Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2712962050

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **October/November 2016**

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 or graphs.
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.

This document consists of **32** printed pages.

CAMBRIDGE International Examinations

1 Fig. 1.1 shows a dead mouse lying on some grass in a field.

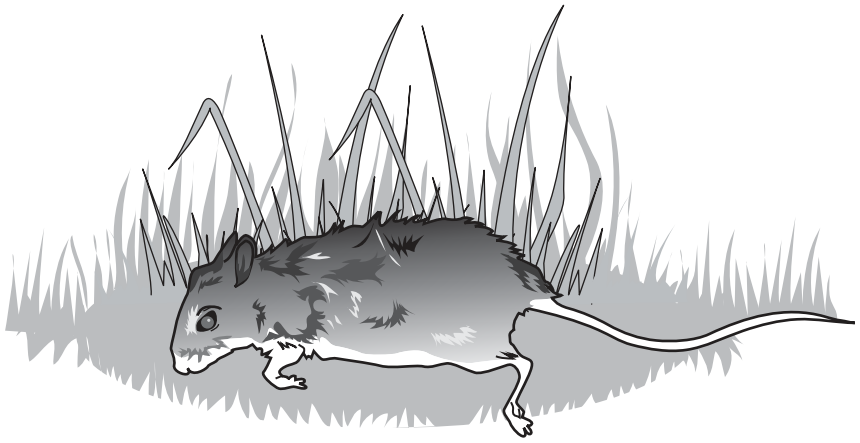


Fig. 1.1

(a) The mouse is decaying. Name a type of organism that causes this decay.

..... [1]

(b) The grass near the mouse grows taller than in the rest of the field. Suggest why this happens.

.....

.....

..... [1]

(c) Explain why the grass underneath the mouse's body **cannot** grow well.

.....

.....

..... [2]

(d) A living mouse feeds on grass seeds. The mouse is eaten by an owl.

(i) In the space, draw a food chain to show these relationships.

[2]

(ii) Explain why, in this food chain, there will be fewer owls than mice.

.....

.....

..... [2]

2 **(a)** Fig. 2.1 shows a pie chart of the composition of a sample of air.

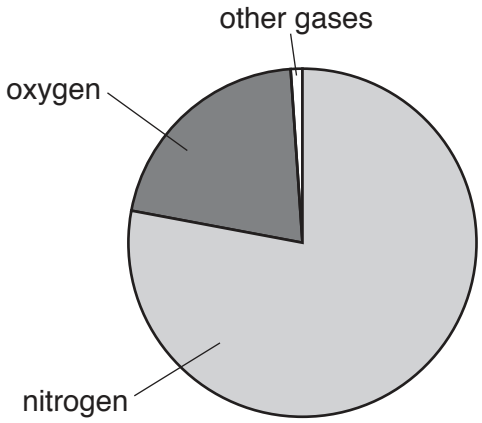


Fig. 2.1

(i) Name **one** gas present in the section labelled *other gases* for a sample of clean air.

..... [1]

(ii) In a sample of air collected near a busy road, carbon monoxide is also present.

Describe how this gas is produced by car engines.

.....

.....

.....

..... [3]

(iii) Fig. 2.2 represents an incomplete diagram of the covalent bonding in a nitrogen molecule.

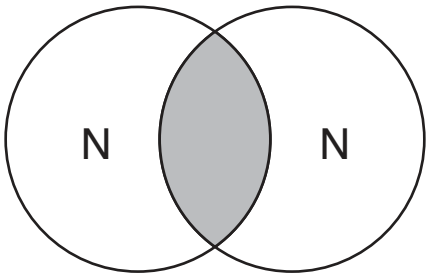


Fig. 2.2

In Fig. 2.2 the shaded area shows where electrons are shared.

State the number of shared electrons in this molecule.

..... [1]

(b) Ozone molecules, O_3, are made from oxygen molecules when electrical sparks pass through air.

Fig. 2.3 shows a device that produces ozone.

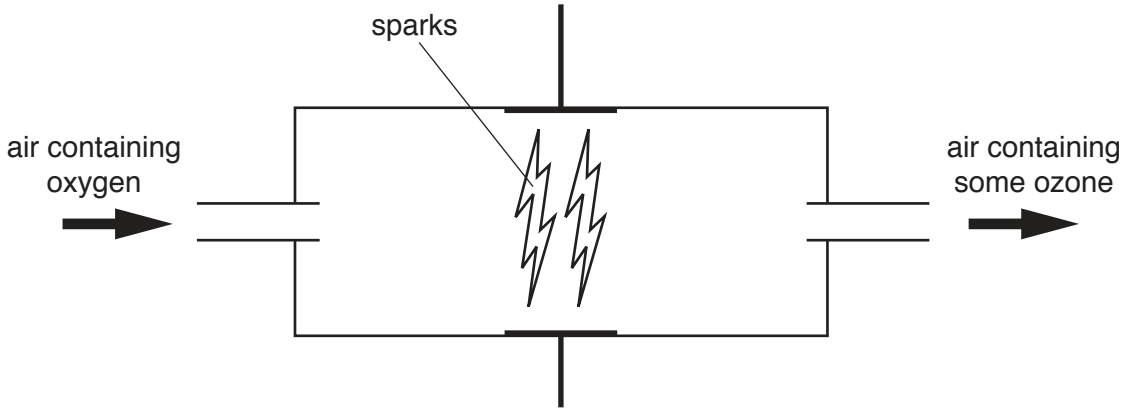


Fig. 2.3

(i) Construct the balanced equation for the formation of ozone, O_3, from oxygen in the air.

..... [2]

(ii) Ozone can be used instead of chlorine in the treatment of water.

Suggest how ozone makes water suitable for use in the home.

