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

CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

**COMBINED SCIENCE**

**5129/02**

Paper 2

October/November 2003

**2 hours 15 minutes**

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.  
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.  
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 |  |
|--------------------|--|
|                    |  |
| <b>TOTAL</b>       |  |

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

- 1 Rock salt is a mixture of sodium chloride and sand. A student added some rock salt to water and stirred the mixture.

(a) Use words from the list below to complete the following sentences.

**insoluble      soluble      solute      solution      solvent**

The sodium chloride dissolved in the water to form a colourless .....

The sand did not dissolve because it is ..... in water.

Sodium chloride is acting as the ..... in this experiment. [3]

(b) Name a process that could be used to separate the sand from the salt solution.

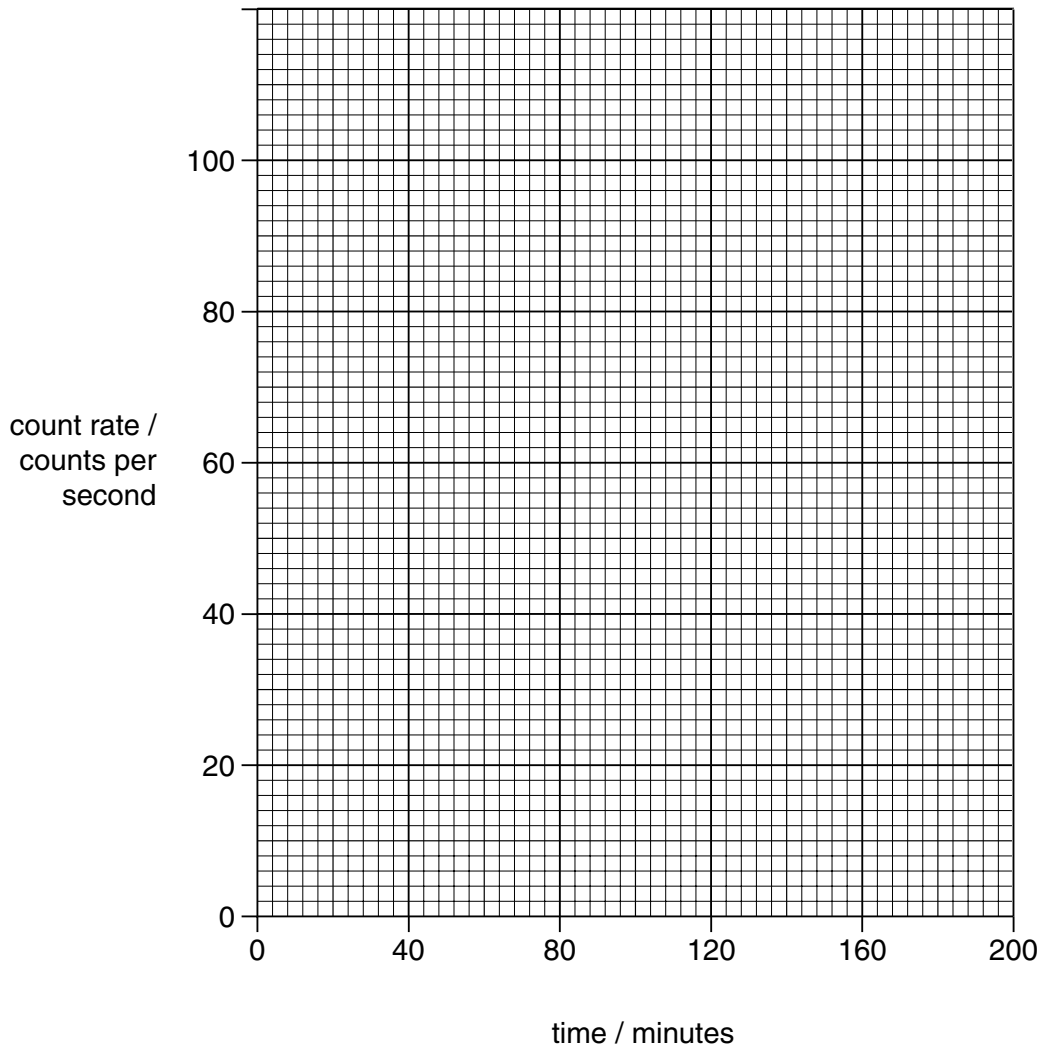
..... [1]

- 2 A student set up an experiment to measure the half-life of a radioactive isotope that emits alpha-particles. Fig. 2.1 shows the count rate measured at 30 minute intervals after the start of the experiment.

|                                |     |    |    |    |     |     |     |
|--------------------------------|-----|----|----|----|-----|-----|-----|
| time / minutes                 | 0   | 30 | 60 | 90 | 120 | 150 | 180 |
| count rate / counts per second | 100 | 69 | 47 | 32 | 22  | 15  | 10  |

**Fig. 2.1**

- (a) On Fig. 2.2, plot a suitable graph of the results. Draw a line of best fit.



[3]

**Fig. 2.2**

- (b) Use the graph to find the time taken for the count rate to fall from 100 counts per second to 25 counts per second.

