UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8820570979

CO-ORDINATED SCIENCES **0654/21**

Paper 2 (Core) **May/June 2011**

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.
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.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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	
Total	

This document consists of **24** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 A student carried out an experiment to find which substances in the environment caused nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 1.1.

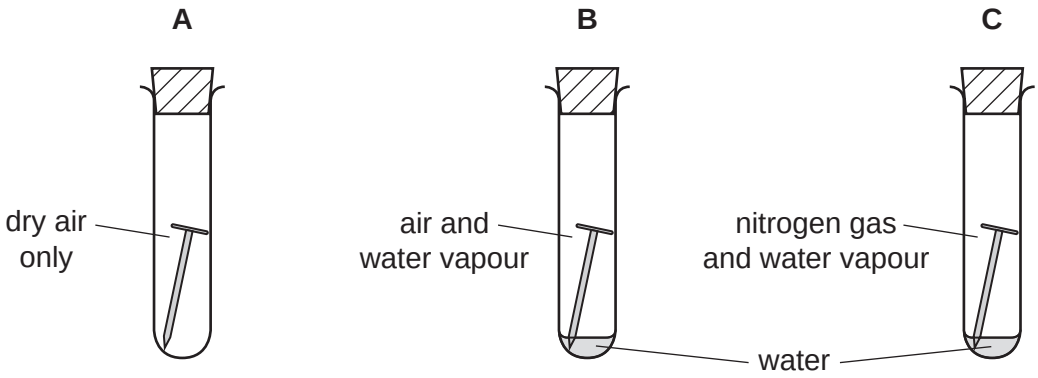


Fig. 1.1

The student observed that only the nail in test-tube **B** became rusty.

(a) Mild steel is an alloy.

Describe briefly how the composition of mild steel is different from iron.

.....

..... [1]

(b) **(i)** Explain why the nail in test-tube **B** in Fig. 1.1 rusted but the nails in the other two tubes did not.

.....

.....

.....

..... [3]

(ii) Name the type of chemical reaction which occurs when mild steel rusts.

..... [1]

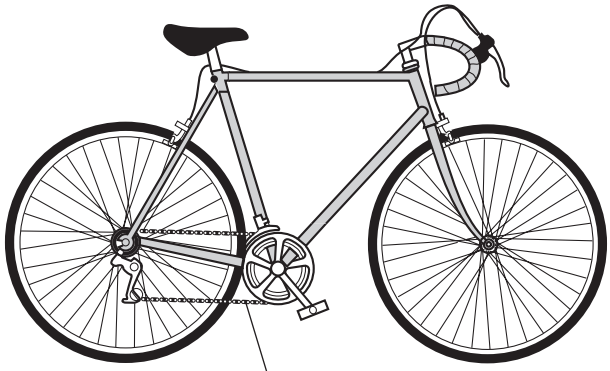
(iii) Objects made mainly of iron have been recovered from sunken ships which have lain on the sea-bed for many years.

Suggest why such objects have not rusted away.

.....

..... [1]

(c) Bicycle chains that are made of steel are usually kept covered in oil made of hydrocarbon molecules, which help to prevent rusting.



(i) Explain which of the chemical formulae, **V** to **Z**, shown below, represent hydrocarbons.

V H_2OC

W C_2H_2

X $C_6H_{12}O_6$

Y $C_{10}H_{22}$

Z HCN

chemical formulae .....

explanation .....

..... [2]

(ii) Suggest **one** property of a hydrocarbon oil which makes it suitable for use as a barrier to prevent rusting.

..... [1]

(d) Most bicycle tyres are made of rubber which is a natural material made of polymer molecules.

For Examiner's Use

Describe briefly how a polymer molecule differs from a simple molecule. You may draw a diagram to help you to answer this question.

.....

..... [1]

For Examiner's Use

2 **(a)** Fig. 2.1 shows how radar is used to detect aircraft.