.....

..... [1]

[Turn over

3 **(a)** A train is travelling between two stations.

Fig. 3.1 shows a speed/time graph for this journey.

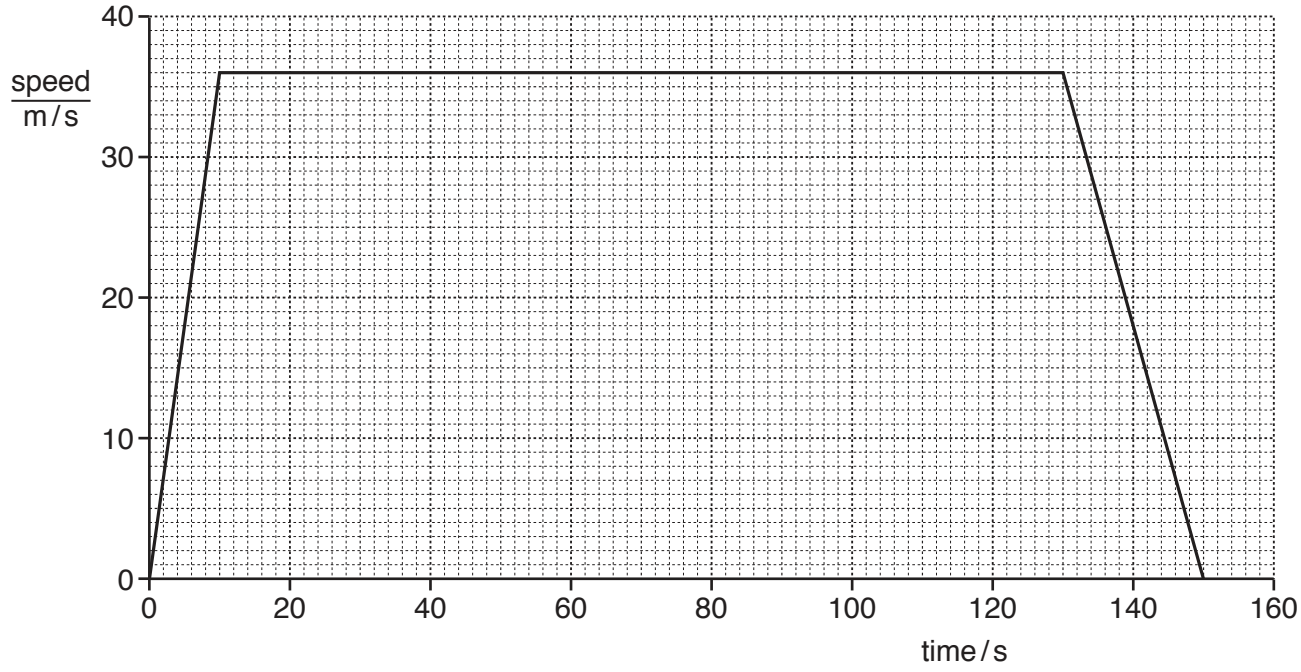


Fig. 3.1

(i) Calculate the total distance travelled by the train.

Show your working.

distance = ... m [1]

(ii) State how you determined the total distance travelled by the train from information in Fig. 3.1.

.....

..... [1]

(iii) Show that the acceleration of the train shown in Fig. 3.1 is 3.6 m/s^2.

[2]

(b) The mass of the train is 7×10^4 kg. The acceleration of the train is $3.6\,m/s^2$.

(i) Calculate the accelerating force acting on the train.

State the formula you use, show your working and give the unit.

formula

working

force = ... unit = ... [3]

(ii) Calculate the kinetic energy of the train when it is travelling at the maximum speed shown in Fig. 3.1.

State the formula you use and show your working.

formula

working

kinetic energy = ...J [2]

(c) The train has an electric motor.

A simple electric motor is shown in Fig. 3.2.

