Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES **0654/03**

Paper 3 Extended

May/June 2006

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

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.

Answer **all** questions.
You may use a pencil for any diagrams, graphs, tables or rough working.
A copy of the Periodic Table is printed on page 24.
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	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

This document consists of **21** printed pages and **3** blank pages.

1 Blood contains red cells, white cells and plasma.

(a) Outline the function of white blood cells.

.....

.....

..... [2]

(b) The heart pumps blood around the body. Explain how the heart pushes blood into the arteries.

.....

.....

..... [2]

(c) State **one** difference between the structure of arteries and the structure of veins.
Explain how this difference relates to their different functions.

structure .....

function .....

.....

..... [3]

(d) Plants do not have a heart to pump fluids around them.
Water is carried through xylem vessels from a plant's roots to its leaves.

Explain why this happens more quickly when it is warm than when it is cold.

.....

.....

.....

..... [3]

2 **(a)** A student uses a pH sensor connected to a computer to investigate four liquids, **A**, **B**, **C** and **D**. The apparatus is shown in Fig. 2.1.

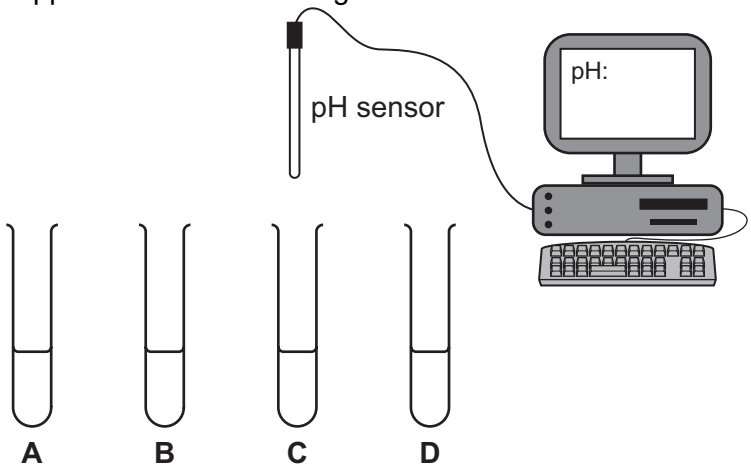


Fig. 2.1

The results obtained when the pH sensor was placed into the liquids in the test-tubes are shown in Table 2.1.

Table 2.1

tube	pH
A	14.0
B	7.0
C	1.0
D	6.0

(i) Which liquid in Table 2.1 could be pure water?
Explain your answer.

.....

..... [1]

(ii) Which liquid in Table 2.1 would react with iron(II) sulphate to form a green precipitate of iron(II) hydroxide?
Explain your answer.

.....

..... [2]

(iii) Which liquid in Table 2.1 contains the highest concentration of H^+ ions?
Explain your answer.

.....

..... [1]

[Turn over

(b) The student then used a temperature sensor in a second experiment as shown in Fig. 2.2.

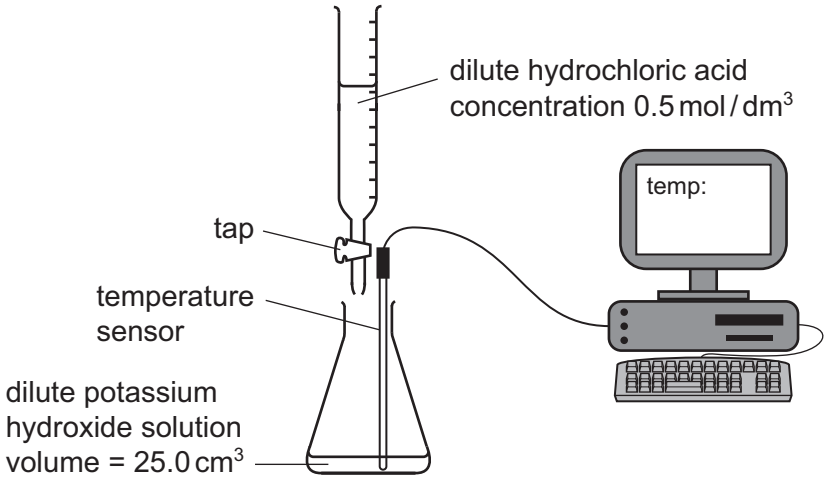


Fig. 2.2

The student opened the tap and added the hydrochloric acid slowly to the potassium hydroxide solution. She plotted a graph of the temperature of the mixture against the volume of acid added. Her graph is shown in Fig. 2.3.