Radar uses microwaves with a frequency of about 10 000 MHz. Short microwave pulses are sent from the transmitter, reflected from the aircraft and received. The time it takes for the wave pulse to make the journey there and back is measured.

Microwave pulses travel at 300 000 000 m / s.

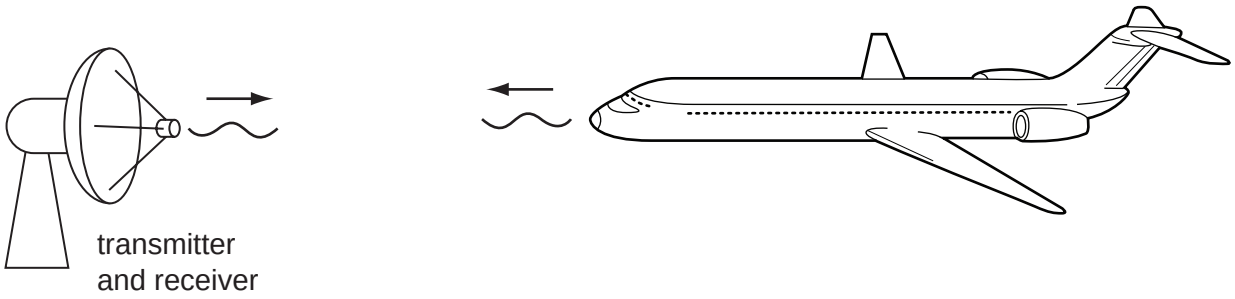


Fig. 2.1

(a) **(i)** Explain the meaning of the term *frequency*.

.....

..... [1]

(ii) A radar transmitter sends a microwave pulse which is reflected from the aircraft. The microwave pulse returns to the receiver 0.000 027 s after transmission.

Calculate the distance of the aircraft from the radar transmitter.

State the formula that you use and show your working.

formula used

working

..... m [3]

(b) The mass of the aircraft is 140 000 kg.

Calculate the kinetic energy of the aircraft as it travels at 100 m / s.

State the formula that you use and show your working.

formula used

working

..... J [2]

(c) Fig. 2.2 shows four forces acting on the aircraft as it flies at a constant speed and altitude.

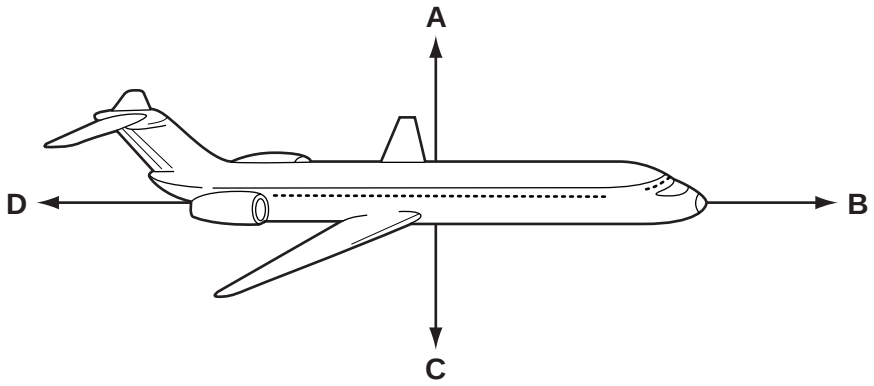


Fig. 2.2

(i) Name forces **C** and **D**.

C .....

D ..... [1]

(ii) Explain how you know that forces **B** and **D** must be equal and opposite.

.....

..... [1]

(d) As the aircraft lands, it is travelling at 85 m / s. It moves along the runway and decelerates at a uniform rate for 40 s until it stops.

For Examiner's Use

Calculate the deceleration of the aircraft along the runway.

State the formula that you use and show your working.

formula used

working

..... m / s^2 [2]

3

The smell of food cooking is detected by special cells in a person's nose. The salivary glands may respond to this stimulus by secreting saliva.

