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0653/41

May/June 2019

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 24.

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.

- 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.

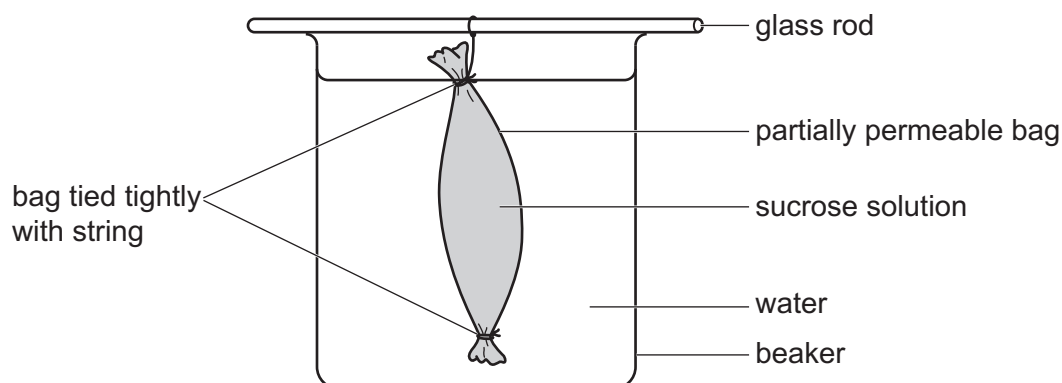


Fig. 1.1

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

- (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]

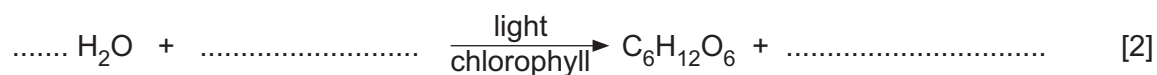
- (b) Suggest **one** molecule from the list which is unable to pass through the partially permeable bag.

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.



(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.

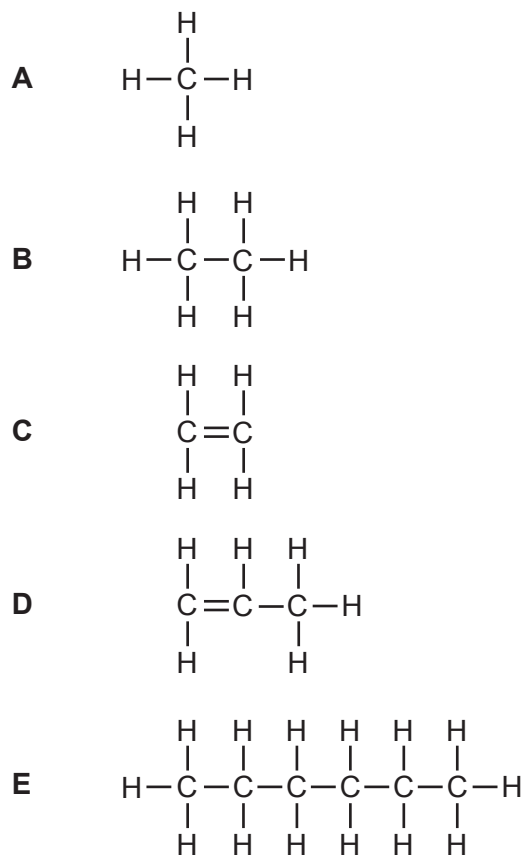


Fig. 2.1

- (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.

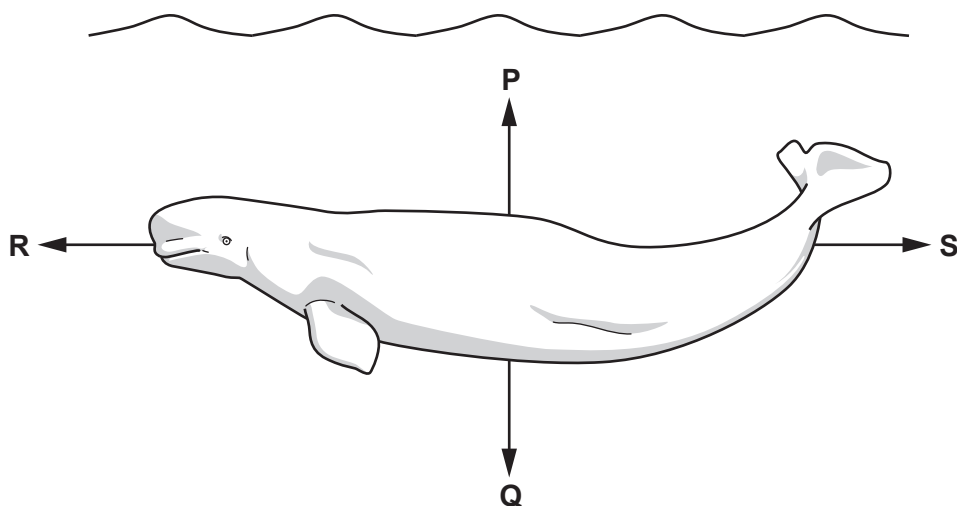


Fig. 3.1

- (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.

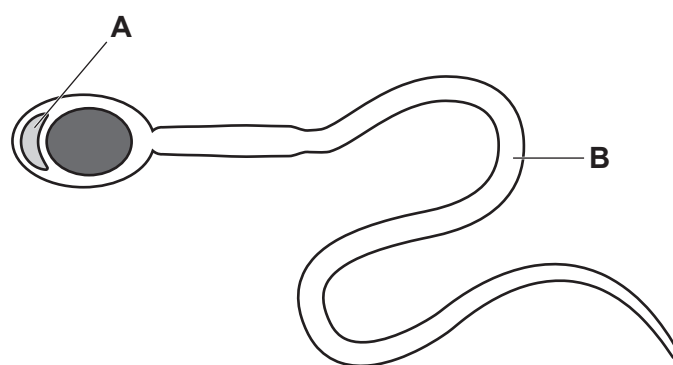


Fig. 4.1

- (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.

