



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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.

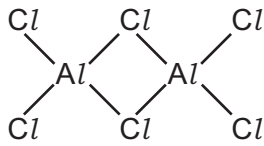
The number of marks is given in brackets [] at the end of each question or part question.

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

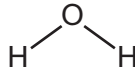
This document consists of **16** printed pages.

1 The structures of six compounds are shown below.

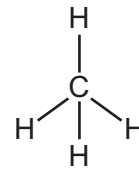
A



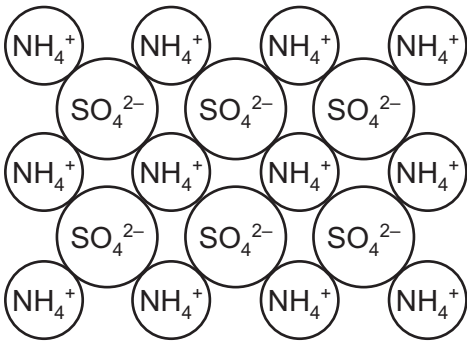
B



C



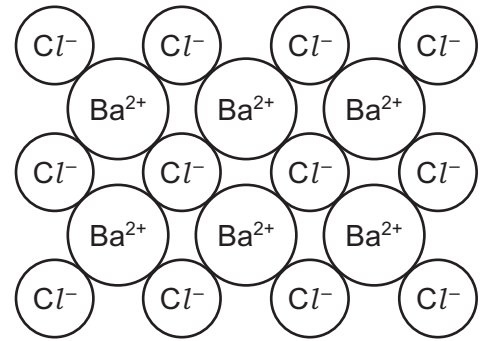
D



E



F

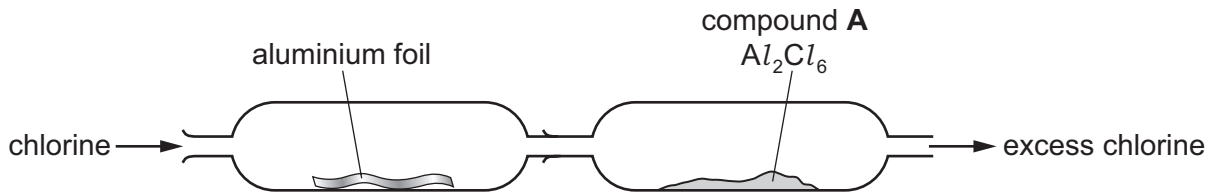


Answer the following questions about these substances.
Each compound may be used once, more than once or not at all.

(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.

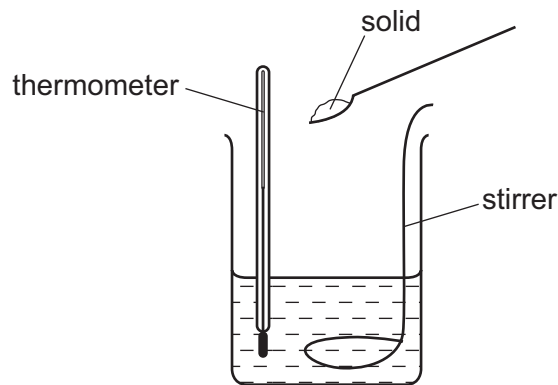


- (i) On the diagram above, draw an arrow to show where heat is applied. [1]
- (ii) Suggest **one** safety precaution that should be taken when carrying out this experiment.
 [1]
- (iii) Complete the symbol equation for this reaction.



[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

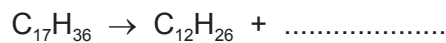
kerosene

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.

