Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

9640139400

COMBINED SCIENCE **0653/41**

Paper 4 (Extended) **May/June 2019**

1 hour 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.
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 24.

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 **22** printed pages and **2** blank pages.

Cambridge Assessment International Education

[Turn over

1 Fig. 1.1 shows a bag containing sucrose solution placed in a beaker of water for 20 minutes.

The bag acts like the partially permeable membranes in cells. It allows small molecules to pass through. It does not allow larger molecules such as sucrose to pass through.

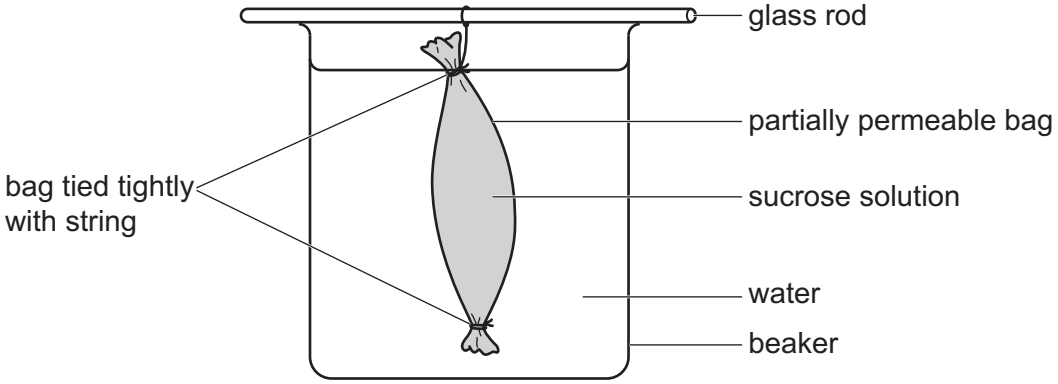


Fig. 1.1

The mass of the bag and its contents shown in Fig. 1.1 increases from 25.6 g to 27.3 g.

(a) (i) Calculate the percentage increase in the mass of the bag and its contents.

percentage increase = ...% [2]

(ii) Water molecules move into the bag.

Explain in detail why this happens.

.....

.....

.....

..... [2]

(b) Suggest **one** molecule from the list which is unable to pass through the partially permeable bag.

carbon dioxide **glucose** **oxygen** **nitrogen** **protein**

..... [1]

(c) Water is one of the raw materials needed for photosynthesis.

(i) Complete the balanced symbol equation for photosynthesis.

..... H_2O + ... $\xrightarrow[\text{chlorophyll}]{\text{light}}$ $C_6H_{12}O_6$ + ... [2]

(ii) State **two** ways in which the plant uses the glucose produced by photosynthesis.

1. .....

2. .....

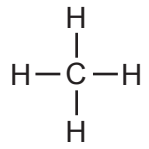
[2]

[Total: 9]

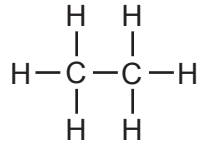
2 When large hydrocarbon molecules are cracked, they break down into smaller hydrocarbon molecules.

Fig. 2.1 shows the structures of five hydrocarbon molecules **A** to **E** which are produced when the alkane, $C_{10}H_{22}$, is cracked.

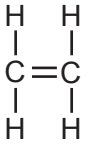
A



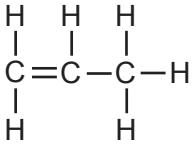
B



C



D



E

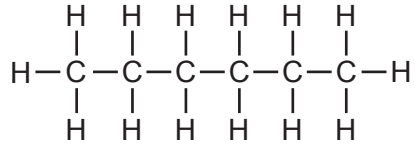


Fig. 2.1

(a) State **one** condition used for cracking hydrocarbons.

..... [1]

(b) State **all** the molecules from **A** to **E** that:

(i) are saturated

..... [1]

(ii) are alkanes

..... [1]

(iii) produce carbon dioxide and water on complete combustion in oxygen.

..... [1]

(c) Draw a dot-and-cross diagram to show the bonding in molecule **C**.

[2]

(d) Molecules **C** and **D** are members of the same homologous series.

Explain what is meant by the term *homologous series*.

.....

.....