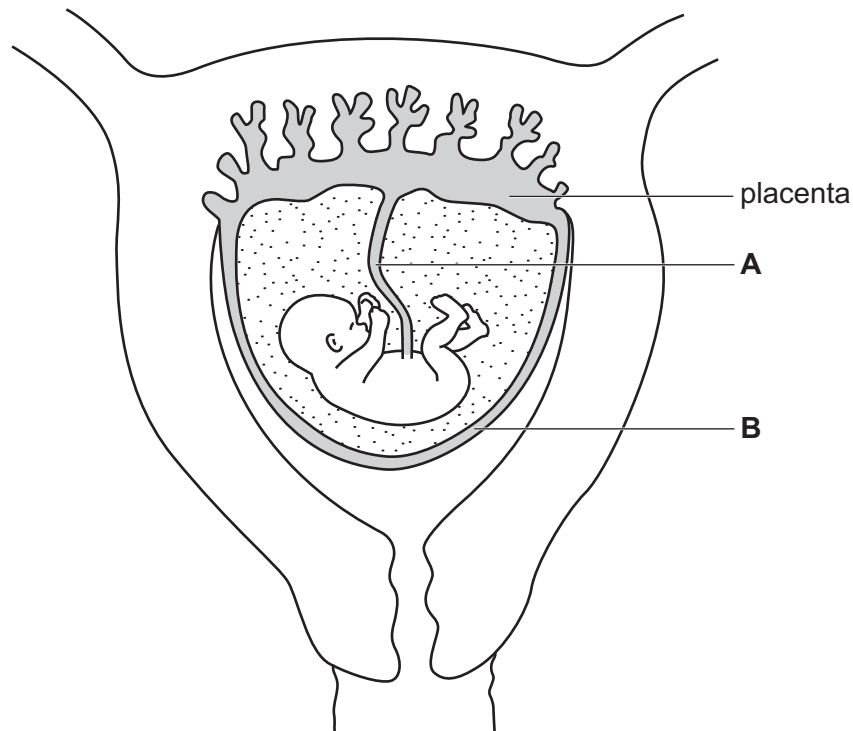


Fig. 4.2

(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.

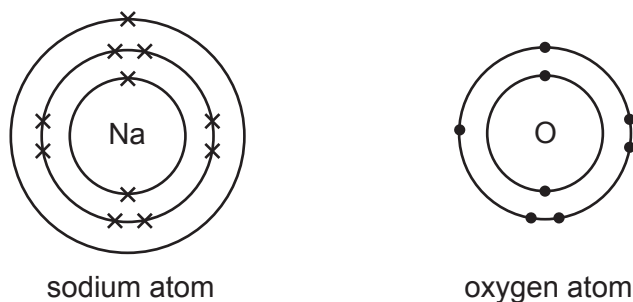


Fig. 5.1

- (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.

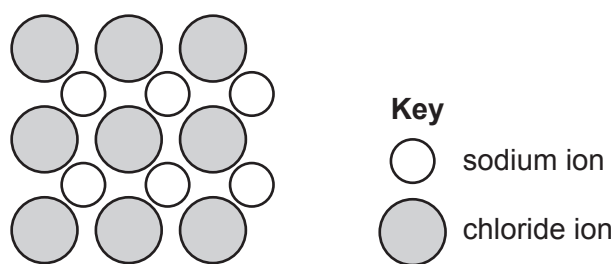


Fig. 5.2

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.

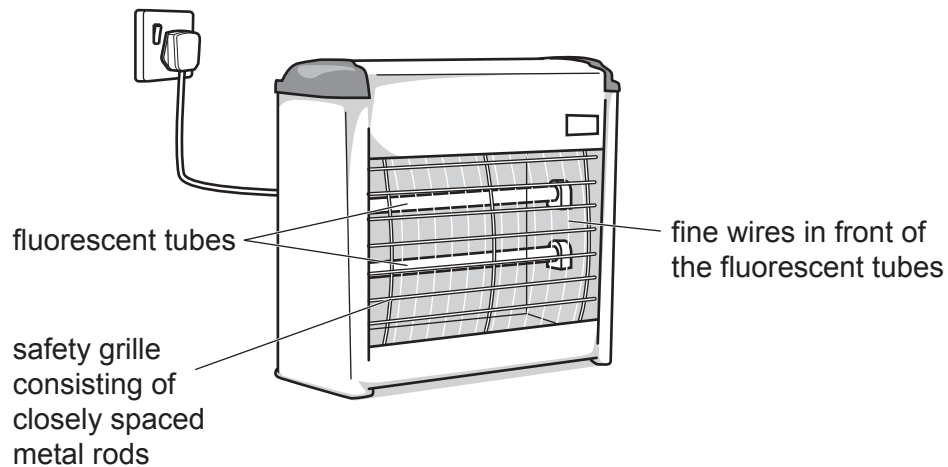


Fig. 6.1

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 $184 \times 10^{-9} \text{ m}$.

The speed of electromagnetic radiation is $3.0 \times 10^8 \text{ m/s}$.

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]

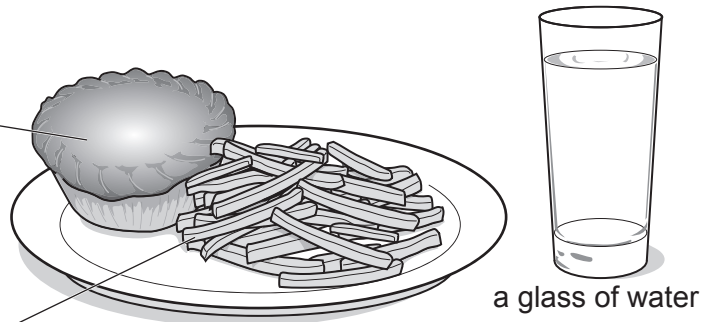
- (b) A person eats the meal shown in Fig. 7.1.

meat pie

(contains protein
and a large
proportion of fat
and carbohydrate)

potatoes fried in oil

(contains a large
proportion of carbohydrate
and fat)



a glass of water

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.

