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Candidate Name \_\_\_\_\_

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
**Joint Examination for the School Certificate**  
**and General Certificate of Education Ordinary Level**

**CHEMISTRY**

PAPER 2 Theory

**OCTOBER/NOVEMBER SESSION 2002**

**5070/2**

1 hour 30 minutes

Candidates answer on the question paper.  
Additional materials:  
Answer paper

**TIME** 1 hour 30 minutes

**INSTRUCTIONS TO CANDIDATES**

Write your name, Centre number and candidate number in the spaces at the top of this page and on any separate answer paper used.

**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 the lined pages provided and/or on separate answer paper.

At the end of the examination, fasten any separate answer paper securely to the question paper.

**INFORMATION FOR CANDIDATES**

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 16.

FOR EXAMINER'S USE	
Section A	
B7	
B8	
B9	
B10	
TOTAL	

## Section A

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

The total mark for this section is 45.

**A1** Use the substances named in the table to answer the following questions.

name of substance	melting point / °C	boiling point / °C	percentage by volume in clean air
argon	-189	-186	0.93
carbon dioxide	sublimes at -78		0.03
helium	-270	-269	0.0005
nitrogen	-210	-196	78.03
oxygen	-219	-183	20.99

**(a) (i)** Name a monatomic gas.

.....

**(ii)** Name the gas used in the Haber Process to make ammonia.

.....

**(iii)** Which substances are liquids at  $-187\text{ }^{\circ}\text{C}$ ?

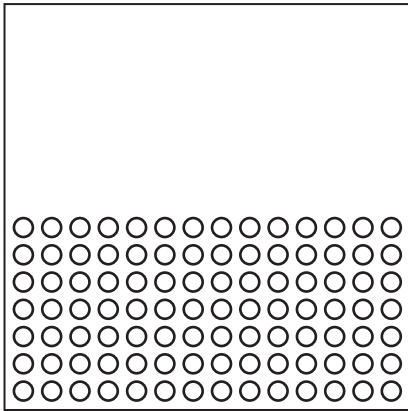
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**(iv)** Name the substance which is a liquid over the largest range of temperature.

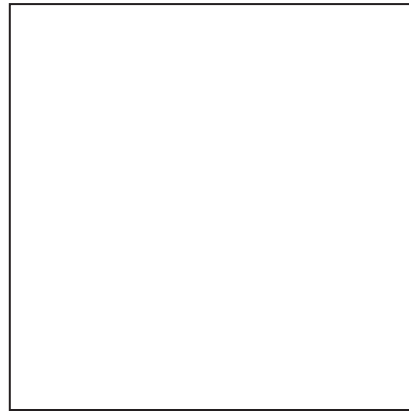
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Box A represents the arrangement of particles in carbon dioxide at  $-79^{\circ}\text{C}$ .

- (v) Draw a diagram in box B to show the arrangement of particles in carbon dioxide at  $-77^{\circ}\text{C}$ .



Box A



Box B

[6]

The percentage amounts of the same gases were measured in air from a crowded classroom.

- (b) (i) Name one gas whose percentage is **higher** in air from a crowded classroom.

.....

- (ii) Name one gas whose percentage is **lower** in air from a crowded classroom.

.....

[2]

**A2** Chlorofluorocarbons (CFCs) are sometimes used as propellants in aerosols. 'Holes' in the ozone layer are caused by reactions involving chlorofluorocarbons.

**(a)** Explain why holes in the ozone layer can cause harm to humans.

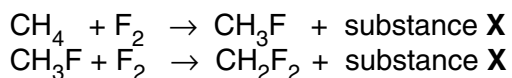
.....[2]

Difluoromethane,  $\text{CH}_2\text{F}_2$  is a hydrofluorocarbon.  
It can be used instead of CFCs in aerosols.

**(b)** Draw a dot and cross diagram to show the bonding in  $\text{CH}_2\text{F}_2$ .  
Your diagram only needs to show outer shell electrons.

[2]

**(c)** Difluoromethane can be made by reacting methane with fluorine.



**(i)** Name substance **X**.

.....

**(ii)** What is the name for this type of reaction?

.....

**(iii)** Gaseous bromine will also react with methane.  
Suggest whether the reaction is faster or slower than with fluorine.  
Explain your answer.