..... [2]

[Total: 8]

3 Fig. 3.1 shows a whale swimming underwater.

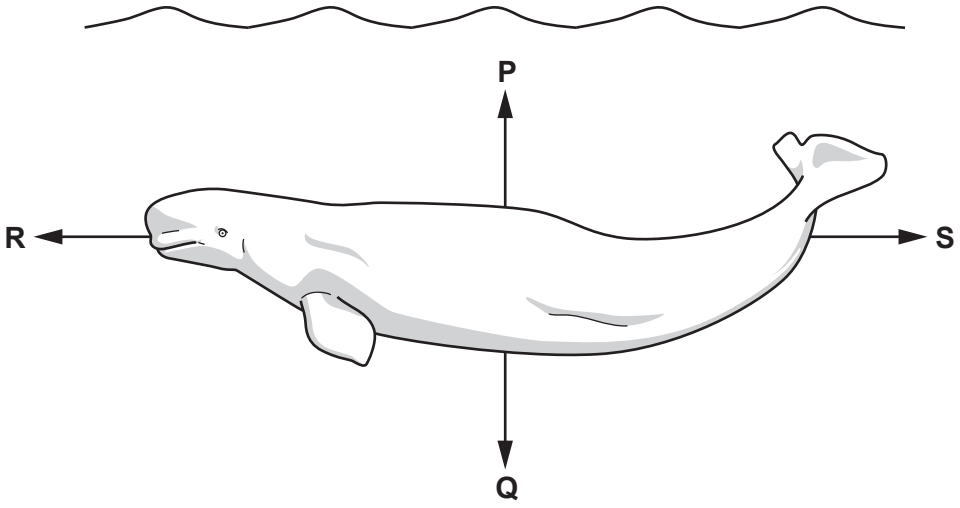


Fig. 3.1

(a) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Force **Q** has a value of 14 000 N. The whale is swimming at constant depth.

(i) State the value of force **P**.

force **P** = ... N [1]

(ii) The gravitational field strength *g* is 10 N / kg.

Calculate the mass of the whale.

mass = ... kg [1]

(b) The whale pushes itself forward with a force of 500 N at a constant speed of 5.4 km / h. It travels a distance of 2.0 km.

(i) Determine the speed of the whale in m / s.

Show your working.

speed = ... m / s [2]

(ii) Calculate the work done by the whale on this journey.

Show your working.

work done = ... J [2]

(iii) Use your answers to **(a)(ii)** and **(b)(i)** to calculate the kinetic energy of the whale.

Show your working.

kinetic energy = ... J [2]

(c) The whale communicates with other whales by emitting high-pitched sounds.

(i) Explain why whales in the sea can hear each other over great distances with less time delay than if the sound travelled through air.

.....

..... [1]

(ii) Beluga whales produce sound frequencies in the range 4 kHz to 150 kHz.

Human voices produce frequencies at the lower end of the range of human hearing.

A diver claims that Beluga whales can imitate the human voice.

Use your knowledge of human hearing to suggest how well Beluga whales can imitate the human voice. Explain your answer.

.....

.....

.....

..... [2]

[Total: 11]

4 Fig. 4.1 is a diagram of a sperm cell showing its adaptive features.

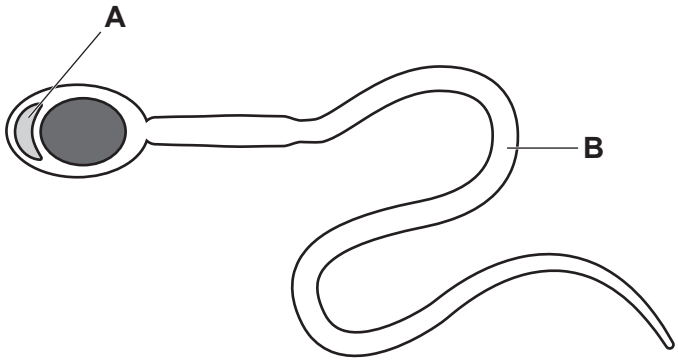


Fig. 4.1

(a) Name the adaptive features **A** and **B**.

A .....

B .....
[2]

(b) During fertilisation, the nucleus of the sperm cell fuses with the nucleus of an egg cell inside the female reproductive system.

(i) State where, inside the female reproductive system, fertilisation takes place.

..... [1]

(ii) Explain why additional sperm cells cannot enter the egg after fertilisation.

.....

..... [1]

(c) Fig. 4.2 shows a diagram of a uterus containing a fetus.