.....

[1]

- (c) Use your answer to (b) to calculate the half-life of this isotope.

[2]

3 Some of the organisms in an ecosystem are listed below.

- frogs**      **grass**      **grasshoppers**      **hawks**
- rabbits**    **sheep**      **snails**              **thrushes**

In this ecosystem, the following feeding habits are seen.

Hawks eat rabbits, thrushes and young sheep.

Rabbits, sheep and grasshoppers eat grass.

Snails eat grass and are eaten by thrushes.

Frogs and thrushes eat grasshoppers.

(a) Name the energy source for the ecosystem.

..... [1]

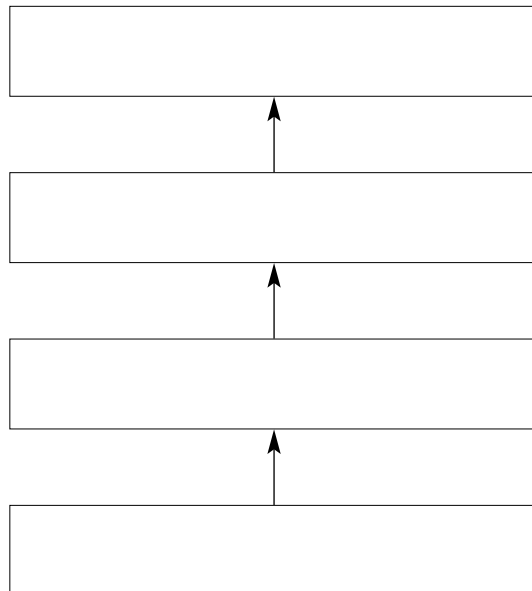
(b) Name a producer in the ecosystem.

..... [1]

(c) How many of the named organisms are herbivores?

..... [1]

(d) Use the information above to construct a food chain with **four** stages in the boxes below.



[2]

- 4 Fig. 4.1 is a flow diagram for the manufacture of fertilisers.

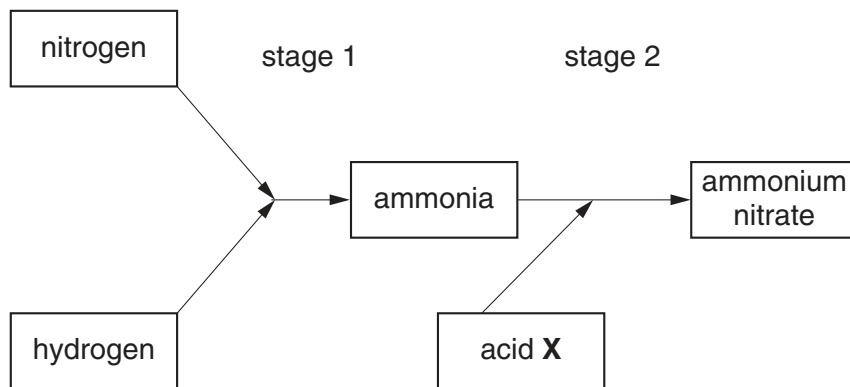


Fig. 4.1

- (a) (i) Name the catalyst used in stage 1.

.....

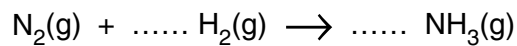
- (ii) Why is a catalyst used in a reaction?

.....

.....

[2]

- (b) (i) Balance the equation for the reaction in stage 1.



- (ii) What does the symbol (g) in the equation mean?

.....

[3]

- (c) (i) Name acid X, used in stage 2.

.....

- (ii) Name the type of reaction that occurs between acid X and ammonia in stage 2.

.....