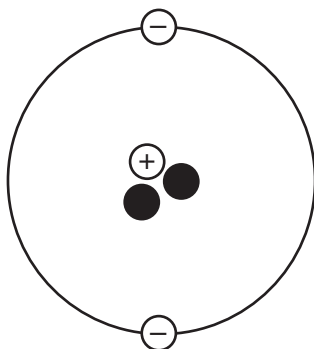
.....

.....

.....

[3]

- A3** Tritium is an isotope of hydrogen.  
An **ion** of tritium has the following structure.



- (a) Complete the following table to show the names and charges of the particles in this tritium ion.

symbol	name	charge
●	neutron	
⊕		+1
⊖		-1

[2]

- (b) Using the symbol T to represent tritium, give the formulae of

(i) the ion shown above .....

(ii) the compound formed between tritium and sodium. ....

[2]

- (c) Would you expect the oxide of tritium to be a solid, a liquid or a gas?  
Explain your reasoning.

.....

.....

.....[1]

**A4** Propane and propene are organic compounds.

- (a) State one similarity and one difference between the **structures** of propane and propene.

similarity .....

difference .....[2]

- (b) Name a substance that can be used to distinguish between propane and propene. In each case, describe what you would see.

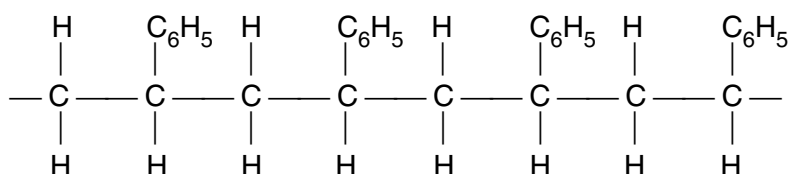
substance .....

observation with propane .....

observation with propene .....[2]

- (c) Another compound, **Z**, can be polymerised to form polystyrene.

Part of the structure of polystyrene is shown below.



- (i) Draw the structure of compound **Z**.

- (ii) Name the two products which are formed by complete combustion of polystyrene.

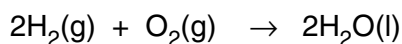
.....

- (iii) Give one advantage of disposing of waste polystyrene by burning.

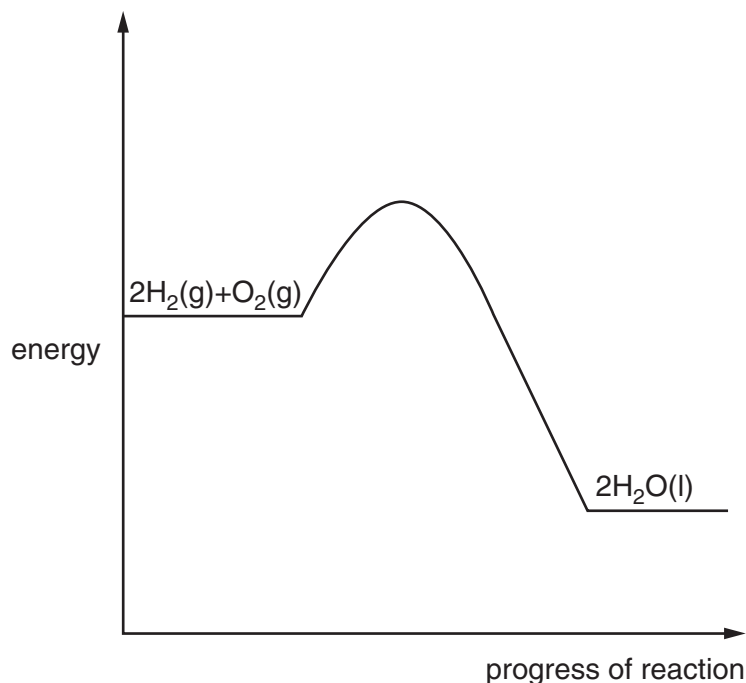
.....

[4]

- A5** In the future, fuel cells may be used to power cars.  
In a fuel cell, the overall reaction is represented by the equation



- (a) This is the energy profile diagram for the reaction between hydrogen and oxygen.



