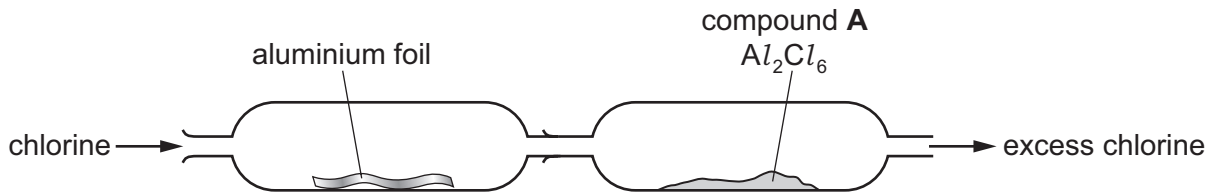


Answer the following questions about these substances.
Each compound may be used once, more than once or not at all.

(a) Which substance, **A**, **B**, **C**, **D**, **E** or **F**,

- (i) gives a white precipitate on addition of an aqueous solution of sodium sulfate, [1]
- (ii) is a component of many fertilisers, [1]
- (iii) contains a Group III element, [1]
- (iv) is an acidic gas at room temperature, [1]
- (v) turns anhydrous cobalt chloride pink, [1]
- (vi) is the main component of natural gas? [1]

- (b) Compound **A** can be made by direct combination of chlorine and aluminium using the apparatus shown below.

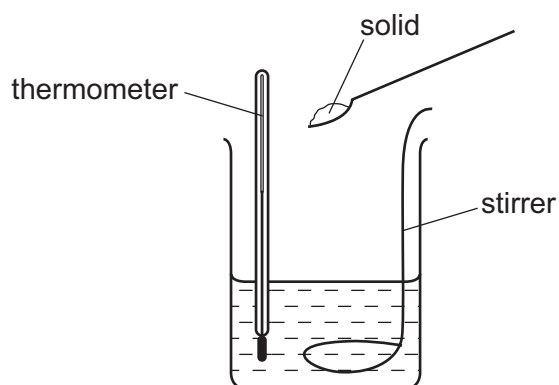


- (i) On the diagram above, draw an arrow to show where heat is applied. [1]
- (ii) Suggest **one** safety precaution that should be taken when carrying out this experiment.
 [1]
- (iii) Complete the symbol equation for this reaction.



[Total: 9]

- 2 A student measures the maximum temperature changes when five different solids, **P**, **Q**, **R**, **S** and **T**, are dissolved separately in water. She uses the apparatus shown below.



- (a) The student stirs the mixture as each solid is added.

Suggest why she does this.

.....
 [1]

- (b) Suggest **two** factors which should be kept the same to make the experiment a fair test.

1.
 2. [2]

- (c) The table of results is shown below.

solid added	initial temperature of the water / °C	highest temperature of the solution / °C
P	20	24
Q	18	23
R	19	16
S	22	23
T	20	18

- (i) Which solid gave the greatest temperature change when dissolved in water?

..... [1]

- (ii) Which solids gave an endothermic energy change when dissolved in water?

..... and [2]

(d) Radioactive isotopes can be used as a source of energy.

- (i) Which **one** of the following isotopes is a radioactive isotope?
Put a ring around the correct answer.



[1]

- (ii) An isotope of radium, Ra, has 226 nucleons in its nucleus.

How many neutrons does this isotope contain?
Use your Periodic Table.

..... [1]

- (iii) Give **one** use of radioactive isotopes in medicine.

..... [1]

(e) Fractions obtained from the distillation of petroleum are also sources of energy.

- (i) Which **one** of the following fractions is used as a fuel for jet aircraft?
Put a ring around the correct answer.

bitumen

gasoline

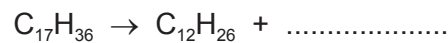
kerosene

naphtha

[1]

- (ii) Heptadecane, $\text{C}_{17}\text{H}_{36}$, is present in the fuel oil fraction.

Complete the equation for the cracking of heptadecane to form two hydrocarbons.



[1]

[Total: 11]

- 3 (a) Nickel is extracted from nickel(II) oxide, NiO, by heating with carbon.

Complete the symbol equation for this reaction.

