Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4078960309

CHEMISTRY **0620/22**

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 20.
You may lose marks if you do not show your working or if you do not use appropriate units.

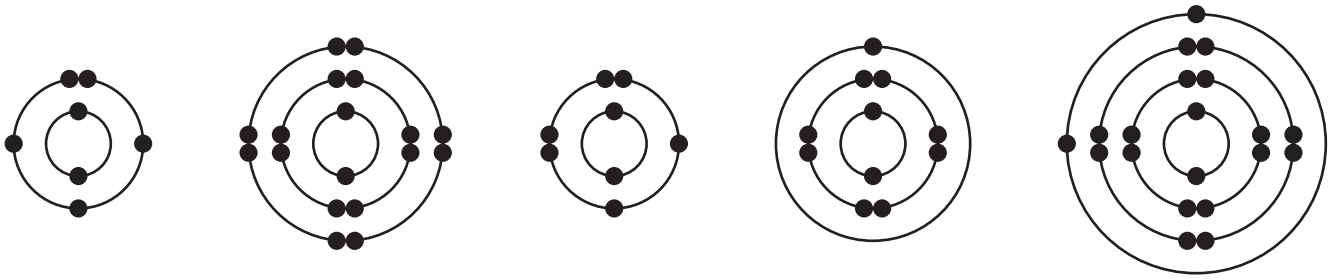
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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 **17** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

1 **(a)** The electronic structure of five atoms, **A**, **B**, **C**, **D** and **E**, are shown below.



A **B** **C** **D** **E**

Answer the following questions about these structures.
Each structure can be used once, more than once or not at all.

Which structure:

(i) represents an atom of an element in Group V of the Periodic Table, ... [1]

(ii) has a complete outer shell of electrons, ... [1]

(iii) represents an oxygen atom, ... [1]

(iv) has a proton number of 20, ... [1]

(v) is an atom of an element in Period 4 of the Periodic Table, ... [1]

(vi) has a single valency electron? ..... [1]

(b) Complete the following sentences about isotopes using words from the list below.

atoms **ions** **molecules** **neutrons** **nuclei** **protons**

Isotopes are ..... of the same element with the same number of .....

but different numbers of ..... . [3]

[Total: 9]

2 The table below shows some nutritional information on a bottle of apple juice.

contents	mass present in g / 100 cm^3
protein	0.10
sugars	10.40
unsaturated fat	0.10
saturated fat	0.06
chloride ions, Cl^-	0.04
magnesium ions, Mg^{2+}	0.01
nitrate ions, NO_3^-	0.01
potassium ions, K^+	0.02
sodium ions, Na^+	0.05
X, SO_4^{2-}	0.01

(a) Answer these questions using information from the table.

(i) Which negatively charged ion is present in the highest concentration?

..... [1]

(ii) State the name of the ion, **X**, whose formula is SO_4^{2-}.

..... [1]

(iii) The formulae for some chlorides are shown below.

aluminium chloride, $AlCl_3$
calcium chloride, $CaCl_2$
lead(IV) chloride, $PbCl_4$
potassium chloride, KCl

Deduce the formula for magnesium chloride.

..... [1]

(iv) Calculate the mass of sugars in 250 cm^3 of this apple juice.

..... g [1]

[Turn over

(b) The fats in the apple juice are both saturated and unsaturated.
Describe a test to distinguish between saturated and unsaturated compounds.

test .....

result with saturated compound .....

result with unsaturated compound .....
[3]

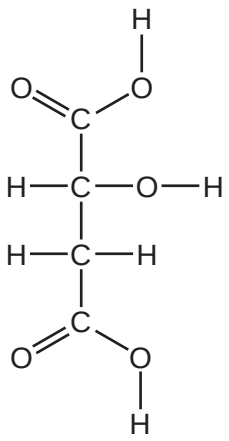
(c) Apple juice is slightly acidic.

(i) Which **one** of the following pH values is slightly acidic?
Put a ring around the correct answer.

pH 1 **pH 5** **pH 7** **pH 9** **pH 14**

[1]

(ii) One of the acids found in apple juice is malic acid.
The structure of malic acid is shown below.



On the structure of malic acid above, put a ring around a carboxylic acid functional group. [1]

[Total: 9]

3 Hydrogen chloride gas can be prepared by the action of concentrated sulfuric acid on sodium chloride.

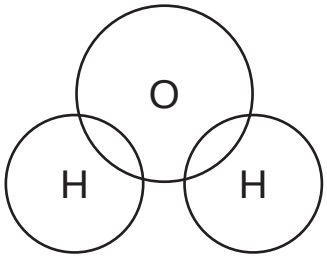
$$H_2SO_4 + 2NaCl \rightarrow Na_2SO_4 + 2HCl$$

(a) Write the word equation for this reaction.