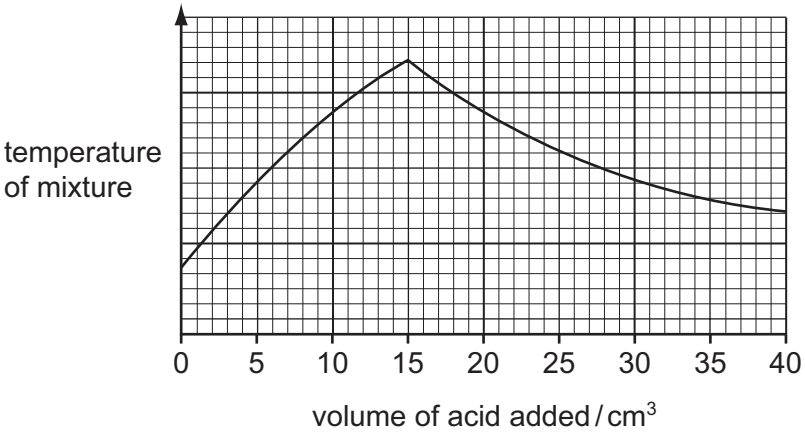


Fig. 2.3

The mixture became neutral when 15.0 cm^3 of acid had been added.

(i) Explain why the temperature of the mixture increased when the acid was first added to the potassium hydroxide solution.

.....

..... [1]

(ii) Suggest why the temperature of the mixture decreased once 15.0 cm^3 of acid had been added.

.....

.....

..... [2]

The balanced equation for this reaction is

$$HCl\,(aq) + KOH\,(aq) \rightarrow KCl\,(aq) + H_2O\,(l)$$

(iii) Show that the number of moles of hydrochloric acid required to neutralise all of the potassium hydroxide was 0.0075.
Show your working.

..... [2]

(iv) Calculate the concentration of the potassium hydroxide solution in mol / dm^3.
Show your working.

..... [3]

(v) Write an ionic equation for the neutralisation of any acid by any alkali.

..... [1]

[Turn over

3 **(a)** Nuclear fission and nuclear fusion are both sources of energy.

(i) Apart from releasing energy, in what way are these two processes similar?

.....

..... [1]

(ii) In what way are these two processes different?

.....

..... [1]

(iii) There are safety concerns about the use of nuclear fission as an energy resource. Describe and explain **one** of these safety concerns.

.....

.....

.....

..... [3]

(b) **(i)** The voltage of electricity generated in a power station is increased using transformers for transmission through power lines to the users.

Explain why this is done.

.....

..... [2]

(ii) Fig. 3.1 shows a diagram of a simple transformer.

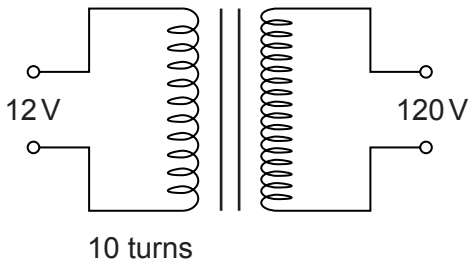


Fig. 3.1

Use the equation $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ to calculate the number of turns on the coil in the secondary circuit.

number of turns = ... [1]

(iii) Explain how a transformer changes the voltage of an electrical supply. Your explanation should include the terms *induced current* and *magnetic field*.

.....

.....

.....

.....

..... [3]

4 Big-horn sheep live on rocky mountain sides in Canada. The males have very large horns. The size of their horns is caused by their genes.

(a) State **one** feature shown in the photograph that is found only in mammals.

.....

[1]

(b) **(i)** Name the part of a cell that contains the genes.

.....

[1]

(ii) In which cells in the big-horn sheep's body will the gene for horn size be present?