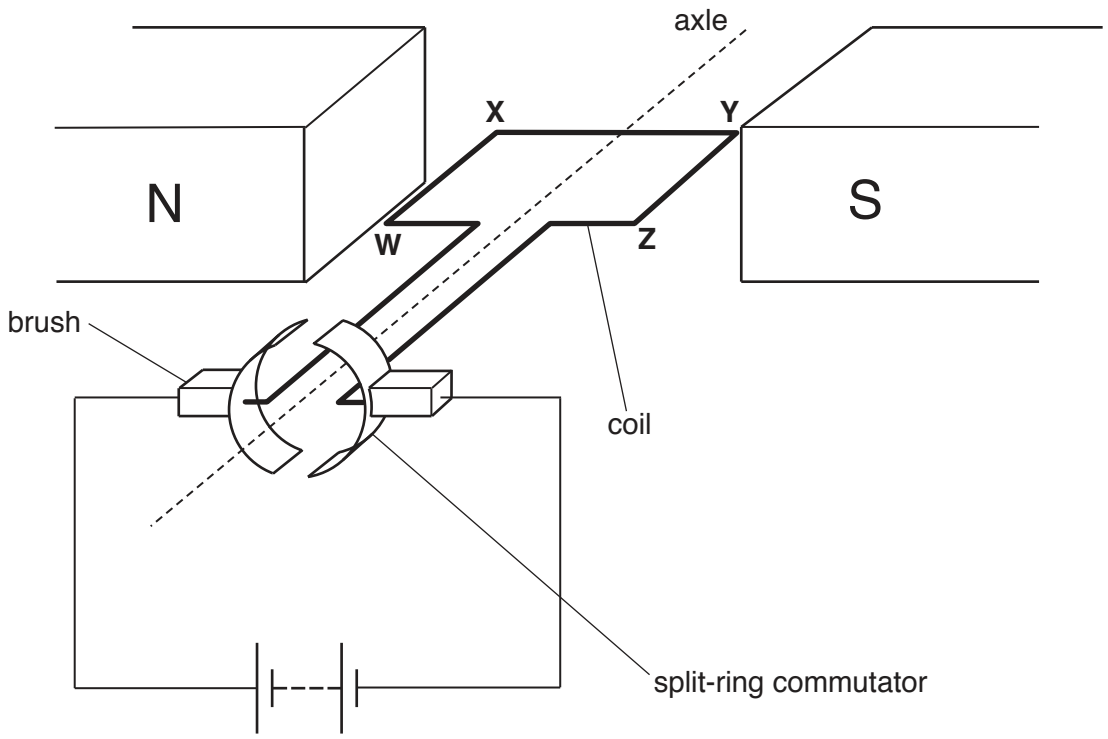


Fig. 3.2

The motor consists of a coil of wire mounted on an axle and placed in a magnetic field. The ends of the coil are connected to a battery by a split-ring commutator and two carbon brushes.

(i) Describe and explain what happens to the coil **WXYZ** when an electric current passes through it.

.....

.....

.....

.....

.....

..... [3]

(ii) Describe and explain the purpose of the split-ring commutator.

.....

.....

..... [2]

4 The small intestine has many villi on its internal surface. Fig. 4.1 shows the structure of a villus.

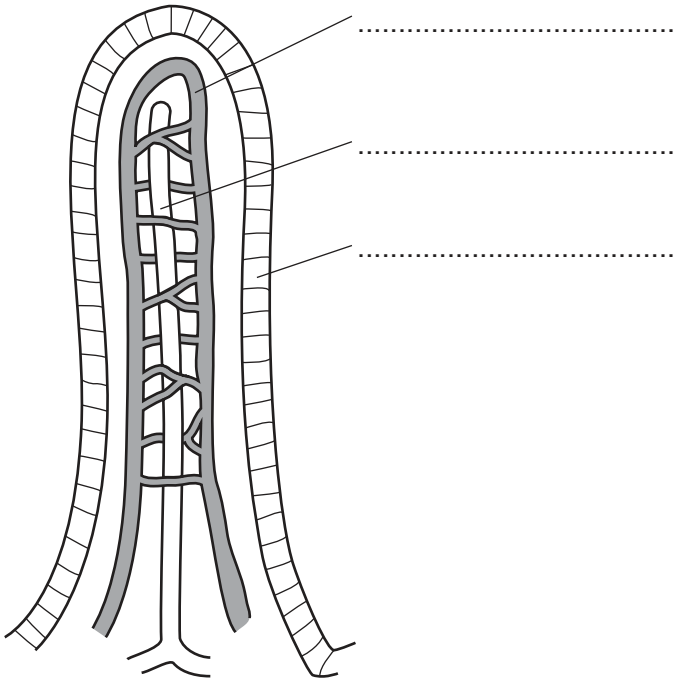


Fig. 4.1

(a) Complete the labels to identify the structures on Fig. 4.1. [3]

(b) Describe the importance of the shape of the villi in the function of the digestive system.

.....

.....

..... [2]

(c) A person develops a condition in which the villi of the small intestine become reduced in size.

(i) Suggest how the person would be affected by this change in size of villi.

.....

..... [1]

(ii) Suggest how the person should change their diet.

.....

..... [1]

5 **(a)** A student is asked to safely produce some hydrogen.

Fig. 5.1 shows the apparatus and a choice of elements available.

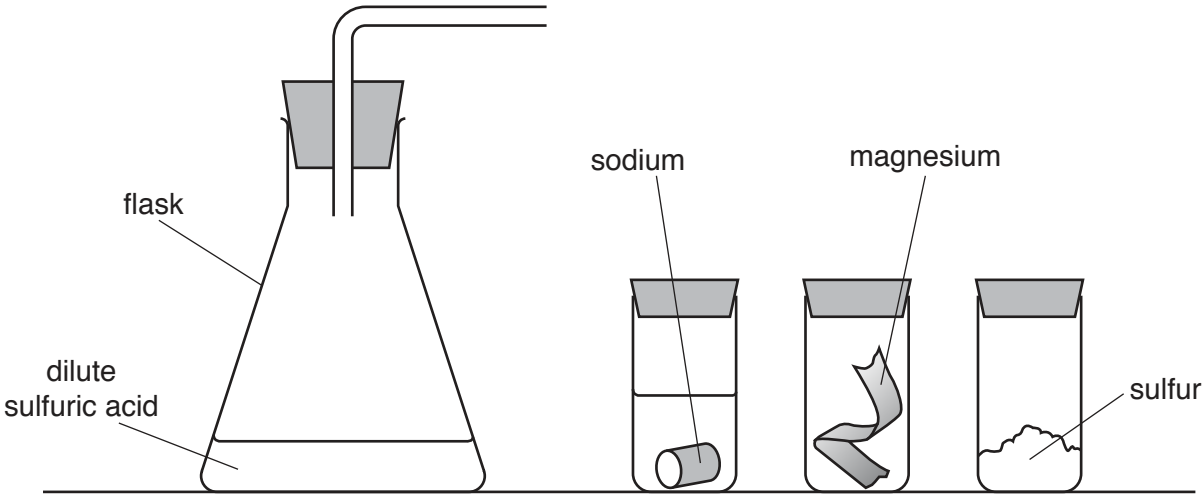


Fig. 5.1

(i) The student correctly decides to add magnesium to the acid to produce hydrogen safely.

Explain why the other two elements are unsuitable for this task.

sodium .....

.....

sulfur .....

.....

[2]

(ii) Predict how the pH of the mixture changes during the reaction between dilute sulfuric acid and magnesium. Explain your answer.

pH .....

explanation .....