(a) Name the receptor and the effector in this response.

receptor .....

effector ..... [2]

(b) When food has been taken into a person's mouth, it is mixed with saliva.

Saliva contains the enzyme amylase.

(i) What is an *enzyme*?

.....

.....

..... [2]

(ii) Describe the function of amylase.

.....

.....

..... [2]

(c) Fig. 3.1 shows a section through a molar tooth.

For Examiner's Use

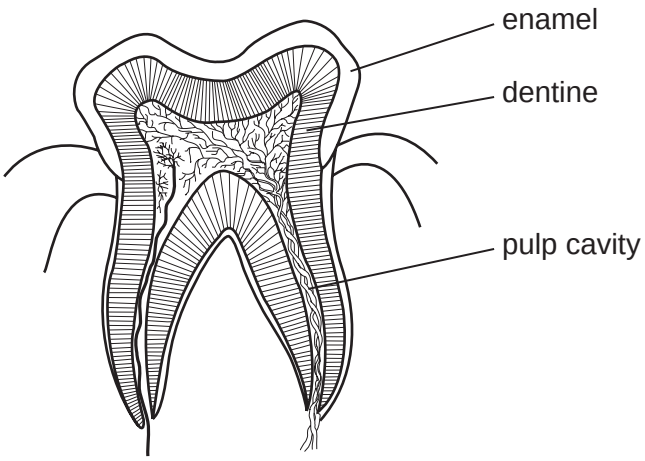


Fig. 3.1

(i) Describe how the molar teeth help in the digestion of food.

.....

.....

.....

..... [2]

(ii) If food is left on or between the teeth, they may start to decay.

Describe how tooth decay happens.

.....

.....

.....

.....

..... [3]

(iii) Explain why a diet containing milk and other dairy foods can help to form strong teeth.

.....

.....

..... [2]

For Examiner's Use

4 **(a)** In older television sets there is a tube which contains three heated wires (filaments). The picture on the screen is produced when emissions from these wires are made to hit the screen.

(i) Name the particles emitted by these hot wires.

..... [1]

(ii) State the charge on these particles.

..... [1]

(iii) The heated wire has an electrical resistance.

State **two** factors which affect the resistance of a piece of wire.

1 .....

2 ..... [2]

(b) The picture on the television screen is composed of many tiny dots of light. The dots of light consist of the three primary colours of light.

(i) Name these three colours.

1 .....

2 .....

3 ..... [2]

(ii) Suggest why only three colours are needed.

.....

..... [1]

(c) Fig. 4.1 shows the energy transferred each second by a television.

For Examiner's Use

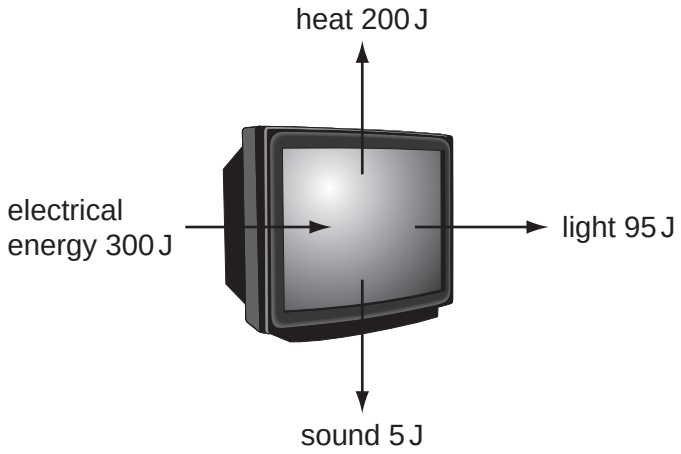


Fig. 4.1

(i) Name the form of energy that is lost as waste energy by the television.

..... [1]

(ii) State the effect of the waste energy on the air around the television.

..... [1]

(iii) Calculate the energy efficiency of the television.

Show your working.

