UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/02**

Paper 2 Theory **October/November 2007**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

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.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **three** questions.
Write your answers on any lined pages and/or separate answer paper.

A copy of the Periodic Table is printed on page 20.
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.

For Examiner's Use	
Section A	
B7	
B8	
B9	
B10	
Total	

This document consists of **19** printed pages and **1** blank page.

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 Choose from the following gases to answer the questions below.

ammonia
butane
carbon dioxide
carbon monoxide
hydrogen
methane
nitrogen
nitrogen dioxide
oxygen

Each gas can be used once, more than once or not at all.

Which gas is

(a) the main constituent of natural gas,

.....[1]

(b) used by plants in photosynthesis to form glucose,

.....[1]

(c) produced when aqueous sodium nitrate is warmed with aqueous sodium hydroxide and aluminium foil,

.....[1]

(d) a product of the incomplete combustion of hydrocarbons,

.....[1]

(e) produced by the Haber process,

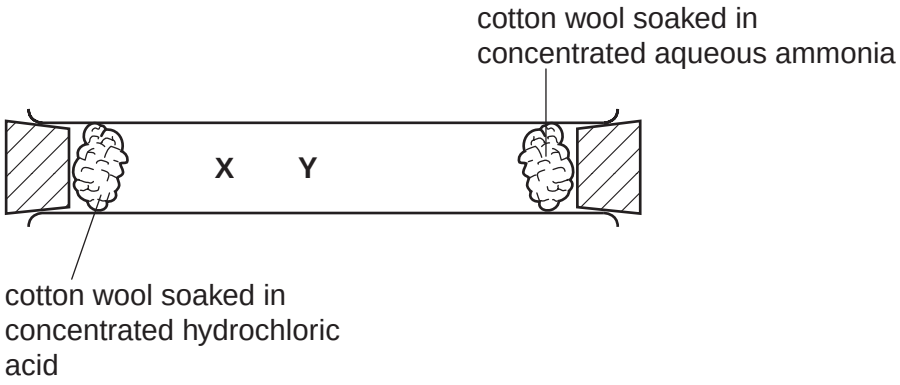
.....[1]

(f) formed at the cathode when an aqueous solution of sulphuric acid is electrolysed?

.....[1]

[Total: 6]

A2 A student set up the apparatus shown below.



Colourless fumes of hydrogen chloride are given off by the hydrochloric acid.
Colourless fumes of ammonia are given off by the aqueous ammonia.

(a) After a few seconds, white fumes were seen at point **X** in the tube.
Name the compound formed at point **X**.

.....[1]

(b) Use the kinetic particle theory to explain this observation.

.....

.....

.....[3]

(c) The student repeated the experiment using a solution of methylamine, CH_3NH_2, in place of ammonia, NH_3.
The white fumes were seen at point **Y** in the tube, rather than at point **X**.
Explain this difference.

.....

.....[2]

[Total: 6]

A3 Germanium, Ge, is an element in Group IV of the Periodic Table. Some of its chemistry resembles that of carbon.

(a) How many electrons does an atom of germanium have in its outer shell?

.....[1]

(b) Germanium forms a range of saturated compounds with hydrogen. These compounds resemble the alkanes.

(i) Predict the general molecular formula for these compounds.

.....[1]

(ii) Germanoethane, Ge_2H_6, has a similar structure to ethane.
Draw the full structural formula for germanoethane.

[1]

(iii) Hydrochloric acid reacts with magnesium germanide, Mg_2Ge, to form germanomethane, GeH_4, and magnesium chloride.
Write an equation for this reaction.

[1]

(c) Germanium(IV) oxide, GeO_2, is an amphoteric oxide.
What do you understand by the term *amphoteric*?