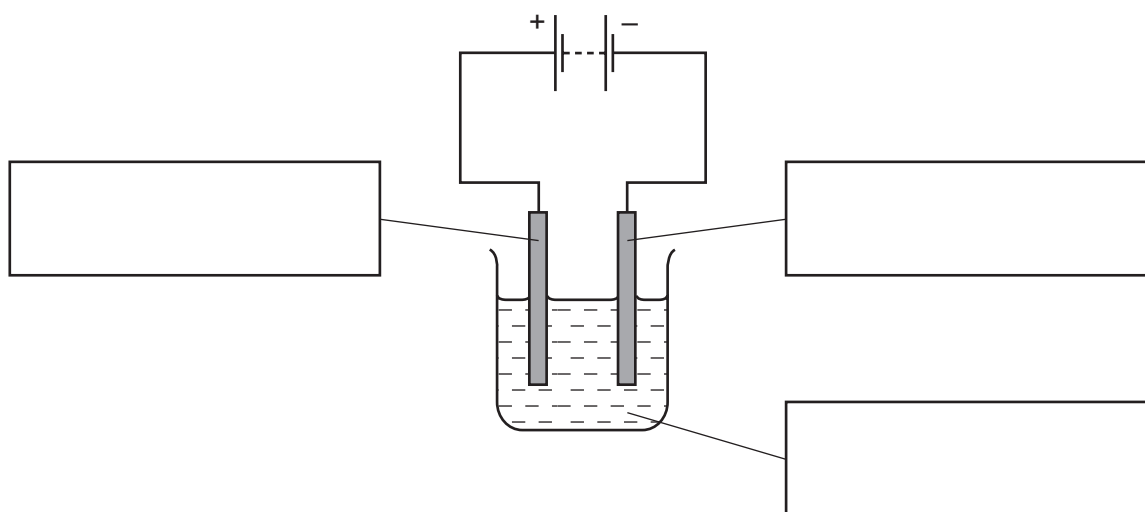


[2]

- (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]

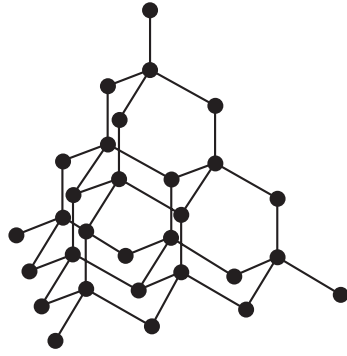
(ii) Give **two** reasons why graphite is used for electrodes.

1.

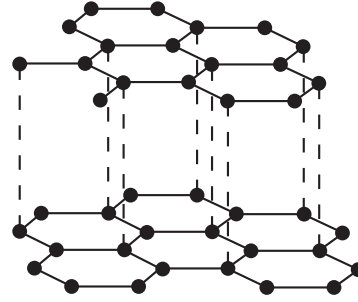
2.

[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.

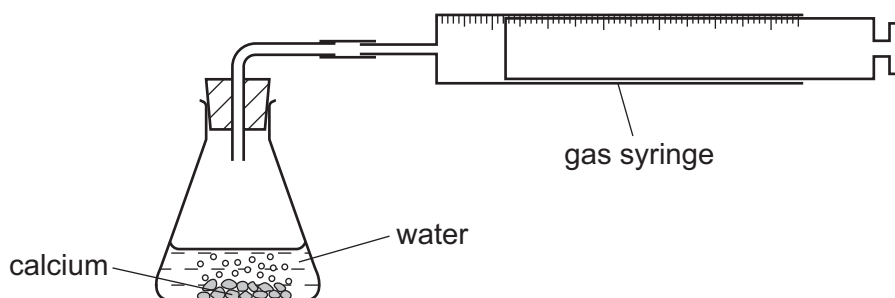
.....
.....
..... [2]