.....

.....

.....

[2]

(b) The hydrogen produced is burnt in air. A cold metal plate is held above the burning hydrogen, as shown in Fig. 5.2.

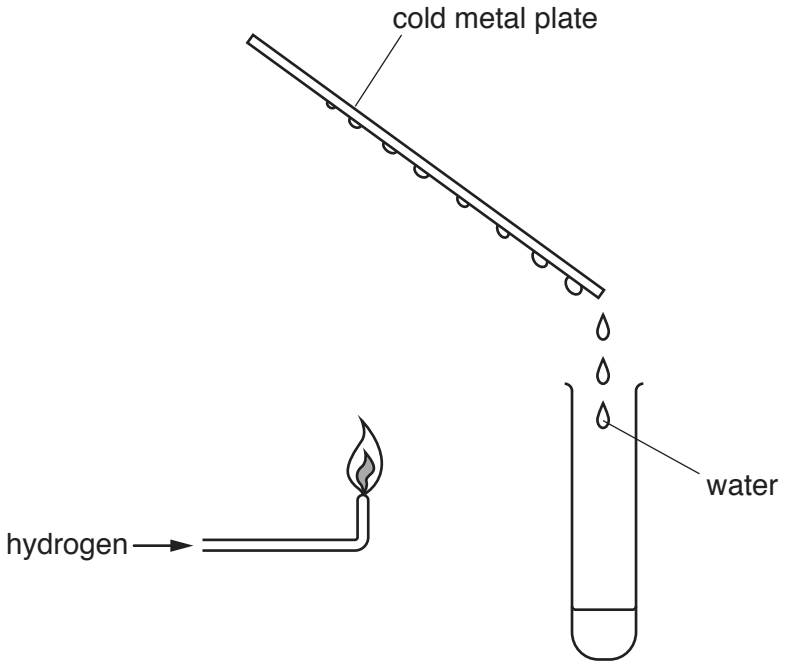


Fig. 5.2

(i) Water condenses on the metal plate.

Describe a chemical test for water. Give the positive result.

test .....

result .....

[2]

(ii) The word equation for the combustion of hydrogen is shown.

$$\underbrace{\text{hydrogen} + \text{oxygen}}_{\text{reactants}} \rightarrow \underbrace{\text{water}}_{\text{product}}$$

Predict whether the product of the reaction contains a greater or smaller amount of chemical potential energy than the reactants.

Explain your answer.

.....

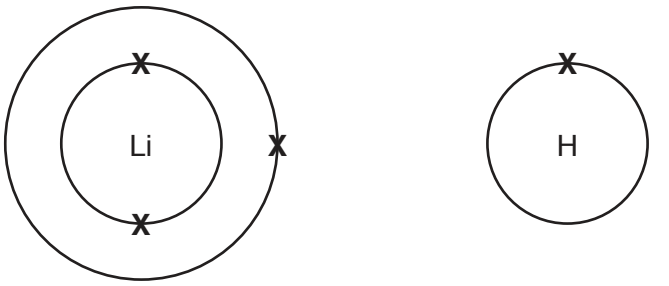
.....

..... [2]

[Turn over

(c) When lithium combines with hydrogen, the ionic compound lithium hydride, LiH, is formed.

(i) Fig. 5.3 shows the electron arrangements in a lithium atom and in a hydrogen atom.



lithium atom hydrogen atom

Fig. 5.3

Draw diagrams to show the electron arrangements in a lithium **ion** and in a hydride **ion**.

Include the ionic charges in your diagrams.

[2]

(ii) The balanced equation for the reaction is shown.

$$2Li + H_2 \rightarrow 2LiH$$

The relative atomic mass of lithium is 7 and of hydrogen is 1.

The volume of one mole of gas is 24 dm^3.

Use this information to calculate,

the relative formula mass of lithium hydride,

.....

the number of moles in 100 g of lithium hydride,

.....

the number of moles of hydrogen molecules that are needed to produce 100 g of lithium hydride,

.....

the volume of hydrogen used, in dm^3.

..... dm^3
[4]

6 **(a)** Electricity is generated in a nuclear power station by nuclear fission. Nuclear fission releases thermal energy which heats water.

(i) Calculate the thermal energy needed to heat 5000 kg of water from 20 °C to 100 °C.

The specific heat capacity of water is 4200 J / kg °C.

State the formula you use and show your working.

formula

working

energy = ... J [3]

(ii) Some of the thermal energy released in nuclear fission is used to turn water at 100 °C into steam at 100 °C. There is no change in temperature during this process. Describe why energy is needed to do this.

.....

.....

..... [1]

(iii) Fig. 6.1 shows the arrangement of particles in a gas, liquid and solid.

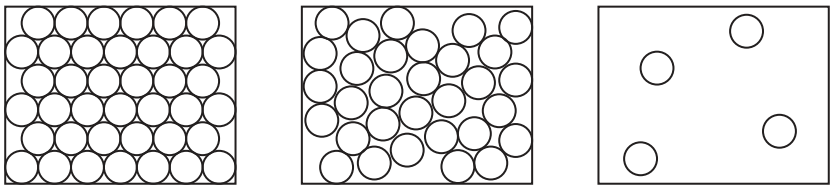


Fig. 6.1

State and explain which diagram, **A**, **B** or **C**, best represents

water at 100 °C, ...

explanation .....

.....

steam at 100 °C. .....

explanation .....

.....

[2]

(b) Plutonium-239 (Pu-239) is produced by some nuclear power stations. Pu-239 is radioactive and has a half-life of 24 000 years.

1 kg of Pu-239 is sealed in a lead container.

Calculate the mass of Pu-239 remaining after 96 000 years.