..... [1]

(b) Hydrogen chloride dissolves in water to form hydrochloric acid.

(i) Complete the dot-and-cross diagram to show the arrangement of the outer shell electrons in water.



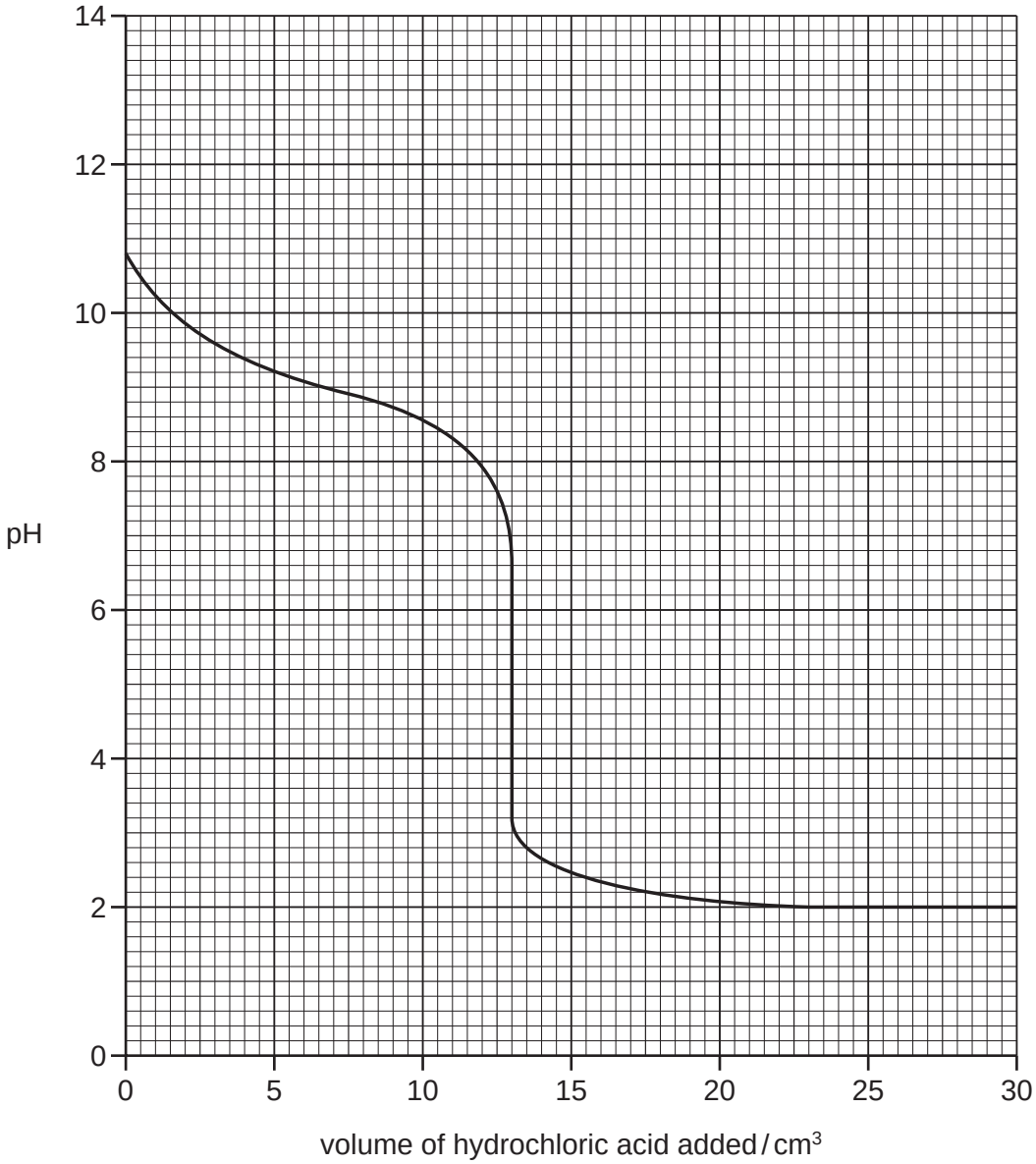
[2]

(ii) Describe what you would observe when a few drops of silver nitrate solution are added to hydrochloric acid.

..... [2]

[Turn over

(c) The graph below shows how pH changes when aqueous ammonia is neutralised by hydrochloric acid.



(i) What is the pH of the aqueous ammonia at the start of the experiment?