.....[1]

(d) An aqueous solution of germanium(II) chloride reduces iron(III) ions to iron(II) ions.
Describe a test for iron(II) ions and give the result.

test .....

result .....[2]

[Total: 7]

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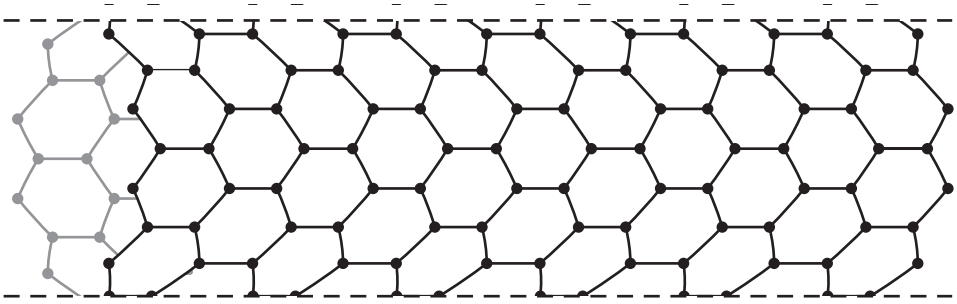
A4 In recent years scientists have made tube-shaped structures of carbon called nanotubes.



● carbon atom

(a) State **two** differences between the structure of a carbon nanotube and the structure of diamond.

.....

.....

.....[2]

(b) Carbon nanotubes are fifty times stronger than steel.
Use ideas about structure and bonding to suggest why these nanotubes are so strong.

.....

.....[1]

(c) Carbon nanotubes are good electrical conductors.

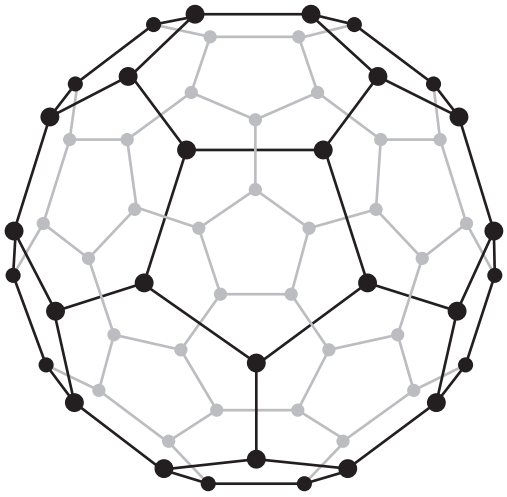
(i) State the name of another form of carbon which can conduct electricity.

.....[1]

(ii) Carbon nanotubes conduct electricity nearly as well as copper.
Explain why copper is a good conductor of electricity.

.....[1]

(d) Another form of carbon is buckminsterfullerene.



● carbon atom

Argon can be trapped inside the cage-like structure of buckminsterfullerene.

(i) Explain why argon is unreactive.

.....[1]

(ii) One isotope of argon is $^{38}_{18}Ar$.

Calculate the number of neutrons in this isotope of argon.

.....[1]

(e) Recently, chemists have been trying to attach atoms of transition elements to buckminsterfullerene to make more efficient catalysts.
State **two** properties, other than catalysis, which distinguish transition elements from other metals.

.....

.....[2]

[Total: 9]

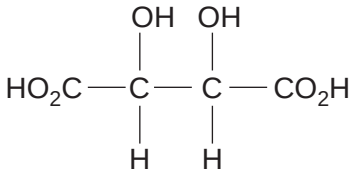
A5 Red grapes contain a number of coloured pigments.
Some red grapes are crushed and the pigments extracted with a solvent. The deep red solution contains a mixture of pigments.

(a) Name the technique used to separate the pigments in this mixture and draw a labelled diagram of the apparatus you would use.

name of technique .....

[3]

(b) Tartaric acid can also be extracted from grape juice.
The structure of tartaric acid is shown below.



(i) Deduce the empirical formula of tartaric acid.

