Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **May/June 2015**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 32.

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.

1 **(a)** Fig. 1.1 shows a wind-powered generator used to power an Arctic research station.

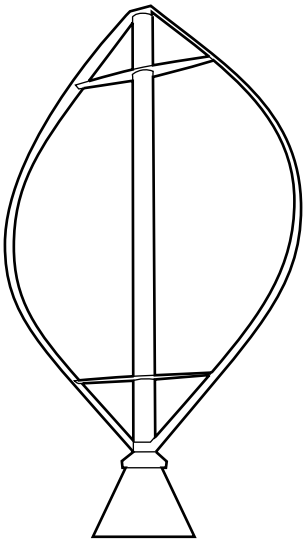


Fig. 1.1

During one 24-hour period, the average power output of the wind-powered generator is 20 kW. Calculate the energy output of the generator in joules over the 24-hour period.

Show your working.

energy = ... J [2]

(b) In the Arctic, harmful ultraviolet radiation is able to reach the surface of the Earth. The scientists at the research station are exposed to this ultraviolet radiation. Ultraviolet radiation is ionising radiation.

(i) State **one** danger to human beings of being exposed to large quantities of ultraviolet radiation.

..... [1]

(ii) Ultraviolet radiation is part of the electromagnetic spectrum.

Name **one** other radiation which is part of the electromagnetic spectrum and state a use for this radiation.

radiation .....

use .....
[1]

(c) Sometimes the scientists pull a flat sledge across the ice and snow carrying some of their equipment.

Fig. 1.2 shows a scientist pulling a loaded sledge across the ice.

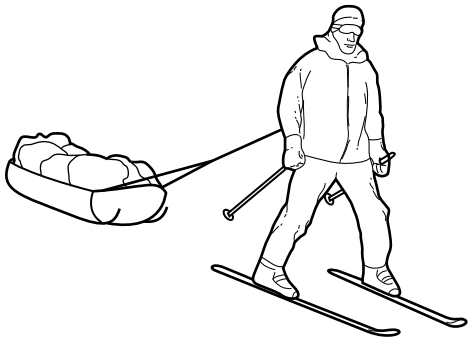


Fig. 1.2

The scientist pulls the sledge at a constant speed of 0.8 m / s. The mass of the loaded sledge is 30 kg.

Calculate the kinetic energy of the sledge.

State the formula that you use and show your working.

formula

working

kinetic energy = ... J [2]

(d) The scientist carries a nylon tent. As he walks, the nylon material gains a static charge.

Explain what happens to cause the nylon to become charged.

.....

.....

.....

..... [2]

(e) The scientists are investigating polar bears which live in the cold Arctic region. Polar bears have black skin covered in thick white fur.

Explain why white fur keeps a polar bear warmer than black fur.

.....

..... [1]

(f) If the scientists run into difficulties when they are on the ice, they ask for help by launching a rocket (flare). Observers see the rocket explode with a flash of light and hear a loud bang. This is shown in Fig. 1.3.

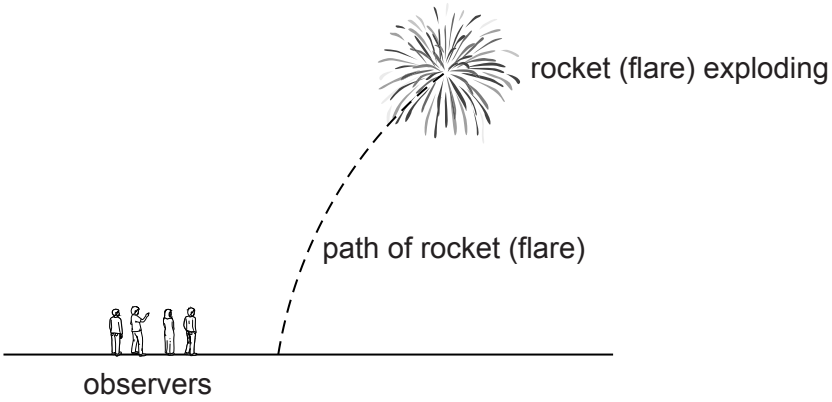


Fig. 1.3

Explain why the flash of light is seen before hearing the bang.

.....

..... [1]

2 Fig. 2.1 shows apparatus a student uses to study the change in temperature when some metallic zinc is added to copper sulfate solution.

The student checks that the temperature of the copper sulfate solution is steady and then adds powdered zinc.

Data from the experiment are shown in the graph below the apparatus.