..... [1]

(ii) What volume of hydrochloric acid has been added when the pH is 10?

..... [1]

(iii) What volume of hydrochloric acid has been added when the pH is changing most quickly?

..... [1]

(d) Concentrated hydrochloric acid reduces manganese(IV) oxide, MnO_2, to manganese(II) chloride.

$$4HCl + MnO_2 \rightarrow MnCl_2 + Cl_2 + 2H_2O$$

How does this equation show that manganese(IV) oxide gets reduced?

..... [1]

(e) The table shows some properties of four metals, **A**, **B**, **C** and **D**, and their oxides.

metal	density in g / cm^3	boiling point / °C	colour of oxide	charge on the metal ion
A	2.99	2831	white	3+
B	0.53	1342	white	1+
C	7.86	2750	black or red-brown	2+ or 3+
D	7.14	907	white	2+

Which **one** of these metals is a transition metal?
Use the information in the table to explain your answer.

.....

.....

..... [2]

[Total: 11]

[Turn over

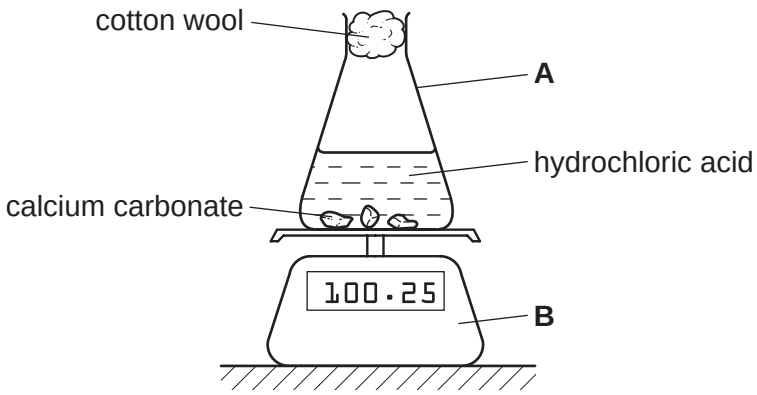
4 Calcium carbonate reacts with dilute hydrochloric acid.

(a) Complete the symbol equation for this reaction.

$$CaCO_3 + ...HCl \rightarrow CaCl_2 + CO_2 + ...$$

[2]

(b) The rate of this reaction can be followed using the apparatus shown below.



(i) State the names of the pieces of apparatus labelled **A** and **B**.

A .....

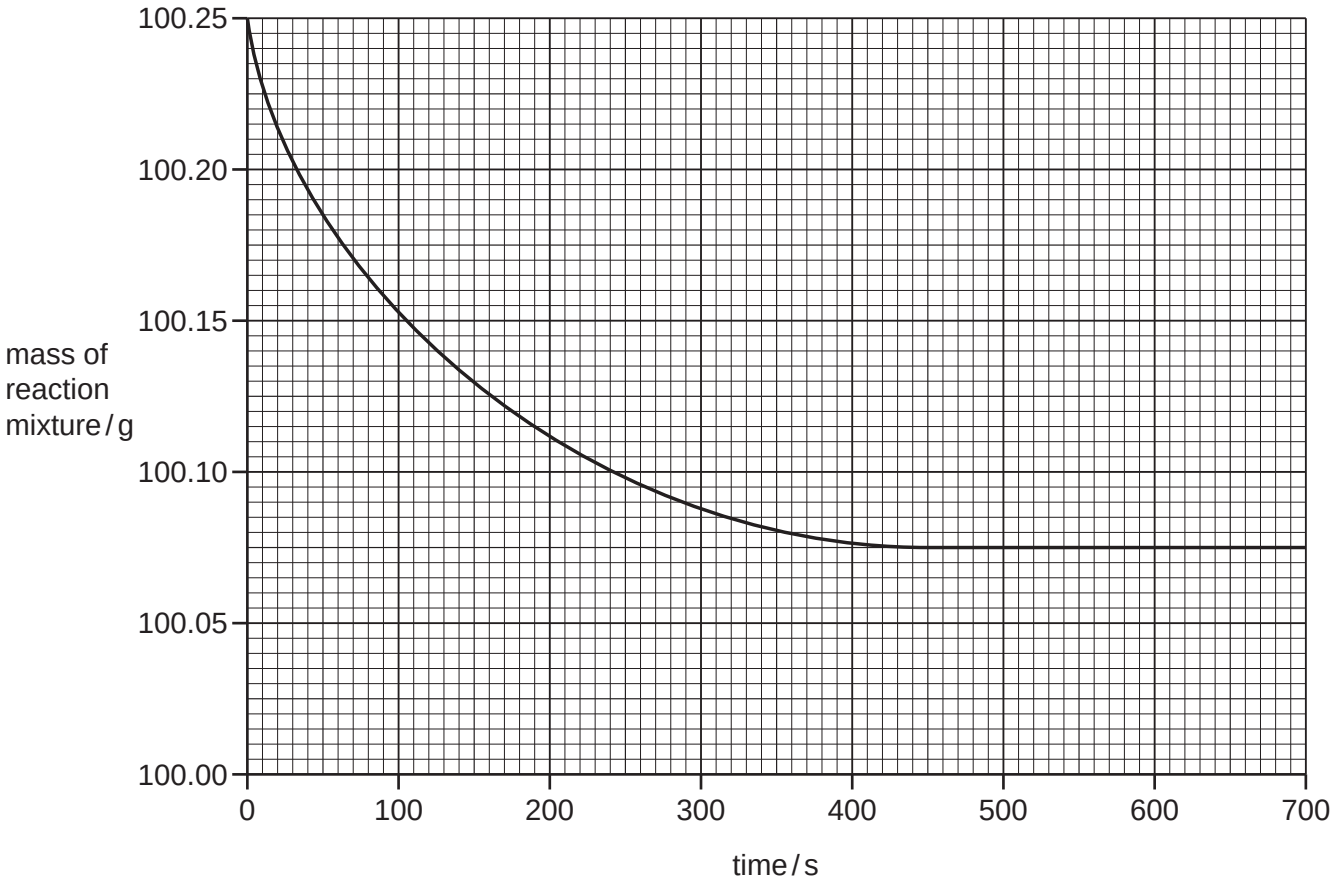
B .....