.....[1]

(ii) A solution of tartaric acid was titrated with 0.100 mol/dm^3 potassium hydroxide.

$$C_2H_2(OH)_2(CO_2H)_2 + 2KOH \rightarrow C_2H_2(OH)_2(CO_2K)_2 + 2H_2O$$

tartaric acid

It required 6.00 cm^3 of the potassium hydroxide solution to neutralise 20.0 cm^3 of tartaric acid. Calculate the concentration, in mol/dm^3, of the tartaric acid solution.

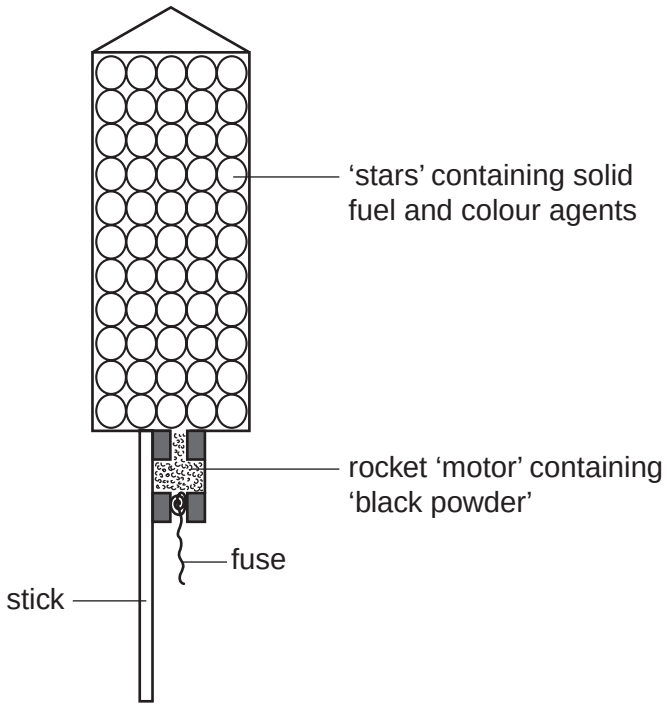
.....mol/dm^3 [3]

(iii) Tartaric acid is purified by recrystallisation.
On analysis, 8.00 g of impure tartaric acid was found to contain 7.40 g of pure tartaric acid. Calculate the percentage purity of the impure tartaric acid.

.....% [1]

[Total: 8]

A6 The diagram shows the inside of a firework rocket.



(a) Black powder is a mixture of charcoal, potassium nitrate and sulphur.
When black powder is ignited, the potassium nitrate decomposes to form potassium nitrite, KNO_2, and oxygen.
Write the equation for the decomposition of potassium nitrate.

.....[1]

(b) The oxygen liberated by the potassium nitrate oxidises the sulphur to sulphur dioxide.
State one harmful effect of sulphur dioxide on the environment.

.....[1]

(c) The gases produced by the burning charcoal and sulphur cause the rocket to move upwards.
Explain why the charcoal and sulphur in the rocket 'motor' are present as small grains rather than as large lumps.

.....

.....[2]

(d) Sodium sulphate is often used in fireworks to give yellow sparks.
Describe a test for sulphate ions and give the result.

test .....

result .....[2]

(e) Potassium chlorate(V), $KClO_3$, is often used in fireworks to produce flash and noise effects.

(i) An aqueous solution of potassium chlorate(V) is a good oxidising agent. Describe a chemical test for an oxidising agent and state the result.

test .....

result .....[2]

(ii) When potassium chlorate(V) reacts as an oxidising agent, the chlorate(V) ions are reduced to chloride ions.

$$ClO_3^- + 6H^+ + 6e^- \rightarrow Cl^- + 3H_2O$$

How does this equation show that the chlorate(V) ion gets reduced?

.....

.....[1]

[Total: 9]

Section B

Answer **three** questions from this section.

The total mark for this section is 30.

B7 The exhaust from an internal combustion engine contains the pollutant gases carbon monoxide and nitrogen dioxide.

