| Centre Number | Candidate Number | Name |
|---|---|---|
| | | |

MINISTRY OF EDUCATION, BOTSWANA

in collaboration with

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

**Botswana General Certificate of Secondary Education**

SCIENCE : DOUBLE AWARD **0569/03**

Paper 3 October/November 2003

**2 hours**

Candidates answer on the Question Paper
No additional materials are required

**Read the following carefully before you start.**

Write your centre number, candidate number and name in the spaces provided at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Do not use staples, paper clips, highlighters, glue or correction fluid.

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use a calculator.

A copy of the Periodic Table is printed on page 16.

| For Examiner's Use | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| TOTAL | |

**1** A girl pours hot water into a bottle and a Thermos flask, Fig. 1.1. She notices that the bottle gets hotter than the flask.
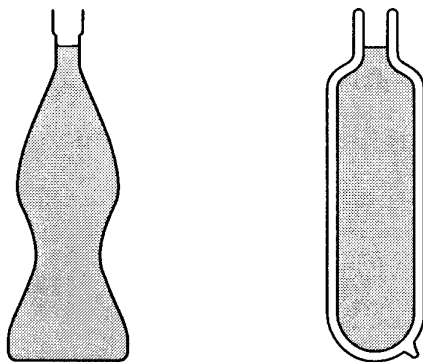


**Fig. 1.1**

**(a)** By what process does heat from the water in the bottle reach her hand?

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

**(b)** State **two** features of the Thermos flask that reduce heat loss from the flask, and explain how each reduces heat loss.

1 .................................................................................................................................

.................................................................................................................................

.................................................................................................................................

2 .................................................................................................................................

.................................................................................................................................

.................................................................................................................... [4]

**2** An electric motor rated at 200 W is used to raise a 20 kg bag to the roof of a building 10 m high.

**(a)** What form of energy does the bag gain as it rises?

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

**(b)** Calculate the work done to raise the bag to the roof. (1 kg has a weight of 10 N).

work done = ............................... [2]

**(c)** Assuming no energy losses, how long will it take for the bag to reach the roof?

time = ............................... [2]

**[Turn over**

**3** **(a)** Fig. 3.1 shows the positions of air particles when two sound waves, **A** and **B** pass through the air in the same time interval.

•••• • • ••••• • • ••••• • •          •••• • • • ••• • • • •

       **A**                  **B**

**Fig. 3.1**

    **(i)** What type of wave is a sound wave?

    ........................................................................................................................................

    **(ii)** Which sound wave has a higher pitch?

    ........................................................................................................................................

    Explain your answer.

    ........................................................................................................................................

    ........................................................................................................................................

    **(iii)** One wave is reflected by a vertical wall. What effect will this have on its pitch?

    ........................................................................................................................................

    Explain your answer.

    ........................................................................................................................................

    ........................................................................................................... [5]

**(b)** A student stands 400 m away from a vertical wall. She fires a starter pistol and hears an echo after 2.4 s. Calculate the speed of sound in air.

speed = .............................. [2]

**(c)** A magnifying glass produces a virtual enlarged image.

convex lens
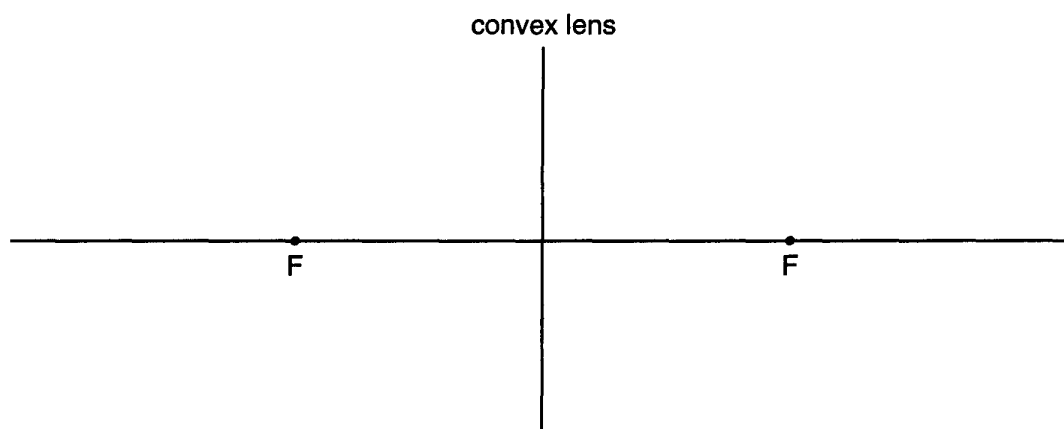


Complete the diagram to show;

