Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES **0654/03**

Paper 3

October/November 2005

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 in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 20.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **20** printed pages.

1 **(a)** Red is said to be a *primary colour*, while yellow is said to be a *secondary* Explain what is meant by this statement and name one other primary colour and other secondary colour.

explanation

.....

.....

primary colour .....

secondary colour ..... [3]

(b) Below is a list of some waves.

gamma	**infra-red**	**radio**	**sound**
ultrasound	**ultraviolet**	**visible light**	

Write down **one** wave from the list that is

(i) a transverse wave,

..... [1]

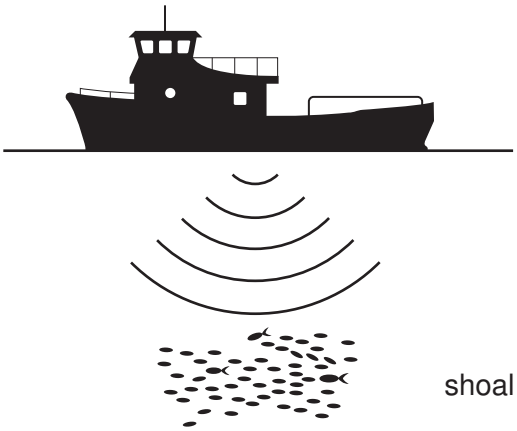
(ii) a longitudinal wave,

..... [1]

(iii) emitted by hot objects but cannot be seen by the human eye.

..... [1]

(c) A fishing boat uses echo sounding to detect a shoal of fish.



Short pulses of high frequency sound are sent out from the boat and the echo from the shoal of fish is detected 0.2 seconds later.

Sound waves travel through water at a speed of 1600 m / s.

(i) Calculate the distance that the shoal of fish is below the boat.

Show your working and state the formula that you use.

formula used

working

..... [2]

(ii) The sound waves have a wavelength of 0.2 m.
Calculate the frequency of the waves.

Show your working and state the formula that you use.

formula used

working

..... [3]

2 **(a)** Fig. 2.1 shows a vertical section through a human heart.

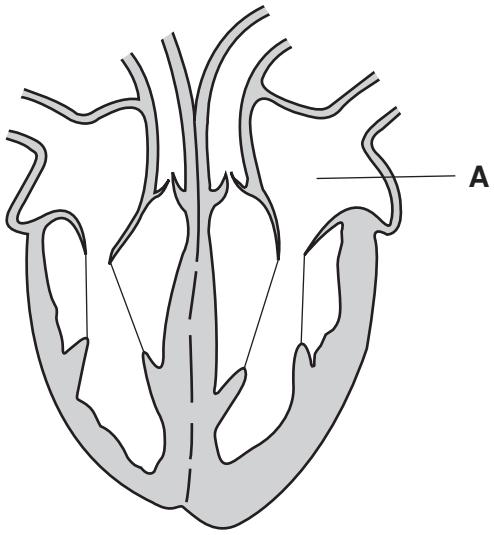


Fig. 2.1

(i) Name the part labelled **A**.

.....

[1]

(ii) Using a labelling line and the letter **M**, label the muscular wall of the left ventricle.[1]

(b) The muscular walls of the heart are supplied with oxygen by blood that flows through the coronary arteries.

Explain why a person may suffer a heart attack if one of the coronary arteries becomes blocked.

.....

.....

.....

.....

..... [3]

(c) Table 2.1 shows part of a chart that doctors in New Zealand use to estim chances of a woman having a heart attack.

Table 2.1

	percentage of women who are expected to have a heart attack within 5 years							
	age 40		age 50		age 60		age 70	
	no diabetes	with diabetes	no diabetes	with diabetes	no diabetes	with diabetes	no diabetes	with diabetes
non-smokers	1	3	3	7	5	12	7	23
smokers	4	7	6	13	12	22	15	33

(i) Use the information in Table 2.1 to describe how a woman's age affects her chances of having a heart attack, if she does not have diabetes and does not smoke.

.....

.....

.....

..... [2]

(ii) Imagine that you are a doctor. A woman smoker with diabetes asks you how she can improve her chances of living a long and healthy life.

Explain how you would use the **information in Table 2.1** to explain to her why it is very important that she should give up smoking.

.....

.....

.....

.....

..... [3]

(iii) State **one** step that the woman could take, other than giving up smoking, which might reduce her chances of having a heart attack.

..... [1]

3 The chemical symbol of the element lithium is shown below.

$$^{7}_{3}\mathrm{Li}$$

(a) (i) State the number of electron shells (energy levels) in a lithium atom.

