Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTER NUMBER	
CANDIDATE NUMBER	

CHEMISTRY (US) **0439/21**

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 Center 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.

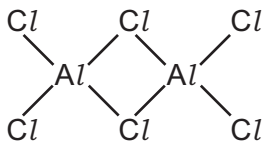
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

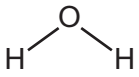
CAMBRIDGE International Examinations

1 The structures of six compounds are shown below.

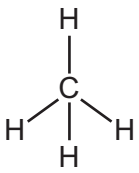
A



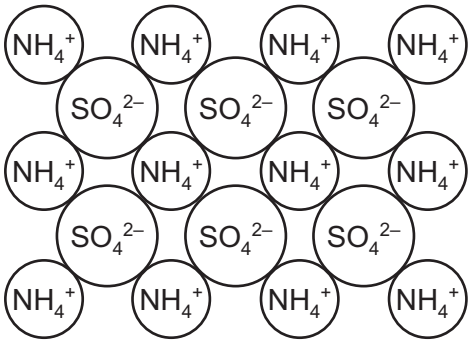
B



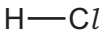
C



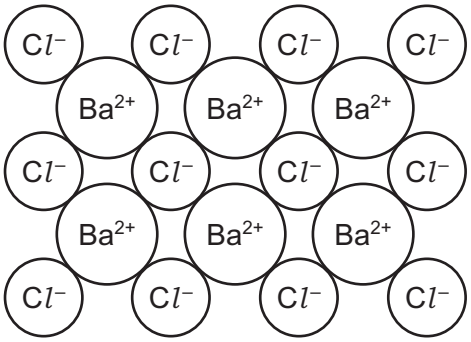
D



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 fertilizers, ... [1]

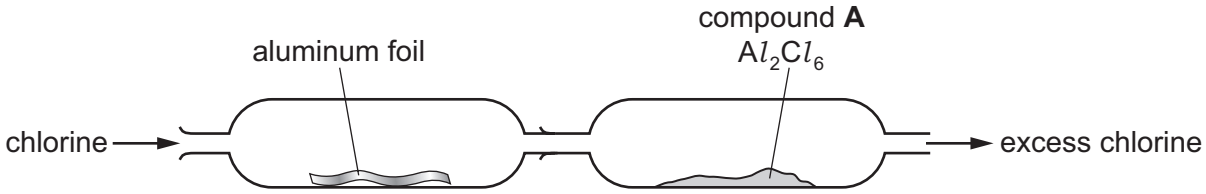
(iii) contains a Group III element, ... [1]

(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 aluminum 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]

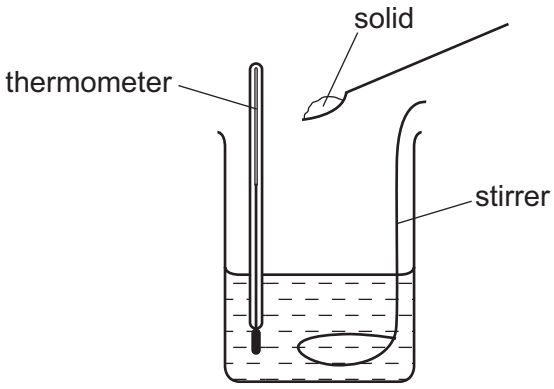
(iii) Complete the symbol equation for this reaction.

$$2Al + ...Cl_2 \rightarrow Al_2Cl_6$$

[1]

[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.

$^{12}_{6}C$ $^{235}_{92}U$ $^{1}_{1}H$ $^{65}_{30}Zn$

[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, $C_{17}H_{36}$, is present in the fuel oil fraction.

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

$$C_{17}H_{36} \rightarrow C_{12}H_{26} + ...$$

[1]

[Total: 11]

[Turn over

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

Complete the symbol equation for this reaction.