**(i)** where the object should be placed. Label the object O. [1]

**(ii)** how the image is formed. [4]

**4** Fig. 4.1 shows two skydivers **A** and **B** falling in air.



**A**                              **B**
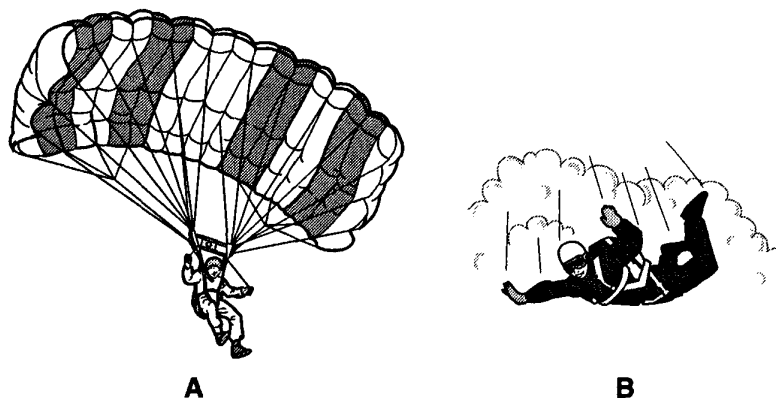
**Fig. 4.1**

**(a)** Name the two vertical forces acting on each diver.

1 ................................................................................................................................

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

**(b)** Explain why diver **B** would fall faster than diver **A**.

...................................................................................................................................

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

**[Turn over**

**5** Fig. 5.1 shows two resistors in parallel. These resistors can be replaced by a single resistor **X**, without changing the brightness of the lamp.

4.5 V

8 Ω

2 Ω
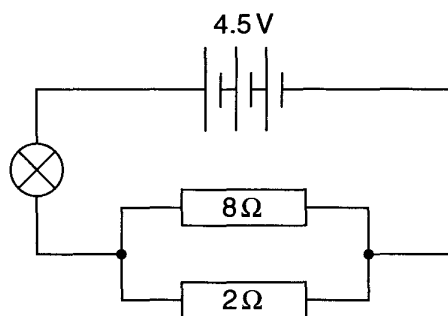
**Fig. 5.1**

**(a)** What would be the resistance of resistor **X**?

resistance = ............................ [2]

**(b)** What would be the effect on the brightness of the lamp of removing the 8 Ω resistor?

..................................................................................................................................

Explain your answer.

..................................................................................................................................

..................................................................................................................................

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

**(c)** **(i)** State **one** difference between a step-down and a step-up transformer.

..................................................................................................................................

**(ii)** A transformer connected to a 240 V supply draws a current of 10 A. The voltage output of the transformer is 600 V. Calculate the current in the secondary coil.

current = ............................ [2]

**(iii)** Why is it preferable to use low current in the transmission of electricity over long distances?

..................................................................................................................................

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

**6** Fig. 6.1 shows the arrangement of particles in structures **X** and **Y**.
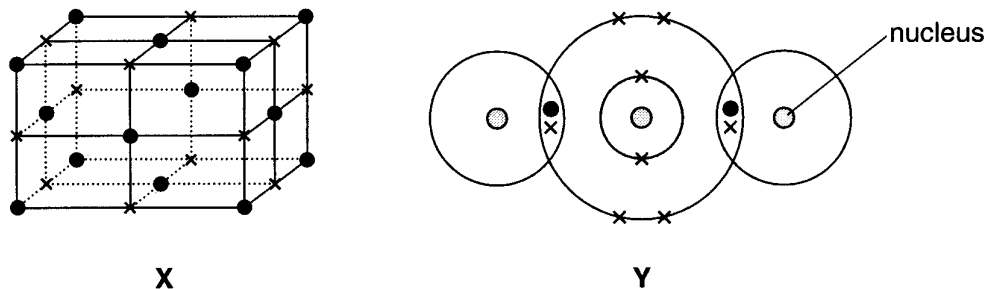


**Fig. 6.1**

**(a) (i)** Write the chemical formula of a compound with structure **X**.

.......................................................................................................................................