..... % [2]

For Examiner's Use

5 The Earth provides raw materials which are processed into useful products.

(a) Choose products from the list to complete the right hand column of Table 5.1. The first one has been done as an example.

aluminium **ceramics** **chlorine** **glass** **paper** **steel**

Table 5.1

raw material	useful product
iron ore	steel
clay	
rock salt	
sand and metal oxides	
wood	

[4]

(b) Air is a mixture of elements and compounds.

The gases nitrogen and oxygen can be separated from air which has been liquefied.

Nitrogen dioxide, NO_2, is a compound of nitrogen and oxygen.

(i) State **two** differences between a **mixture** of two elements and a **compound** of the same elements.

1 .....

.....

2 .....

..... [2]

(ii) Nitrogen and oxygen can be separated from liquefied air because they have different boiling points.

Suggest the process which is used to separate these elements from liquefied air.

..... [1]

(c) Nitrogen and hydrogen can be made to react together to form ammonia, NH_3.

At room temperature the rate of this reaction is extremely low and conditions must be chosen to increase it.

Suggest **two** ways in which the reaction rate could be increased.

1 .....

2 ..... [2]

(d) Ammonia is used to make salts which are used as fertilisers.

State the type of substance which reacts with ammonia to make salts, and name the type of chemical reaction which occurs.

type of substance .....

type of reaction ..... [2]

For Examiner's Use

6 Fig. 6.1 shows a sperm cell.

Fig. 6.1

(a) (i) State the name and number of the structures contained in the nucleus of a sperm cell.

.....

.....

.....

.....

[2]

(ii) On Fig. 6.1, use label lines to label and name **two** structures, other than the nucleus, that are found in **all** animal cells. [2]

(iii) Describe **two** ways in which the shape of a sperm cell helps it to swim to an egg.

1 .....

.....

2 .....

.....

[2]

(b) Name the organ in which sperm are produced. ..... [1]

(c) An investigation was carried out into the oxygen use of sperm while they were at rest and while they were swimming. The researchers measured the oxygen use of a group of 10^9 (one thousand million) sperm.

The results are shown in Table 6.1.

Table 6.1

	oxygen use / units per 10^9 sperm per hour
resting sperm	24
swimming sperm	83

(i) Suggest why the researchers measured the oxygen use for 10^9 sperm, rather than for a single sperm.

.....

..... [1]

(ii) Explain why more oxygen is used when the sperm are swimming than when they are resting.

.....

.....

..... [2]

For Examiner's Use

7 **(a)** A house has a door bell which is operated by a switch at the door. The switch is closed when the bell push is operated.

Fig. 7.1 shows the electrical circuit for this.

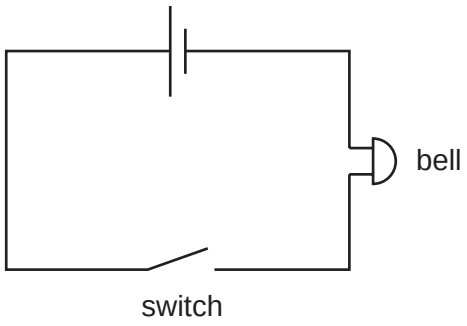


Fig. 7.1

On Fig. 7.1, add another switch and connecting wires to enable the bell to work from another door as well. [1]

(b) Fig. 7.2 shows a circuit for a two-way switch to operate a lamp.

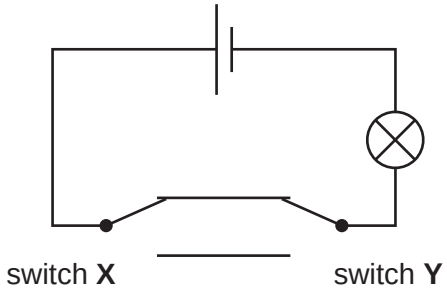


Fig. 7.2

Using the circuit diagram in Fig. 7.2, complete Table 7.1. State the position of the switch and whether the lamp is off or on.