Show your working.

mass = ... kg [2]

(c) The decay of some radioactive nuclides involves the release of α-particles and γ-rays.

State the differences in the ways that α-particles and γ-rays behave in an electric field and in a magnetic field. Give reasons for your answers.

electric field .....

.....

.....

magnetic field .....

.....

.....

[3]

Please turn over for Question 7.

7 Fig. 7.1 shows some of the stages involved in brewing beer.

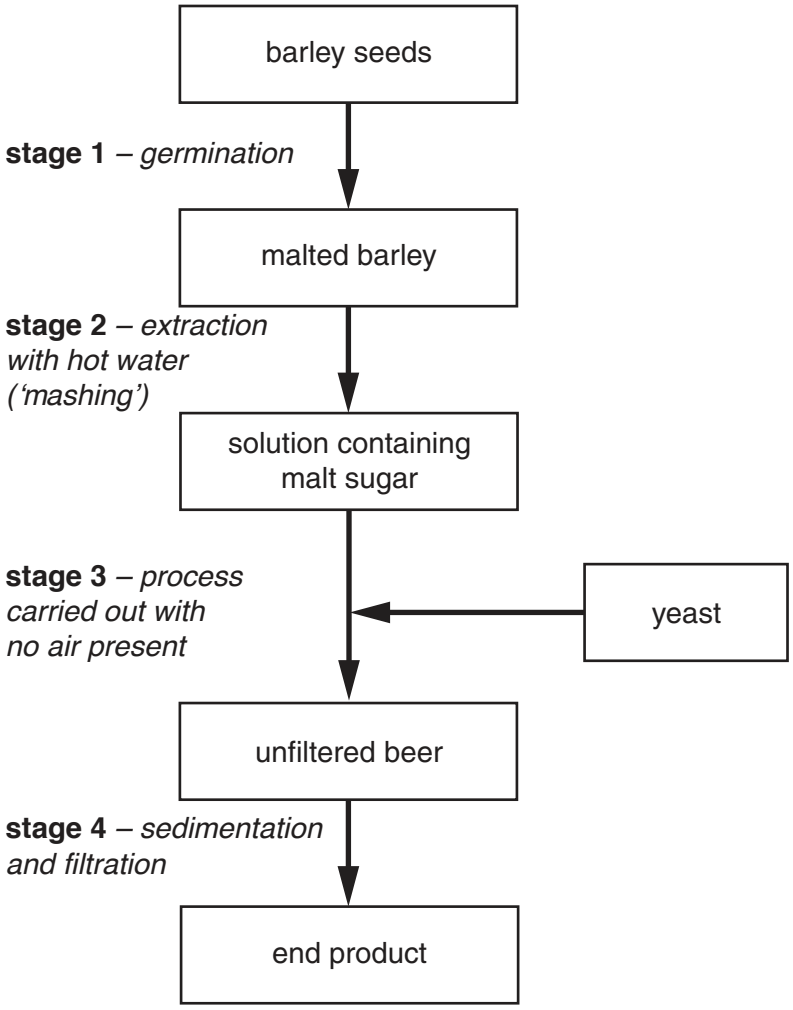


Fig. 7.1

(a) During **stage 1**, the barley seeds produce an enzyme that breaks down stored starch into malt sugar.

Name this enzyme.

..... [1]

(b) At **stage 3**, yeast is added to the solution containing malt sugar.

State **two** functions of the **malt sugar** in this mixture.

1 .....

2 .....

[2]

(c) **(i)** Name the process carried out by the yeast at **stage 3**.

..... [1]

(ii) Write a word equation for the process that takes place in **stage 3**.

..... [1]

(d) If air is bubbled through the mixture at **stage 3**, suggest and explain what would happen to

the rate of growth of the yeast,

.....

.....

.....

the rate of production of the beer.

.....

.....

.....

[3]

8 **(a)** Fig. 8.1 shows the structure of a hydrocarbon molecule.

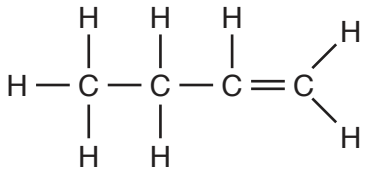


Fig. 8.1

Name this compound and the homologous series to which it belongs.

name .....

homologous series .....
[2]

(b) Table 8.1 shows the names, boiling points and relative molecular masses of the first five members of a homologous series.

Table 8.1

name	boiling point / °C	relative molecular mass
methane	– 162	16
ethane	– 89	30
propane	– 42	44
butane	– 1	58
pentane	+ 36	

(i) Describe and explain the trend shown in the boiling points in Table 8.1.

.....

.....

.....

..... [2]

(ii) Use the data in Table 8.1 to predict the relative molecular mass of pentane.

Explain your answer.

relative molecular mass .....

explanation .....

.....

.....
[2]

(c) When pure ethene gas is heated under pressure with a catalyst, a white solid is produced.

(i) State the type of chemical reaction that occurs and name the white solid.

type of reaction .....

name of white solid .....
[2]

(ii) Complete the diagram below to show the structure of the white solid produced.

[2]

9 **(a)** A car travels along a road. During the journey the temperature of the air in the tyres increases by 25 °C. The volume of air in the tyres remains the same.

Explain in terms of particles why the pressure of the air in the tyres increases.

.....

.....

.....

..... [2]

(b) Fig. 9.1 shows a circuit diagram for two lamps in a car. A 12 V battery is connected to the lamps.