- (i) Label on the diagram the **activation energy** of the reaction.
- (ii) The fuel cell contains a catalyst. Draw a second curve on the diagram to show the energy profile for the catalysed reaction.
- (iii) Explain why this reaction is exothermic in terms of bond breaking and bond forming.

.....

.....

.....

[5]

- (b) Choose from the following list the metal that is most likely to act as a catalyst. Give a reason for your choice.

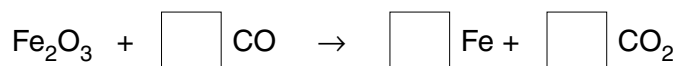
**beryllium**                      **lead**                      **titanium**                      **aluminium**

metal .....

reason .....[1]

**A6** Iron is manufactured in the blast furnace from haematite.

(a) In the furnace, a redox reaction takes place between iron and carbon monoxide.



(i) Balance the equation by inserting numbers into the boxes.

(ii) Explain how carbon monoxide is acting as a reducing agent.

.....  
.....

(iii) State the change in oxidation state of iron during the reaction.

from..... to .....

(iv) Explain why this is an example of reduction, in terms of electron transfer.

.....  
.....

[5]

(b) Scrap iron can be recycled by adding it to the molten iron, after it leaves the blast furnace.

Give **one** reason, other than cost, why scrap iron is recycled.

.....[1]

(c) Magnetite is another ore of iron.

A student found that a sample of magnetite contained 50.4 g of iron and 19.2 g of oxygen. Calculate the empirical formula of magnetite.

.....[3]

(d) Iron from the blast furnace is used to make steel for building bridges.

Some bridges have blocks of magnesium attached to them.

Explain why.

.....  
.....[2]

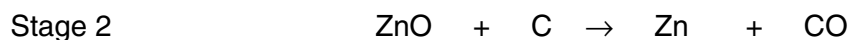


## Section B

Answer **three** questions from this section.

Write your answers on the lined pages that follow.

**B7** Zinc can be extracted from calamine,  $\text{ZnCO}_3$ , in a two-stage process.



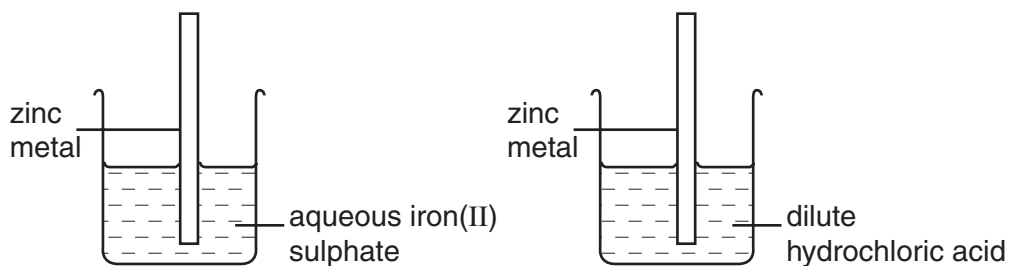
(a) Explain why the gases from stage 2 must be removed for the safety of the workers. [1]

(b) Explain why the same two-stage process cannot be used to extract sodium from sodium carbonate,  $\text{Na}_2\text{CO}_3$ . [2]

(c) Industrial processes release large amounts of carbon dioxide. This contributes to global warming.

Describe **two** environmental consequences of an increase in global warming. [2]

(d) In the laboratory, two experiments were set up using zinc metal.



For each experiment, describe what you would observe and how you would test any gases evolved. Write an equation for the reaction in each beaker. [5]

[Total : 10]

**B8** Aqueous copper(II) sulphate is electrolysed using carbon electrodes.

- (a) Give the formulae of all the ions present in the solution.
- (b) A copper coating forms on the cathode, and a gas is evolved at the anode.
- (i) Write a half equation for the formation of copper at the cathode.
- (ii) Name the gas formed at the anode and describe a test for this gas.