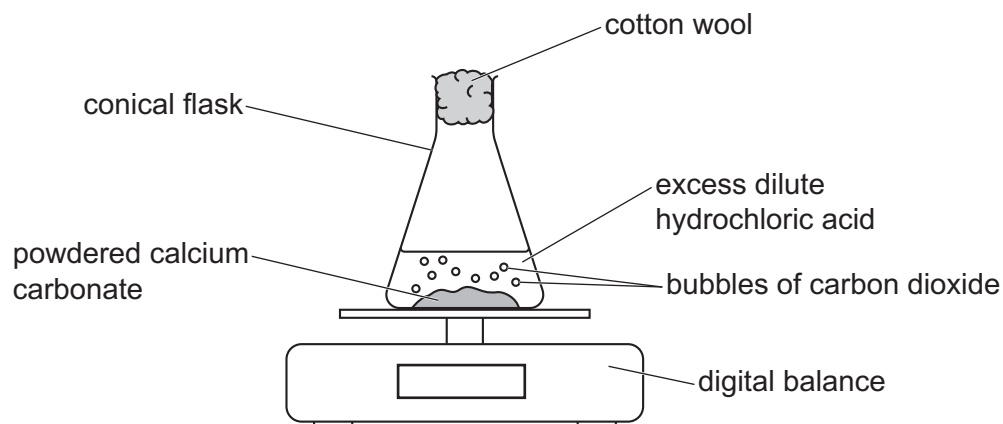


Fig. 8.1

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.

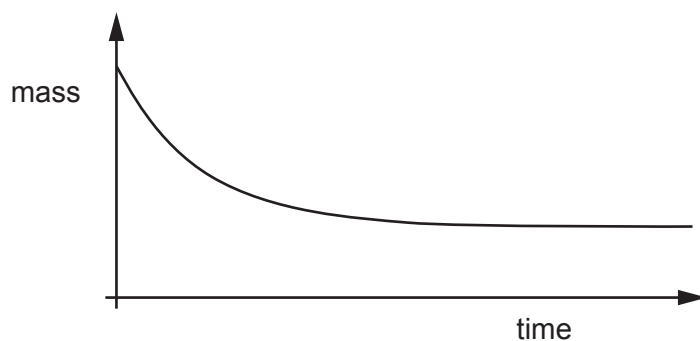


Fig. 8.2

- (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.

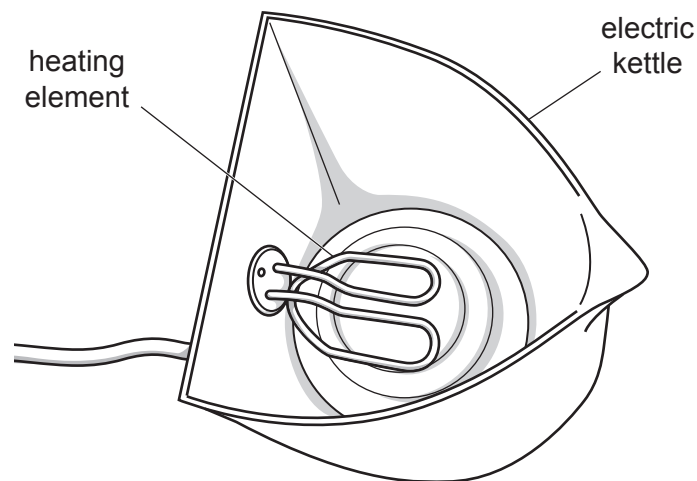


Fig. 9.1

- (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 = ... $^{\circ}\text{C}$ [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: —  —

a.c. power supply

—  —

Fig. 9.2

[2]

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

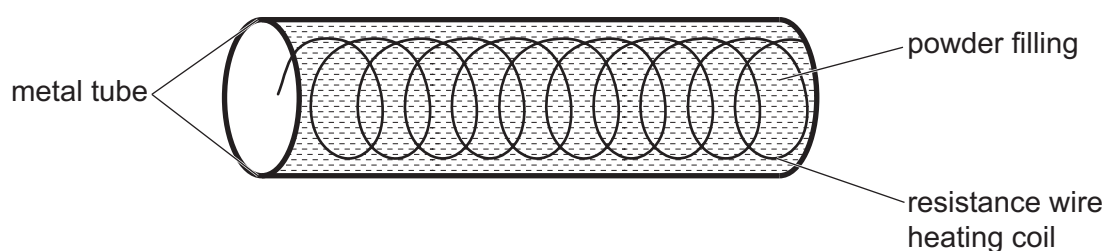


Fig. 9.3

- (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																			
		Key atomic number atomic symbol name relative atomic mass																			
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 —						

lanthanoids

actinoids

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
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 dm³ at room temperature and pressure (r.t.p.).



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0653/42

May/June 2019

1 hour 15 minutes

No Additional Materials are required.

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A copy of the Periodic Table is printed on page 20.

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

- 1 (a) When apples are cut open the exposed surface turns from white to brown. This happens because an enzyme inside the apples causes a brown substance to be produced in the presence of oxygen.

Fig. 1.1 shows an investigation of various treatments on freshly cut apple pieces to see if the browning of apples can be prevented. The dishes of apple pieces and each treatment are shown.