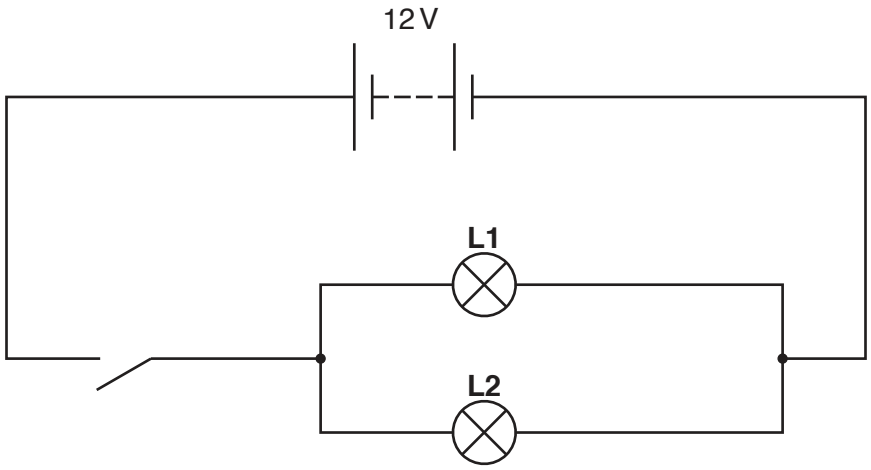


Fig. 9.1

Lamps **L1** and **L2** are identical and each have a resistance of 2.5 Ω when lit.

Calculate the combined resistance of **L1** and **L2** when connected in parallel.

Show your working.

resistance = ... Ω [2]

(c) Relays are often used as switches in car circuits that use large currents.

Explain why relays are used in this way.

.....

.....

..... [2]

(d) Different metals can be used to make cables for electrical circuits in a car.

A scientist investigates six different wires used in making these cables. He wants to determine the resistance of each piece of wire.

Table 9.1 shows data the scientist collects.

Table 9.1

wire	metal composition	length / cm	cross-sectional area / mm^2
A	copper	10	0.5
B	nichrome	10	0.5
C	copper	20	0.5
D	nichrome	20	0.5
E	copper	10	1.0
F	nichrome	20	1.0

(i) State which wire, **A** or **E**, has the lower resistance. Explain your answer.

wire .....

explanation .....

.....

[1]

(ii) Wire **B** has a greater resistance than wire **A**.

State which wire, **B**, **C**, **D**, **E** or **F**, has the greatest resistance. Explain your answer.

wire .....

explanation .....

.....

.....

[2]

[Turn over

10 Fig. 10.1 shows a fruit from a dandelion plant. The fruit is dispersed from the parent plant by the wind.

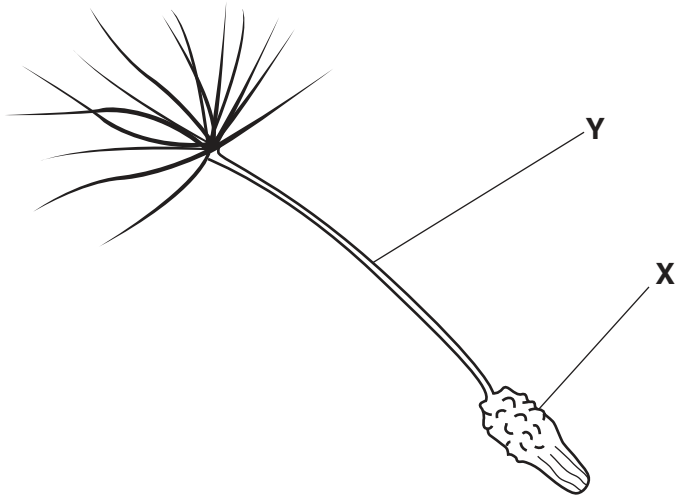


Fig. 10.1

(a) Suggest **one** way in which the structure of this dandelion fruit helps with wind dispersal.

.....

..... [1]

(b) **(i)** Name the structure that is contained within the part of the fruit labelled **X**.

..... [1]

(ii) The part labelled **X** has small spikes or spines on it.

Suggest a function for these spikes.

.....

..... [1]

(c) The part of the fruit labelled **Y** in Fig. 10.1 is called the beak of the fruit. A student thought that fruits with longer beaks would be carried further in the wind.

The student does an experiment to investigate this. She measures the length of the beaks of 20 dandelion fruits.

She releases each fruit in turn and measures the distance that the fruit travels before it lands. The graph in Fig. 10.2 shows her results.