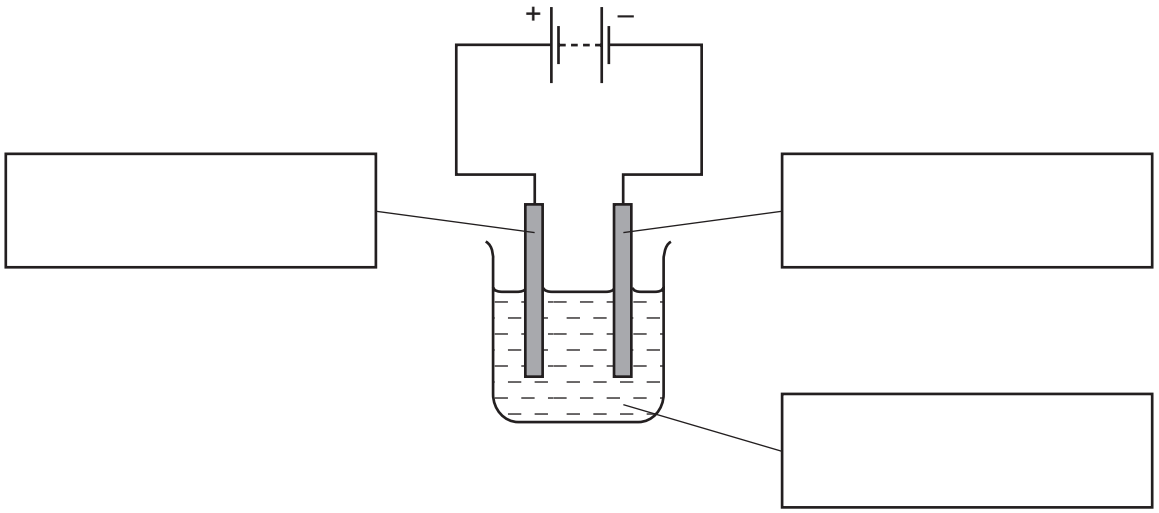
$$.....NiO + C \rightarrow 2Ni + ...$$

[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 electrolyzed using graphite electrodes.

(i) Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). .....

[2]

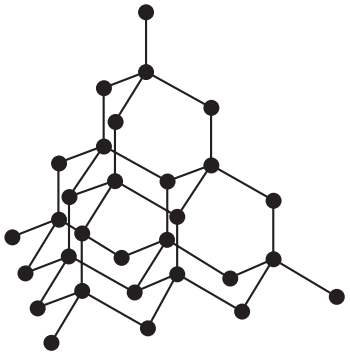
(ii) Give **two** reasons why graphite is used for electrodes.

1. .....

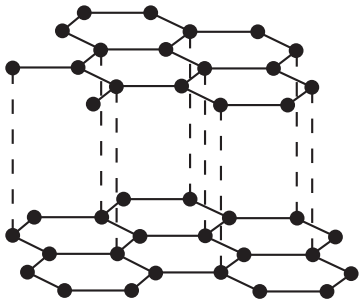
2. .....

[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.

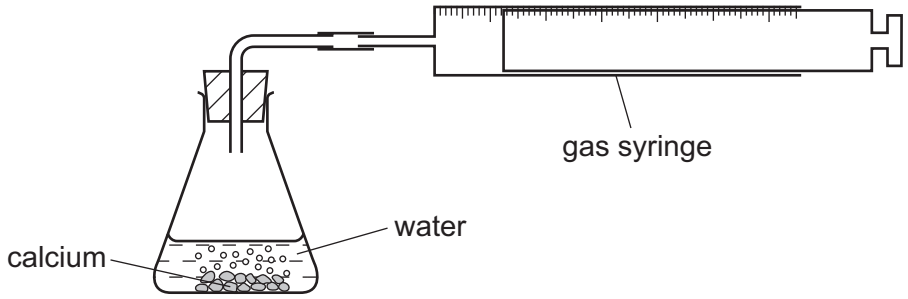
.....

.....