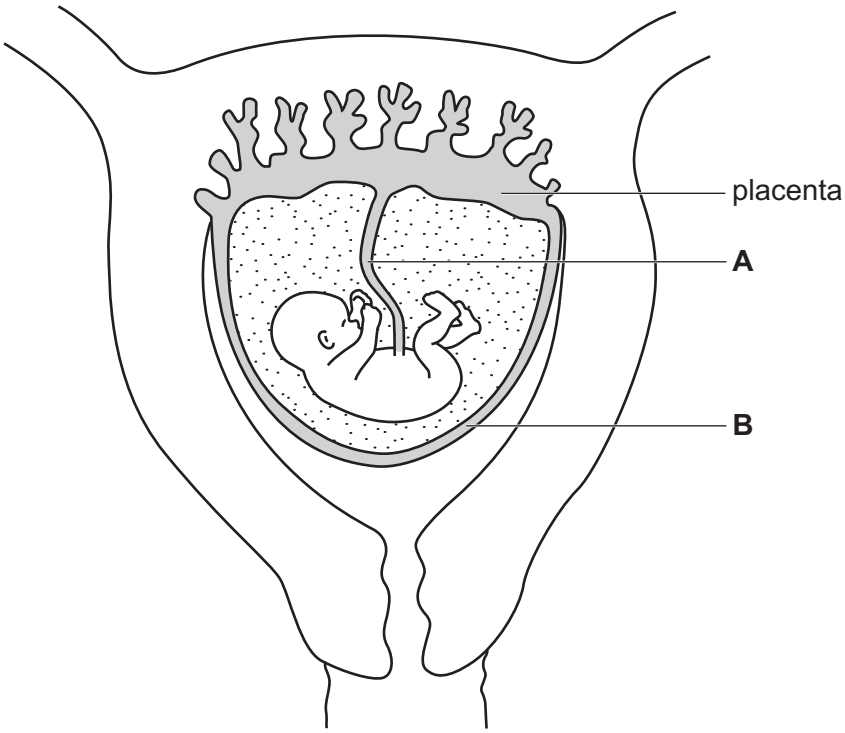


Fig. 4.2

(i) Name structures **A** and **B** shown in Fig. 4.2.

A .....

B .....
[2]

(ii) The placenta is the organ where exchange of materials between mother and child occurs.

Underline **two** words or phrases from the list to show substances that have a net movement **from mother to baby** through the placenta.

amino acids **bone** **carbon dioxide** **cellulose** **glucose**

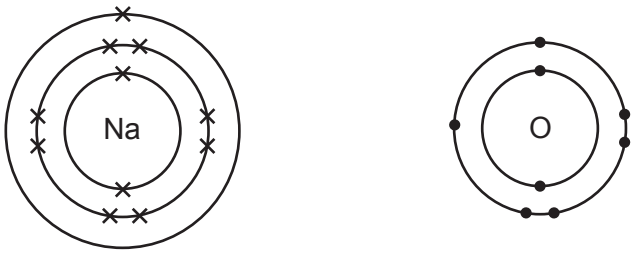
glycogen **white blood cells**

[2]

[Total: 8]

5 **(a)** Sodium burns in oxygen to produce sodium oxide, an ionic compound.

Fig. 5.1 shows the electronic structure of a sodium atom and of an oxygen atom.



sodium atom oxygen atom

Fig. 5.1

(i) Describe the changes in the electronic structure of a sodium atom and of an oxygen atom when sodium reacts with oxygen.

You may wish to draw diagrams to help you answer this question.

.....

.....

.....

..... [2]

(ii) Predict the chemical formula of sodium oxide.

Explain your answer.

chemical formula .....

explanation .....

.....

[2]

(b) Fig. 5.2 shows part of the structure of a sodium chloride crystal.

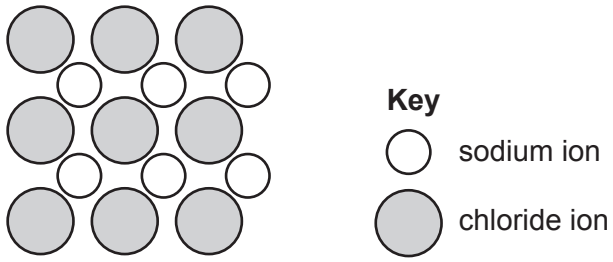


Fig. 5.2

Explain how ionic bonding keeps sodium ions and chloride ions together.

.....

..... [1]

(c) Sodium chloride is made by reacting aqueous sodium hydroxide with dilute hydrochloric acid.