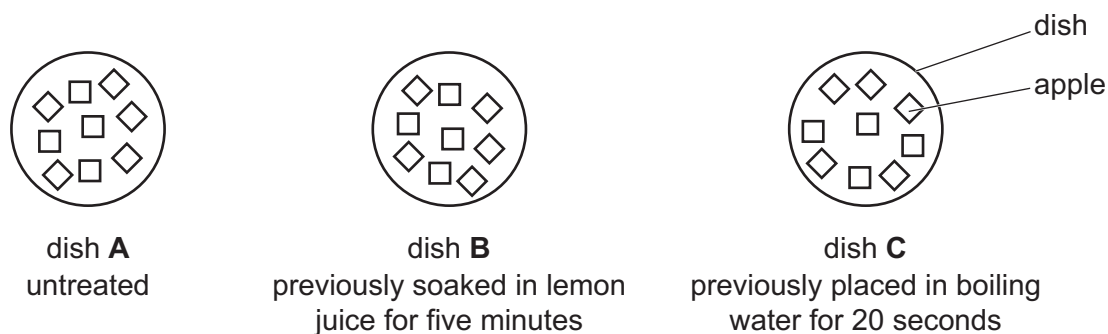


Fig. 1.1

After treatment the dishes are left uncovered for 10 minutes.

Table 1.1 shows the results of the investigation.

Table 1.1

dish	appearance of apple after 10 minutes	explanation
A	brown	
B	unchanged	the acid in the lemon juice denatured the enzyme
C	unchanged	

- (i) Complete Table 1.1 to explain the appearance of the apples after 10 minutes in dish **A** and dish **C**. [2]
- (ii) Explain in detail how denaturation affects enzyme molecules.

.....

.....

..... [2]

(b) Hydrochloric acid is another acid that could be used to stop the apples from turning brown. Hydrochloric acid is contained in gastric juice in the stomach.

(i) State **two** functions of hydrochloric acid in gastric juice.

1.

2.

[2]

(ii) Suggest why it is dangerous to use hydrochloric acid to stop the apples from turning brown before eating them.

..... [1]

(c) Apples contain starch.

Fig. 1.2 shows a molecule of glucose, and how glucose molecules join together to make starch.

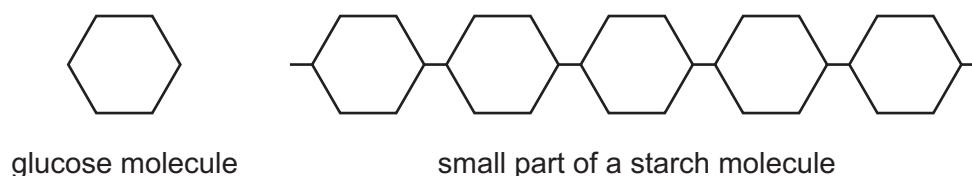


Fig. 1.2

(i) Suggest **one other** large molecule that can be made by glucose molecules joining together.

..... [1]

(ii) Name the smaller molecules that form proteins.

..... [1]

(iii) State the elements present in proteins.

.....

..... [1]

[Total: 10]

- 2 Catalytic cracking breaks down large saturated hydrocarbon molecules into smaller hydrocarbon molecules. This process produces some unsaturated hydrocarbon molecules.

(a) State what is meant by the term *hydrocarbon*.

.....
 [1]

(b) Fig. 2.1 shows apparatus used for catalytic cracking.

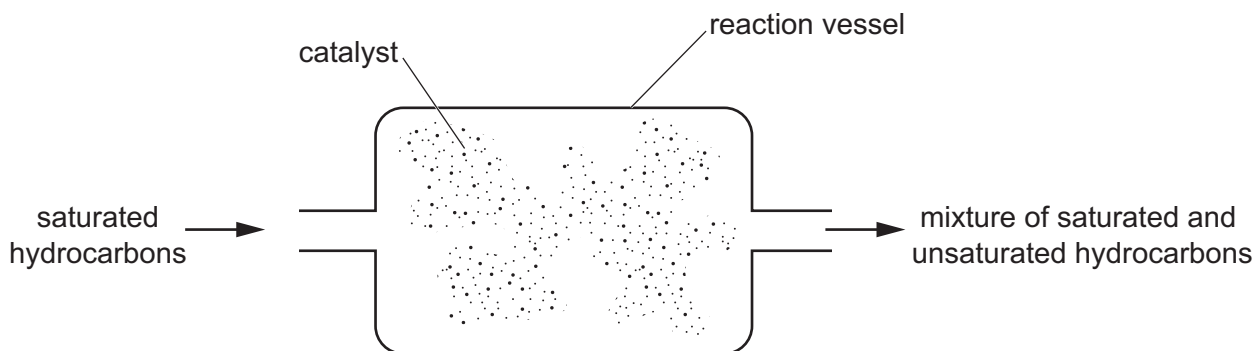


Fig. 2.1

(i) State **one** other reaction condition, apart from a catalyst, used in the reaction vessel.

..... [1]

(ii) Cracking is an endothermic reaction.

Describe what is meant by an *endothermic reaction*. Use ideas about chemical energy and thermal energy in your answer.

.....

 [2]

(iii) Describe how aqueous bromine is used to show that this cracking process produces unsaturated hydrocarbons from saturated hydrocarbons.

.....

 [2]

(c) One of the products of cracking hydrocarbons is propene, C_3H_6 .

(i) Complete the diagram in Fig. 2.2 to show the structure of one molecule of propene.



Fig. 2.2

[3]

(ii) Construct the balanced symbol equation for the complete combustion of propene.

..... [2]

[Total: 11]

- 3 Fig. 3.1 shows a forklift truck moving a large heavy box towards a shelf.

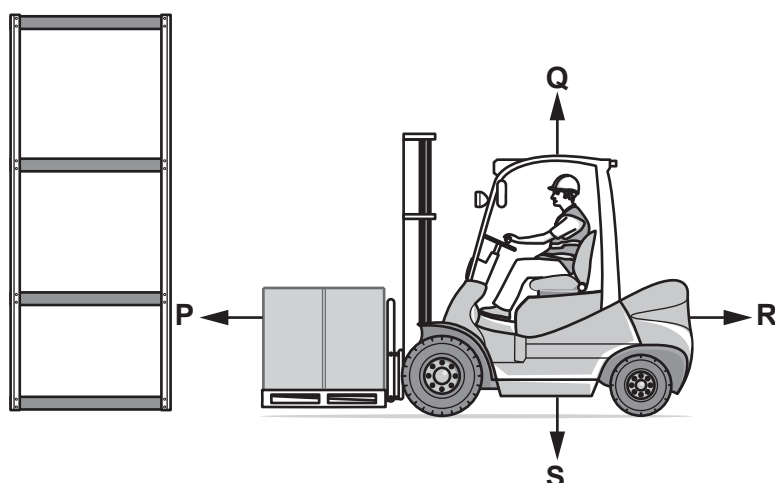


Fig. 3.1

- (a) The arrows labelled **P**, **Q**, **R** and **S** show four forces acting on the forklift truck.