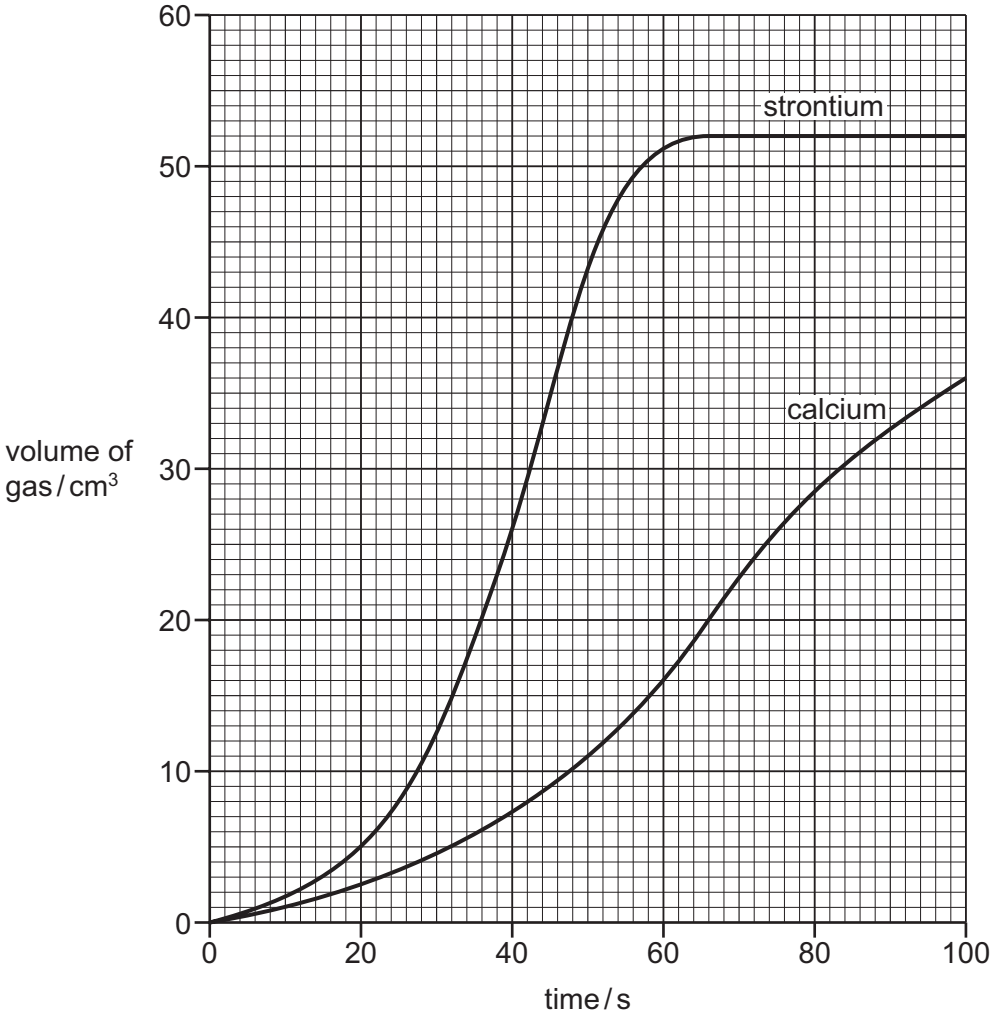
..... [2]

[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.

..... cm^3 [1]

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

..... s [1]

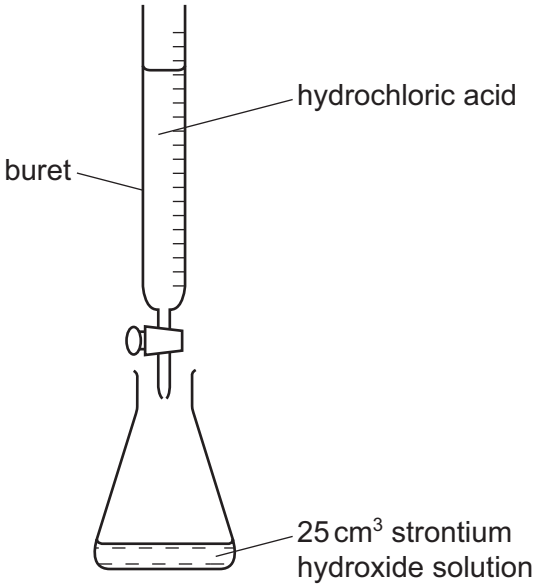
(iv) How do you know from the graph that the reaction between calcium and water was **not** complete 100 seconds after the reaction started?

..... [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 cm^3 of the strontium hydroxide solution into the flask?