(a) Many vehicles have a catalytic converter fitted on their exhaust systems.
Describe the chemical reactions which occur in the catalytic converter to reduce the emissions of carbon monoxide and nitrogen dioxide. [3]

(b) Unburnt hydrocarbons such as heptane, C_7H_{16}, are oxidised in the catalytic converter. Write an equation for the complete combustion of heptane. [1]

(c) Carbon monoxide reacts with nickel to form a compound containing nickel, carbon and oxygen only. Analysis of 5.70 g of this compound showed that it contained 1.97 g nickel, 1.60 g carbon and 2.13 g oxygen.
Determine the empirical formula of this compound. [3]

(d) Nickel is used in the manufacture of margarine to catalyse the reduction of unsaturated vegetable oils to saturated oils.

(i) What do you understand by the following terms?

- catalyst
- unsaturated [2]

(ii) What other reactant is needed to convert an unsaturated oil into a saturated oil? [1]

[Total: 10]

B8 Propanoic acid, $C_2H_5CO_2H$, is a weak acid.

(a) Explain what is meant by the term *weak acid*. [1]

(b) Propanoic acid reacts with sodium carbonate. Write the equation for this reaction. [1]

(c) Magnesium reacts with propanoic acid to form magnesium propanoate and hydrogen.

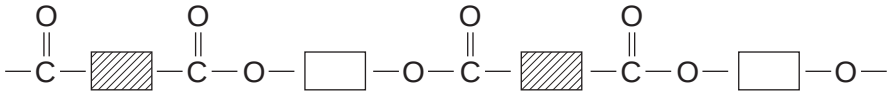
$$Mg + 2C_2H_5CO_2H \rightarrow (C_2H_5CO_2)_2Mg + H_2$$

A student added 4.80 g of magnesium to 30.0 g of propanoic acid.

(i) Which one of these reactants, magnesium or propanoic acid, is in excess? Explain your answer. [2]

(ii) Calculate both the number of moles of hydrogen and the volume of hydrogen formed at r.t.p. [2]

(d) *Terylene* has the simplified structure shown.



(i) State the functional groups on the monomers used to make *Terylene*. [1]

(ii) State the type of polymerisation that occurs when *Terylene* is made. [1]

(iii) State one large scale use of *Terylene*. [1]

(e) Many problems are caused by the disposal of plastics.
Describe one method of disposal of a plastic and a problem caused by this method. [1]

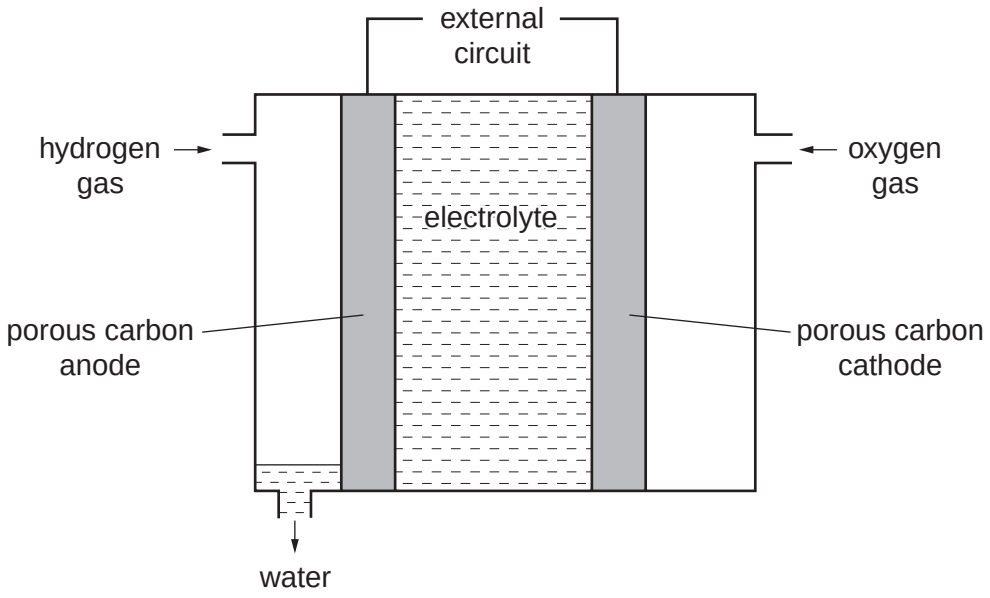
[Total: 10]