.....

[1]

(c) Hunters kill big-horn sheep and keep their horns as trophies. They kill the sheep with the largest horns.

Fig. 4.1 shows how the average size of the horns in a population of big-horn sheep changed between 1970 and 2005.

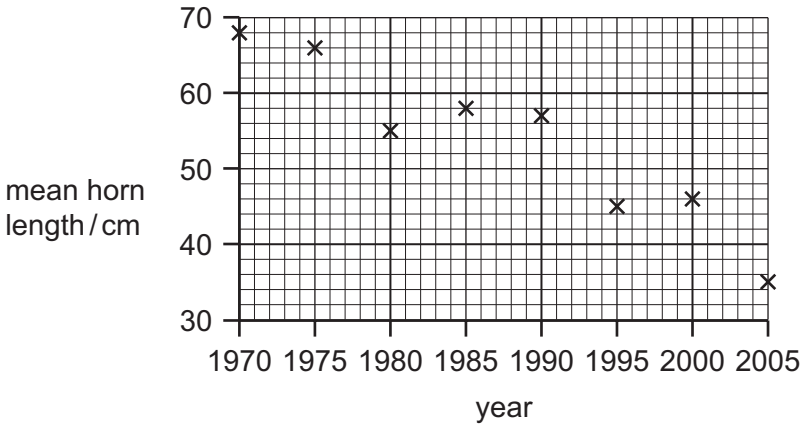


Fig. 4.1

Explain how hunting of big-horn sheep could have caused the general trend shown in Fig. 4.1.

.....

.....

.....

.....

..... [4]

(d) In summer it may be very hot in the mountains, but in winter it is very cold.

(i) Explain how the big-horn sheep's sweat glands can help to keep them cool in summer.

.....

.....

..... [2]

(ii) Explain how vasoconstriction can help to keep the sheep warm in winter.

.....

.....

.....

..... [3]

5 **(a)** Electrical signals can be sent along wires in digital form.

(i) Describe what is meant by a *digital* signal.

.....

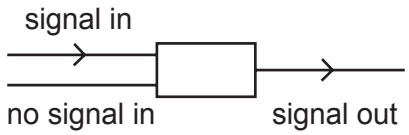
..... [1]

(ii) Give **one** advantage of using digital signals rather than analogue signals.

.....

..... [1]

(b) Electrical signals can pass in and out of electronic gates.
Identify the gates in Fig. 5.1 below.



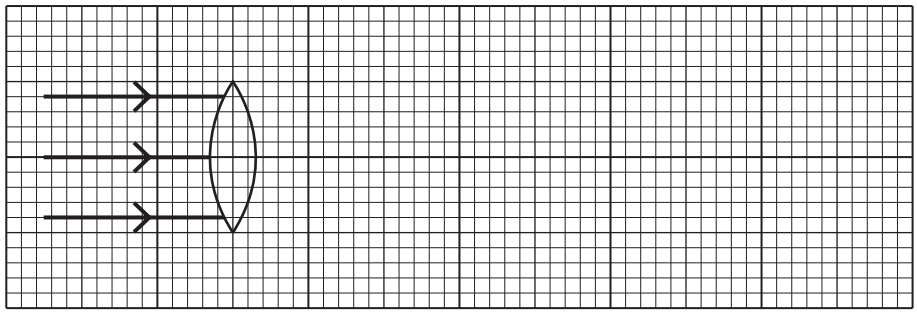
..... gate

..... gate [2]

Fig. 5.1

(c) Rays of light entering the eye are refracted by the lens.

(i) Complete Fig. 5.2 below to show what happens when parallel rays of light are refracted by a lens of focal length 10 cm.



scale 1:2

[3]

Fig. 5.2

(ii) Human eyes are able to detect the three primary colours.
Name these colours.

1. .....

2. .....

3. ..... [1]

(iii) These three colours of light are electromagnetic waves. Apart from their colour, state **one** other way in which they differ from each other.

.....

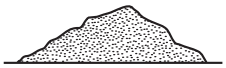
..... [1]

6 **(a)** The diagrams below show some common raw materials which are changed by chemical reactions into useful products.