**(ii)** Write the chemical formula of the compound with structure **Y**.

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

**(b)** Complete the table by naming the type of structure and bonding in **X** and **Y**.

| | type of structure | bonding |
|---|---|---|
| **X** | | |
| **Y** | | |

[4]

**(c)** Why does the compound with structure **X** have a high melting point, while that with structure **Y** has a low melting point?

**X** .........................................................................................................................

.........................................................................................................................

**Y** .........................................................................................................................

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

**(d)** Give **one** other property each for compounds with the bonding in **X** and in **Y**.

**X** .........................................................................................................................

.........................................................................................................................

**Y** .........................................................................................................................

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

**[Turn over**

**7** The equation represents the complete combustion of 2.0 g of propane at room temperature and pressure.

$$C_3H_8(g) + \quad O_2(g) \rightarrow \quad CO_2(g) + \quad H_2O(l)$$
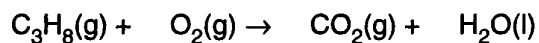
**(a)** Balance the equation. [1]

**(b)** Calculate the number of moles of propane that were burnt.

number of moles = ............................. [2]

**(c)** Calculate the mass of oxygen that reacted with propane.

mass of $O_2$ = ............................. g [2]

**(d)** Calculate the volume of carbon dioxide produced.

volume of $CO_2$ = ............................. dm³ [2]

**(e)** When the carbon dioxide produced was dissolved in water, it formed a weak acid.

   **(i)** What is a weak acid?

   ..............................................................................................................................

   **(ii)** Name the weak acid formed.

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

**8** The world-wide chemical industry has some advantages and disadvantages if it is not undertaken properly.

**(a)** State **two** environmental problems that may be caused by the chemical industry.

1 ..................................................................................................................................

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

**(b)** Some products of the chemical industry are *recycled*.

**(i)** What is *recycling*?

..................................................................................................................................

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

**(ii)** Give two advantages of recycling.

1 ..................................................................................................................................

2 .......................................................................................................................... [1]

**(iii)** Name **one** substance that can be recycled.

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

**9** Dudu prepared some alcohol by mixing yeast, malt, sugar and warm water. The mixture was left for 2-3 days.

**(a)** Name the substance added to speed up the reaction.

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

**(b)** Name the process used to prepare the alcohol.

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

**(c)** Write an equation to represent the reaction that took place.

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

**[Turn over**

**(d)** The equation shows the reaction between the alcohol and ethanoic acid to form **P** and water.

$$CH_3COOH + C_2H_5OH \longrightarrow P + H_2O$$
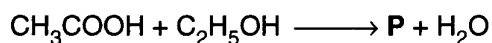
**(i)** Name the group of organic compounds to which **P** belongs.

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

**(ii)** Draw the molecular formula of **P**.

[1]

**(iii)** State **one** physical property of **P**.

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

**(e)** Equations **S** and **R** represent the preparation of ethanol, $C_2H_5OH$, from butane.

$$CH_3CH_2CH_2CH_3 \xrightarrow{\ \ S\ \ } M\ +\ CH_3CH_3$$

R | hydrolyse with steam

$$C_2H_5OH$$
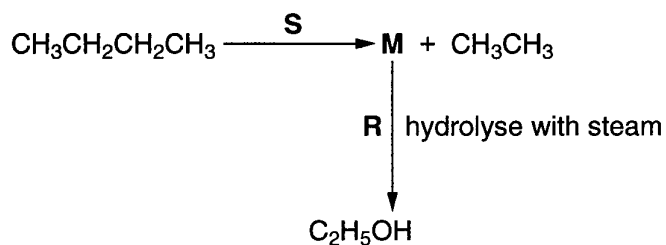
**(i)** Write the chemical formula of **M**.