.....

[1]

(ii) Lithium is obtained as the free element by electrolysis of molten lithium chloride, LiC*l*.
Explain briefly how lithium ions, Li^+, become atoms at the cathode in this process.

.....

.....

[1]

(b) Lithium reacts with water according to the symbolic equation below.

$$2Li + 2H_2O \longrightarrow 2LiOH + H_2$$

Explain why fire-fighters must **not** use water to try to extinguish burning lithium.

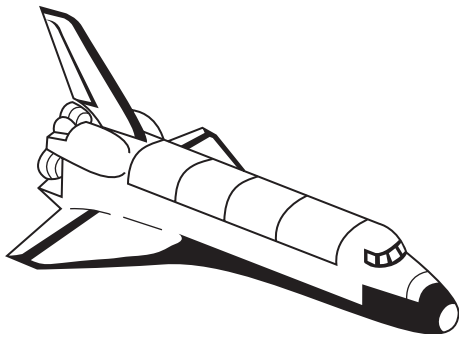
.....

.....

.....

[2]

(c) Lithium hydroxide crystals are used in manned space vehicles to remove carbon dioxide gas from the air exhaled by the astronauts.



The symbolic equation for this reaction is

$$2LiOH + CO_2 \longrightarrow Li_2CO_3 + H_2O$$

(i) The formula and charge of a lithium ion is Li^+. Deduce the formula and ch the carbonate ion.
Explain your answer.

.....

[2]

(ii) A space vehicle carries a crew of 7 astronauts. Each astronaut exhales 18 moles of carbon dioxide every day.

Calculate the total number of moles of carbon dioxide that the crew will exhale during a mission into space which lasts 10 days.
Show your working.

.....

[2]

(iii) Calculate the mass of lithium hydroxide crystals which must be loaded on board the space vehicle to react with all the carbon dioxide exhaled during the mission.
Show your working.

.....

[3]

(iv) Suggest why lithium hydroxide and not the hydroxide of any of the other Group 1 metals is used on the space vehicle.

.....

.....

.....

[2]

4 Fig. 4.1 shows a flying squirrel. A flying squirrel uses large flaps of skin as a parachute to enable it to fall, glide and land safely. The air trapped under these flaps, as squirrel falls, provides an upward force called air resistance.

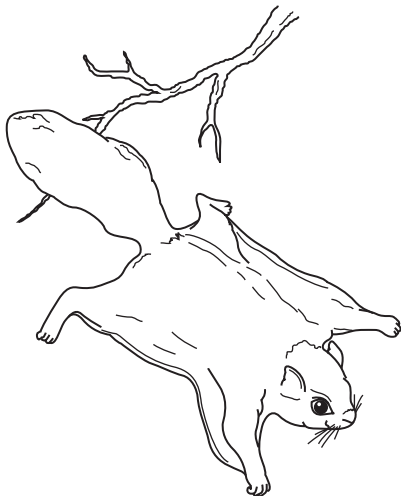


Fig. 4.1

(a) (i) As the squirrel starts to fall, it is accelerating.

State the meaning of the term *accelerating*.

.....

..... [1]

(ii) The squirrel weighs 20 N. Suggest a value for the air resistance while the squirrel is accelerating.

air resistance ..... N

Explain your answer.

.....

..... [2]

(iii) At one point as the squirrel falls, the resultant downward force on the squirrel is 10 N. Calculate the acceleration of the squirrel if its mass is 2 kg.

Show your working and state the formula that you use.

formula used

working

..... [2]

(b) Later in its fall, the squirrel reaches a steady speed (terminal velocity) of 3 m / s.

(i) State the value of the air resistance now.

air resistance ..... N

Explain your answer.

..... [2]

(ii) Explain why the value of the air resistance has changed.

.....

..... [1]

(iii) The surface area of the squirrel on which the air resistance acts is 0.4 m^2.
Use your answer to **(b)(i)** and the formula

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

to calculate the pressure on the squirrel.

Show your working.