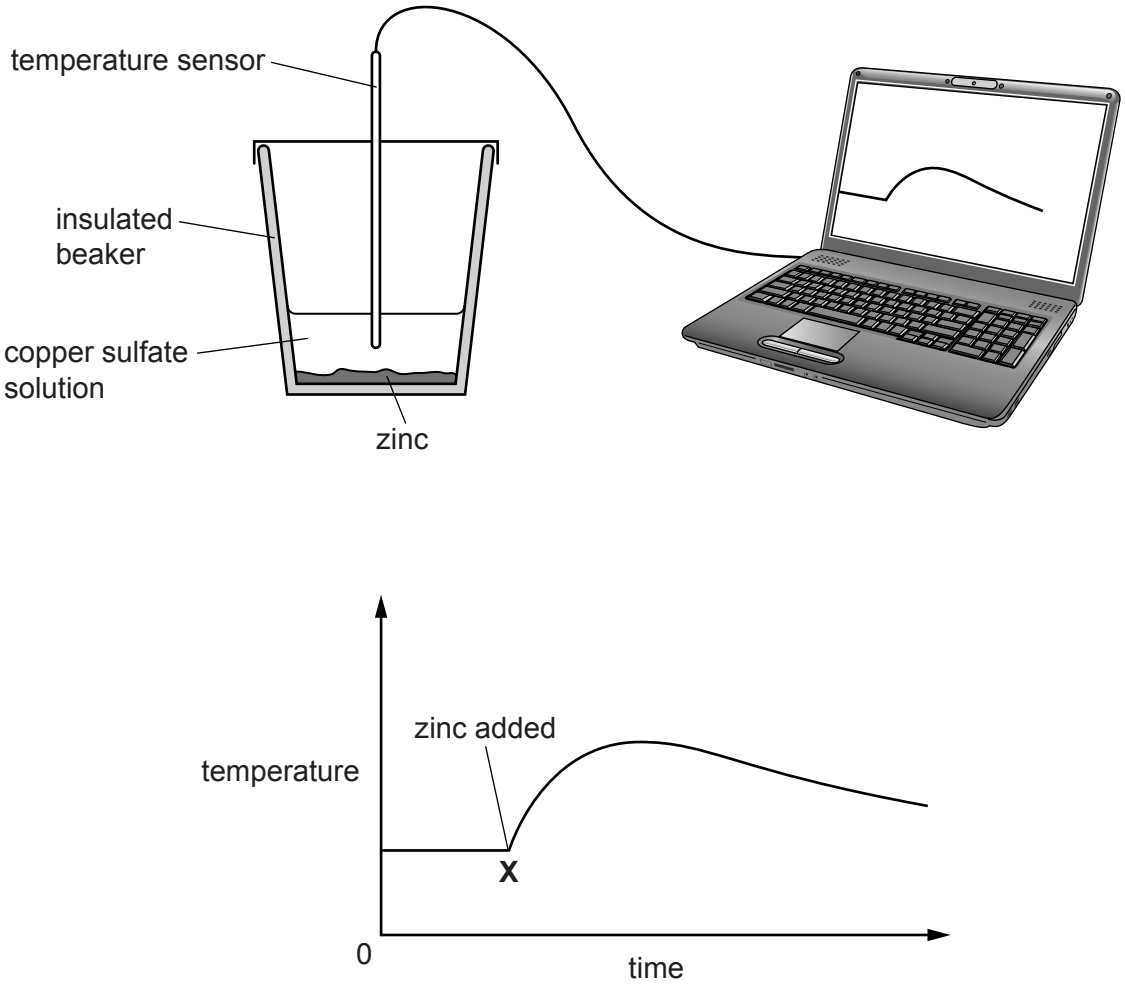


Fig. 2.1

(a) (i) State the word that is used to describe a chemical reaction that causes an increase in temperature.

..... [1]

(ii) Suggest why the temperature after **X** in Fig. 2.1 rises to a maximum and then decreases.

.....

.....

..... [2]

(iii) Predict and explain the temperature changes, if any, when the student carries out a second experiment in which he adds powdered copper to a zinc sulfate solution.

.....

.....

.....

..... [3]

(b) Hand warmers are used by people who may be out of doors in cold weather.

Fig. 2.2 shows one type of hand warmer.

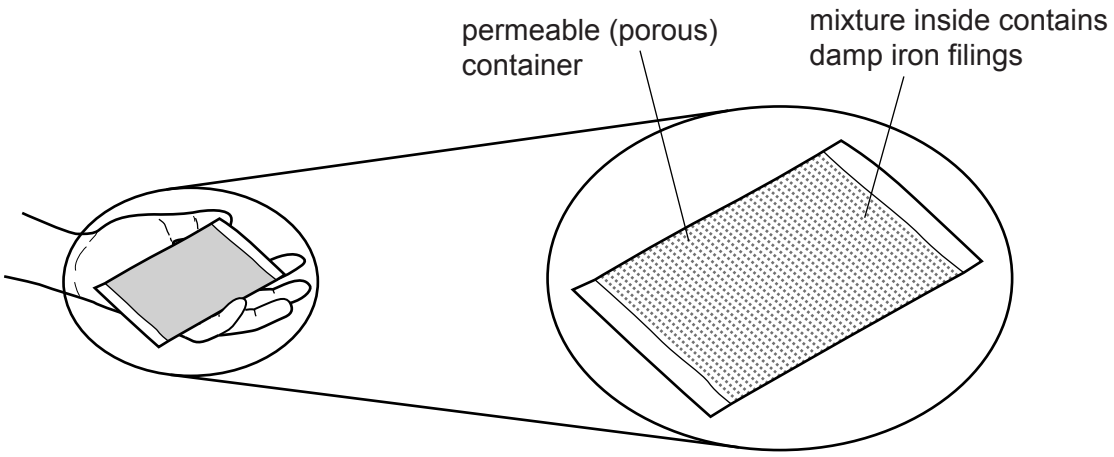


Fig. 2.2

When the hand warmer is exposed to the air, the air diffuses through the permeable (porous) container and causes a chemical reaction that releases thermal energy (heat).

During the reaction that occurs inside the hand warmer, iron is oxidised by oxygen gas to iron oxide, Fe_2O_3.

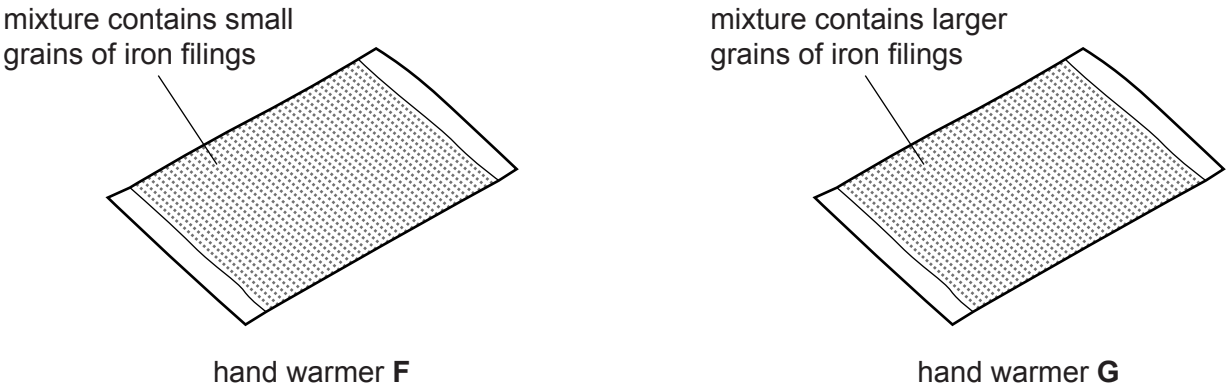
Suggest a balanced symbol equation for this oxidation reaction.