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

**(ii)** Name the type of reaction **S**.

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

**(iii)** Name the homologous series to which $CH_3CH_3$ belongs.

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

**10** Blood vessels supply cells with energy sources and substances for growth, and act as removal system for wastes.

**(a) (i)** Describe how energy is obtained by cells.

..............................................................................................................................

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

**(ii)** With reference to **named** substances, explain how blood promotes growth in the tissues.

..............................................................................................................................

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

**(iii)** Complete the table below to show where any **two** named waste products are excreted.

| | *waste product* | *organ* |
|---|---|---|
| **(i)** | | |
| **(ii)** | | |

[4]

**(b)** Some young women develop a condition in which there are fewer red blood cells than normal.

**(i)** What physical effect does this have on them?

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

**(ii)** Suggest the cause of this condition.

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

**[Turn over**

**11** Fig. 11.1 shows blood vessels in the skin.



capillary

blood flow →
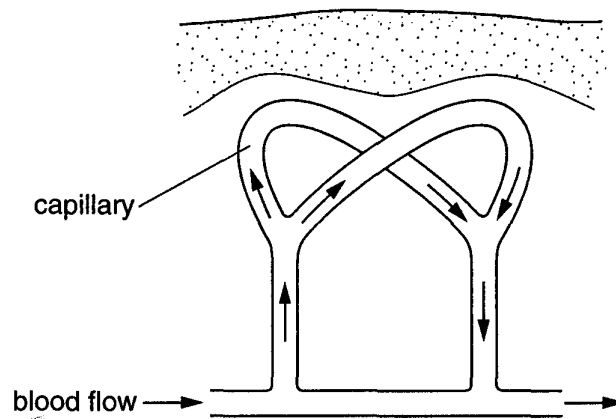
**Fig. 11.1**

When a person carries out vigorous exercise, there is a change in the capillary in the skin.

**(a) (i)** On Fig. 11.1, show how the capillary would change if vigorous exercise is carried out. [1]

**(ii)** Explain how the change you have shown helps in regulating body temperature.

........................................................................................................................................

........................................................................................................................................

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

**(b)** Describe the role of the following skin structures in cooling the body.

**(i)** hair: .......................................................................................................................

........................................................................................................................................

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

**(ii)** sweat glands: .........................................................................................................

........................................................................................................................................

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

**(iii)** receptors. .............................................................................................................

........................................................................................................................................

........................................................................................................................................

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

**12** A student used three culture solutions **A**, **B** and **C** to investigate the necessity of mineral salts for plant growth. Three leafy shoots were put in the culture solutions treated as follows:

**A**  solution with all mineral salts

**B**  solution lacking nitrate ions

**C**  solution lacking magnesium ions

The leafy shoots were exposed to the same conditions of growth for four weeks. Air was bubbled through the solutions.

**(a)** Which plant will show the healthiest growth?

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

**(b)** Describe and explain the appearance of

    **(i)**  plant **B**

        appearance: ......................................................................................................

        explanation: ................................................................................................. [2]

    **(ii)**  plant **C**

        appearance: ......................................................................................................

        explanation: ................................................................................................. [2]

**(c)** Why was it necessary to bubble air through the solutions during the experiment?

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

**(d)** What was the purpose of plant **A**?

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

**(e)** **(i)**  Name the process by which the plants take up mineral salts.

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

    **(ii)**  State **two** ways in which the process in **(i)** differs from osmosis.

        ......................................................................................................................

        ......................................................................................................................