Table 7.1

switch X	**switch Y**	**lamp off or on**
up	up	
up	down	
down		off
	down	on

[2]

For Examiner's Use

(c) Fig. 7.3 shows a hot water storage tank in the house. The water is heated by an electric immersion heater at the bottom of the tank.

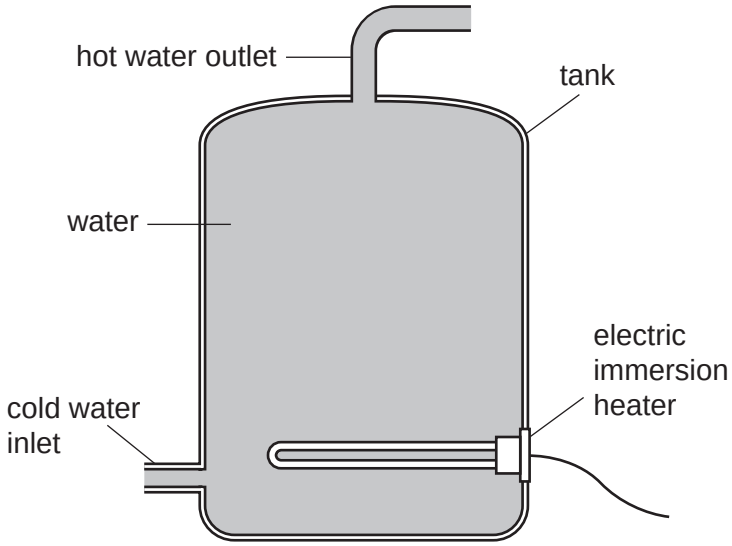


Fig. 7.3

(i) The heater is placed at the bottom of the tank and heats all the water.

Explain why only some of the water would be heated if the heater is placed at the top of the tank.

.....

.....

..... [2]

(ii) The heater has a power output of 5 kW. How many joules of energy does the heater deliver in one second?

..... J [1]

For Examiner's Use

(d) Fig. 7.4 shows a circuit breaker. It is designed to switch off the current in a circuit if the current becomes too large.

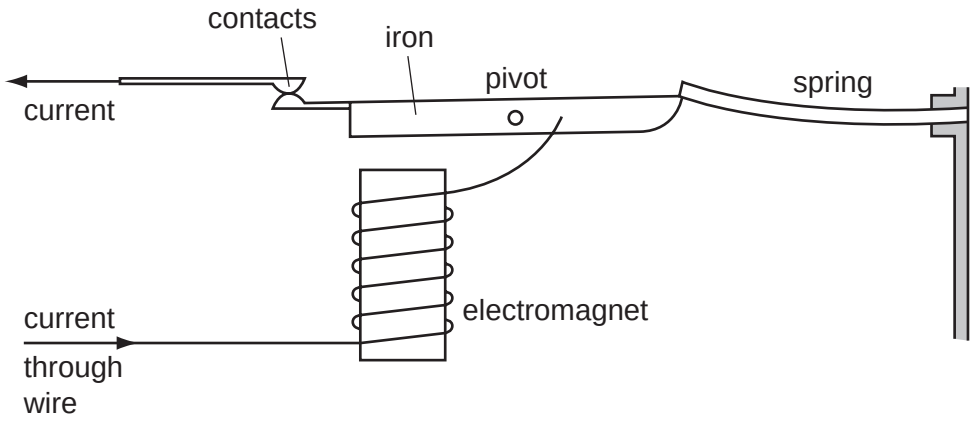


Fig. 7.4

Explain how the circuit breaker switches off the current if the current becomes too large.

.....

.....

.....

..... [3]

(e) Fig. 7.5 shows a wind turbine outside the house, used to generate some of the electricity for the people in the house.

Fig. 7.5

There are advantages and disadvantages of using wind turbines to generate electricity rather than using fossil fuels.

(i) Name **one** example of a fossil fuel.