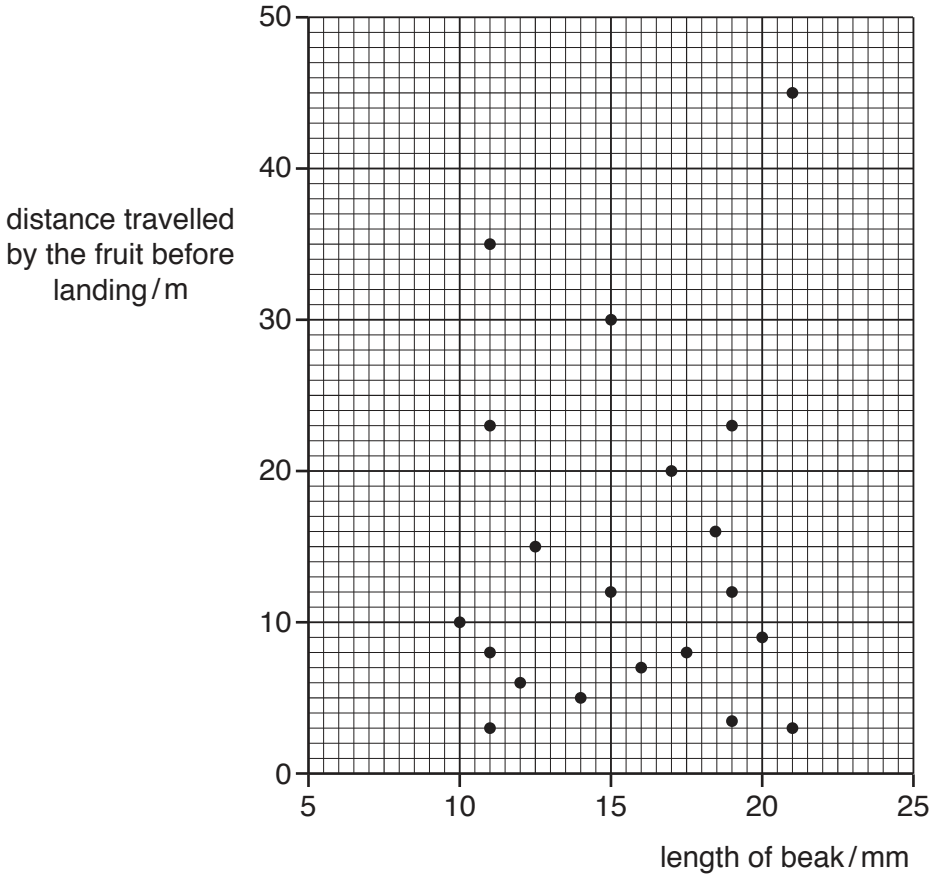


Fig. 10.2

(i) State whether the results in Fig. 10.2 support the student's idea that fruits with longer beaks travel further. Explain your answer.

.....

.....

..... [1]

(ii) Suggest **one** other feature of the fruit that might affect how far the fruit is carried by the wind.

..... [1]

(d) Give **one** reason why it is helpful to the dandelion species if the fruits are carried a long distance from the parent plant.

.....

..... [1]

(e) **(i)** Wind is one method of fruit dispersal.

State **one** other method of fruit dispersal.

..... [1]

(ii) For the method you have chosen in **(e)(i)**, state how the structure of a fruit or seed may help it to be dispersed in this way.

.....

.....

..... [1]

11 (a) Copper is a transition metal.

Some properties, **A** to **E**, of metallic elements are listed.

A form some coloured compounds

B good conductors of electricity

C good conductors of thermal energy

D malleable

E used as catalysts

State the letters which describe copper, but do **not** describe Group I metals.

..... [1]

(b) Fig. 11.1 shows a method of obtaining a sample of copper from copper oxide.

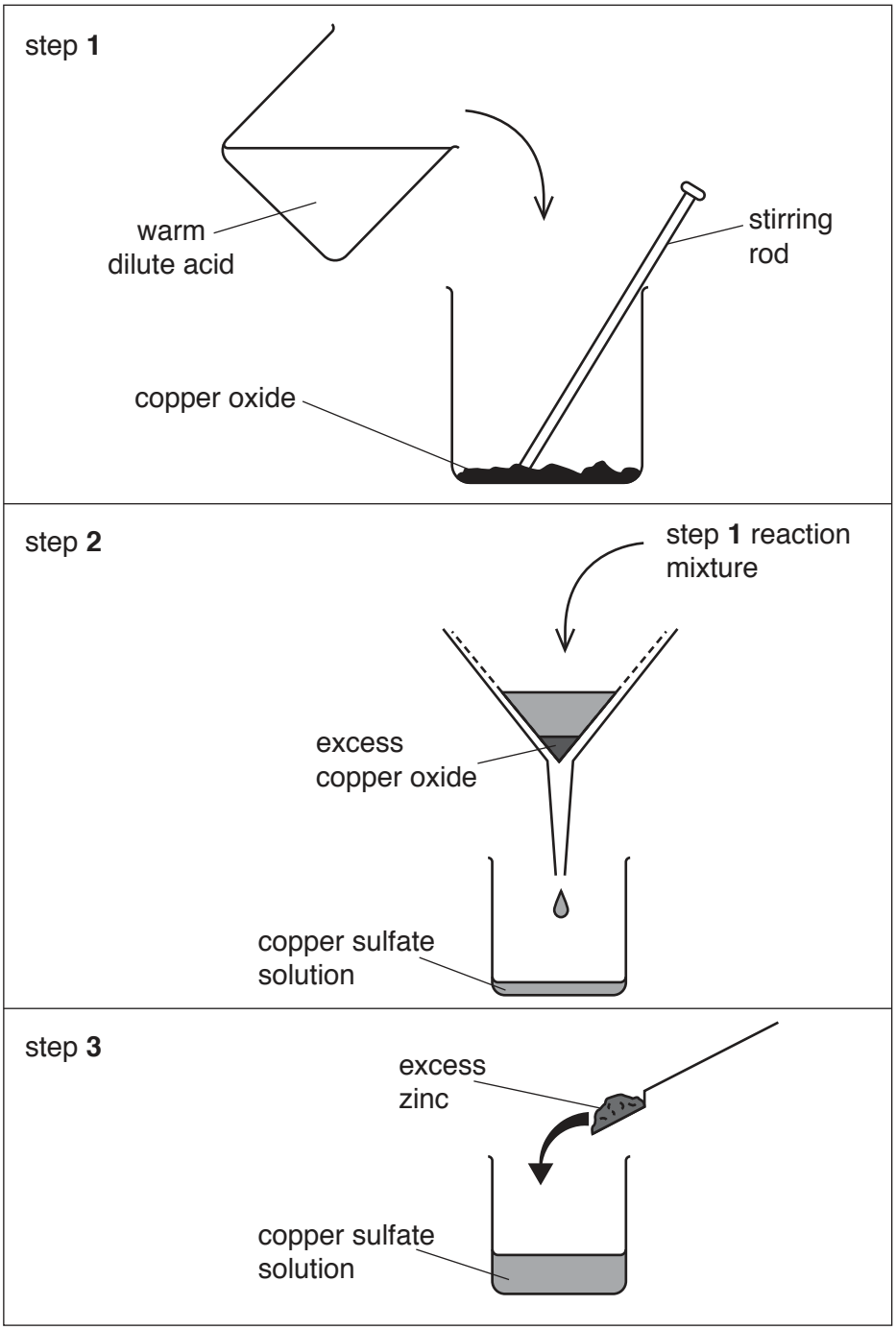


Fig. 11.1

(i) Complete the **word** equation for the reaction in step **1**.