Choose words from the list to complete each box.

aluminium **ammonia** **ceramics** **chlorine**

glass **paper** **plastics**

raw materials		**useful products**
 silicon(IV) oxide mixed with metal oxides	→	
 clay	→	
 petroleum (crude oil)	→	

[3]

(b) Explain why silicon (IV) oxide has a very high melting point.
You may draw a diagram if it helps your answer.

.....

.....

.....

..... [2]

(c) Petroleum (crude oil) undergoes many processes in order to provide a wide range of useful chemicals.
Some of the alkane molecules from petroleum are cracked on the surface of a hot catalyst to produce a mixture of saturated and unsaturated hydrocarbons.
Fig. 6.1 shows a schematic diagram of catalytic cracking.

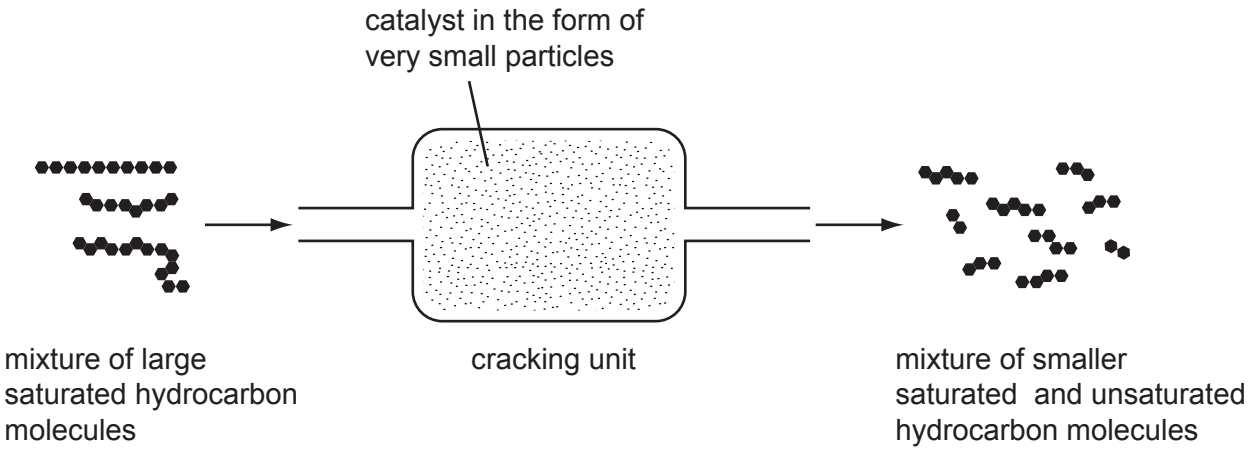


Fig. 6.1

(i) Name the unsaturated hydrocarbon, produced by cracking, which is used to make ethanol, C_2H_6O.

..... [1]

(ii) Write a balanced equation for the reaction referred to in **(i)** that produces ethanol.

..... [1]

(iii) Describe how a sample of the mixture coming from the cracking unit could be tested to show that it contained unsaturated compounds.

.....

.....

..... [2]

(iv) The mixture coming from the cracking unit contains molecules of different sizes. Suggest the name of a process which could be used to separate the mixture into individual substances.

..... [1]