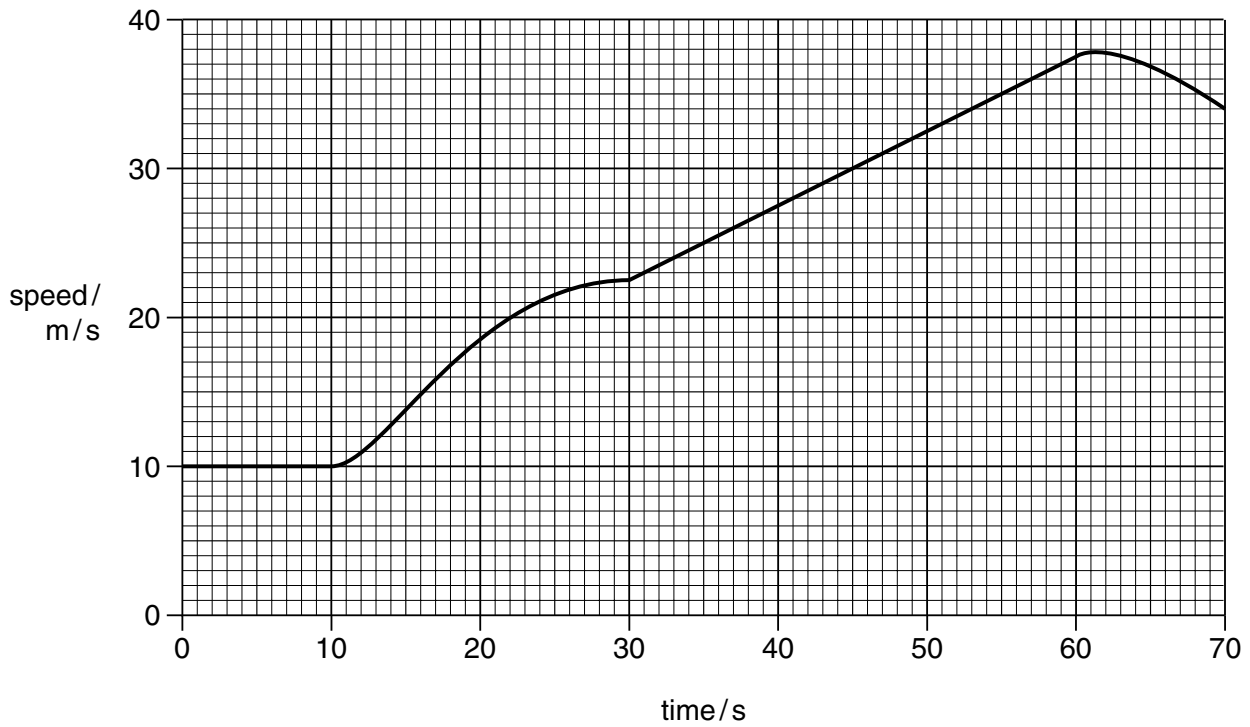
[2]

- (d) The fertiliser, ammonium nitrate, contains nitrogen, an element essential for the growth of plants. Name **two** other elements essential for the growth of plants.

..... and .....

[2]

5 Fig. 5.1 shows the change of speed of a car with time.



**Fig. 5.1**

(a) Between which two times is the car

(i) moving with constant speed,

..... s to ..... s [1]

(ii) moving with a constant acceleration?

..... s to ..... s [1]

(b) Explain the difference between *speed* and *velocity*.

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

(c) When the brakes are used to stop the car, one form of energy is converted into another.

Name these two forms of energy.

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

(d) The car has a mass of 920 kg. The maximum forward force produced by the car is 230 N.

Calculate the maximum acceleration.

[2]

6 (a) Explain what is meant by a *balanced diet*.

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

(b) Study this list of eight foods.

- |                |                |               |                  |
|----------------|----------------|---------------|------------------|
| <b>banana</b>  | <b>chicken</b> | <b>egg</b>    | <b>orange</b>    |
| <b>peanuts</b> | <b>rice</b>    | <b>tomato</b> | <b>tuna fish</b> |

Choose **one** food from those listed above that would

(i) increase the quantity of vitamin C in a diet,

..... [1]

(ii) increase the quantity of protein in a diet,

..... [1]

(iii) help a person suffering from constipation.

..... [1]

(c) State three advantages of feeding babies on breast milk.

1. ....
2. ....
3. .... [3]



- 7 Fig. 7.1 shows the properties of some elements. The letters A-E are **not** the symbols of the elements.

| element | melting point / °C | boiling point / °C | conducts electricity | addition to water | electronic structure |
|---------|--------------------|--------------------|----------------------|-------------------|----------------------|
| A       | 119                | 444                | no                   | insoluble         | 2,8,6                |
| B       | 659                | 2447               | yes                  | insoluble         | 2,8,3                |
| C       | 63                 | 766                | yes                  | reacts violently  | 2,8,8,1              |
| D       | -7                 | 59                 | no                   | soluble           | 2,8,18,7             |
| E       | -248               | -246               | no                   | insoluble         | 2,8,8                |

**Fig. 7.1**

Use the letters A-E to answer the questions.

- (a) Which element is a liquid at room temperature?

..... [1]

- (b) Which elements are metals? Give a reason for your choice.

elements .....

reason .....

..... [3]

- (c) Which element is in Group I of the Periodic Table?

..... [1]

- (d) Which element is an inert gas? Give a reason for your choice.

element .....

reason ..... [2]

8 Fig. 8.1 shows a simple transformer. The output of the transformer is connected to a lamp.

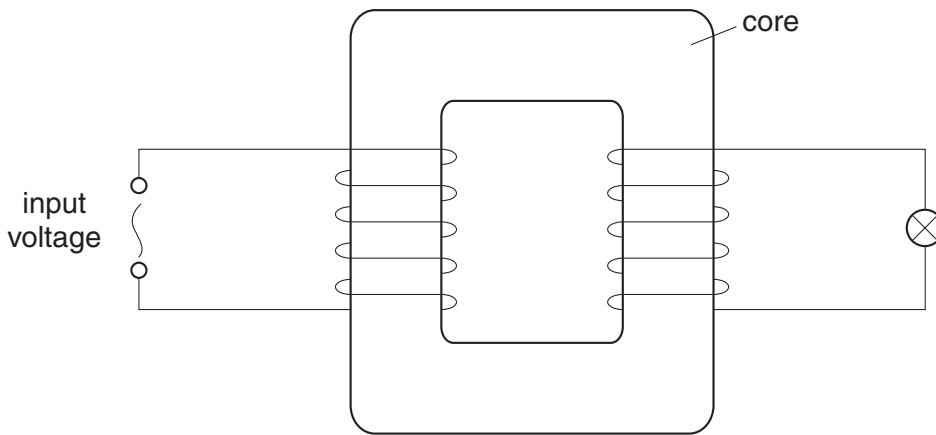


Fig. 8.1

(a) Name the two coils.