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

**[Turn over**

**13** Fig. 13. 1 shows the percentage of undigested food taken in through the mouth until it leaves the alimentary canal.
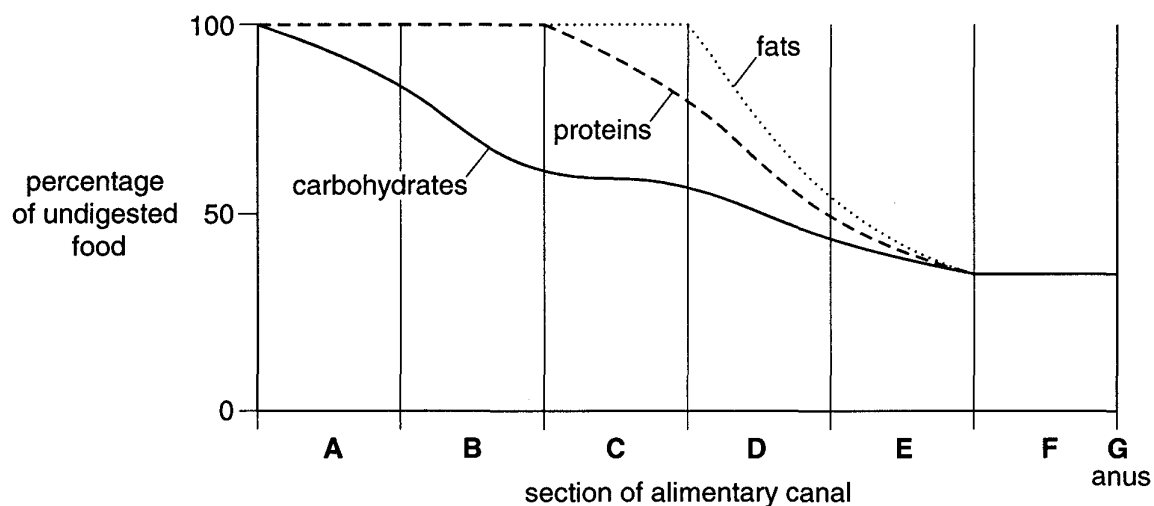


**Fig. 13.1**

**(a)** Name section **B**.

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

**(b)** Why does the digestion of carbohydrates stop in section **C**?

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

**(c)** In which section does most digestion occur?

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

**(d)** State the function of section **F**.

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

**(e)** State what happens to the undigested material at **G**.

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

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# DATA SHEET
## The Periodic Table of the Elements