..... [2]

(c) Hand warmers like the one in Fig. 2.2 may release thermal energy for up to seven hours.

The total surface area of the iron filings used in the hand warmer affects the rate of oxidation.

A scientist compares two hand warmers, **F** and **G**.



hand warmer **F** hand warmer **G**

The only difference between these hand warmers is that the size of the grains of iron in **F** is smaller than those in **G**.

(i) Predict and explain which hand warmer, **F** or **G**, releases thermal energy for the longer time period.

hand warmer .....

explanation .....

.....

.....

..... [3]

(ii) State and explain whether the chemical potential energy of the contents of the hand warmer increases, decreases or remains unchanged when it is used.

.....

.....

..... [2]

3 Fig. 3.1 shows apparatus that can be used to compare the composition of inspired and expired air.

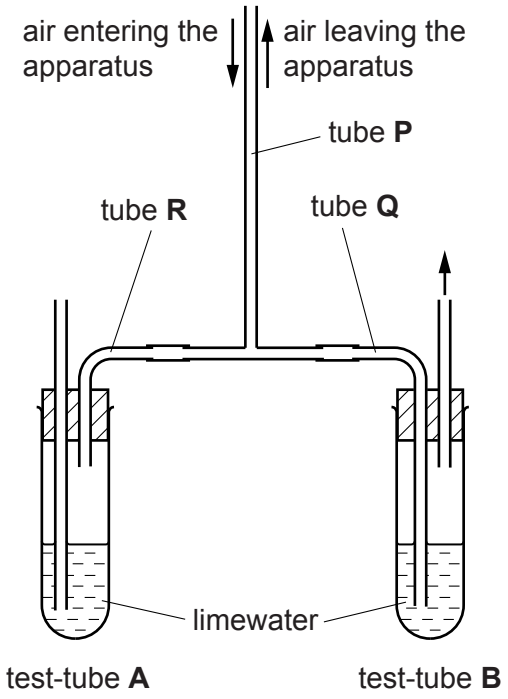


Fig. 3.1

(a) A person breathes slowly in and out of the apparatus at tube **P** for half a minute, as shown in Fig. 3.1.

(i) On Fig. 3.1, draw two arrows to show the directions of air flow in tubes **Q** and **R** while the person is breathing in and out through the apparatus. [1]

(ii) As the person breathes in and out, the composition of the air flowing **into the apparatus** through tube **P** is different from the air **leaving the apparatus** through tube **P**.

State **two** of these differences for the air leaving the apparatus.

1 .....

2 .....

[2]

(iii) Describe what you would expect to observe in the limewater in test-tube **A** and in test-tube **B** after half a minute.

test-tube **A** .....

test-tube **B** .....
[2]

(iv) Assume that the change that you predicted in **(a)(iii)** occurs. State what could then be concluded from this experiment.

.....

.....[1]

(b) Suggest and explain how the results of this experiment would be different if the person breathing through the apparatus had just finished some vigorous exercise.

difference

.....

.....

explanation

.....

.....

.....
[2]

4 Table 4.1 shows information about five materials, **H** to **L**.

Table 4.1

	name	chemical formula
H	argon	Ar
I	aspirin (pain killer)	$C_9H_8O_4$
J	hydrogen	H_2
K	oxygen	O_2
L	sea water	–

(a) (i) State and explain which of the materials, **H** to **L**, are elements.

.....

.....

..... [2]

(ii) Explain why a chemical formula can be written for water but **cannot** be written for sea water.

.....

..... [1]

(iii) Aspirin is a white solid compound at room temperature.

Describe, without practical details, **one** way in which the purity of a sample of aspirin could be checked.

.....

.....

..... [2]

(b) Fig. 4.1 shows an incomplete diagram of the electron arrangement in an atom of argon, proton number 18.

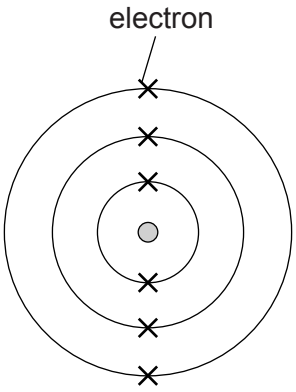


Fig. 4.1

(i) Complete Fig. 4.1 by adding the missing electrons. [2]

(ii) Most of the argon atoms in the Earth's atmosphere have a nucleon number of 40 (Ar-40).

Most of the argon atoms in space have a nucleon number of 36 (Ar-36).

Explain why both types of atoms are argon but can have different nucleon numbers.

.....

.....

..... [2]

[Turn over

5 **(a)** Fig. 5.1 shows a torch (flashlight) shining at a plane mirror.