..... [2]

5 Fig. 5.1 shows a section through a human eye. The eye is focused on a distant object.

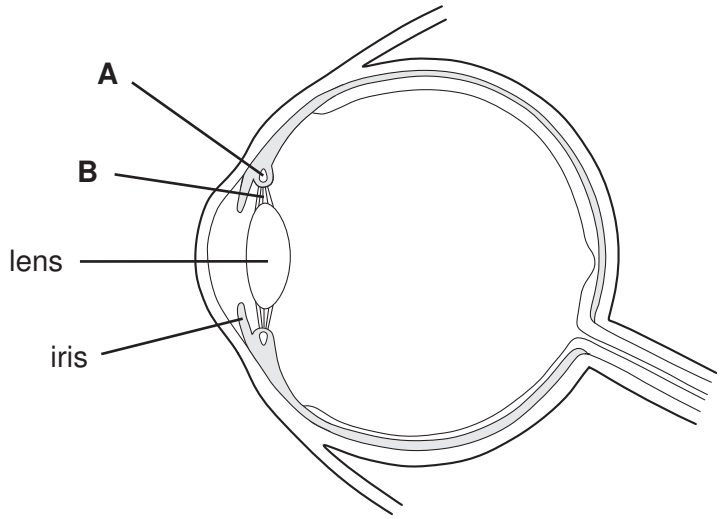


Fig. 5.1

(a) When the eye focuses on a near object, the lens becomes thicker.

(i) Describe the changes that will take place in parts **A** and **B** when the eye focuses on a near object.

A. .....

.....

B. .....

..... [2]

(ii) Explain why the lens needs to become thicker in order to focus on a near object. You may draw a diagram if it helps your answer.

.....

.....

.....

..... [3]

(b) The iris is the coloured part of the eye. It can become wider or narrower to regu amount of light that can reach the retina.

The colour of the iris of a rabbit is determined by the rabbit's genes. A rabbit with the genotype **Bb** or **BB** has brown eyes. A rabbit with the genotype **bb** has yellow eyes.

(i) Use a genetic diagram to explain how two rabbits with brown eyes may have young with yellow eyes.

[3]

Occasionally, a mutation occurs in some of the cells of the iris, which may result in the iris becoming a different colour.

(ii) Ionising radiation may cause mutation. Explain how it does this.

.....

.....

..... [1]

(iii) Explain why this change in colour of the iris will not be passed on to the rabbit's offspring.

.....

.....

..... [2]

6 Fig. 6.1 shows the apparatus a student used to investigate the effect of strong hea sodium hydrogencarbonate, $NaHCO_3$.

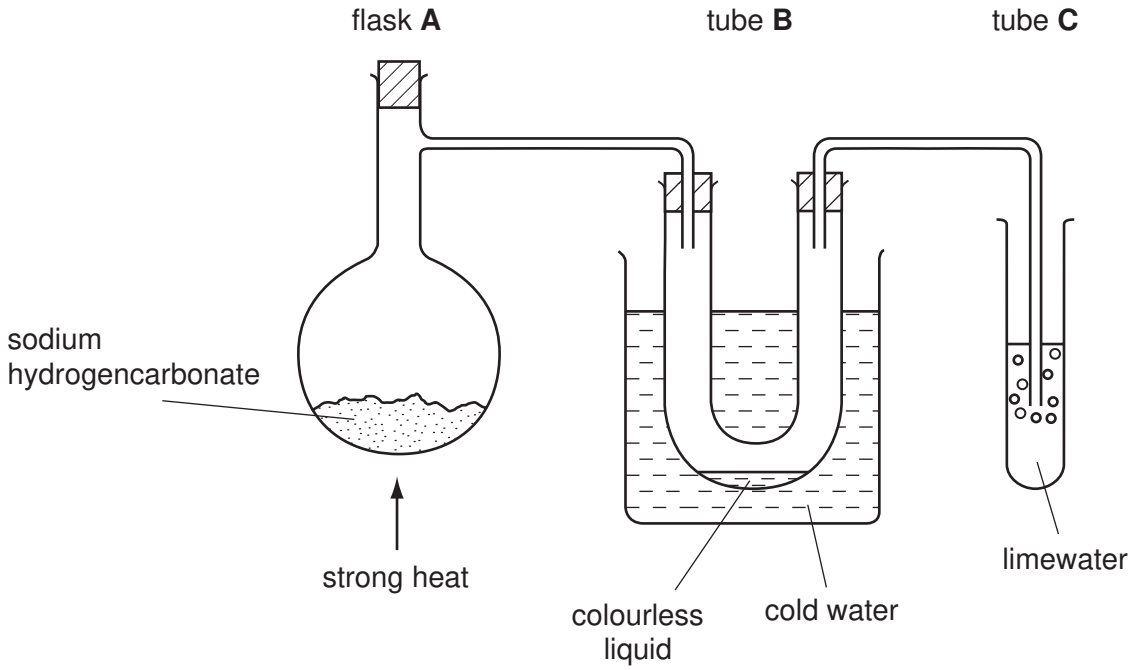


Fig. 6.1

Table 6.1 shows observations the student made before and after heating the sodium hydrogencarbonate for several minutes.