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

(b) Name a suitable material for the core.

..... [1]

(c) The transformer is used with an alternating input voltage. Explain why it is not used with a constant input voltage.

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

(d) The potential difference across the lamp is 6.0 V and its resistance is  $24 \Omega$ .

Calculate

(i) the current through the lamp,

[2]

(ii) the power of the lamp.

[2]

9 Fig. 9.1 shows a section through part of a green leaf.

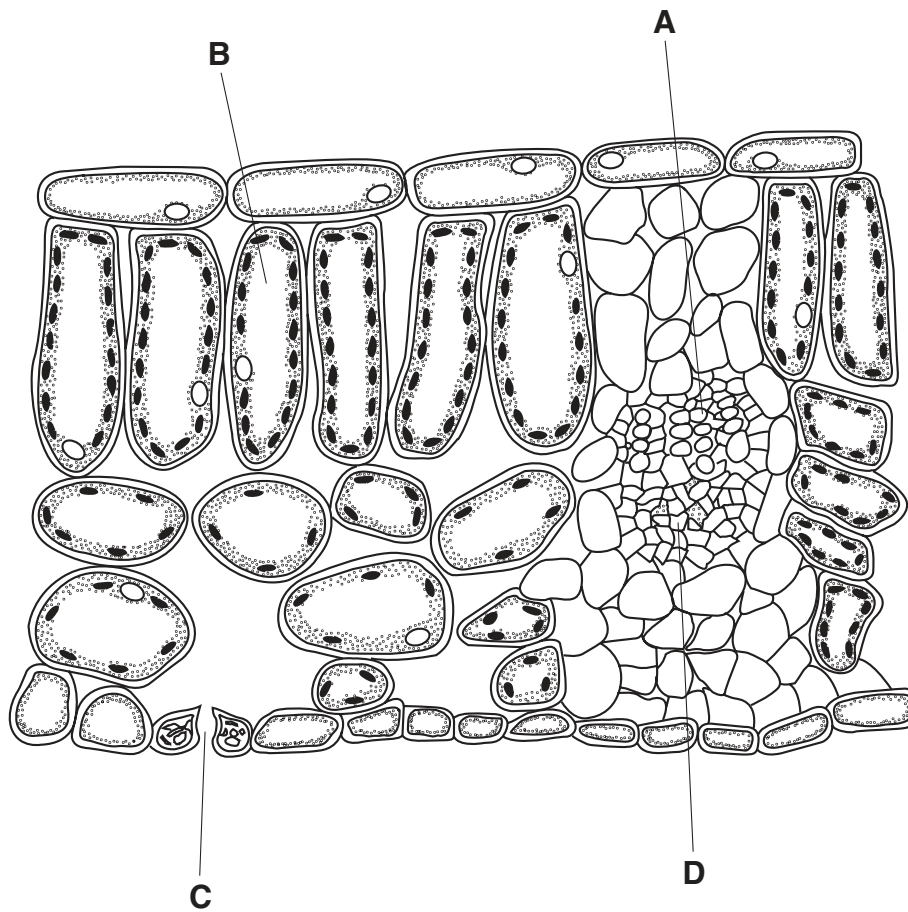


Fig. 9.1

(a) Name

(i) the process by which the plant makes carbohydrates,

.....

(ii) the green pigment required for the process named in (i),

.....

(iii) the type of cell that carries out the process named in (i).

.....

[3]

(b) From Fig. 9.1 give the letter that identifies cells that carry out the process named in (a)(i).

.....

[1]

(c) (i) From Fig. 9.1 give the letter that identifies a place where gas exchange with the atmosphere occurs.

.....

(ii) Name the structure through which this gas exchange takes place.

.....

(iii) Name the gas that passes out of the structure in (ii) during

1. the day, .....

.....

2. the night. ....

.....

[4]