Construct the symbol equation for this reaction.

Include state symbols.

..... [2]

(d) Lithium, sodium, potassium and rubidium are Group I elements in the Periodic Table, shown on page 24.

Table 5.1 shows the melting points of some of these Group I elements.

Table 5.1

Group I element	melting point / °C
lithium	181
sodium	98
potassium	64
rubidium	

Rubidium is a solid at 20 °C.

(i) Complete Table 5.1 by suggesting the melting point of rubidium. [1]

(ii) Explain your answer to **(d)(i)**.

.....

..... [1]

(iii) Explain why these Group I metals cannot be extracted from their ores by heating the ores with carbon.

.....

..... [1]

[Total: 10]

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6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

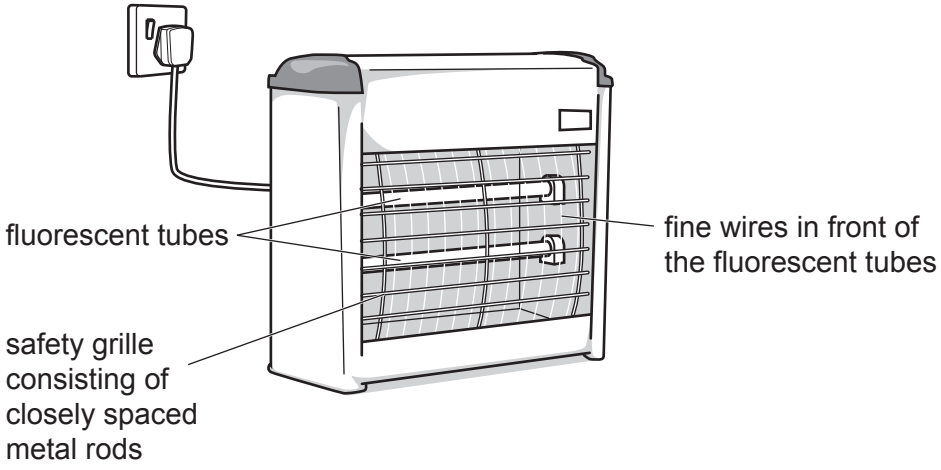


Fig. 6.1

The device is connected to the electricity supply.

(a) Fig. 6.1 shows several fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches two wires at once, it completes an electric circuit.

A current of 0.50 A flows through the insect for 0.10 s.

(i) Calculate the energy transferred to the insect.

Show your working.

energy = ... J [2]

(ii) Calculate the total electric charge that passes through the insect.

Show your working and give the unit of your answer.

charge = ... unit ..... [3]

(b) The fluorescent tubes emit ultraviolet radiation that can be seen by many insects. This attracts them to the device.

The wavelength of the ultraviolet radiation is 184×10^{-9} m.

The speed of electromagnetic radiation is 3.0×10^{8} m/s.

Calculate the frequency of the ultraviolet radiation emitted.

Show your working.

frequency = ... Hz [2]

(c) Suggest why a grille of metal rods is placed across the front of the device.

.....

..... [1]

[Total: 8]

7 **(a)** A balanced diet for a person contains all nutrients in the correct amounts for their needs.

Iron is needed in the diet. If a person does not take in enough iron they suffer from anaemia.

(i) State the name of the substance made in the body using iron.

..... [1]

(ii) Explain why a person suffering from anaemia may feel tired.

.....

.....

..... [2]

(b) A person eats the meal shown in Fig. 7.1.