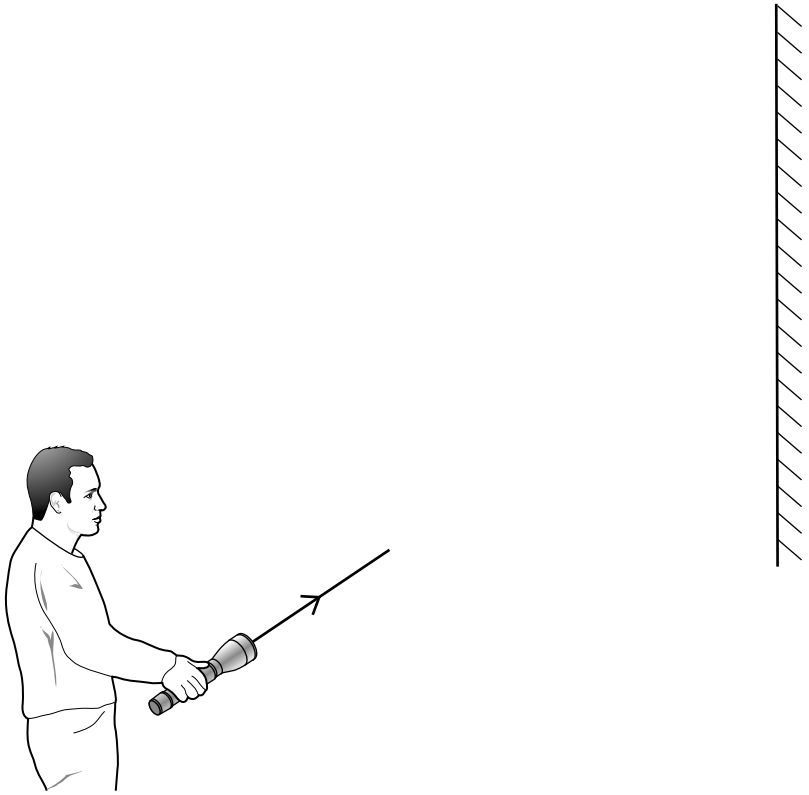


Fig. 5.1

(i) A ray of light reflects off the mirror.

Use a ruler to complete the diagram to show the ray of light reflecting off the mirror. [2]

(ii) Label the angle of incidence on your diagram in Fig. 5.1. [1]

(b) Some large torches have two lamps.

These lamps can be connected to the battery in series or in parallel.

(i) Complete the circuit diagrams in Fig. 5.2 to show a series circuit and a parallel circuit for a torch containing two lamps.

Each circuit must contain a switch which switches both lamps on and off at the same time.

Fig. 5.2

[3]

(ii) Each lamp in the torch has a resistance of 5 Ω.

Calculate the combined resistance of two lamps when placed in parallel.

State the formula that you use and show your working.

formula

working

resistance = ... Ω [2]

6 For healthy growth, plants must absorb magnesium ions from the soil. If a plant cannot absorb enough magnesium, its leaves lose their green colour. Later, the plant grows more slowly.

(a) (i) Explain why a lack of magnesium causes plants to lose their green colour.

.....

..... [1]

(ii) Explain why, later, the plant grows more slowly.

.....

.....

..... [2]

(b) Two groups of wheat plants of the same variety were grown in two different fields, field **A** and field **B**. The two fields were next to each other, and with the same conditions except for the amount of fertiliser added to the soil.

- Field **A** had regularly been treated with a nitrogen-containing fertiliser over the previous five years.
- Field **B** had not been treated with any fertiliser during this time.

In each field, the height of the wheat plants was measured over a period of 120 days, and the final wheat yield was also measured. Fig. 6.1 shows the results.

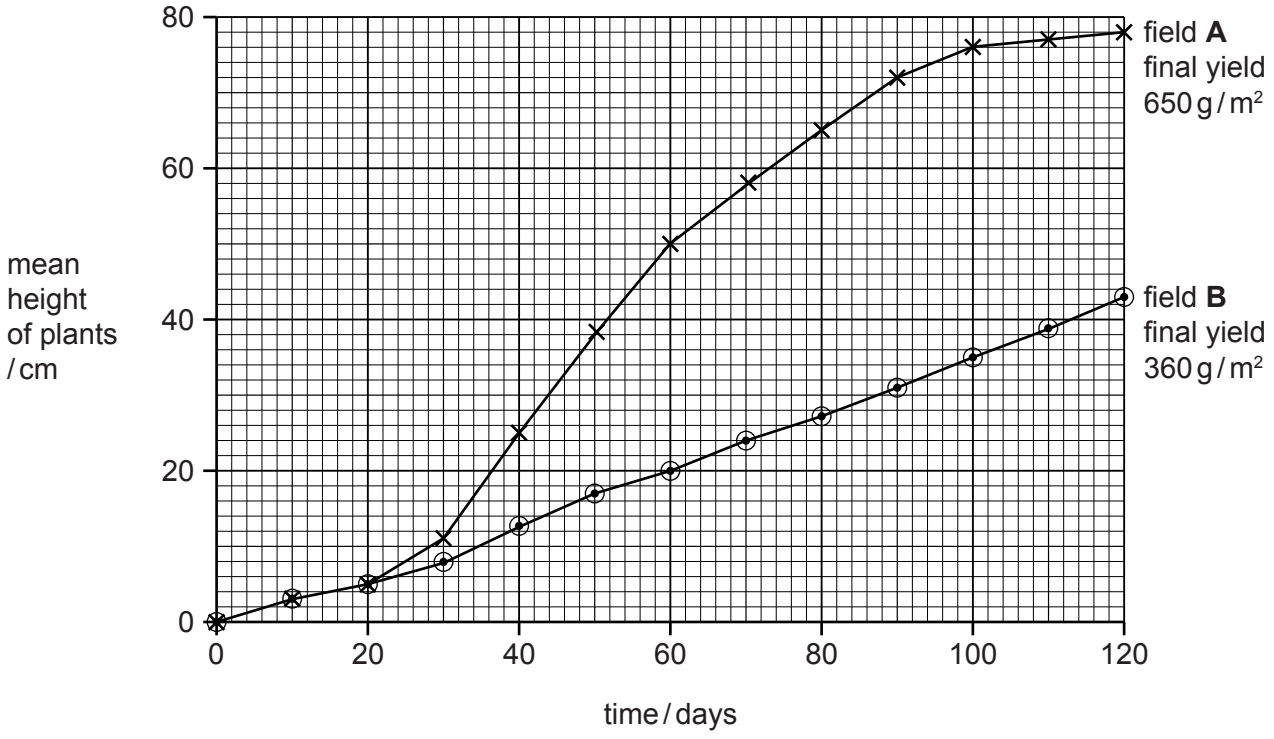


Fig. 6.1

(i) Compare the change in heights of the wheat plants in field **B** with those in field **A** for the first 20 days,

.....

.....

next 100 days.

.....

.....

..... [3]

(ii) Suggest why adding fertiliser to field **A** resulted in a higher final yield.

.....

.....

..... [2]

(c) Describe how fertiliser from farms can damage the environment in nearby rivers or lakes.

.....

.....

.....

.....