[3]

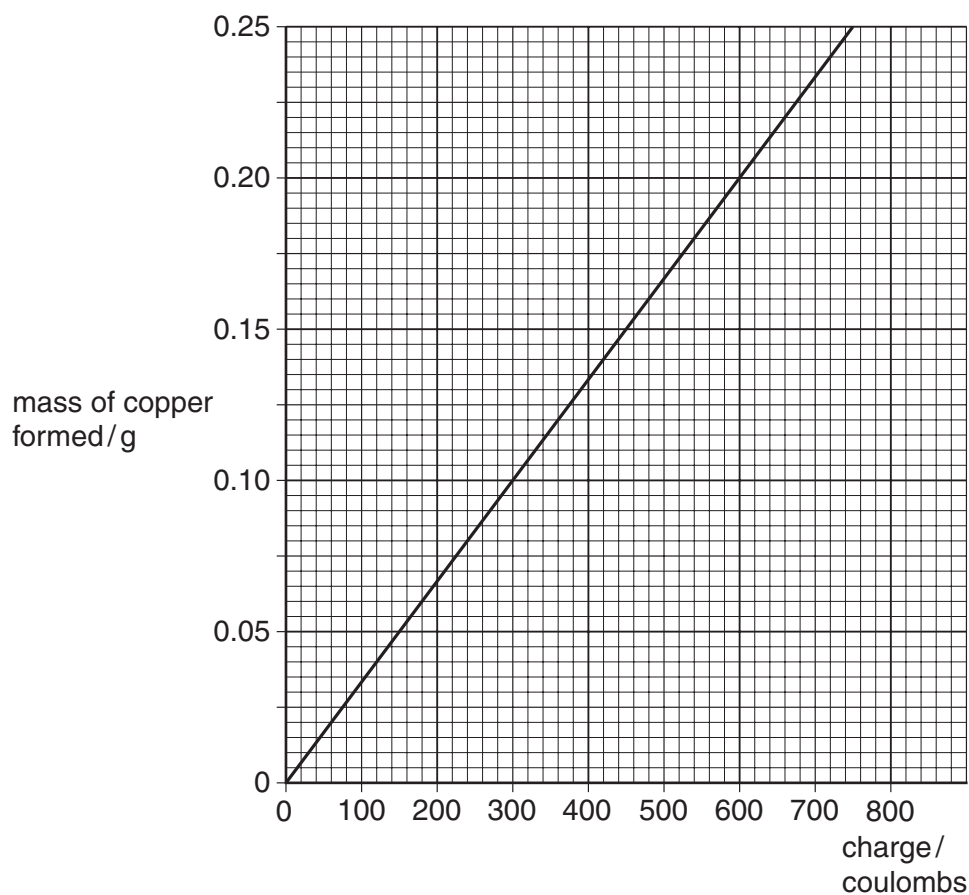
(c) After some time, the blue colour of the aqueous copper(II) sulphate fades and the pH of the solution decreases.

Explain why these changes take place.

[2]

- (d) A student investigated the relationship between the mass of copper formed and the charge passed through the solution.

This is a graph of the results.



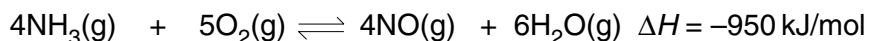
- (i) What mass of copper is formed when a charge of 600 coulombs is passed through the solution?
- (ii) Use your graph to predict the charge needed to form 1 g of copper, and hence predict the charge needed to deposit 1 mole of copper.

[3]

[Total : 10]

**B9** Ammonia is used to manufacture nitric acid, by a two-stage process.

**Stage 1:** the ammonia is converted to nitrogen(II) oxide.



- (a) (i) State and explain how the **rate** changes when the pressure is increased. Use ideas about colliding particles.
- (ii) State and explain how the **yield** changes when the pressure is increased. Use ideas about reacting volumes of gases.

[4]

(b) During the reaction, the ammonia and oxygen are passed through a powdered catalyst.

- (i) Explain why the catalyst becomes hot during the reaction.
- (ii) Explain why the catalyst is used in the form of a powder.

[2]

**Stage 2:** the nitrogen dioxide is converted to nitric acid.



- (c) Calculate the maximum mass of nitric acid which can be made from  $720 \text{ dm}^3$  of nitrogen(II) oxide, NO, at room temperature and pressure.
- (d) Use the two equations to construct an overall equation for the conversion of ammonia to nitric acid.

[3]

[1]

[Total : 10]

**B10** Emissions from coal fired power stations contain sulphur dioxide, which causes acid rain.

Sulphur dioxide can be removed from the emissions by reaction with calcium carbonate.