State which letter represents the driving force moving the truck.

.....

[1]

- (b) The forklift truck lifts the box upwards from the ground to a shelf 3.0 m above the ground.

The upwards force on the box as it moves is equal to the weight of the box.

The box has a mass of 500 kg.

The gravitational field strength g is 10 N/kg.

Calculate the work done on the box.

Show your working.

work done = ... J [3]

- (c) The forklift truck is driven to collect another box.

Fig. 3.2 shows the speed–time graph for this journey.

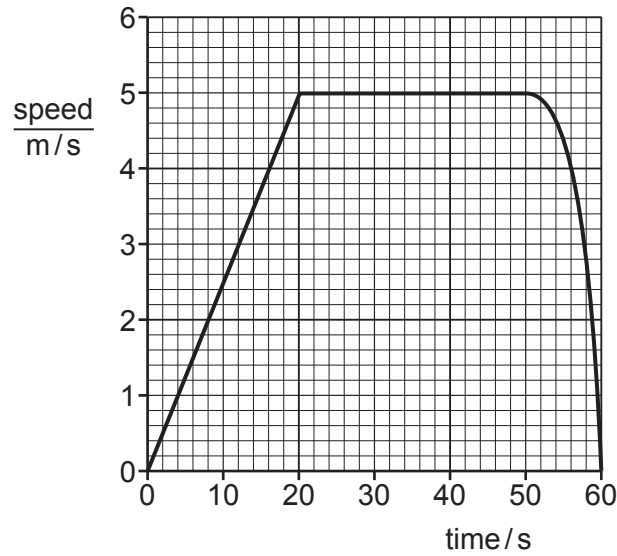


Fig. 3.2

- (i) Describe the motion of the truck between 50 s and 60 s.

.....
 [2]

- (ii) The truck travels 40 m between 50 s and 60 s.

Use this information and Fig. 3.2 to find the total distance travelled by the truck.

Show your working.

distance = ... m [2]

- (iii) The mass of the forklift truck is 1500 kg.

Use data from Fig. 3.2 to calculate the kinetic energy of the truck at time = 30 s.

kinetic energy = ... J [2]

[Total: 10]

- 4 (a) Fig. 4.1 shows a simplified diagram of the carbon cycle.

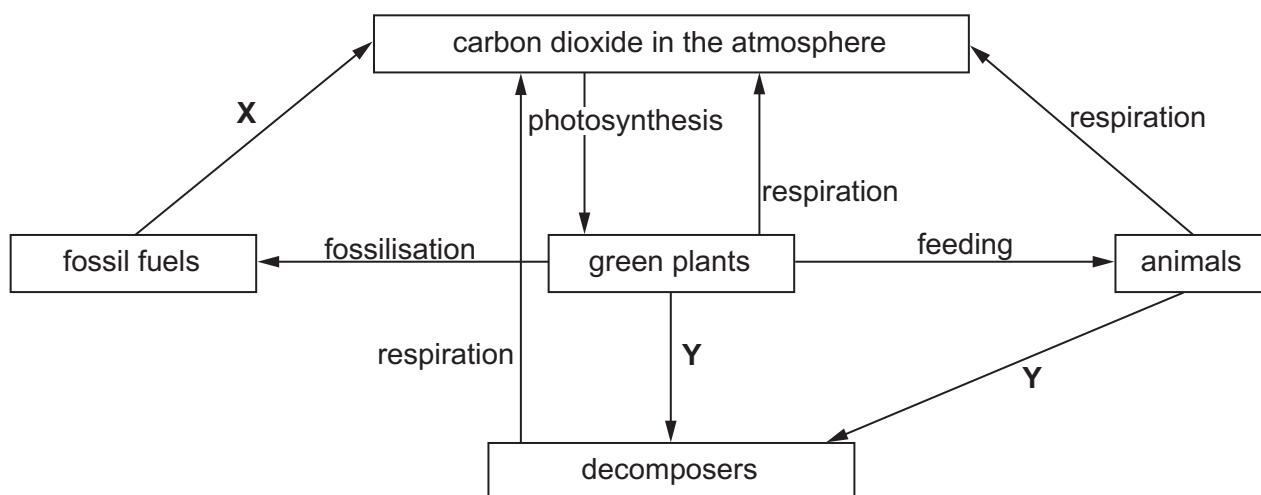


Fig. 4.1

- (i) Name process **X**.

..... [1]

- (ii) Name process **Y**.

..... [1]

- (iii) Explain the effect of clearing forests on the concentration of carbon dioxide in the atmosphere.

.....

.....

..... [2]

- (b) Nitrate ions can be added to water in a lake accidentally. The effects of this can lead to the death of organisms living in the water.

Use the words in the list to complete the sentences which explain how this happens.

Each word can be used once, more than once, or not at all.

addition	death	decomposers	decreased	feeding
	growth	increased	respiration	

- There is an increased availability of nitrate ions.
- This results in an increased of producers on the surface of the lake.
- This leads to decomposition after the of producers.
- Increased aerobic respiration by occurs which results in a reduction of dissolved oxygen.
- This causes the death of organisms in the water.

[4]

[Total: 8]

- 5 (a) Table 5.1 shows the melting points of some Group I elements.

Table 5.1

chemical symbol	melting point/°C
Li	181
Na	98
K	
Rb	39
Cs	28

- (i) Suggest the melting point of potassium.