7 Fig. 7.1 shows three aeroplanes at an airport.

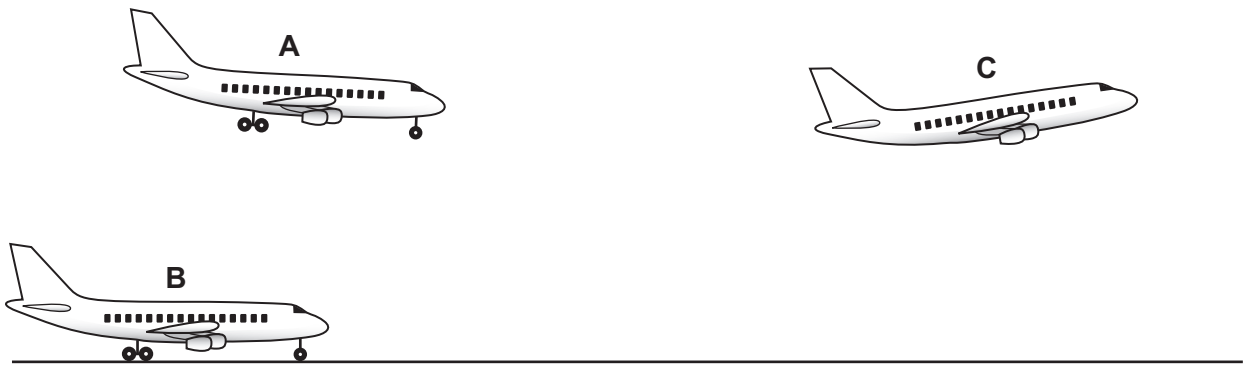


Fig. 7.1

(a) Aeroplane **A** is moving at a constant velocity towards the main runway.
Aeroplane **B** is stationary, waiting for take off.
Aeroplane **C** has just taken off and is accelerating.

(i) Which, if any, of the aeroplanes has zero momentum?

Explain your answer.

.....

..... [1]

(ii) The momentum of one of the aeroplanes is changing.

State which aeroplane and explain your answer.

.....

..... [1]

(b) Fig. 7.2 shows a speed-time graph for aeroplane **C**.

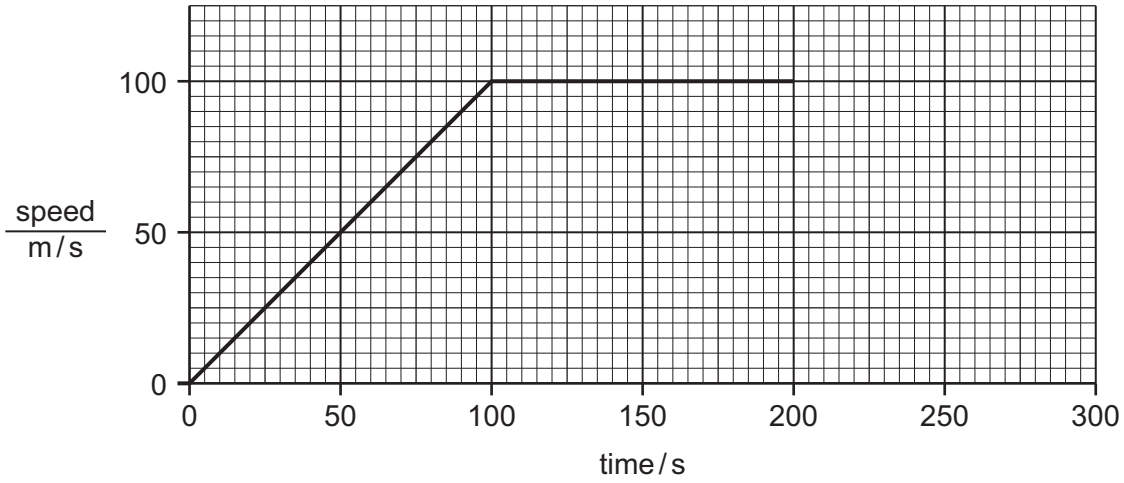


Fig. 7.2

Calculate the distance covered by the aeroplane in the first 200 seconds.
Show your working.

..... [2]

(c) The mass of aeroplane **C** is 120 000 kg.
Calculate the kinetic energy of the aeroplane as it travels at 100 m/s.

Show your working and state the formula that you use.

formula used

working

..... [3]

8 In many parts of the world, cattle are farmed to provide meat and milk for humans. The cattle may be fed on maize. This information can be shown as a food chain.

maize → **cattle** → **humans**

(a) The arrows in the food chain represent the flow of energy along the chain.

Explain how the maize plants obtain their energy.

.....

.....

.....

..... [3]

(b) Fig. 8.1 is a pyramid of biomass for this food chain.

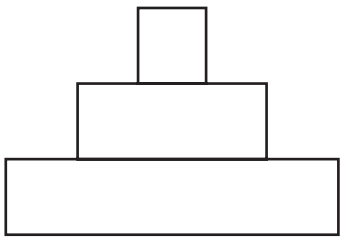


Fig. 8.1

(i) State the meaning of the term *biomass*.