[2]

(ii) Explain why the mass of the reaction mixture decreases with time.

..... [1]

(c) The graph below shows how the mass of the reaction mixture changes with time.
The calcium carbonate was in excess and large pieces of calcium carbonate were used.



(i) At what time was the reaction just complete?

..... [1]

(ii) Calculate the total loss in mass of the reaction mixture in this experiment.

..... [1]

(iii) How does the rate of reaction change when:

smaller pieces of calcium carbonate are used,

.....

the temperature is decreased,

.....

the concentration of hydrochloric acid is decreased?

.....
[3]

[Turn over

(d) When heated, calcium carbonate breaks down to form calcium oxide and carbon dioxide.

Which **two** words from the list below describe this reaction?
Tick **two** boxes.

combustion	☐
decomposition	☐
endothermic	☐
exothermic	☐
oxidation	☐

[2]

(e) Calcium oxide is used in flue-gas desulfurisation.

(i) Explain how flue-gas desulfurisation works.

.....

.....

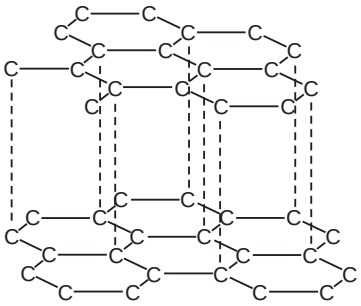
..... [2]

(ii) Give **one** other use of calcium oxide.

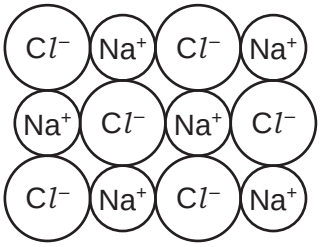
..... [1]

[Total: 15]

5 The structures of graphite and sodium chloride are shown below.



graphite



sodium chloride

(a) Describe the similarity and differences in these structures.

.....

.....

.....

.....

.....

..... [4]

(b) Graphite is a form of carbon.
Carbon is an element.

(i) What is meant by the term *element*?

.....

..... [1]

(ii) Write a symbol equation for the complete combustion of carbon.

[2]

(c) The table shows some properties of four substances, **A**, **B**, **C** and **D**.

substance	melting point / °C	boiling point / °C	electrical conductivity
A	–7	+59	does not conduct
B	–157	–152	does not conduct
C	+769	+1930	conducts when molten but not when solid
D	+1410	+2355	does not conduct

Which **one** of these substances, **A**, **B**, **C** or **D**,

(i) is a liquid at room temperature, ... [1]

(ii) is a giant ionic structure, ... [1]

(iii) is a noble gas, ... [1]

(iv) is a giant covalent structure? ..... [1]

[Total: 11]

6 The table below shows some properties of the first five members of the alkane homologous series.

alkane	molecular formula	boiling point / °C	density of the liquid alkane in g / cm^3
methane	CH_4	–164	0.47
ethane	C_2H_6	–88	
propane	C_3H_8	–42	0.59
butane	C_4H_{10}	0	0.60
pentane		+36	0.63

(a) (i) What do you understand by the term *homologous series*?