10 Fig. 10.1 shows apparatus used to pass steam over heated magnesium.

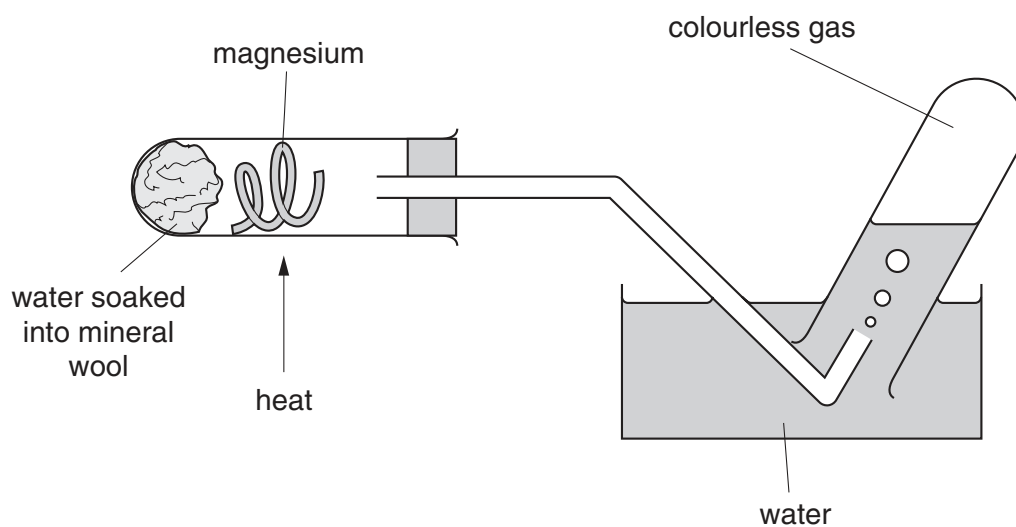


Fig. 10.1

The products of the reaction are magnesium oxide and a colourless gas.

(a) Complete the equation for the reaction between magnesium and steam.



(b) Explain why the magnesium has been oxidised and the steam reduced during the reaction.

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

(c) (i) Calculate the relative molecular mass of magnesium oxide.  
 ( $A_r$ : Mg, 24; O, 16)

.....  
 .....

(ii) Use your answer to (i) to calculate the mass of magnesium oxide produced when 1.2 g of magnesium reacts with excess steam.

.....  
 ..... [3]

11 Fig. 11.1 shows apparatus to demonstrate the transfer of thermal energy. The electric heater glows red. The metal plate heats up, the wax melts and the cork falls.

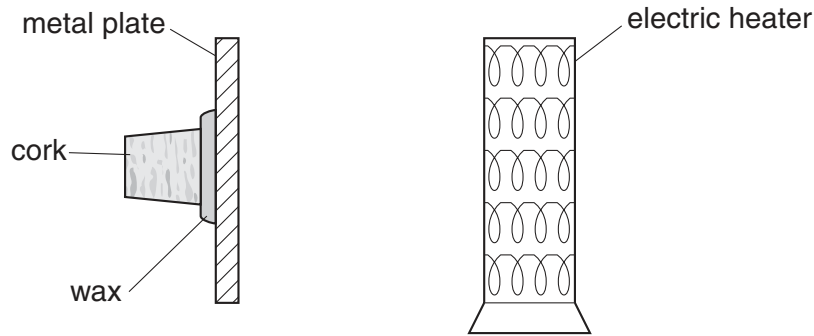


Fig. 11.1

(a) There is air in the space between the heater and the metal plate.

Explain why very little heat is transferred from the electric heater to the metal plate by

(i) conduction,

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

(ii) convection.

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

(b) Name the process by which most of the thermal energy is transferred from the electric heater to the metal plate.

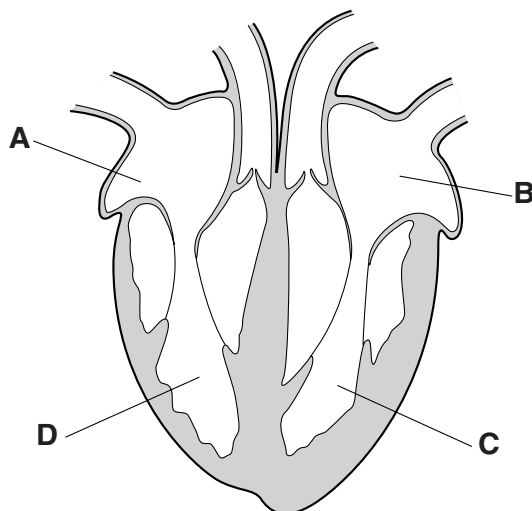
..... [1]

(c) What is the best colour to paint the metal plate so that the cork falls in the shortest time? Explain your answer.

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

12 Fig. 12.1 shows a section through the heart.

The four chambers are labelled **A**, **B**, **C** and **D**.



**Fig. 12.1**

(a) A red blood cell from the liver is pumped through the heart to the lungs.

(i) Give the letters of the two chambers through which it passes.

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

(ii) Give the letters of two chambers that have blood with the highest concentration of carbon dioxide.

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

(iii) Give the letter of the chamber that has blood with the highest pressure.

..... [1]

(iv) On Fig. 12.1 mark a cross (X) on a valve that closes when chambers **C** and **D** contract. [1]

(b) Name the type of tissue that forms the wall of chamber **C**.

..... [1]

(c) When a person is excited, a chemical substance is released from the adrenal glands. This is carried in the blood to the heart, where it causes the heart to beat faster.

Name this type of substance.

..... [1]



13 Petrol contains the hydrocarbon octane,  $C_8H_{18}$ . Petrol is used as a liquid fuel in cars. In the car engine, some petrol is changed from a liquid to a gas, mixed with air and then ignited.