- (a) Name the raw material used as a source of calcium carbonate.
- (b) The sulphur dioxide reacts with the calcium carbonate to produce calcium sulphite,  $\text{CaSO}_3$ , and carbon dioxide.
- (i) Write an equation for the reaction between calcium carbonate and sulphur dioxide.
- (ii) A large coal-fired power station produces 960 tonnes of sulphur dioxide each year.

Calculate the mass of calcium carbonate needed to react with 960 tonnes of sulphur dioxide ( $1 \text{ tonne} = 1 \times 10^6 \text{ g}$ ).

[3]

(c) Sulphur dioxide can be recovered by heating the calcium sulphite.

Describe, with the aid of equations, the manufacture of sulphuric acid from sulphur dioxide.

[6]

[Total : 10]

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**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																																																																																																																	
I	II	III	IV	V	VI	VII	0																																																																																																												
7 <b>Li</b> Lithium	9 <b>Be</b> Beryllium	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>1 <b>H</b> Hydrogen</td> <td colspan="10"></td> </tr> <tr> <td>11 <b>B</b> Boron</td> <td>12 <b>C</b> Carbon</td> <td>13 <b>Al</b> Aluminium</td> <td>14 <b>Si</b> Silicon</td> <td>15 <b>P</b> Phosphorus</td> <td>16 <b>S</b> Sulphur</td> <td>17 <b>Cl</b> Chlorine</td> <td>18 <b>Ar</b> Argon</td> <td>19 <b>F</b> Fluorine</td> <td>20 <b>Ne</b> Neon</td> <td>21 <b>Sc</b> Scandium</td> <td>22 <b>Ti</b> Titanium</td> <td>23 <b>V</b> Vanadium</td> <td>24 <b>Cr</b> Chromium</td> <td>25 <b>Mn</b> Manganese</td> <td>26 <b>Fe</b> Iron</td> <td>27 <b>Co</b> Cobalt</td> <td>28 <b>Ni</b> Nickel</td> <td>29 <b>Cu</b> Copper</td> <td>30 <b>Zn</b> Zinc</td> <td>31 <b>Ga</b> Gallium</td> <td>32 <b>Ge</b> Germanium</td> <td>33 <b>As</b> Arsenic</td> <td>34 <b>Se</b> Selenium</td> <td>35 <b>Br</b> Bromine</td> <td>36 <b>Kr</b> Krypton</td> <td>37 <b>Rb</b> Rubidium</td> 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1 <b>H</b> Hydrogen																																																																																																																			
11 <b>B</b> Boron	12 <b>C</b> Carbon	13 <b>Al</b> Aluminium	14 <b>Si</b> Silicon	15 <b>P</b> Phosphorus	16 <b>S</b> Sulphur	17 <b>Cl</b> Chlorine	18 <b>Ar</b> Argon	19 <b>F</b> Fluorine	20 <b>Ne</b> Neon	21 <b>Sc</b> Scandium	22 <b>Ti</b> Titanium	23 <b>V</b> Vanadium	24 <b>Cr</b> Chromium	25 <b>Mn</b> Manganese	26 <b>Fe</b> Iron	27 <b>Co</b> Cobalt	28 <b>Ni</b> Nickel	29 <b>Cu</b> Copper	30 <b>Zn</b> Zinc	31 <b>Ga</b> Gallium	32 <b>Ge</b> Germanium	33 <b>As</b> Arsenic	34 <b>Se</b> Selenium	35 <b>Br</b> Bromine	36 <b>Kr</b> Krypton	37 <b>Rb</b> Rubidium	38 <b>Sr</b> Strontium	39 <b>Y</b> Yttrium	40 <b>Zr</b> Zirconium	41 <b>Nb</b> Niobium	42 <b>Mo</b> Molybdenum	43 <b>Tc</b> Technetium	44 <b>Ru</b> Ruthenium	45 <b>Rh</b> Rhodium	46 <b>Pd</b> Palladium	47 <b>Ag</b> Silver	48 <b>Cd</b> Cadmium	49 <b>In</b> Indium	50 <b>Sn</b> Tin	51 <b>Sb</b> Antimony	52 <b>Te</b> Tellurium	53 <b>I</b> Iodine	54 <b>Xe</b> Xenon	55 <b>Cs</b> Caesium	56 <b>Ba</b> Barium	57 <b>La</b> Lanthanum	58 <b>Ce</b> Cerium	59 <b>Pr</b> Praseodymium	60 <b>Nd</b> Neodymium	61 <b>Pm</b> Promethium	62 <b>Sm</b> Samarium	63 <b>Eu</b> Europium	64 <b>Gd</b> Gadolinium	65 <b>Tb</b> Terbium	66 <b>Dy</b> Dysprosium	67 <b>Ho</b> Holmium	68 <b>Er</b> Erbium	69 <b>Tm</b> Thulium	70 <b>Yb</b> Ytterbium	71 <b>Lu</b> Lutetium	72 <b>Hf</b> Hafnium	73 <b>Ta</b> Tantalum	74 <b>W</b> Tungsten	75 <b>Re</b> Rhenium	76 <b>Os</b> Osmium	77 <b>Ir</b> Iridium	78 <b>Pt</b> Platinum	79 <b>Au</b> Gold	80 <b>Hg</b> Mercury	81 <b>Tl</b> Thallium	82 <b>Pb</b> Lead	83 <b>Bi</b> Bismuth	84 <b>Po</b> Polonium	85 <b>At</b> Astatine	86 <b>Rn</b> Radon	87 <b>Fr</b> Francium	88 <b>Ra</b> Radium	89 <b>Ac</b> Actinium	90 <b>Th</b> Thorium	91 <b>Pa</b> Protactinium	92 <b>U</b> Uranium	93 <b>Np</b> Neptunium	94 <b>Pu</b> Plutonium	95 <b>Am</b> Americium	96 <b>Cm</b> Curium	97 <b>Bk</b> Berkelium	98 <b>Cf</b> Californium	99 <b>Es</b> Einsteinium	100 <b>Fm</b> Fermium	101 <b>Md</b> Mendelevium	102 <b>No</b> Nobelium	103 <b>Lr</b> Lawrencium																							