..... [3]

7 Natural gas is a mixture of hydrocarbons usually found near deposits of petroleum (crude oil).

Biogas is a gaseous mixture produced by the decomposition of organic material such as plants and animal waste.

The three charts, **A**, **B** and **C**, in Fig. 7.1 show the compositions of three gaseous mixtures, air, natural gas and biogas.

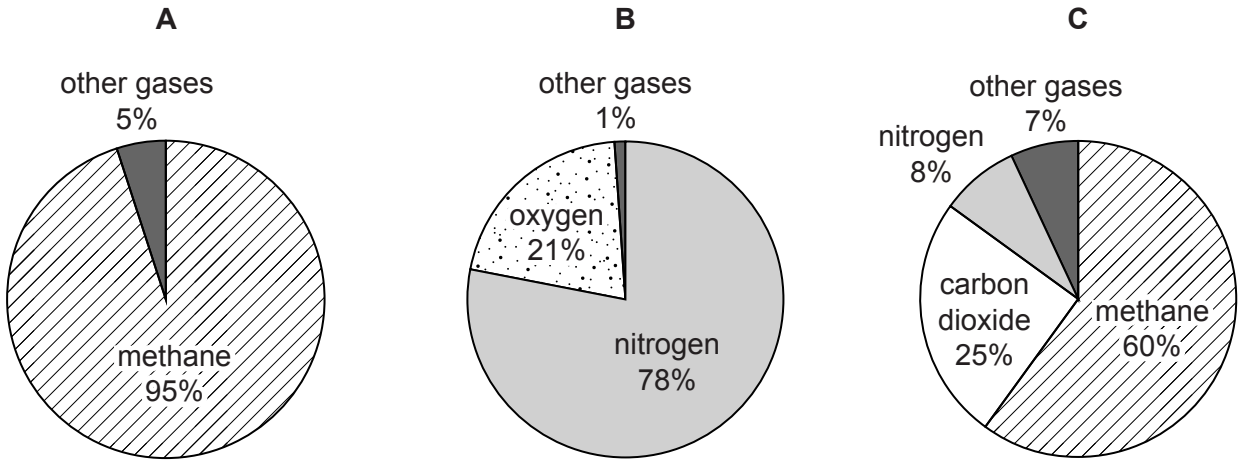


Fig. 7.1

(a) (i) Deduce which chart, **A**, **B** or **C**, shows the composition of biogas.

chart .....

explanation .....

.....

..... [2]

(ii) **Name** two compounds that are formed when the main compound in natural gas burns completely in air.

1 .....

2 ..... [2]

(b) Fig. 7.2 shows a simplified diagram of waste gases from a car engine passing over a catalyst.

Mixtures of hydrocarbons, such as diesel, are used as car fuel.

The waste gases from car engines contain many substances that cause air pollution.

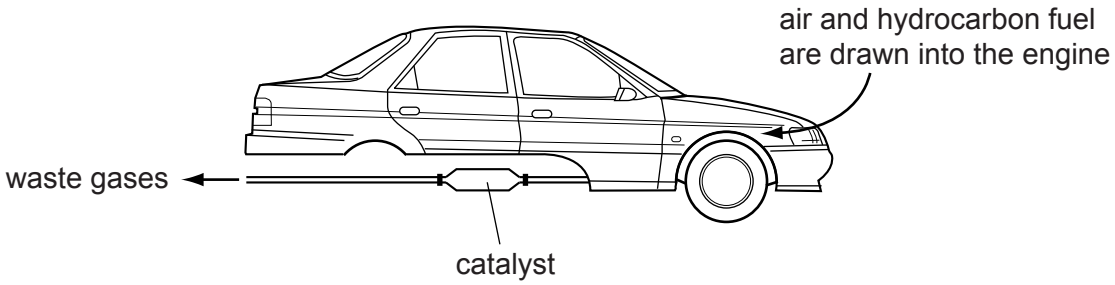


Fig. 7.2

Chemical reactions on the catalyst remove nitrous oxide, N_2O, and carbon monoxide, CO, from the waste gases.

(i) State the meaning of the term *catalyst*.

.....

.....

..... [2]

(ii) Use information from Fig. 7.2 to suggest how nitrous oxide and carbon monoxide are formed inside the car's engine.

nitrous oxide

.....

.....

.....

carbon monoxide

.....

.....

.....

[4]

8 **(a)** Fig. 8.1 shows a pea seed cut in half.

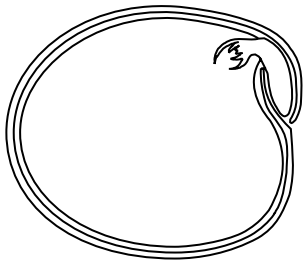


Fig. 8.1

Many plant seeds, such as peas, beans and rice, are used as foods for humans.

Suggest why plant seeds like these contain more energy than foods, such as lettuce or cabbage, that have come from other parts of plants.

.....

.....

..... [2]

(b) Fig. 8.2 shows an apple cut in half lengthways.

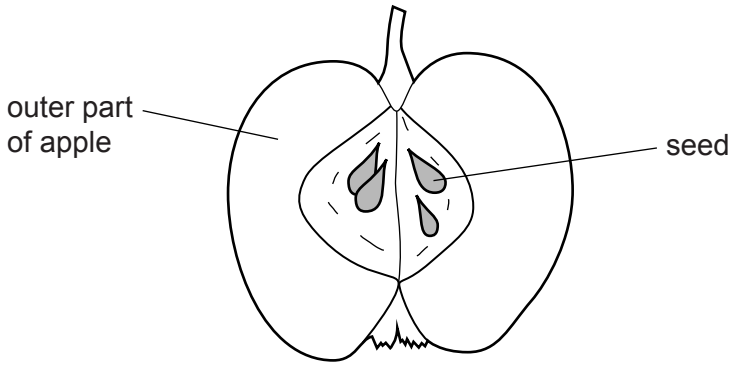


Fig. 8.2

Apple seeds taste bitter when chewed. The chewed seeds are poisonous if eaten in large quantities. However, the outer part of the apple is not poisonous.