Table 6.1

	before heating	after heating
flask **A**	white solid	white solid
tube **B**	tube empty	colourless liquid has condensed
tube **C**	clear liquid	liquid has become cloudy

(a) State two observations from Table 6.1 which show that a chemical reaction occurs when sodium hydrogencarbonate is heated.

1. .....

.....

2. .....

..... [2]

(b) An incomplete symbolic equation for the reaction in Fig. 6.1 is shown below.

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + ...$$

Use the incomplete equation above to deduce the name of the colourless liquid which condenses in tube B.
Explain your answer.

.....

.....

..... [2]

(c) Sodium carbonate is sometimes added to hard water in order to soften it. The symbolic equation below shows the reaction that occurs when sodium carbonate is added to a sample of hard water.
In this equation the symbols **(aq)** and **(s)** show whether the substance is an **aq**ueous solution or a **s**olid respectively.

$$Na_2CO_3(aq) + CaCl_2(aq) \longrightarrow 2NaCl(aq) + CaCO_3(s)$$

(i) Name the type of chemical reaction shown above.

..... [1]

(ii) Explain why this reaction softens the water.

.....

.....

..... [2]

(d) Sodium carbonate is mixed with silicon(IV) oxide and other oxides to make glass. The mixture has to be heated to a very high temperature in order to melt it and allow the glass to form.
Explain, in terms of their structures, why compounds like sodium carbonate and silicon(IV) oxide have such high melting points.

.....

.....

.....

.....

..... [3]

7 **(a)** A car has two headlight lamps at the front and two rear light lamps at the back. The lamps are connected in parallel with each other across a 12 V battery.

(i) Draw a circuit diagram to show how the two headlight lamps are connected to the battery. Include a switch in your circuit to control the two headlight lamps.

[3]

(ii) If one lamp fails, the other stays lit. Explain why this happens.

.....

..... [1]

(iii) Each headlight lamp takes a current of 5 A and each rear light lamp takes a current of 1 A. What is the total current taken by these four lamps?

Show your working

..... [2]

(b) Fig. 7.1 shows a speaker for a car radio.

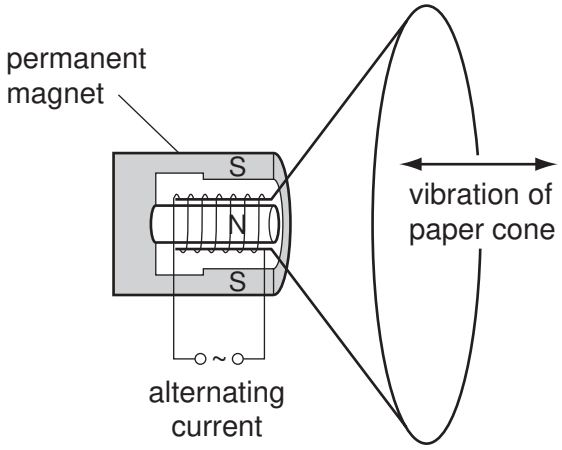


Fig. 7.1

Explain why the cone of the speaker vibrates when an alternating current passes through the coil.

.....

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.....

.....

..... [3]

(c) The pressure of the air in car tyres must be correct to give a good grip on the road surface.

(i) Explain in terms of particles why adding more air to a car tyre increases the pressure in the tyre.

.....

.....

..... [2]

(ii) Tyres become warmer during long journeys. Explain in terms of particles why this will result in an increase in tyre pressure.

.....

.....

..... [2]

8 A gardener in a country with a cool climate grows peppers in a glasshouse. Fig. 8.1 how light intensity affects the rate of growth of the pepper plants.

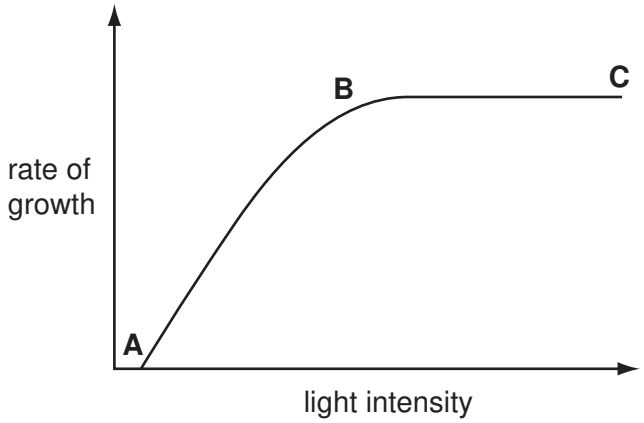


Fig. 8.1

(a) Explain the reasons for the shape of the graph

between **A** and **B**,

.....