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

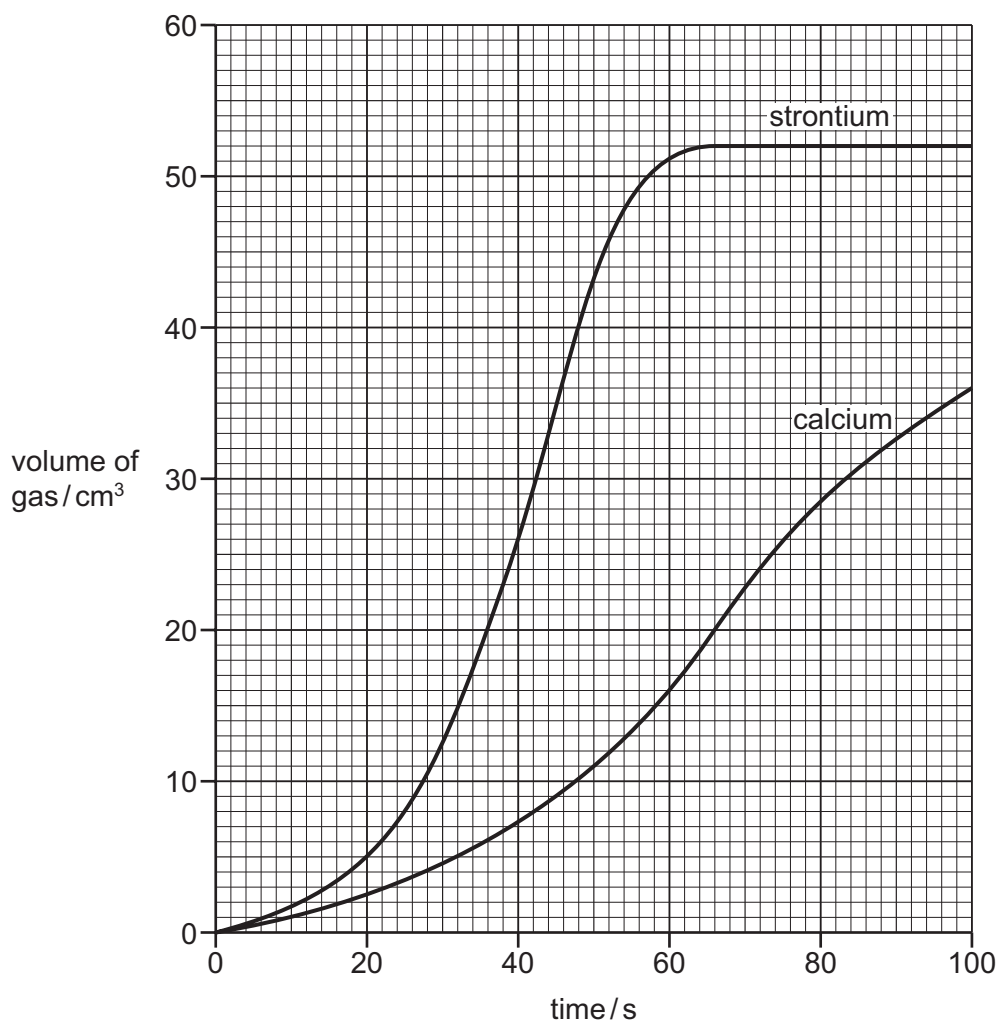
.....
.....
..... [2]

[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?

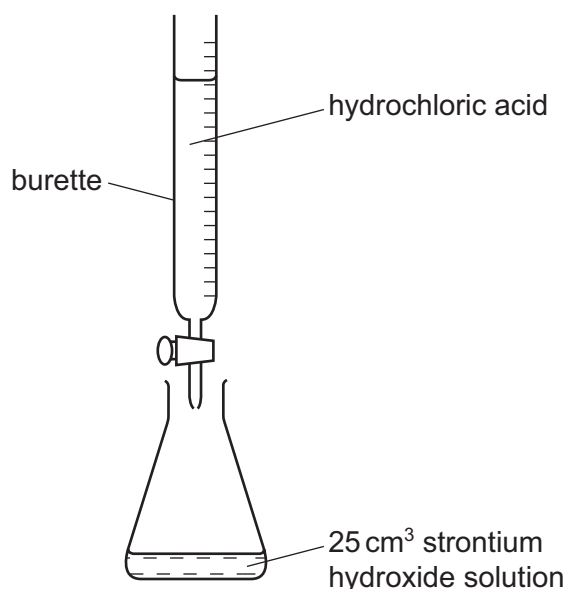
..... [1]

(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]