(a) What term describes the change of state from liquid to gas?

..... [1]

(b) Describe the **arrangement** and **movement** of the octane molecules when it is

(i) a liquid, .....

.....

.....

(ii) a gas. ....

.....

.....

[4]

(c) Name the homologous series containing octane.

..... [1]

(d) Name the poisonous gas produced when octane burns in a **limited** supply of oxygen.

..... [1]

14 Fig. 14.1 shows some regions of the electromagnetic spectrum.

|       |           |           |               |                 |       |       |
|-------|-----------|-----------|---------------|-----------------|-------|-------|
| radio | microwave | infra-red | visible light | <b>region A</b> | X-ray | gamma |
|-------|-----------|-----------|---------------|-----------------|-------|-------|

**Fig. 14.1**

(a) Name **region A**.

..... [1]

(b) In which region of the electromagnetic spectrum are the longest wavelengths found?

..... [1]

(c) State a property that is the same for all electromagnetic waves in a vacuum.

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

(d) Sound and light are both wave motions. State two differences between sound and light.

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

- 15 Choose some of the words below and fill in the gaps to complete the following sentences. You may use each word once, more than once, or not at all.

**condoms**      **contraceptive pills**      **penis**      **sperm**  
**sperm ducts**      **testes**      **vagina**      **vasectomy**

Contraceptive methods in males include the use of condoms, which cover the penis and prevent both fluid and ..... from entering the woman's .....

Another method, called ....., involves cutting the .....

Using ..... can also prevent transmission of HIV. [5]