..... °C [1]

- (ii) Potassium reacts rapidly with water.

Compare the reactivity of rubidium with the reactivity of potassium.

.....
 [1]

- (iii) Name the gas produced when potassium reacts with water.

..... [1]

- (iv) Caesium metal is stored in a sealed glass tube as shown in Fig. 5.1.

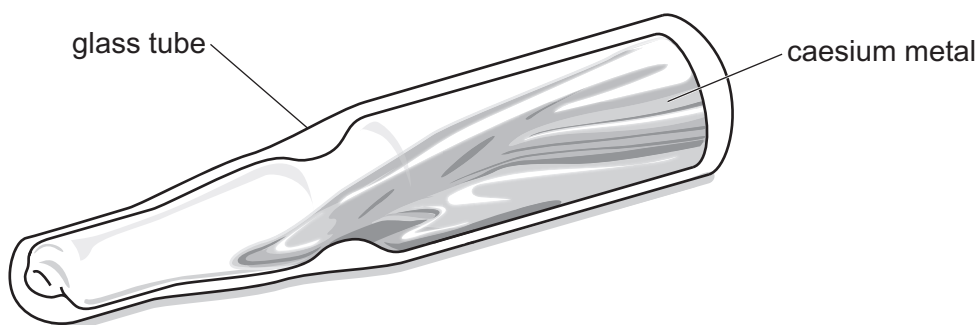


Fig. 5.1

The caesium melts when a warm hand is placed around the sealed glass tube.

Explain, in terms of particles, why thermal energy is needed to melt caesium metal.

.....

 [1]

- (b) Chlorine is in Group VII of the Periodic Table.

Potassium reacts with chlorine forming potassium chloride.

- (i) Describe the formation of ions from potassium atoms and chlorine atoms. You may draw a diagram if it helps your answer.

.....

.....

.....

..... [2]

- (ii) Fig. 5.2 shows some ions in a potassium chloride lattice.

Complete Fig. 5.2 to show the arrangement of potassium ions, K^+ , and chloride ions, Cl^- .

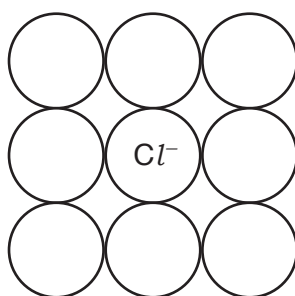


Fig. 5.2

[1]

- (iii) Explain how ionic bonding keeps potassium ions and chloride ions together.

.....

..... [1]

[Total: 8]

- 6 (a) The Sun is made of very hot gases.

Near the surface of the Sun most of the thermal energy is transferred to the surface by convection.

Describe how convection is able to transfer thermal energy from inside the Sun to the surface of the Sun.

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

- (b) Some of the energy emitted from the surface of the Sun is transferred to Earth as infrared radiation.

Infrared radiation travels between the Sun and the Earth at a speed of $3.0 \times 10^8 \text{ m/s}$.

- (i) The radiation travels 150 000 000 km from the Sun to Earth.

Show that it takes approximately 8 minutes to travel from the Sun to the Earth.

[3]

- (ii) The shortest infrared wavelength emitted by the Sun is $7.4 \times 10^{-7} \text{ m}$.

Calculate the frequency of this infrared radiation.

Show your working.

frequency = ... Hz [2]

- (c) State one use of infrared radiation in the home.

..... [1]

[Total: 8]

- 7 Fig. 7.1 shows a plant responding to light coming from one side.

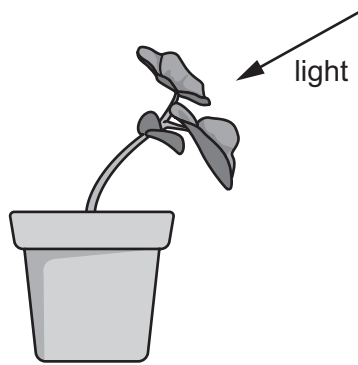


Fig. 7.1

- (a) Name this plant response.

..... [1]

- (b) Explain in detail why the plant bends towards the light.

Refer to the hormone auxin in your answer.

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

- (c) Hormones are also present in animals.

Give an example of a specific situation when the secretion of adrenaline is increased by a large amount.

..... [1]

(d) The word equation for respiration is shown.



Two effects of the secretion of adrenaline are an increase in breathing rate and an increase in heart rate.

Describe how these two effects of adrenaline enable the cells of the body to increase their rate of respiration.

increase in breathing rate

.....

.....

increase in heart rate

.....

.....

[2]

(e) State **two** ways in which the energy released by respiration is used by the body.

1.

2.

[2]

[Total: 9]

- 8 (a) A scientist analyses solution **Q** using chromatography.

She thinks that it contains cobalt ions, Co^{2+} , copper ions, Cu^{2+} , and nickel ions, Ni^{2+} .

She places a sample of solution **Q** and samples of solutions containing Co^{2+} , Cu^{2+} , and Ni^{2+} ions onto a piece of chromatography paper.

The chromatogram she obtains is shown in Fig. 8.1.

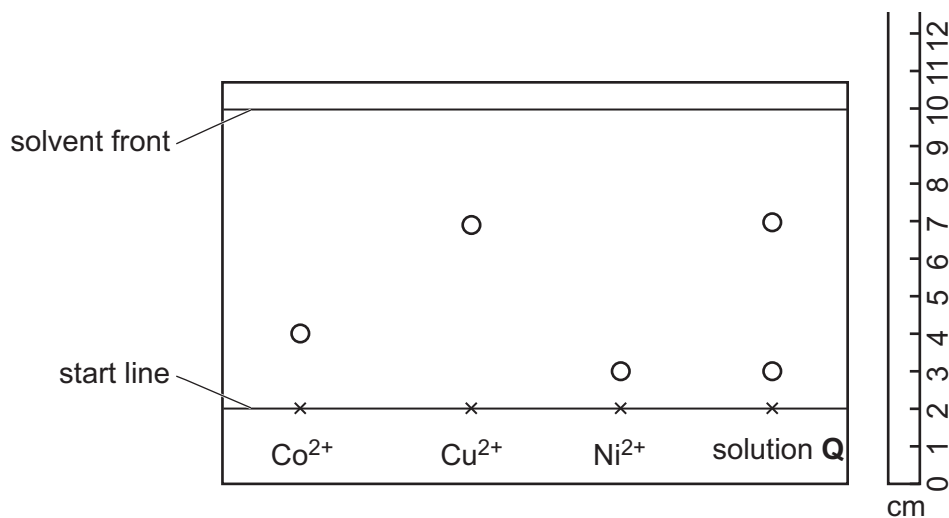


Fig. 8.1

- (i) State which metal ions are present in solution **Q**.