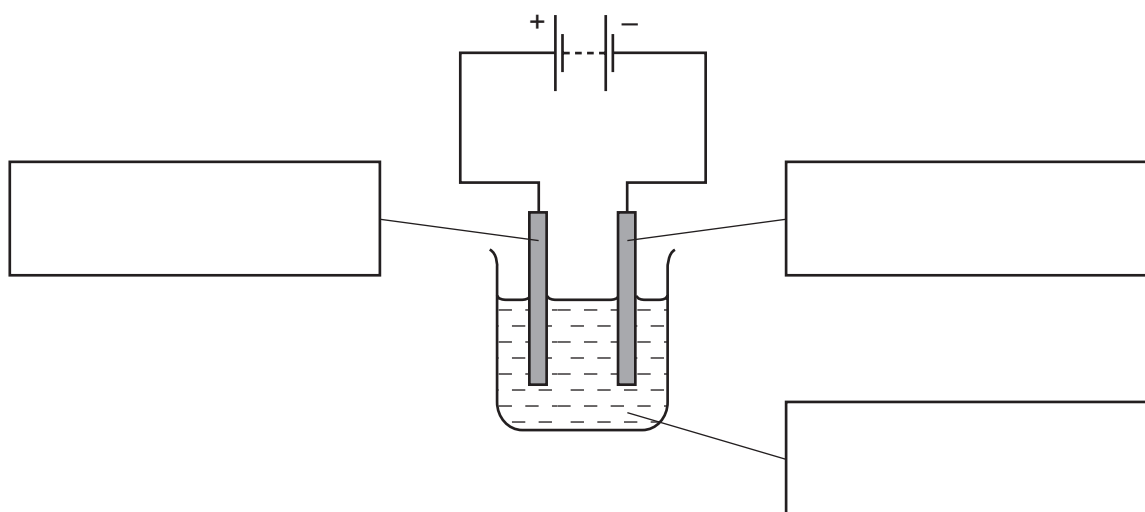


[2]

- (b) Nickel is refined by electrolysis.

(i) Complete the boxes to label the diagram below to show

- the negative electrode (cathode),
- the positive electrode (anode),
- the electrolyte.



[2]

(ii) At which electrode is the pure nickel formed?

..... [1]

- (c) Molten nickel(II) chloride can be electrolysed using graphite electrodes.

(i) Predict the products of this electrolysis at

the positive electrode (anode),

the negative electrode (cathode).

[2]

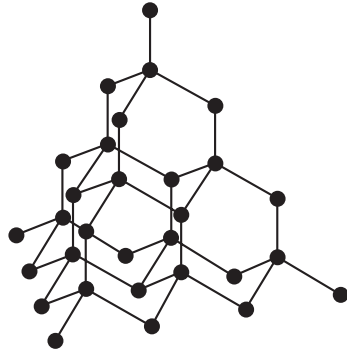
(ii) Give **two** reasons why graphite is used for electrodes.

1.

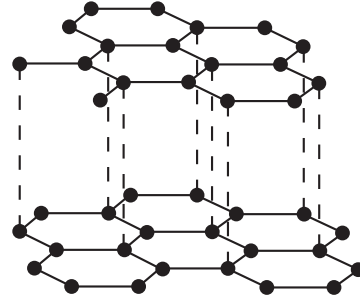
2.

[2]

(d) The structures of diamond and graphite are shown below.



diamond



graphite

(i) Explain how the structure of diamond relates to its use in cutting hard materials.

.....

.....

..... [2]

(ii) Explain how the structure of graphite relates to its use as a lubricant.