.....

..... [2]

(ii) Deduce the molecular formula for pentane.

..... [1]

(iii) Describe how the boiling points of these alkanes change as the number of carbon atoms increases.

..... [1]

(iv) Deduce the density of liquid ethane.

..... [1]

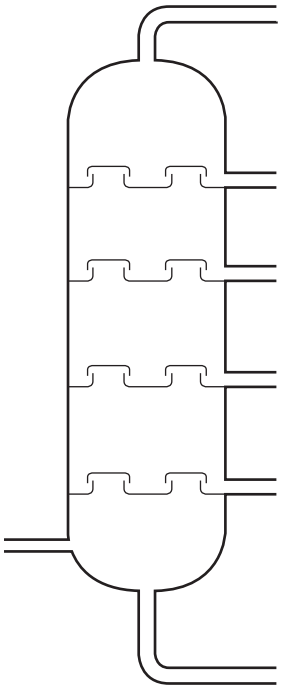
(b) Methane is a fuel which is a gas at room temperature.
State the name of a fuel which is:

a solid at room temperature, ...

a liquid at room temperature. .....
[2]

[Turn over

(c) The diagram below shows a distillation column used to separate petroleum into different fractions.



(i) On the diagram above:

- put a letter **X** to show where the temperature in the column is lowest,
- put a letter **F** to show where the fraction containing the largest molecules is collected,
- put a letter **M** to show where petroleum enters the distillation column.

[3]

(ii) The refinery gas fraction contains ethane.
Hydrogen is one of the products formed when ethane is cracked.
Complete the symbol equation for the cracking of ethane.

$$C_2H_6 \rightarrow \text{.....} + \text{.....}$$

[2]

(iii) State the conditions needed for cracking.

..... [2]

[Total: 14]

7 Gallium and aluminium are in Group III of the Periodic Table.

(a) The melting point of gallium is 30 °C.
Use the kinetic particle theory to explain what happens when a spoon made of gallium is put into a cup of tea at 40 °C.

In your answer, refer to:

- the change of state which occurs,
- the change in the arrangement of the particles,
- the change in the motion of the particles.

.....

.....

.....

.....

..... [4]

(b) Gallium burns in air at a high temperature to form gallium(III) oxide.
Complete the symbol equation for this reaction.

$$.....Ga + 3O_2 \rightarrow .....Ga_2O_3$$

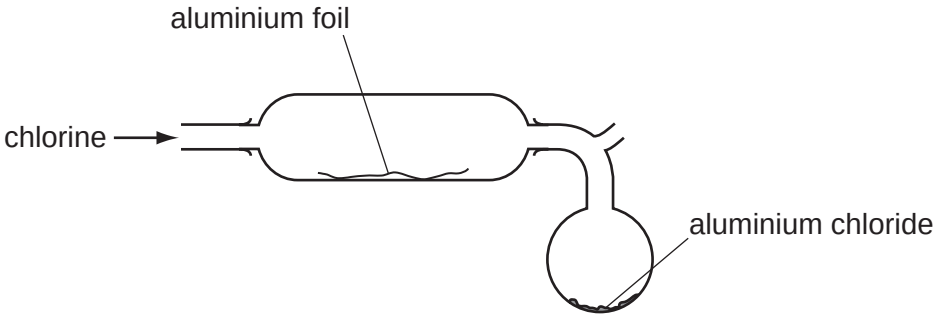
[2]

(c) Explain why aluminium is often used in containers for food and drinks.

.....

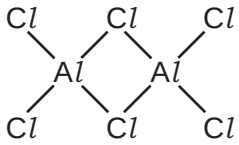
..... [2]

(d) Aluminium chloride can be made by heating aluminium foil in a stream of chlorine.



(i) On the diagram above, draw an arrow to show where heat should be applied. [1]

(ii) At temperatures between 178 °C and 400 °C, aluminium chloride has the structure shown below.



Deduce the molecular formula of this structure.

..... [1]

(iii) Some properties of aluminium and silver are shown in the table below.

	cost	density in g / cm^3	electrical conductivity	melting point / °C
aluminium	high	2.7	good	660
silver	very high	10.5	very good	962

Use the information in the table to suggest why aluminium rather than silver is used in overhead power cables.

..... [1]

[Total: 11]

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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											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	**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 †															

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

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 dm^3 at room temperature and pressure (r.t.p.).