..... [1]

- (ii) Calculate the R_f value for the copper ions (Cu^{2+}).

Show your working.

R_f value = ... [2]

- (b) Cobalt, copper and nickel are in Period 4 of the Periodic Table, shown on page 20.

Name the collection of metals that contains cobalt, copper and nickel.

..... [1]

- (c) Copper can be extracted from aqueous copper(II) chloride using the apparatus shown in Fig. 8.2.

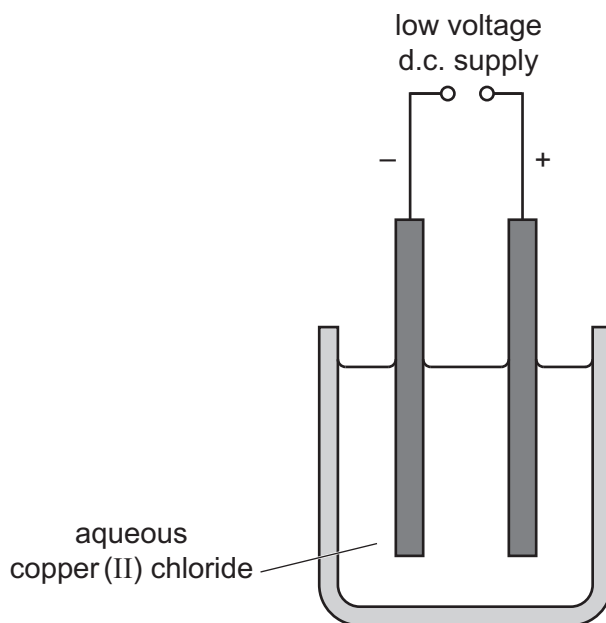


Fig. 8.2

- (i) Identify the ions that move to each electrode.

to the anode

to the cathode

[2]

- (ii) The scientist thinks that one compound in solution **Q** is copper(II) chloride.

Deduce the formula of copper(II) chloride.

formula of copper(II) chloride = ... [1]

[Total: 7]

9 Fig. 9.1 shows an electrically-powered bicycle.

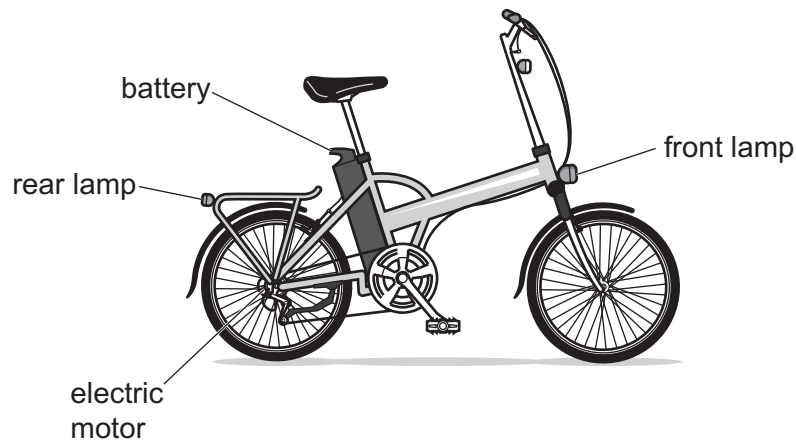


Fig. 9.1

- (a) The battery has to supply power to the electric motor, and to both front and rear lamps. A switch controls the whole circuit.

The rider controls the speed of the bicycle by changing the current in the electric motor.

The two lamps are controlled by one more switch. However, if one lamp fails the other lamp is still lit.

- (i) Name a circuit component that can be used to change the current in a circuit.

..... [1]

- (ii) On Fig. 9.2 complete the circuit diagram for this electric bicycle. Include the component you have named in (a)(i) to change the speed of the motor.



Fig. 9.2

[4]

(b) The battery has an output voltage of 36V, and the current in the motor at maximum speed is 7.0A.

(i) Calculate the power output of the electric motor at maximum speed.

Show your working and give the unit of your answer.

power = ... unit [3]

(ii) The cyclist rides the bicycle at maximum speed for a journey.

State one further quantity required to calculate the total energy provided by the battery on this journey.

..... [1]

[Total: 9]

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Group																	
I	II							VIII									
		1Hhydrogen1							VII								
		Key atomic number atomic symbol name relative atomic mass							VI								
3Li lithium 7	4Be beryllium 9							5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20	He helium 4			
11Na sodium 23	12Mg magnesium 24							13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40				
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131
55Cs caesium 133	56Ba barium 137	57–71lanthanoids	72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —	86Rn radon —
87Fr francium —	88Ra radium —	89–103actinoids	104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	113Nh nihonium —	114Fl flerovium —	115Lv livermorium —	116Lv livermorium —	117Ts tennessine —	118Og oganesson —

lanthanoids

actinoids

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	euporium	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
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	—



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0653/43

May/June 2019

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 20.

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

This document consists of **19** printed pages and **1** blank page.

- 1 (a) Fig. 1.1 is a bar chart which shows some differences in the composition of inspired air and expired air.