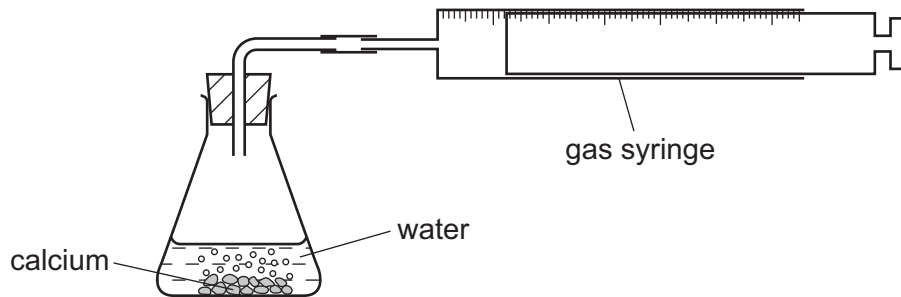
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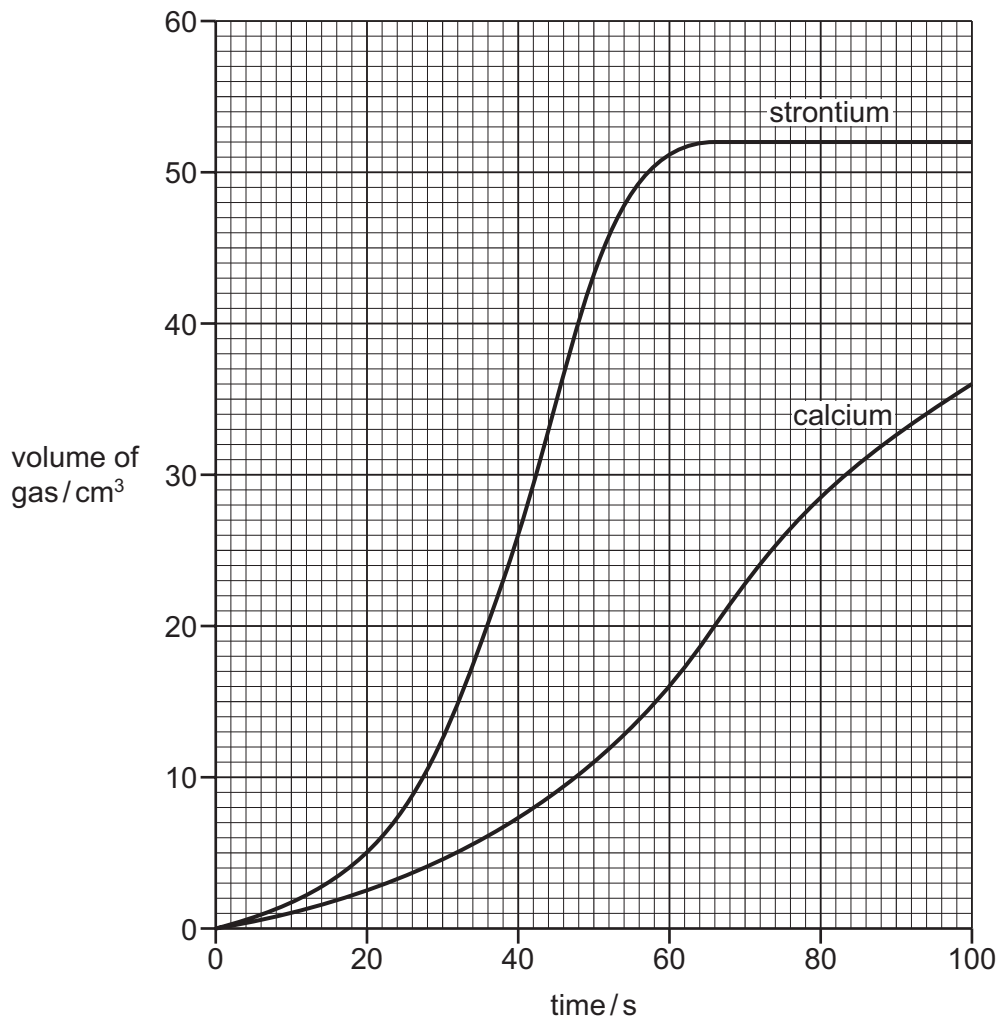
..... [2]

[Total: 13]

- 4 A teacher demonstrated the reactivity of calcium with water. He used the apparatus shown below.



- (a) The teacher measured the volume of gas given off at various times during the reaction. He then repeated the experiment using strontium but keeping all the conditions the same. The graph obtained from the results is shown below.



- (i) Explain how the graph shows that strontium is more reactive than calcium.

.....
 [1]

- (ii) For the reaction between calcium and water, deduce the volume of gas produced in the first 50 seconds.

..... cm³ [1]

(iii) At what time was the reaction between strontium and water complete?

..... s [1]

(iv) How do you know from the graph that the reaction between calcium and water was **not** complete 100 seconds after the reaction started?