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

| I   | II                                   | III                                  | IV                                   | V                                    | VI                                  | VII                                 | 0  |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
|---|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--|--|--|--------------------------------|--|--|--|--|--|-------------------------------|----------------------------------|------------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-------------------------------|--------------------------------|---------------------------------|-------------------------------------|---------------------------------|---------------------------------|-----------------------------------|------------------------------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------------|------------------------------------|---------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|------------------------------------|-------------------------------------|--------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|--|-------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|----------------------------------|--------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|----------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|----------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|----------------------------|---------------------------|------------------------------|------------------------------|--------------------------------|--------------------------------|---------------------------------|--------------------------------|
|   |                                      |                                      |                                      |                                      |                                     |                                     | <sup>4</sup><br><b>He</b><br>Helium<br>2 |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 7<br><b>Li</b><br>Lithium<br>3  | 9<br><b>Be</b><br>Beryllium<br>4     | 11<br><b>B</b><br>Boron<br>5         | 12<br><b>C</b><br>Carbon<br>6        | 14<br><b>N</b><br>Nitrogen<br>7      | 16<br><b>O</b><br>Oxygen<br>8       | 19<br><b>F</b><br>Fluorine<br>9     | 20<br><b>Ne</b><br>Neon<br>10            |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 23<br><b>Na</b><br>Sodium<br>11   | 24<br><b>Mg</b><br>Magnesium<br>12   | 27<br><b>Al</b><br>Aluminium<br>13   | 28<br><b>Si</b><br>Silicon<br>14     | 31<br><b>P</b><br>Phosphorus<br>15   | 32<br><b>S</b><br>Sulphur<br>16     | 35.5<br><b>Cl</b><br>Chlorine<br>17 | 40<br><b>Ar</b><br>Argon<br>18           |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 39<br><b>K</b><br>Potassium<br>19   | 40<br><b>Ca</b><br>Calcium<br>20     | 45<br><b>Sc</b><br>Scandium<br>21    | 48<br><b>Ti</b><br>Titanium<br>22    | 59<br><b>Co</b><br>Cobalt<br>27      | 64<br><b>Cu</b><br>Copper<br>29     | 79<br><b>Se</b><br>Selenium<br>34   | 84<br><b>Kr</b><br>Krypton<br>36         |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 85<br><b>Rb</b><br>Rubidium<br>37   | 88<br><b>Sr</b><br>Strontium<br>38   | 89<br><b>Y</b><br>Yttrium<br>39      | 91<br><b>Zr</b><br>Zirconium<br>40   | 103<br><b>Rh</b><br>Rhodium<br>45    | 108<br><b>Ag</b><br>Silver<br>47    | 128<br><b>Te</b><br>Tellurium<br>52 | 131<br><b>Xe</b><br>Xenon<br>54          |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 133<br><b>Cs</b><br>Caesium<br>55   | 137<br><b>Ba</b><br>Barium<br>56     | 139<br><b>La</b><br>Lanthanum<br>57  | 178<br><b>Hf</b><br>Hafnium<br>72    | 192<br><b>Ir</b><br>Iridium<br>77    | 197<br><b>Au</b><br>Gold<br>79      | 209<br><b>Po</b><br>Polonium<br>84  | 226<br><b>Rn</b><br>Radon<br>86          |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 87<br><b>Fr</b><br>Francium   | 88<br><b>Ra</b><br>Radium            | 227<br><b>Ac</b><br>Actinium         |                                      |                                      |                                     |                                     |  |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
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|   |                                      | 1<br><b>H</b><br>Hydrogen<br>1       |                                      |                                      |                                     |                                     |  |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
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center;">112<br/><b>Cd</b><br/>Cadmium<br/>48</td> <td style="text-align: center;">115<br/><b>In</b><br/>Indium<br/>49</td> <td style="text-align: center;">119<br/><b>Sn</b><br/>Tin<br/>50</td> <td style="text-align: center;">122<br/><b>Pb</b><br/>Lead<br/>82</td> <td style="text-align: center;">127<br/><b>I</b><br/>Iodine<br/>53</td> <td style="text-align: center;">128<br/><b>Te</b><br/>Tellurium<br/>52</td> <td style="text-align: center;">127<br/><b>I</b><br/>Iodine<br/>53</td> <td style="text-align: center;">131<br/><b>Xe</b><br/>Xenon<br/>54</td> </tr> <tr> <td style="text-align: center;">201<br/><b>Hg</b><br/>Mercury<br/>80</td> <td style="text-align: center;">204<br/><b>Tl</b><br/>Thallium<br/>81</td> <td style="text-align: center;">207<br/><b>Pb</b><br/>Lead<br/>82</td> <td style="text-align: center;">209<br/><b>Bi</b><br/>Bismuth<br/>83</td> <td style="text-align: center;">210<br/><b>Po</b><br/>Polonium<br/>84</td> <td style="text-align: center;">210<br/><b>Po</b><br/>Polonium<br/>84</td> <td style="text-align: center;">210<br/><b>Po</b><br/>Polonium<br/>84</td> <td style="text-align: center;">222<br/><b>Rn</b><br/>Radon<br/>86</td> </tr> <tr> <td style="text-align: center;">159<br/><b>Tb</b><br/>Terbium<br/>65</td> <td style="text-align: center;">162<br/><b>Dy</b><br/>Dysprosium<br/>66</td> <td style="text-align: center;">165<br/><b>Ho</b><br/>Holmium<br/>67</td> <td style="text-align: center;">167<br/><b>Er</b><br/>Erbium<br/>68</td> <td style="text-align: center;">168<br/><b>Tm</b><br/>Thulium<br/>69</td> <td style="text-align: center;">168<br/><b>Tm</b><br/>Thulium<br/>69</td> <td style="text-align: center;">173<br/><b>Yb</b><br/>Ytterbium<br/>70</td> <td style="text-align: center;">175<br/><b>Lu</b><br/>Lutetium<br/>71</td> </tr> <tr> <td style="text-align: center;">157<br/><b>Gd</b><br/>Gadolinium<br/>64</td> <td style="text-align: center;">162<br/><b>Dy</b><br/>Dysprosium<br/>66</td> <td style="text-align: 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|  |  |  | 65<br><b>Zn</b><br>Zinc<br>30 | 66<br><b>Ga</b><br>Gallium<br>31 | 70<br><b>Ge</b><br>Germanium<br>32 | 73<br><b>As</b><br>Arsenic<br>33 | 75<br><b>Sb</b><br>Antimony<br>51 | 79<br><b>Se</b><br>Selenium<br>34 | 80<br><b>Br</b><br>Bromine<br>35 | 84<br><b>Kr</b><br>Krypton<br>36 | 112<br><b>Cd</b><br>Cadmium<br>48 | 115<br><b>In</b><br>Indium<br>49 | 119<br><b>Sn</b><br>Tin<br>50 | 122<br><b>Pb</b><br>Lead<br>82 | 127<br><b>I</b><br>Iodine<br>53 | 128<br><b>Te</b><br>Tellurium<br>52 | 127<br><b>I</b><br>Iodine<br>53 | 131<br><b>Xe</b><br>Xenon<br>54 | 201<br><b>Hg</b><br>Mercury<br>80 | 204<br><b>Tl</b><br>Thallium<br>81 | 207<br><b>Pb</b><br>Lead<br>82 | 209<br><b>Bi</b><br>Bismuth<br>83 | 210<br><b>Po</b><br>Polonium<br>84 | 210<br><b>Po</b><br>Polonium<br>84 | 210<br><b>Po</b><br>Polonium<br>84 | 222<br><b>Rn</b><br>Radon<br>86 | 159<br><b>Tb</b><br>Terbium<br>65 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 167<br><b>Er</b><br>Erbium<br>68 | 168<br><b>Tm</b><br>Thulium<br>69 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 167<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 169<br><b>Yb</b><br>Ytterbium<br>70 | 169<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 165<br><b>Ho</b><br>Holmium<br>67 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71 | 144<br><b>Nd</b><br>Neodymium<br>60 | 147<br><b>Pm</b><br>Promethium<br>61 | 152<br><b>Eu</b><br>Europium<br>63 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 141<br><b>Pr</b><br>Praseodymium<br>59 | 146<br><b>Pu</b><br>Plutonium<br>94 | 152<br><b>Eu</b><br>Europium<br>63 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 140<br><b>Ce</b><br>Cerium<br>58 | 145<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62 | 155<br><b>Eu</b><br>Europium<br>63 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 232<br><b>Th</b><br>Thorium<br>90 | 238<br><b>U</b><br>Uranium<br>92 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 232<br><b>Th</b><br>Thorium<br>90 | 238<br><b>U</b><br>Uranium<br>92 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 168<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 90<br><b>Th</b><br>Thorium | 92<br><b>U</b><br>Uranium | 94<br><b>Pu</b><br>Plutonium | 95<br><b>Am</b><br>Americium | 98<br><b>Cf</b><br>Californium | 99<br><b>Es</b><br>Einsteinium | 101<br><b>Md</b><br>Mendelevium | 103<br><b>Lr</b><br>Lawrencium |