..... [1]

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

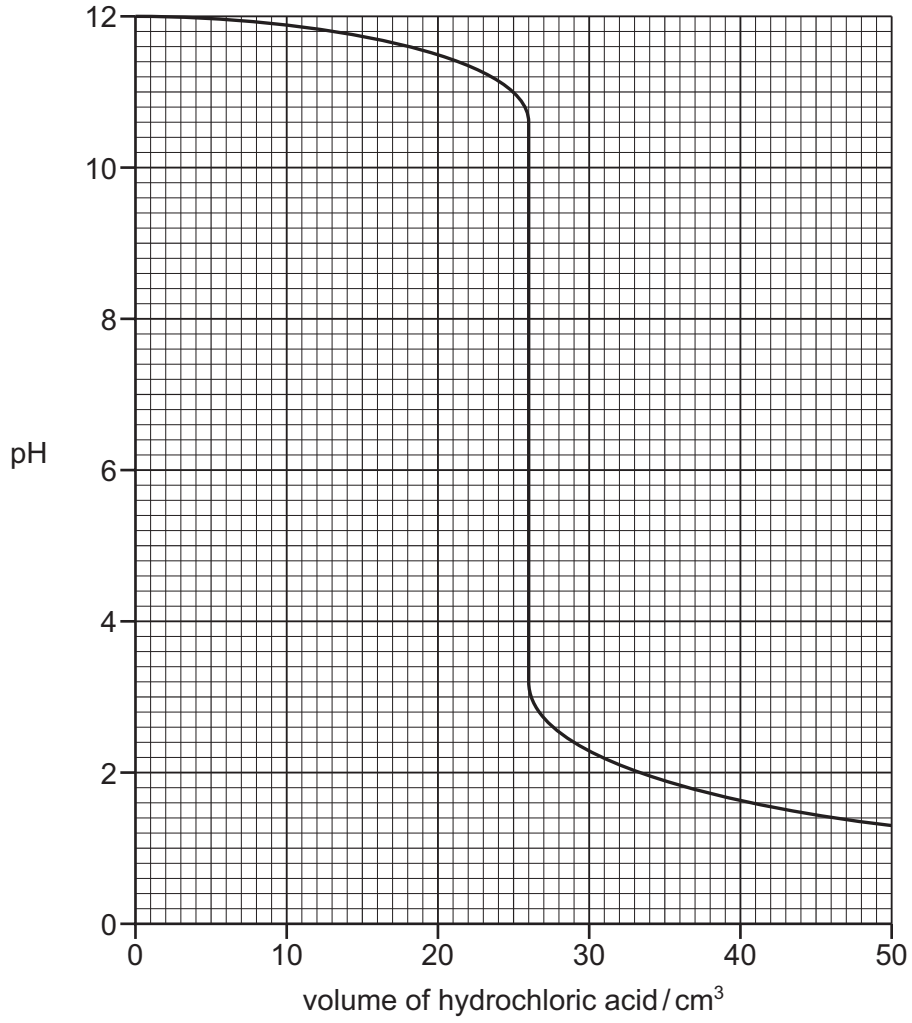
Explain why litmus is added to the flask and describe what happens to the litmus as the titration proceeds.

.....

.....

..... [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

$$Sr(OH)_2 + 2HCl \rightarrow SrCl_2 + 2H_2O$$

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.

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

(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]

[Turn over

(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

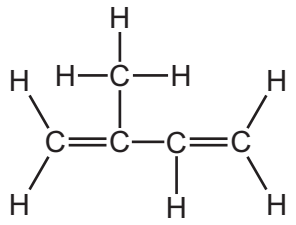
Put these metals in order of their reactivity.

least reactive ⟶ most reactive

[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]

[Turn over

(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.

$$Na_2C_2 + ...H_2O \rightarrow .....NaOH + C_2H_2$$

[2]

(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
																4 **He** Helium 2
					1 **H** Hydrogen 1						11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
7 **Li** Lithium 3	9 **Be** Beryllium 4										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
23 **Na** Sodium 11	24 **Mg** Magnesium 12										70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
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	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
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	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
133 **Cs** Cesium 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						
	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 = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).