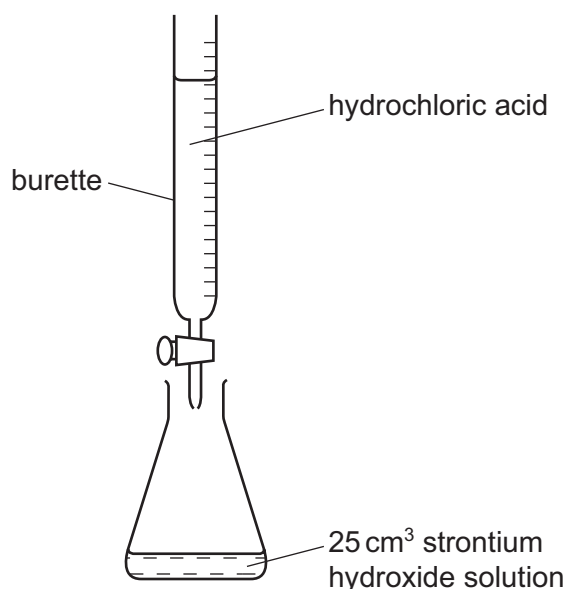
..... [1]

(v) Suggest how the rate of reaction changes when the same mass of calcium is used but in smaller pieces.

..... [1]

(b) The solution formed at the end of the reaction between strontium and water is alkaline. It is a solution of strontium hydroxide.

The teacher titrated this solution with hydrochloric acid using the apparatus shown below.



(i) What piece of apparatus should be used to put exactly 25.0 cm³ of the strontium hydroxide solution into the flask?

..... [1]

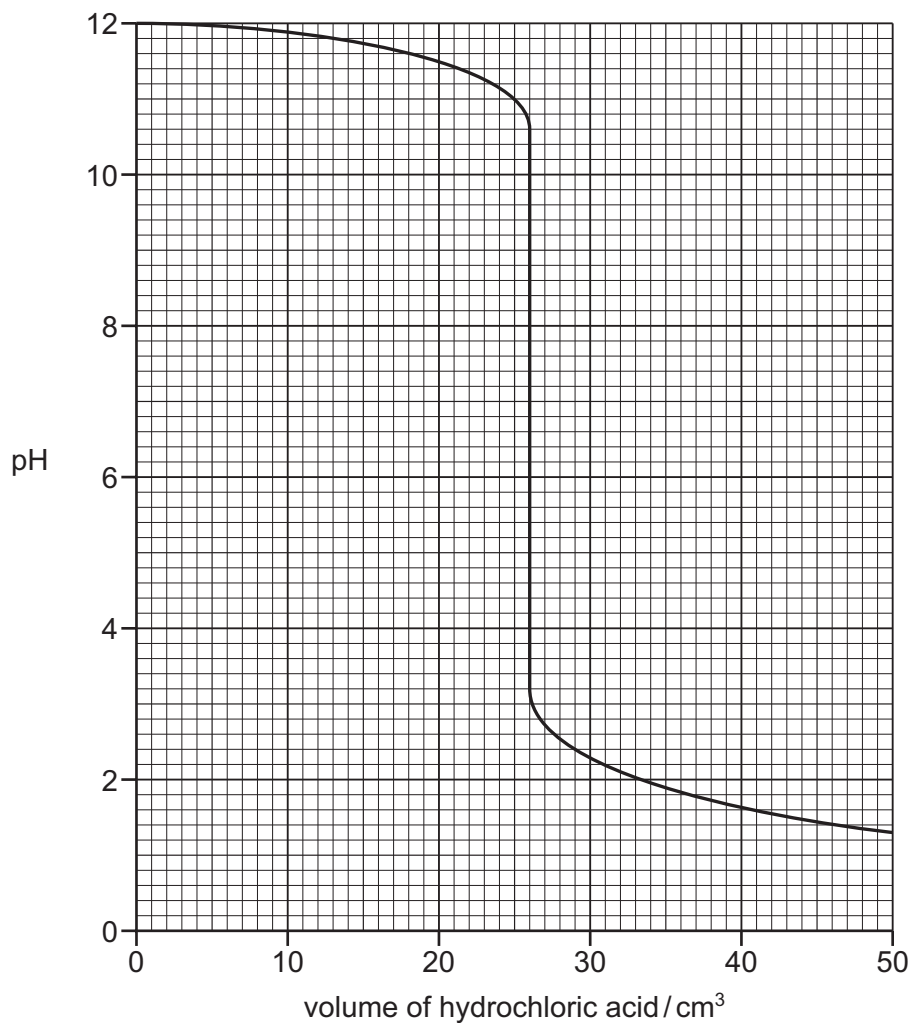
(ii) A few drops of litmus solution was added to the flask.