B9 One of the first buses to use hydrogen as a fuel was operated in Erlangen, Germany, in 1996. The hydrogen was stored in thick pressurised tanks on the roof of the bus.

(a) Describe **two** advantages of using hydrogen as a fuel rather than petrol. [2]

(b) Suggest one disadvantage of using hydrogen as a fuel. [1]

(c) Some buses use hydrogen to generate electrical energy from a fuel cell.
The structure of a typical fuel cell is shown.



(i) The equation for the reaction at the anode is shown.

$$H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$$

What type of reaction is this? Explain your answer. [1]

(ii) At the cathode oxygen reacts with water to form hydroxide ions. Write an ionic equation for this reaction. [1]

(d) In some fuel cells an acidic electrolyte is used.

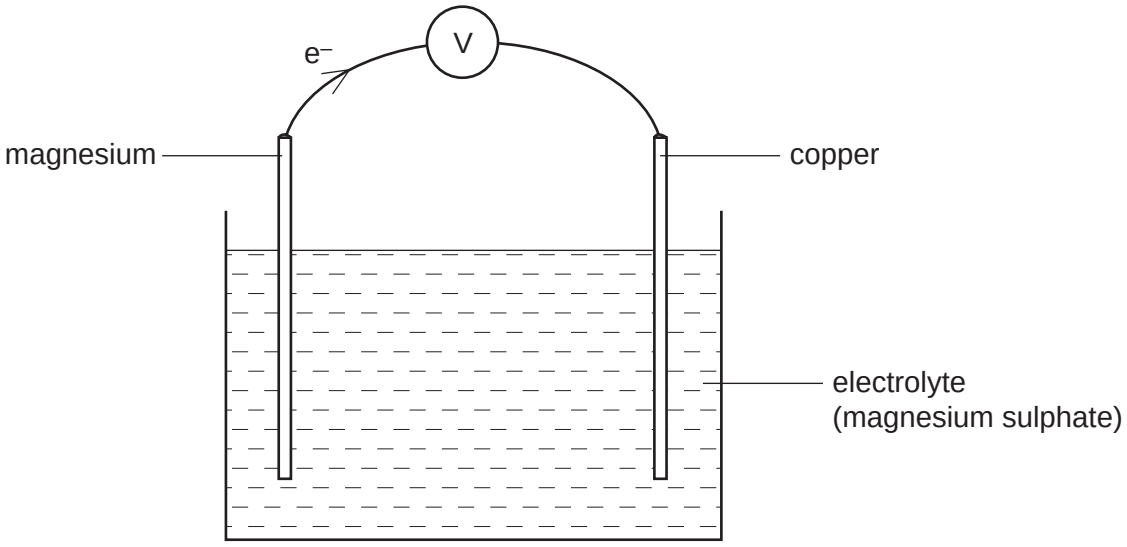
anode reaction: $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

cathode reaction: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$

(i) Write an overall equation for the reaction occurring in this fuel cell. [1]

(ii) Suggest a suitable electrolyte for this fuel cell. [1]

(e) An electric current can also be generated by a simple electrochemical cell such as the one shown.