.....

.....

between **B** and **C**.

.....

.....

..... [3]

(b) The gardener thinks she might be able to increase the growth of her plants by burning a fuel such as methane in the glasshouse.

(i) Write a **word** equation for the complete combustion of methane.

..... [1]

(ii) State two reasons why burning methane in the glasshouse might increase the growth of the pepper plants.

1. .....

2. ..... [2]

(c) Another way of increasing the growth of the plants is to provide them with a f containing nitrogen.

(i) Suggest **one** compound which can be found in a fertiliser and which provides nitrogen to the plants in a form that they can use.

..... [1]

(ii) Explain why extra nitrogen can increase the growth of plants.

.....

.....

..... [2]

(iii) Explain how the careless use of nitrogen-containing fertilisers near to streams and lakes can harm the organisms that live in them.

.....

.....

.....

..... [3]

9 **(a)** Table 9.1 shows some information about two elements **X** and **Y**. Both elements are in the third period of the Periodic Table.
Complete the table by writing the words **high** or **low** in the empty boxes. Two of the boxes have already been completed.

Table 9.1

element	group number in Periodic Table	melting point	electrical conductivity	pH of element oxide in water
X	2	high		
Y	7	low		

[2]

(b) A compound from which the metal titanium can be extracted is ilmenite, $TiFeO_3$.
In order to obtain titanium, ilmenite is first processed to form titanium chloride. Titanium chloride is then reacted with magnesium. Symbolic equations for these two reactions are shown below.

reaction 1

$$2TiFeO_3 + 7Cl_2 + 6C \longrightarrow 2TiCl_4 + 2FeCl_3 + 6CO$$

reaction 2

$$TiCl_4 + 2Mg \longrightarrow 2MgCl_2 + Ti$$

(i) Name **one** element which has been oxidised in **reaction 1**.
Explain your answer.

.....

..... [1]

(ii) Fig. 9.1 shows a diagram of a chlorine atom, showing only the outer electron shell.

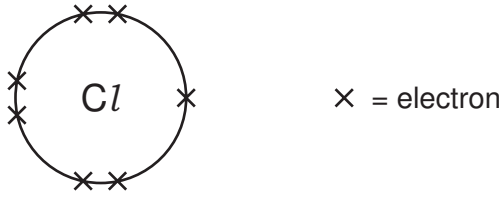


Fig. 9.1

Draw a diagram to show how the outer electrons are arranged in a mole chlorine.

[2]

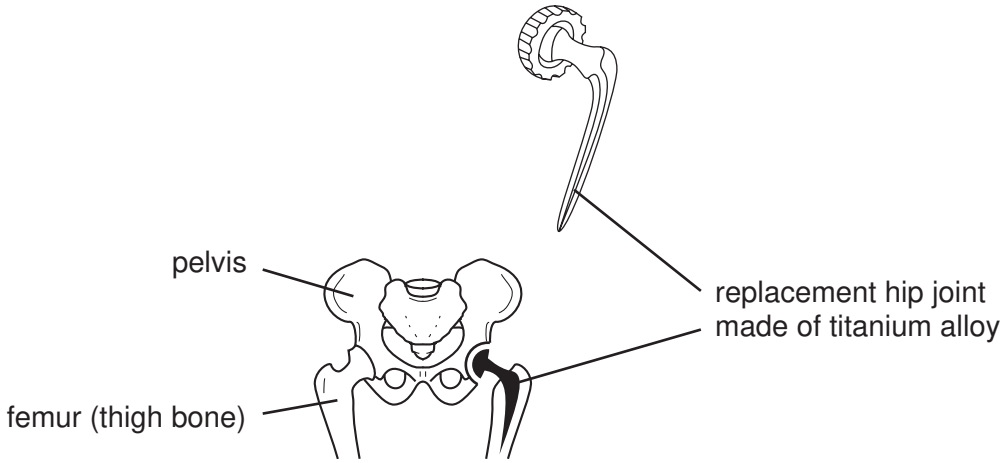
(iii) Describe how the arrangement of the electrons around the magnesium atoms changes during **reaction 2**.

.....

.....

..... [2]

(c) Alloys containing large amounts of titanium are widely used to make replacement hip joints.



Suggest why an alloy of titanium rather than pure titanium is more suitable for making replacement hip joints which have to carry a person's weight.

.....

.....

..... [2]

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	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.).