..... acid	+	copper oxide	→	copper sulfate	+	.....

[2]

(ii) Copper ions are reduced by zinc atoms in step **3** of Fig. 11.1.

State why zinc atoms are able to reduce copper ions.

..... [1]

(iii) Explain why the change to the copper ions in step **3** is described as reduction.

.....

..... [1]

(c) Fig. 11.2 shows laboratory apparatus used in the electrolysis of copper sulfate solution.

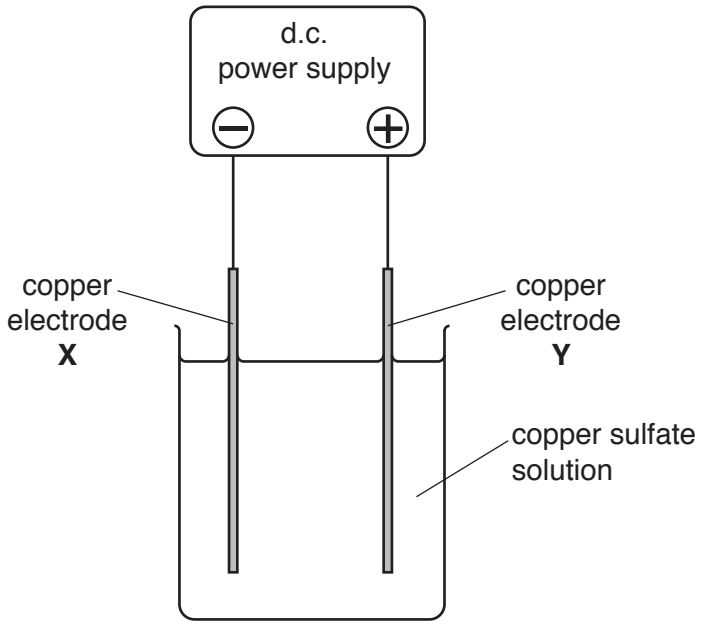


Fig. 11.2

(i) Name electrodes **X** and **Y**.

X .....

Y .....
[1]

(ii) Explain, in terms of the electrode reaction, the change in mass of the negative copper electrode.

.....

.....

.....

..... [2]

12 Nuclear fusion is the main process that releases energy in the Sun. In nuclear fusion, hydrogen nuclei collide and produce heavier, helium nuclei, releasing energy.

(a) In the Sun, four hydrogen nuclei collide to form one helium nucleus. For every helium nucleus formed, 4.2×10^{-12} J of energy are released.

The Sun releases approximately 3.8×10^{26} J every second.

Estimate the number of helium nuclei formed in the Sun every second.

Show your working.

number of helium nuclei = ... [2]

(b) Describe the difference between nuclear fusion and nuclear fission.

.....

..... [1]

(c) Most of the radiation from the Sun that reaches the Earth is in the visible light, infra-red and ultraviolet parts of the electromagnetic spectrum.

(i) Place ultraviolet and infra-red in their correct positions in the incomplete electromagnetic spectrum shown in Fig. 12.1.

γ-rays			visible light		microwaves	

[1]

Fig. 12.1

(ii) State the part of the electromagnetic spectrum shown in Fig. 12.1 that has the highest frequency.

..... [1]

(d) The nuclear reactions that take place in the Sun produce sound energy.

Explain why we cannot hear this sound on Earth.

.....

..... [1]

13 **(a)** Write the balanced **symbol** equation for photosynthesis.

..... [2]

(b) Fig. 13.1 shows the cross-section of a leaf as it appears using a microscope.

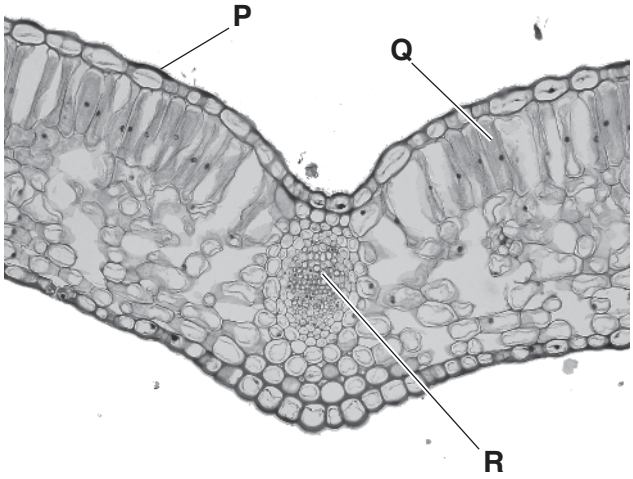


Fig. 13.1

(i) Name the parts of the leaf labelled **P**, **Q** and **R**.

P .....

Q .....

R .....
[3]

(ii) On Fig. 13.1, draw an arrow to show the route taken by carbon dioxide as it enters the leaf. [1]

(c) The leaf absorbs light energy.

(i) Name the cells in the leaf that absorb the most light energy. Explain why these cells are able to absorb so much light.

name of cells .....

explanation .....

.....
[2]

(ii) State what happens to the light energy absorbed by these cells.

.....

..... [1]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			**Key** atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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