.....

..... [1]

(ii) Write the letter **C** in the level or levels in this pyramid that represent the consumers. [1]

(iii) Explain why the pyramid is this shape.

.....

.....

.....

..... [2]

(c) Explain why farmers may spray pesticides onto growing maize crops.

.....

.....

..... [2]

(d) There is more than enough food in the world to feed everyone, but in many places people cannot get enough to eat.

Describe **one** example of a problem of inadequate diet in a named part of the world and suggest a solution to this problem.

.....

.....

.....

..... [3]

9 Growing crops take up several elements they need from the soil.
The chemical symbols of three of these elements are N, P and K.

(a) (i) One of these elements, when uncombined, is a metal.
Name this element.

..... [1]

(ii) State which **two** of these elements have the same number of electrons in the outer shells of their atoms.
Explain your answer briefly.

elements ..... and .....

explanation .....

..... [2]

(b) In industry, nitrogen from the atmosphere is used to make ammonia. Ammonia is used to make the salts ammonium nitrate and ammonium phosphate, which are added to soil used for growing crops.
Fig. 9.1 shows a diagram of the industrial process used to make ammonia.

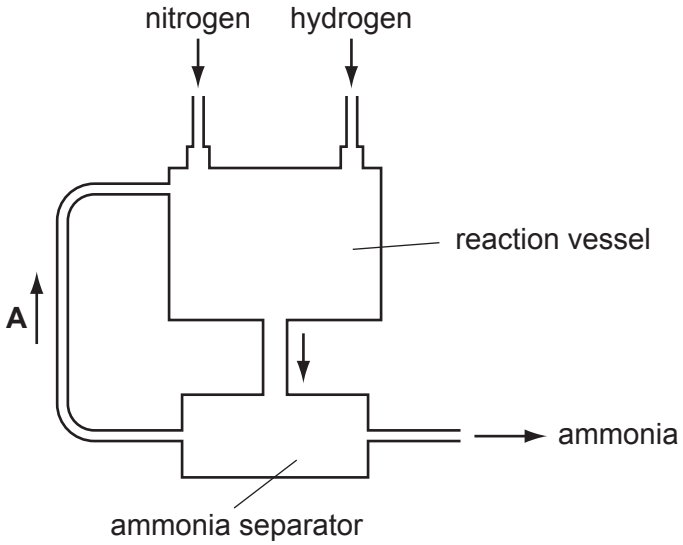


Fig. 9.1

(i) The equation for the formation of ammonia is shown below.

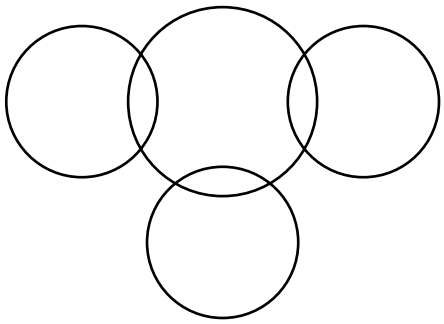
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Name the two **main** gases in the mixture flowing through pipe **A**.

..... and ..... [1]

(ii) Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of ammonia,
- the arrangement of the outer electrons of each atom.



[2]

(iii) The chemical formula of ammonium phosphate is $(NH_4)_3PO_4$.
The formula and charge of the ammonium ion is NH_4^+.

Deduce the formula and charge of the phosphate ion.
Explain your answer.

.....

..... [2]

(iv) The gas mixture inside the reaction vessel in Fig. 9.1 is kept at a high temperature.
Explain the effect this has on the rate of the reaction that produces ammonia.

.....

.....

.....

..... [2]

10 (a) Explain why the pressure inside a car tyre increases as the tyre gets hotter.

.....

.....

.....

..... [2]

(b) Explain why snow skis have a large surface area.

.....

.....

.....

..... [2]

(c) Explain why an earthquake taking place inside the Earth can be detected on the surface.

.....

.....

.....

..... [2]

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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 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
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.).