(i) Explain why it is important for dispersal of the apple seeds that the outer part of the apple is **not** poisonous.

.....

..... [1]

(ii) Suggest why having bitter-tasting seeds helps the survival of apple trees.

.....

.....

..... [2]

(c) Fig. 8.3 shows a fruit from another plant.

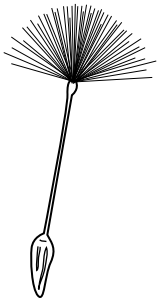


Fig. 8.3

(i) Suggest how the seeds of this plant are dispersed.

.....

..... [1]

(ii) Explain why seed dispersal is important for a plant.

.....

.....

..... [2]

9 **(a)** A cook places a metal saucepan containing water onto a hot-plate on an electric cooker.

The saucepan and water are shown in Fig. 9.1.

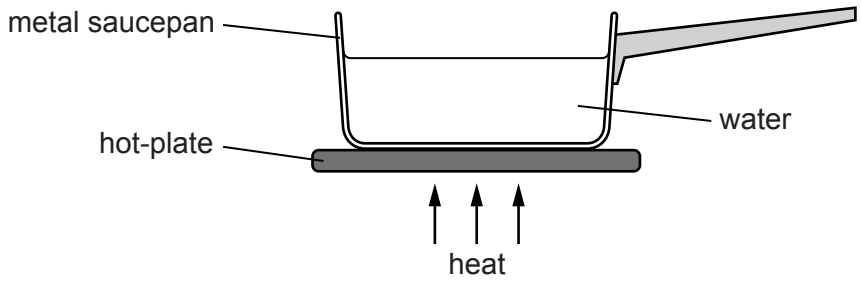


Fig. 9.1

(i) Thermal energy can be transferred by conduction, convection and radiation.

The thermal energy is transferred **through the metal saucepan** by conduction.

Describe this process in terms of particles.

.....

.....

..... [2]

(ii) Fig. 9.2 is a scale diagram showing the energy transformations involved in heating the water.

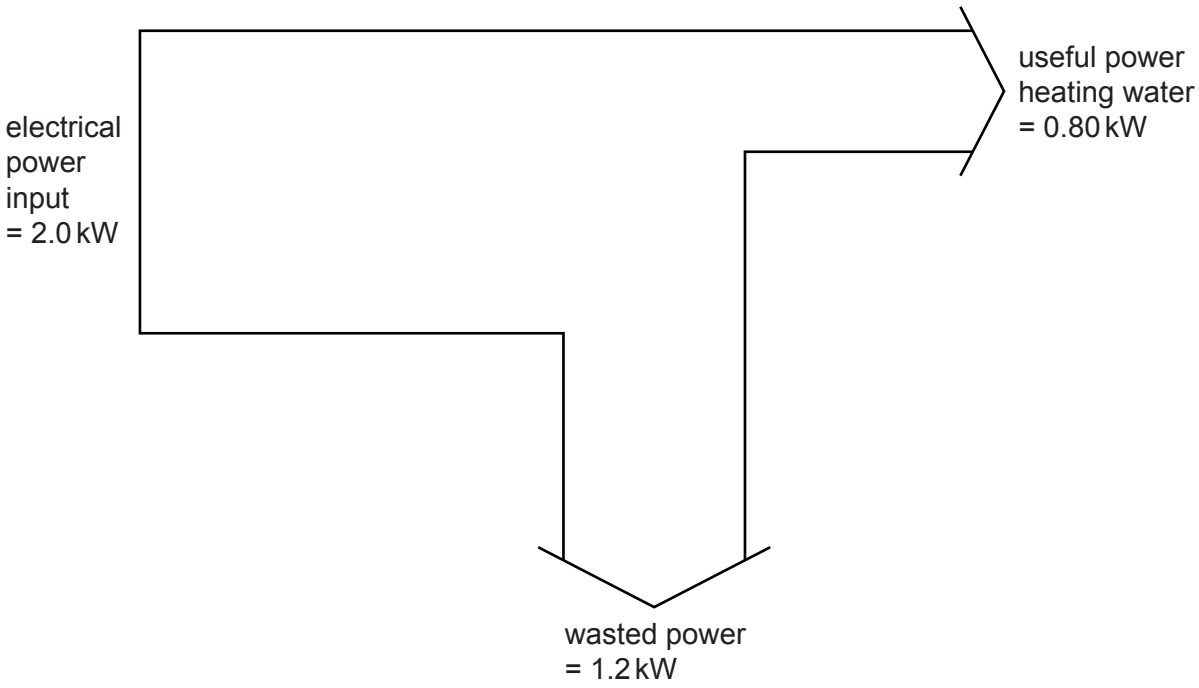


Fig. 9.2

Calculate the efficiency of heating water in this way.

Show your working and give your answer as a percentage.

efficiency = ...% [2]

(b) While water is heated, a small amount of water evaporates. When the temperature of the water reaches 100 °C, the water boils.

State **two** ways in which boiling differs from evaporation.

1.....

.....

2.....

..... [2]

(c) When the water starts to boil, the cook knows that the water is bubbling because he can hear the sound of the bubbling.

Sound waves move through the air as a series of compressions and rarefactions.

State the difference between a compression and a rarefaction.

.....

.....

..... [1]

(d) Fig. 9.3 shows three different ways in which particles may be arranged in substances.

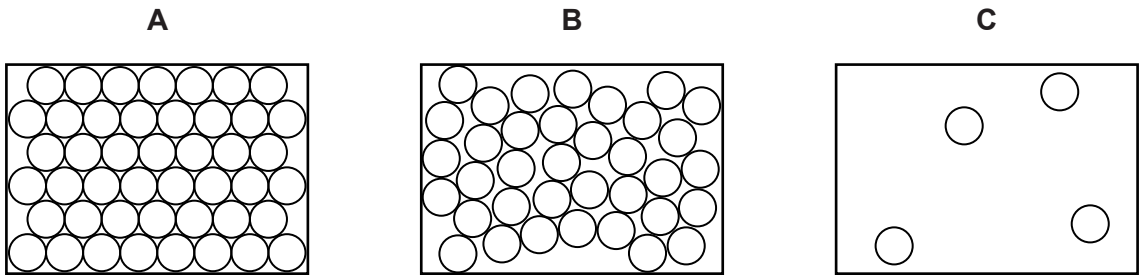


Fig. 9.3

State which diagram best represents the way particles are arranged in the liquid water in the saucepan.