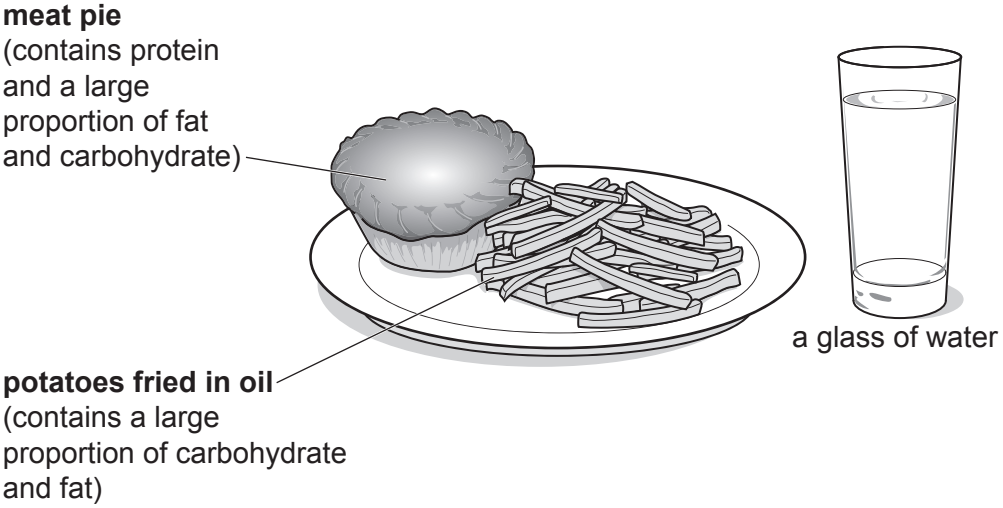


Fig. 7.1

(i) Suggest **one** food that can be added to the meal to make it more balanced.

Explain your answer.

food .....

explanation .....

.....

[2]

(ii) Explain why regularly eating meals similar to the one shown in Fig. 7.1 can lead to obesity.

Use ideas about the energy requirements of the body in your answer.

.....

.....

..... [2]

(c) If the person eats meals similar to the one shown in Fig. 7.1 over a long period they increase their risk of developing coronary heart disease.

(i) Explain what is meant by coronary heart disease.

.....

.....

..... [2]

(ii) Suggest why regularly eating meals similar to the one shown in Fig. 7.1 increases the person's risk of developing coronary heart disease.

.....

..... [1]

[Total: 10]

8 **(a)** Use the Periodic Table on page 24 to deduce the electronic structure of a calcium atom.

..... [2]

(b) A student investigates the rate of reaction between excess dilute hydrochloric acid and powdered calcium carbonate. Carbon dioxide gas is produced in this reaction.

Fig. 8.1 shows some of the apparatus the student uses.

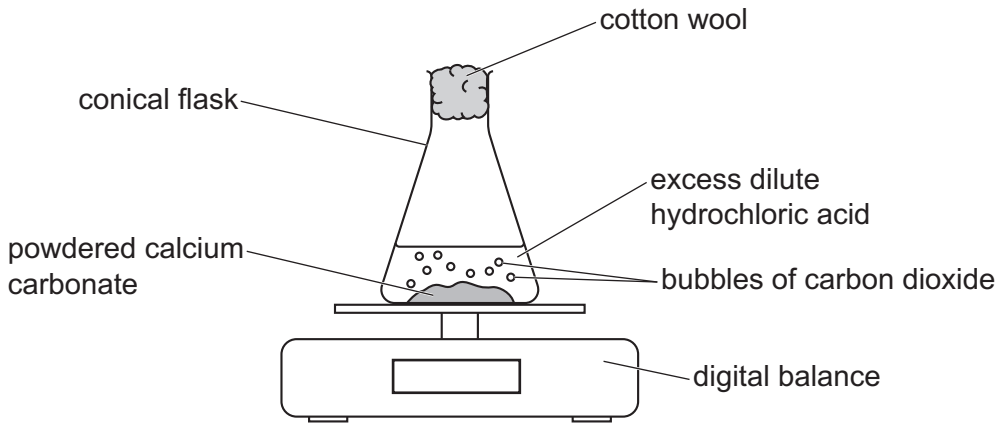


Fig. 8.1

The student measures the mass of the conical flask and its contents during the reaction.

Fig. 8.2 is a graph of the student's results.

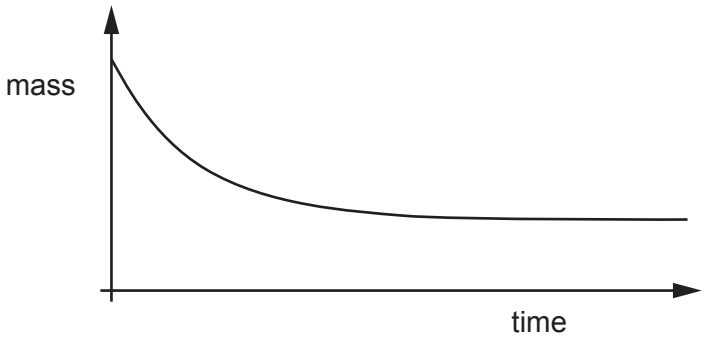


Fig. 8.2

(i) Explain why the mass of the conical flask and its contents decreases.

.....