Explain why litmus is added to the flask and describe what happens to the litmus as the titration proceeds.

.....

 [2]

(c) The graph below shows how the pH of the solution in the flask changes as the acid is added.



(i) Describe how the pH of the solution changes as the titration proceeds.

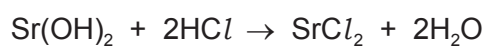
.....

 [3]

(ii) What volume of acid had been added when the solution had a neutral pH?

..... [1]

(iii) The symbol equation for the reaction is

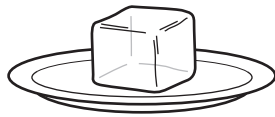


Give the name of the salt formed in this reaction.

..... [1]

[Total: 13]

5 A student left a cube of ice on a plate in a warm room. The diagrams below show what happened to the ice.



at the start



after 10 minutes



after 30 minutes

(a) Describe and explain what happened to the ice. In your answer,

- describe and explain the change of state which occurs,
- explain this change using the kinetic particle theory.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Water is used in industry and in the home.

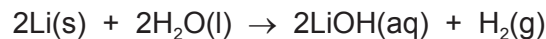
(i) Give **one** use of water in industry.

..... [1]

(ii) Give **one** use of water in the home.

..... [1]

(c) The symbol equation for the reaction of lithium with water is shown below.



(i) Write the word equation for this reaction.

..... [1]

(ii) Describe **two** observations which can be made when lithium reacts with water.

.....

..... [2]

(iii) Describe how the reactivity of potassium with water compares with the reactivity of lithium with water.

..... [1]

(d) Ethanol can be made by the reaction of steam with ethene.

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

[1]

(ii) Describe the conditions required for this reaction.

..... [2]

(e) The table below describes the reaction of water or steam with different metals.

metal	observations
calcium	reacts rapidly with cold water
cerium	reacts slowly with hot water and very rapidly with steam
cobalt	reacts with steam when cobalt powder is very hot
iron	reacts very slowly with hot water and readily with steam

Put these metals in order of their reactivity.

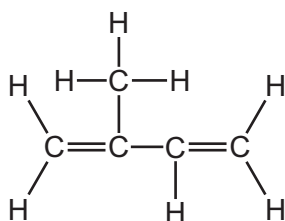
least reactive \longrightarrow most reactive

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[2]

[Total: 16]

- 6 When rubber is distilled, a chemical called isoprene is formed. The structure of isoprene is shown below.



- (a) Deduce the molecular formula of isoprene.

..... [1]

- (b) Isoprene is an unsaturated compound.

Describe a test for an unsaturated compound.

test

result [2]

- (c) Isoprene forms an addition polymer.

- (i) What feature of the isoprene molecule is responsible for it forming an addition polymer?

..... [1]

- (ii) Give the name of another addition polymer.

..... [1]

- (d) Isoprene does **not** conduct electricity.

Explain why.

..... [1]

- (e) State the names of **two** substances formed when isoprene undergoes incomplete combustion.

..... and [2]

(f) Isoprene can be prepared from 3-methylbutan-1-ol.

To which group of compounds does 3-methylbutan-1-ol belong?
Tick **one** box.

alcohols

alkanes

alkenes

carboxylic acids

[1]

[Total: 9]

7 (a) Sodium is in Group I of the Periodic Table.

Describe the structure of a sodium atom.

In your answer refer to,

- the type and number of each subatomic particle present,
- the charges on each type of subatomic particle,
- the position of each type of subatomic particle in the atom.

.....

.....

.....

.....

.....

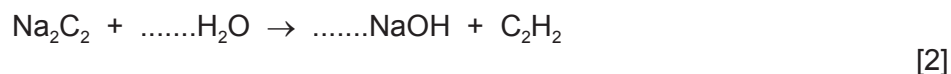
.....

.....

..... [5]

(b) Sodium carbide, Na_2C_2 , reacts with water to form ethyne, C_2H_2 .

(i) Complete the symbol equation for this reaction.



(ii) Ethyne is a hydrocarbon.