Explain your answer.

diagram .....

explanation .....

..... [1]

(e) The saucepan and water have a weight of 20 N. The surface of the base in contact with the cooker is 300 cm^2.

Calculate the pressure in **N/m^2** exerted by the saucepan and water on the surface of the cooker.

State the formula that you use and show your working.

formula

working

pressure = ... N/m^2 [3]

10 Fig. 10.1 shows the structure of the human eye as seen in horizontal section.

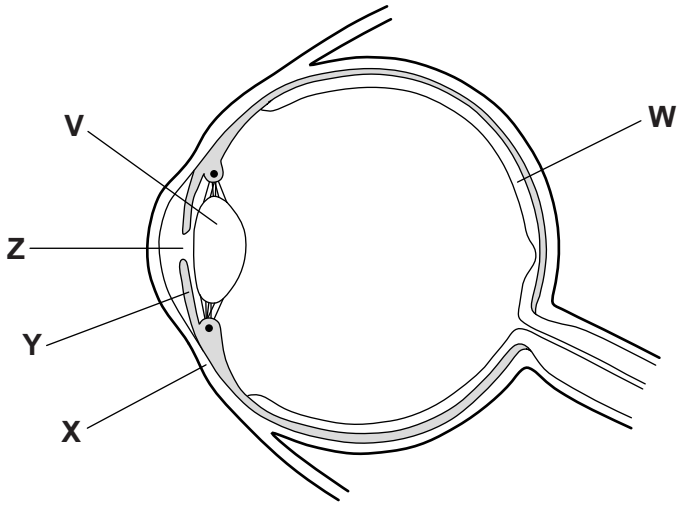


Fig. 10.1

(a) Name the parts of the eye labelled **V** and **W**.

V .....

W .....

[2]

(b) Fig. 10.2 shows an eye as seen from the front. Label Fig. 10.2 to show which parts correspond to the structures labelled **X**, **Y** and **Z** in Fig. 10.1. One has been done for you.

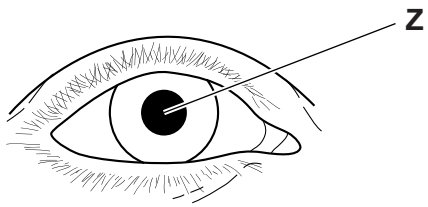


Fig. 10.2

[2]

(c) Complete the rest of Table 10.1 to show what happens when the eye changes its focus from a distant object to a near object.

Table 10.1

structure	change when starting to focus on a near object
ciliary muscles	
suspensory ligaments	
lens – shape	
lens – focal length	decreased

[3]

(d) Older people often find it difficult to focus on near objects, although they are still able to focus well on distant objects.

Suggest and explain a reason for this.

.....

.....

..... [2]

11 Fig. 11.1 shows two electrolysis reactions in beakers **A** and **B**. Gases are produced at three of the four electrodes.

In one of the beakers, the electrolyte is aqueous copper chloride and in the other the electrolyte is dilute sulfuric acid.

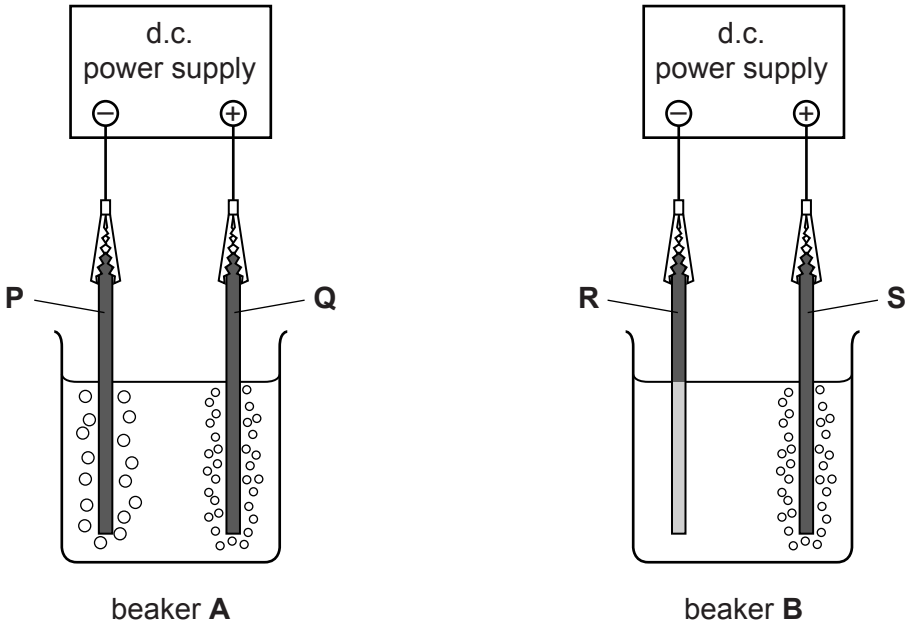


Fig. 11.1

(a) (i) State and explain in which beaker, **A** or **B**, the electrolysis of copper chloride is taking place.

beaker .....

explanation .....

..... [1]

(ii) Name the gaseous element produced on the surface of electrode **Q** in beaker **A**.

Explain your answer.

gas .....

explanation .....

..... [2]

(iii) Name the gas produced on the surface of electrode **P** in beaker **A**.

..... [1]

(b) Fig. 11.2 shows the electrolysis of copper sulfate solution using copper electrodes.