|   |                                      |                                      |                                      |                                      |                                     |                                     |  |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 65<br><b>Zn</b><br>Zinc<br>30   | 66<br><b>Ga</b><br>Gallium<br>31     | 70<br><b>Ge</b><br>Germanium<br>32   | 73<br><b>As</b><br>Arsenic<br>33     | 75<br><b>Sb</b><br>Antimony<br>51    | 79<br><b>Se</b><br>Selenium<br>34   | 80<br><b>Br</b><br>Bromine<br>35    | 84<br><b>Kr</b><br>Krypton<br>36         |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 112<br><b>Cd</b><br>Cadmium<br>48   | 115<br><b>In</b><br>Indium<br>49     | 119<br><b>Sn</b><br>Tin<br>50        | 122<br><b>Pb</b><br>Lead<br>82       | 127<br><b>I</b><br>Iodine<br>53      | 128<br><b>Te</b><br>Tellurium<br>52 | 127<br><b>I</b><br>Iodine<br>53     | 131<br><b>Xe</b><br>Xenon<br>54          |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 201<br><b>Hg</b><br>Mercury<br>80   | 204<br><b>Tl</b><br>Thallium<br>81   | 207<br><b>Pb</b><br>Lead<br>82       | 209<br><b>Bi</b><br>Bismuth<br>83    | 210<br><b>Po</b><br>Polonium<br>84   | 210<br><b>Po</b><br>Polonium<br>84  | 210<br><b>Po</b><br>Polonium<br>84  | 222<br><b>Rn</b><br>Radon<br>86          |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 159<br><b>Tb</b><br>Terbium<br>65   | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    | 167<br><b>Er</b><br>Erbium<br>68     | 168<br><b>Tm</b><br>Thulium<br>69    | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71       |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 157<br><b>Gd</b><br>Gadolinium<br>64  | 162<br><b>Dy</b><br>Dysprosium<br>66 | 167<br><b>Ho</b><br>Holmium<br>67    | 168<br><b>Tm</b><br>Thulium<br>69    | 169<br><b>Yb</b><br>Ytterbium<br>70  | 169<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71       |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    | 165<br><b>Ho</b><br>Holmium<br>67   | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71       |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 144<br><b>Nd</b><br>Neodymium<br>60   | 147<br><b>Pm</b><br>Promethium<br>61 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67   | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70      |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 141<br><b>Pr</b><br>Praseodymium<br>59  | 146<br><b>Pu</b><br>Plutonium<br>94  | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67   | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70      |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 140<br><b>Ce</b><br>Cerium<br>58  | 145<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62   | 155<br><b>Eu</b><br>Europium<br>63   | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67   | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70      |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 232<br><b>Th</b><br>Thorium<br>90   | 238<br><b>U</b><br>Uranium<br>92     | 150<br><b>Sm</b><br>Samarium<br>62   | 152<br><b>Eu</b><br>Europium<br>63   | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67   | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70      |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 232<br><b>Th</b><br>Thorium<br>90   | 238<br><b>U</b><br>Uranium<br>92     | 150<br><b>Sm</b><br>Samarium<br>62   | 152<br><b>Eu</b><br>Europium<br>63   | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67   | 168<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70      |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |
| 90<br><b>Th</b><br>Thorium  | 92<br><b>U</b><br>Uranium            | 94<br><b>Pu</b><br>Plutonium         | 95<br><b>Am</b><br>Americium         | 98<br><b>Cf</b><br>Californium       | 99<br><b>Es</b><br>Einsteinium      | 101<br><b>Md</b><br>Mendelevium     | 103<br><b>Lr</b><br>Lawrencium           |  |  |                                |  |  |  |  |  |                               |                                  |                                    |                                  |                                   |                                   |                                  |                                  |                                   |                                  |                               |                                |                                 |                                     |                                 |                                 |                                   |                                    |                                |                                   |                                    |                                    |                                    |                                 |                                   |                                      |                                   |                                  |                                   |                                   |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                   |                                     |                                    |                                    |                                    |                                      |                                      |                                   |                                   |                                     |                                    |                                     |                                      |                                    |                                      |                                      |                                   |                                   |                                     |  |                                     |                                    |                                      |                                      |                                   |                                   |                                     |                                  |                                      |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                                   |                                  |                                    |                                    |                                      |                                   |                                   |                                     |                            |                           |                              |                              |                                |                                |                                 |                                |

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

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

|          |   |
|----------|---|
|          | a |
| <b>X</b> | b |

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