..... [1]

(ii) Give **one** advantage of generating electricity from the wind.

.....

..... [1]

(iii) Give **one** disadvantage of generating electricity from the wind.

.....

..... [1]

For Examiner's Use

For Examiner's Use

8 Dung beetles live in places where large herbivores, such as elephants, buffalo or cattle, also live.

The beetles collect dung produced by the herbivores and make it into a ball, which they roll away and bury. They lay eggs on the buried ball of dung, so that when their larvae hatch they can feed on the dung. The adults also feed on the dung.

Fig. 8.1 shows a dung beetle rolling a ball of dung.

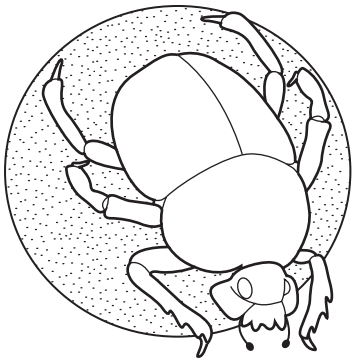


Fig. 8.1

(a) Dung beetles are important in the carbon cycle.

Use some of the words in the list to complete the sentences.

carbon dioxide **digestion** **nitrogen** **oxygen** **photosynthesis**
respiration **roots** **stomata** **water**

Dung beetles digest the dung, producing sugars that are absorbed into their blood.

The sugars are taken into the dung beetles' cells, where they are broken down during ..... . This releases ..... into the air.

Plants absorb this gas through their ..... . The gas is then combined with water to make carbohydrates by ..... .

[4]

(b) Animal dung contains nitrates.

Explain how nitrates can help plants to grow better.

.....

.....

..... [2]

(c) Farmers may use insecticides (pesticides that kill insects) on their land.

For Examiner's Use

(i) Explain why farmers use insecticides.

.....

.....

..... [2]

(ii) Using the information above, explain why using insecticides on land where cattle graze could reduce the amount of nitrates in the soil.

.....

.....

..... [2]

For Examiner's Use

9 The chemical formulae for each of three compounds found in rocks are shown below.

$CaMg(CO_3)_2$	dolomite
$KAlSi_3O_8$	potassium feldspar
SiO_2	quartz

(a) (i) State the total number of atoms shown combined in the formula of potassium feldspar.

..... [1]

(ii) When a flame test is carried out on **one** of the compounds in the list, a lilac colour is produced.

Suggest with a reason which one of the compounds is being tested.

compound .....

reason .....

..... [2]

(iii) **Two** of the elements shown in the chemical formulae above are in Period 4 of the Periodic Table.

State the **name** of **one** of these elements. ..... [1]

(b) Rocks on the Earth's surface are constantly being broken down into small pieces which may end up as part of the soil.

(i) The Moon has no atmosphere.

Suggest **two** reasons why rocks on the Moon do not break down in the same way as rocks on Earth.

1 .....

.....

2 .....

..... [2]

(ii) Explain briefly why the breakdown of rocks can improve the fertility of soil.

.....

.....

..... [2]

For Examiner's Use

(c) Limestone is mainly calcium carbonate, $CaCO_3$. When limestone is heated strongly for some time using a Bunsen flame, a chemical reaction occurs.

The word equation for this reaction is

calcium carbonate ⟶ calcium oxide + carbon dioxide

(i) State the type of chemical reaction which occurs.

Explain your answer.

type of reaction .....

explanation .....

.....

..... [2]

(ii) Predict whether the mass of calcium oxide which is produced in the reaction in **(i)**

- is greater than,
- **or** less than,
- **or** the same as

the mass of the calcium carbonate which is used.

Circle your prediction.

Explain your answer.

.....

.....

..... [1]

(iii) A student adds a little calcium oxide to some water to which has been added some full range indicator solution (Universal Indicator).

State and explain the colour change which the student observes.

colour change from ..... to .....

explanation .....

..... [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** 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
†90-103 Actinoid 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
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.).