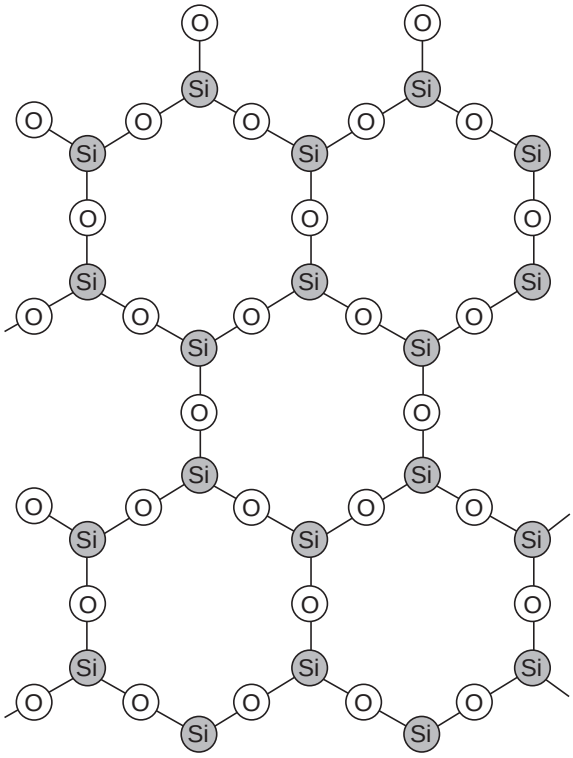


(i) Explain why the flow of electrons is in the direction shown in the diagram. [2]

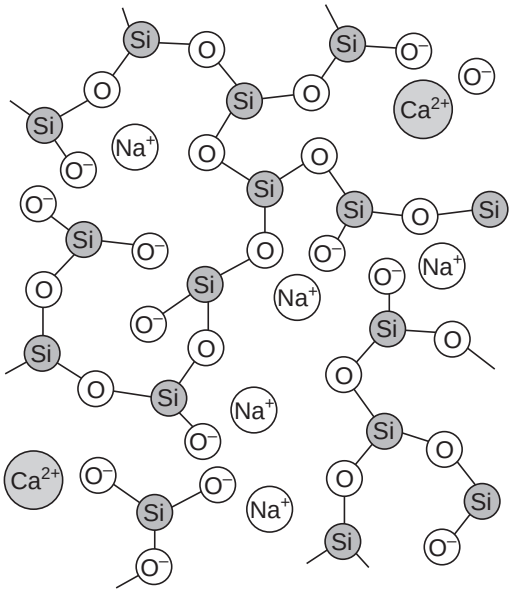
(ii) Suggest why silver nitrate would not be a good electrolyte to use in this cell. [1]

[Total: 10]

B10 Soda-lime glass is made by heating a mixture of calcium carbonate, sodium carbonate and sand in a furnace to a high temperature.
Other glasses contain compounds called silicates. The simplified structures of a silicate and soda-lime glass are shown.



silicate



soda-lime glass

(a) Describe two differences between the silicate and the soda-lime glass. [2]

(b) When soda-lime glass is melted, it conducts electricity.
Use the information in the diagram to explain this fact. [1]

(c) Calcium carbonate decomposes in the furnace.
Write an equation for the thermal decomposition of calcium carbonate.
Include state symbols. [1]

(d) Some types of glass contain lead ions, Pb^{2+}.
Dishwasher powders are highly alkaline.

(i) Which ion is responsible for alkalinity? [1]

(ii) When glasses containing lead ions are washed repeatedly in a dishwasher they go slightly white in colour.
Suggest a chemical explanation for why the glass goes white. Write an equation for the reaction which occurs. [2]

(e) Calcium carbonate reacts with hydrochloric acid.
Describe how you would investigate the rate of reaction of calcium carbonate with hydrochloric acid. Give a brief description of the apparatus you would use and the measurements you would make. [3]

[Total: 10]

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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 Sulphur 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 Radius 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	a = relative atomic mass
X	X = atomic symbol
b	b = proton (atomic) number

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