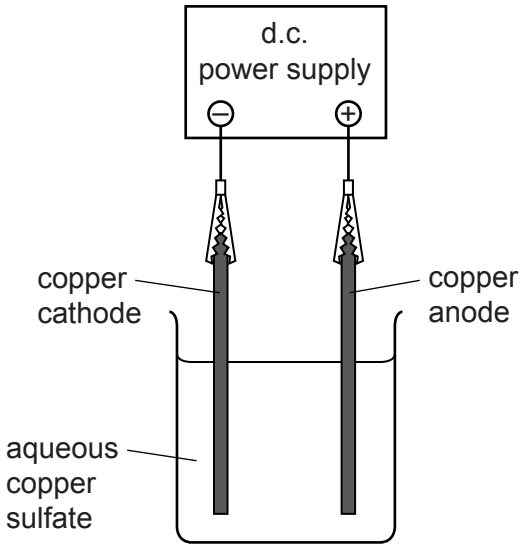


Fig. 11.2

During this electrolysis reaction the masses of the electrodes slowly change.

Table 11.1 shows the mass of the cathode at the start and end of the process.

Table 11.1

cathode mass at the start/g	cathode mass at the end/g
177.42	178.38

(i) Calculate the number of moles of copper deposited on the cathode during the electrolysis. The relative atomic mass of copper is 64.

Show your working.

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

(ii) State and explain what happens to the mass of the anode during the electrolysis.

.....

.....

..... [2]

12 **(a)** Give an example of a fossil fuel.

..... [1]

(b) Fossil fuels are non-renewable. Explain what is meant by *non-renewable*.

.....

..... [1]

(c) Many governments are making efforts to reduce the use of fossil fuels.

Suggest **two** ways in which the use of fossil fuels can be reduced.

1 .....

2 .....
[2]

13 (a) Fig. 13.1 shows a fishing boat using ultrasound waves to detect a shoal of fish, 120 m below the surface.

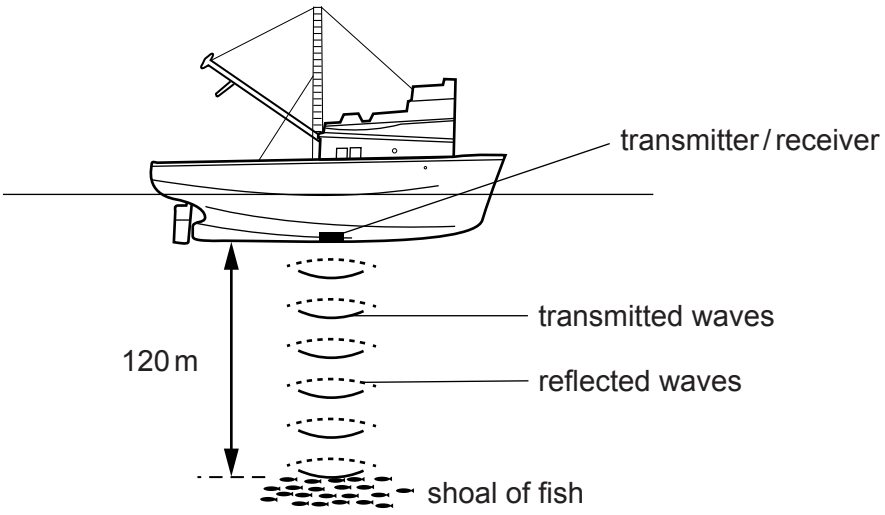


Fig. 13.1

(i) The speed of ultrasound waves in water is 1500 m / s.

Short pulses of ultrasound are sent out from the boat and the echo from the fish is detected by the boat.

Calculate the time taken between the ultrasound waves being emitted and the detection of the echo.

State the formula that you use and show your working.

formula

working

time = ... s [2]

(ii) The frequency of the ultrasound waves used to detect fish is 45 000 Hz.

Calculate the wavelength of the ultrasound waves.

State the formula that you use and show your working.

formula

working

wavelength = ... m [2]

(iii) State the approximate human range of audible frequencies.

from ..... Hz to .....Hz [1]

(iv) State why humans cannot hear ultrasound waves.

.....

..... [1]

(b) The power of ocean waves can be used as a source of energy.

Fig. 13.2 shows a model of a device which could generate electricity from waves. A magnet is able to move inside a coil. The coil is fixed to the concrete block on the sea floor.

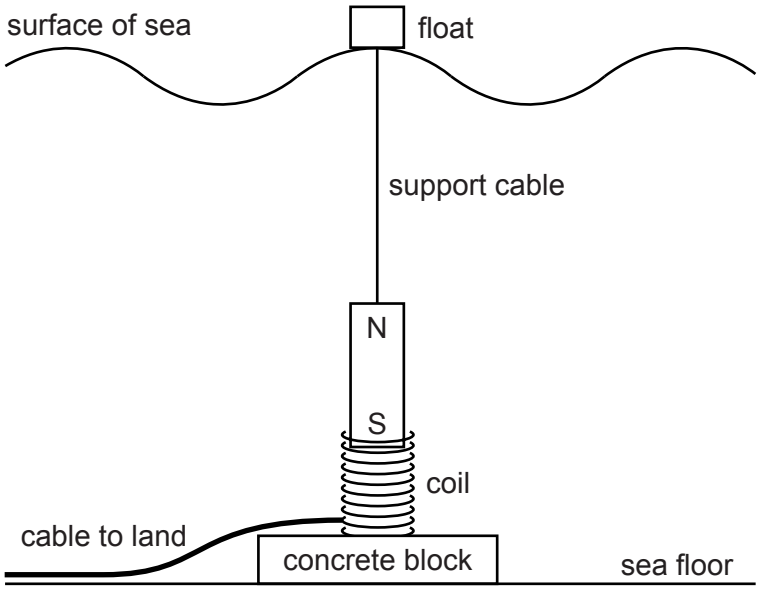


Fig. 13.2

(i) Describe how this device generates an e.m.f.

.....

.....

.....

.....

..... [3]

(ii) Suggest **two** changes which could be made to the device to increase the e.m.f. produced.

1 .....

.....

2 .....

..... [2]

BLANK PAGE

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
						1 **H** Hydrogen 1											4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

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

Key

a **X** b

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

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