..... [1]

(ii) Explain, in terms of particle collisions, the effect of a higher temperature on the rate of a chemical reaction.

.....

.....

.....

..... [2]

(iii) The student repeats the experiment at a higher temperature.

On Fig. 8.2, sketch a line to show the results. [2]

(c) Calcium chloride is produced during the reaction between calcium carbonate and dilute hydrochloric acid.

Name **one other** substance that reacts with dilute hydrochloric acid to produce calcium chloride.

..... [1]

[Total: 8]

9 Fig. 9.1 shows the heating element inside an electric kettle.

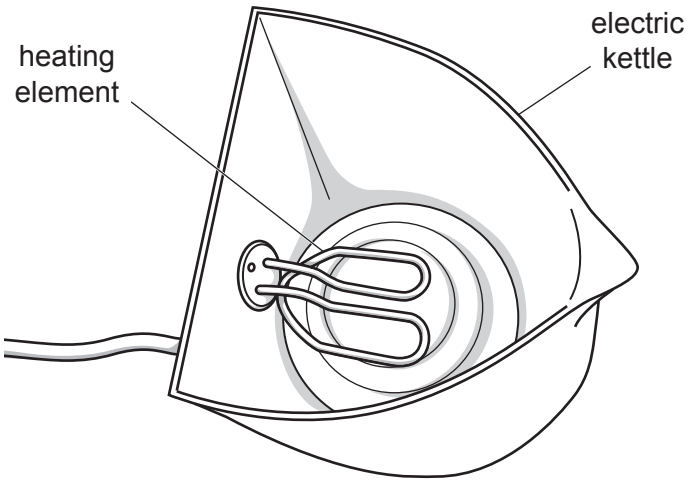


Fig. 9.1

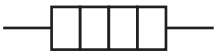
(a) The kettle is filled with cold water at 10 °C. The heating element is turned on to boil the water.

State the temperature of the water inside the kettle when the water is boiling.

temperature = ... °C [1]

(b) The electrical circuit in the kettle contains a switch, the heating element and a fuse.

On Fig. 9.2 complete the circuit diagram for the kettle, including the symbol for a fuse.

The symbol for the heating element is: 

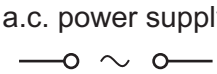


Fig. 9.2

[2]

(c) Fig. 9.3 shows the structure inside the tube of the heating element.

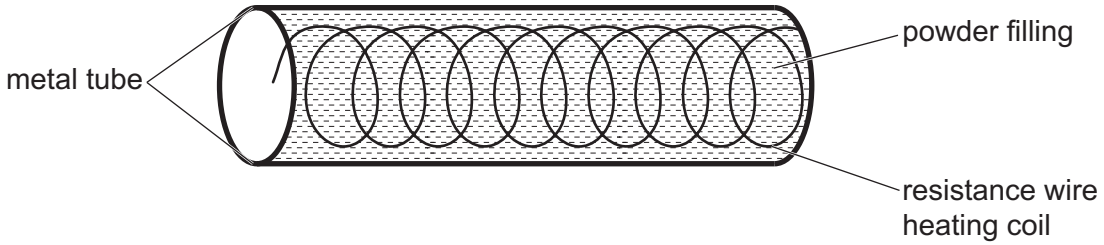


Fig. 9.3

(i) Describe in terms of molecules and other particles how thermal energy is transferred from the powder filling through the metal tube to the water in the kettle.

.....

.....

.....

.....

..... [2]

(ii) Table 9.1 gives the properties of four substances in the form of powders.

The higher the value of the electrical conductivity of a powder, the better an electrical conductor it is.

The higher the value of the thermal conductivity of a powder, the better a thermal conductor it is.

Table 9.1

name of powder	electrical conductivity / units	thermal conductivity / units
aluminium oxide	10^{-14}	30
carbon	10^{4}	100
magnesium oxide	10^{-11}	45
sulfur	10^{-15}	0.21

Use Table 9.1 to suggest the best choice of powder for the powder filling.

Give reasons for your choice.

.....

.....

..... [2]

(iii) The resistance wire in the heating coil is replaced by a wire of the same material and length.

The new wire has a greater cross-sectional area than the original wire.

State how the resistance of the new wire compares to the resistance of the original wire.

Explain your answer.

resistance is .....

explanation .....

.....

[1]

[Total: 8]

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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											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 –		

Key

atomic number
atomic symbol
name
relative atomic mass

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.).