| 23 **Na** Sodium | 24 **Mg** Magnesium | 39 **K** Potassium | 40 **Ca** Calcium | 45 **Sc** Scandium | 48 **Ti** Titanium | 51 **V** Vanadium | 52 **Cr** Chromium | 55 **Mn** Manganese | 56 **Fe** Iron | 59 **Co** Cobalt | 58 **Ni** Nickel | 64 **Cu** Copper | 65 **Zn** Zinc | 70 **Ga** Gallium | 73 **Ge** Germanium | 75 **As** Arsenic | 76 **Se** Selenium | 79 **Br** Bromine | 84 **Kr** Krypton | 85 **Rb** Rubidium | 88 **Sr** Strontium | 89 **Y** Yttrium | 90 **Zr** Zirconium | 91 **Nb** Niobium | 92 **Mo** Molybdenum | 93 **Tc** Technetium | 94 **Ru** Ruthenium | 95 **Rh** Rhodium | 96 **Pd** Palladium | 97 **Ag** Silver | 98 **Cd** Cadmium | 101 **In** Indium | 102 **Sn** Tin | 103 **Sb** Antimony | 106 **Te** Tellurium | 107 **I** Iodine | 108 **Xe** Xenon | 109 **Cs** Caesium | 110 **Ba** Barium | 111 **La** Lanthanum | 112 **Ce** Cerium | 113 **Pr** Praseodymium | 114 **Nd** Neodymium | 115 **Pm** Promethium | 116 **Sm** Samarium | 117 **Eu** Europium | 118 **Gd** Gadolinium | 119 **Tb** Terbium | 120 **Dy** Dysprosium | 121 **Ho** Holmium | 122 **Er** Erbium | 123 **Tm** Thulium | 124 **Yb** Ytterbium | 125 **Lu** Lutetium | 126 **Hf** Hafnium | 127 **Ta** Tantalum | 128 **W** Tungsten | 129 **Re** Rhenium | 130 **Os** Osmium | 131 **Ir** Iridium | 132 **Pt** Platinum | 133 **Au** Gold | 134 **Hg** Mercury | 135 **Tl** Thallium | 136 **Pb** Lead | 137 **Bi** Bismuth | 138 **Po** Polonium | 139 **At** Astatine | 140 **Rn** Radon |

87-103 Lanthanoid series  
103-110 Actinoid series

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

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