What is the meaning of the term *hydrocarbon*?

..... [1]

(iii) Calculate the relative formula mass of sodium carbide.

[1]

[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											20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12	5 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9						35.5 Cl Chlorine 17
39 K Potassium 19	40 Ca Calcium 20	13 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17						84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	27 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35						131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	65 Zn Zinc 30	108 Ag Silver 47	112 Cd Cadmium 48	122 Sb Antimony 51	127 I Iodine 53						209 Po Polonium 84
226 Fr Francium 87	227 Ra Radium 88	59 Ni Nickel 28	79 Cu Copper 29	80 Hg Mercury 80	106 Pd Palladium 46	197 Au Gold 79						204 Pb Lead 82
		55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	64 Ni Nickel 28	78 Pt Platinum 78						201 Hg Mercury 80
		52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	77 Ir Iridium 77						159 Tb Terbium 65
		48 Ti Titanium 22	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	76 Os Osmium 76						157 Gd Gadolinium 64
		45 Sc Scandium 21	51 V Vanadium 23	55 Mn Manganese 25	56 Fe Iron 26	75 Re Rhenium 75						152 Eu Europium 63
		89 Y Yttrium 39	51 V Vanadium 23	55 Mn Manganese 25	56 Fe Iron 26	74 W Tungsten 74						150 Sm Samarium 62
		139 La Lanthanum 57	51 V Vanadium 23	55 Mn Manganese 25	56 Fe Iron 26	73 Ta Tantalum 73						144 Nd Neodymium 60
		178 Hf Hafnium 72	48 Ti Titanium 22	52 Cr Chromium 24	55 Mn Manganese 25	72 Hf Hafnium 72						141 Pr Praseodymium 59
		137 Ba Barium 56	45 Sc Scandium 21	51 V Vanadium 23	52 Cr Chromium 24	73 Ta Tantalum 73						140 Ce Cerium 58
		226 Ra Radium 88	40 Ca Calcium 20	51 V Vanadium 23	52 Cr Chromium 24	71 Ir Iridium 77						139 La Lanthanum 57
		227 Ac Actinium 89	39 Y Yttrium 39	51 V Vanadium 23	52 Cr Chromium 24	70 Pt Platinum 78						137 Ba Barium 56
												232 Th Thorium 90
												152 Am Americium 95
												150 Sm Samarium 62
												144 Nd Neodymium 60
												141 Pr Praseodymium 59
												139 La Lanthanum 57
												137 Ba Barium 56
												127 I Iodine 53
												122 Sb Antimony 51
												119 Sn Tin 50
												108 Ag Silver 47
												106 Pd Palladium 46
												103 Rh Rhodium 45
												101 Ru Ruthenium 44
												96 Mo Molybdenum 42
												93 Nb Niobium 41
												91 Zr Zirconium 40
												89 Y Yttrium 39
												88 Sr Strontium 38
												85 Rb Rubidium 37
												84 Kr Krypton 36
												80 Br Bromine 35
												79 Se Selenium 34
												75 As Arsenic 33
												73 Ge Germanium 32
												70 Ga Gallium 31
												65 Zn Zinc 30
												64 Cu Copper 29
												59 Ni Nickel 28
												56 Fe Iron 26
												55 Mn Manganese 25
												52 Cr Chromium 24
												48 Ti Titanium 22
												45 Sc Scandium 21
												40 Ca Calcium 20
												39 Y Yttrium 39
												38 Sr Strontium 38
												37 Rb Rubidium 37
												35.5 Cl Chlorine 17
												32 S Sulfur 16
												31 P Phosphorus 15
												28 Si Silicon 14
												27 Al Aluminium 13
												24 Mg Magnesium 12
												23 Na Sodium 11
												20 Ca Calcium 20
												19 K Potassium 19
												18 Ar Argon 18
												17 Cl Chlorine 17
												16 O Oxygen 8
												14 N Nitrogen 7
												12 C Carbon 6
												11 B Boron 5
												10 Ne Neon 10
												9 F Fluorine 9
												8 O Oxygen 8
												7 N Nitrogen 7
												6 C Carbon 6
												5 B Boron 5
												4 He Helium 2
												3 Li Lithium 3
												2 He Helium 2

*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 dm³ at room temperature and pressure (r.t.p.).