### Group

| I | II | | | | | | | | | | | | III | IV | V | VI | VII | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1<br>**H**<br>Hydrogen<br>1 | | | | | | | | | | | | 4<br>**He**<br>Helium<br>2 |
| 7<br>**Li**<br>Lithium<br>3 | 9<br>**Be**<br>Beryllium<br>4 | | | | | | | | | | | | 11<br>**B**<br>Boron<br>5 | 12<br>**C**<br>Carbon<br>6 | 14<br>**N**<br>Nitrogen<br>7 | 16<br>**O**<br>Oxygen<br>8 | 19<br>**F**<br>Fluorine<br>9 | 20<br>**Ne**<br>Neon<br>10 |
| 23<br>**Na**<br>Sodium<br>11 | 24<br>**Mg**<br>Magnesium<br>12 | | | | | | | | | | | | 27<br>**Al**<br>Aluminium<br>13 | 28<br>**Si**<br>Silicon<br>14 | 31<br>**P**<br>Phosphorus<br>15 | 32<br>**S**<br>Sulphur<br>16 | 35.5<br>**Cl**<br>Chlorine<br>17 | 40<br>**Ar**<br>Argon<br>18 |
| 39<br>**K**<br>Potassium<br>19 | 40<br>**Ca**<br>Calcium<br>20 | 45<br>**Sc**<br>Scandium<br>21 | 48<br>**Ti**<br>Titanium<br>22 | 51<br>**V**<br>Vanadium<br>23 | 52<br>**Cr**<br>Chromium<br>24 | 55<br>**Mn**<br>Manganese<br>25 | 56<br>**Fe**<br>Iron<br>26 | 59<br>**Co**<br>Cobalt<br>27 | 59<br>**Ni**<br>Nickel<br>28 | 64<br>**Cu**<br>Copper<br>29 | 65<br>**Zn**<br>Zinc<br>30 | | 70<br>**Ga**<br>Gallium<br>31 | 73<br>**Ge**<br>Germanium<br>32 | 75<br>**As**<br>Arsenic<br>33 | 79<br>**Se**<br>Selenium<br>34 | 80<br>**Br**<br>Bromine<br>35 | 84<br>**Kr**<br>Krypton<br>36 |
| 85<br>**Rb**<br>Rubidium<br>37 | 88<br>**Sr**<br>Strontium<br>38 | 89<br>**Y**<br>Yttrium<br>39 | 91<br>**Zr**<br>Zirconium<br>40 | 93<br>**Nb**<br>Niobium<br>41 | 96<br>**Mo**<br>Molybdenum<br>42 | **Tc**<br>Technetium<br>43 | 101<br>**Ru**<br>Ruthenium<br>44 | 103<br>**Rh**<br>Rhodium<br>45 | 106<br>**Pd**<br>Palladium<br>46 | 108<br>**Ag**<br>Silver<br>47 | 112<br>**Cd**<br>Cadmium<br>48 | | 115<br>**In**<br>Indium<br>49 | 119<br>**Sn**<br>Tin<br>50 | 122<br>**Sb**<br>Antimony<br>51 | 128<br>**Te**<br>Tellurium<br>52 | 127<br>**I**<br>Iodine<br>53 | 131<br>**Xe**<br>Xenon<br>54 |
| 133<br>**Cs**<br>Caesium<br>55 | 137<br>**Ba**<br>Barium<br>56 | 139<br>**La**<br>Lanthanum<br>57 * | 178<br>**Hf**<br>Hafnium<br>72 | 181<br>**Ta**<br>Tantalum<br>73 | 184<br>**W**<br>Tungsten<br>74 | 186<br>**Re**<br>Rhenium<br>75 | 190<br>**Os**<br>Osmium<br>76 | 192<br>**Ir**<br>Iridium<br>77 | 195<br>**Pt**<br>Platinum<br>78 | 197<br>**Au**<br>Gold<br>79 | 201<br>**Hg**<br>Mercury<br>80 | | 204<br>**Tl**<br>Thallium<br>81 | 207<br>**Pb**<br>Lead<br>82 | 209<br>**Bi**<br>Bismuth<br>83 | **Po**<br>Polonium<br>84 | **At**<br>Astatine<br>85 | **Rn**<br>Radon<br>86 |
| **Fr**<br>Francium<br>87 | 226<br>**Ra**<br>Radium<br>88 | 227<br>**Ac**<br>Actinium<br>89 † | | | | | | | | | | | | | | | | |

*58-71 Lanthanoid series
†90-103 Actinoid series

| 140<br>**Ce**<br>Cerium<br>58 | 141<br>**Pr**<br>Praseodymium<br>59 | 144<br>**Nd**<br>Neodymium<br>60 | **Pm**<br>Promethium<br>61 | 150<br>**Sm**<br>Samarium<br>62 | 152<br>**Eu**<br>Europium<br>63 | 157<br>**Gd**<br>Gadolinium<br>64 | 159<br>**Tb**<br>Terbium<br>65 | 162<br>**Dy**<br>Dysprosium<br>66 | 165<br>**Ho**<br>Holmium<br>67 | 169<br>**Er**<br>Erbium<br>68 | 169<br>**Tm**<br>Thulium<br>69 | 173<br>**Yb**<br>Ytterbium<br>70 | 175<br>**Lu**<br>Lutetium<br>71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 232<br>**Th**<br>Thorium<br>90 | **Pa**<br>Protactinium<br>91 | 238<br>**U**<br>Uranium<br>92 | **Np**<br>Neptunium<br>93 | **Pu**<br>Plutonium<br>94 | **Am**<br>Americium<br>95 | **Cm**<br>Curium<br>96 | **Bk**<br>Berkelium<br>97 | **Cf**<br>Californium<br>98 | **Es**<br>Einsteinium<br>99 | **Fm**<br>Fermium<br>100 | **Md**<br>Mendelevium<br>101 | **No**<br>Nobelium<br>102 | **Lr**<br>Lawrencium<br>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.).