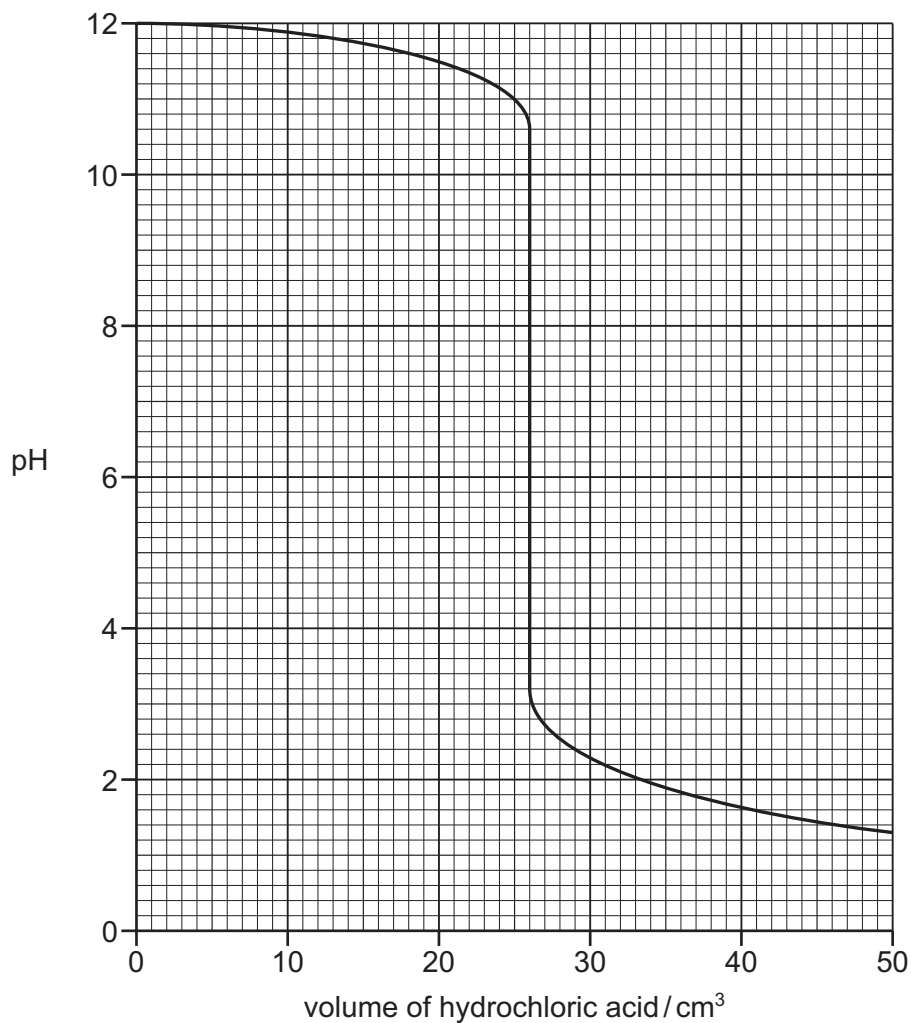
(ii) A few drops of litmus solution was added to the flask.

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.

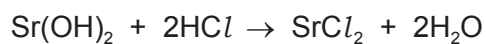
.....

 [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

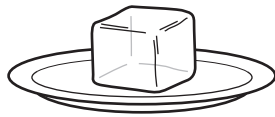


Give the name of the salt formed in this reaction.

..... [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.

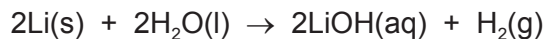
(i) Give **one** use of water in industry.

..... [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.

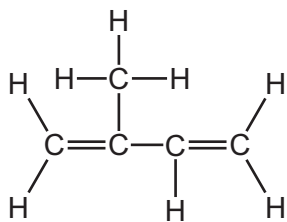
least reactive \longrightarrow most reactive

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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.

.....

.....

.....

.....

.....

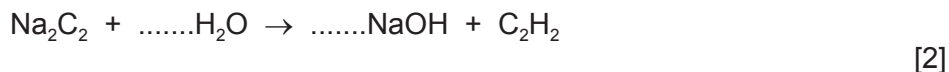
.....

.....

..... [5]

(b) Sodium carbide, Na₂C₂, reacts with water to form ethyne, C₂H₂.

(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																																																																																																																											
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	†	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	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	226 Ra Radium 88	227 Ac Actinium 89	†	232 Th Thorium 90	232 Pa Protactinium 91	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	146 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71

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

Key

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

X = atomic symbol

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