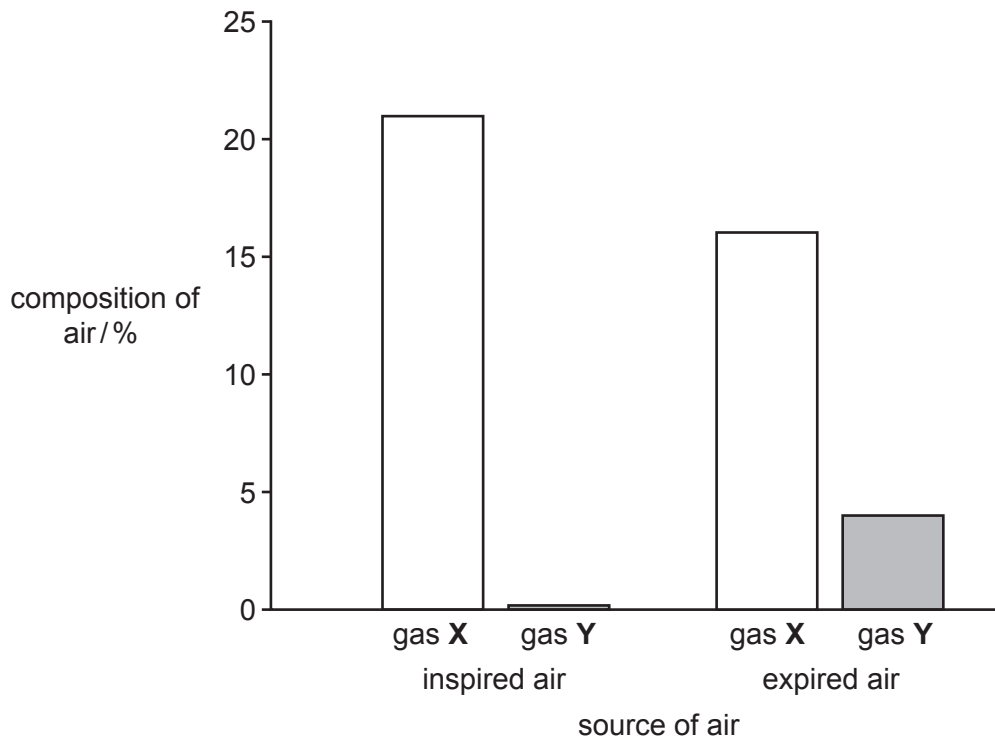


Fig. 1.1

Identify gas **X** and gas **Y** in Fig. 1.1.

Give a reason for each answer using data from Fig. 1.1.

gas **X**

reason

.....

gas **Y**

reason

.....

[2]

- (b) Gaseous exchange takes place in the alveoli of the lungs.

State **two** features of the alveoli that allow efficient gas exchange.

1.

2.

[2]

(c) Fig. 1.2 is a diagram showing some cells which line the trachea.

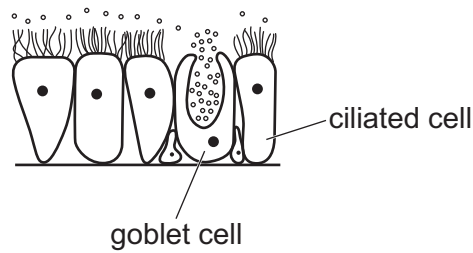


Fig. 1.2

Describe how the goblet cells and ciliated cells protect the gas exchange system from pathogens and particles.

.....

.....

.....

.....

..... [3]

(d) State **two** diseases caused by tobacco smoking.

1.

2. [2]

[Total: 9]

- 2 (a) A simple example of cracking is the cracking of ethane to produce ethene and hydrogen.



The energy level diagram for this reaction is shown in Fig. 2.1.

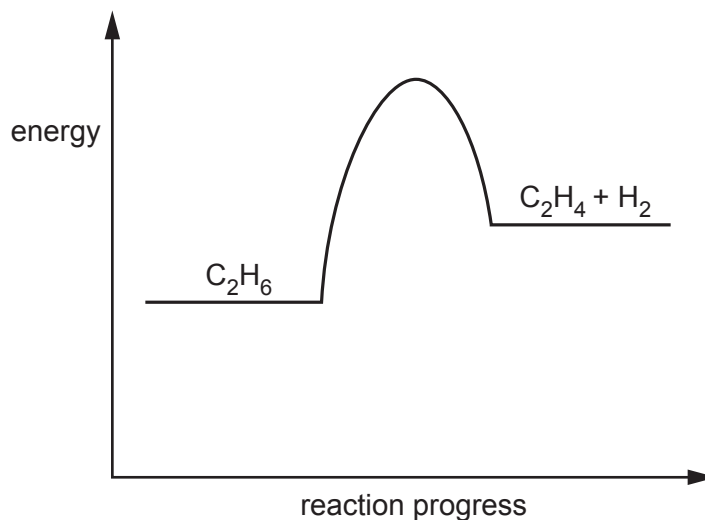


Fig. 2.1

- (i) On Fig. 2.1 draw a double headed arrow ($\updownarrow$) to show the activation energy for this reaction. [1]

- (ii) Use the energy level diagram to explain why the reaction is endothermic.

.....
 [1]

- (iii) State **one** condition required for the process of cracking.

..... [1]

- (b) Ethane and ethene are not in the same homologous series.

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

.....

 [2]

- (c) Draw a dot-and-cross diagram to show the bonding in a molecule of ethane, C_2H_6 .

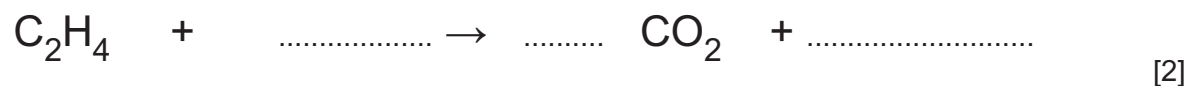
[3]

- (d) When fuels are burned, carbon dioxide is released into the atmosphere.

State **one** possible negative effect of an increase in the concentration of carbon dioxide in the atmosphere.

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

- (e) Complete the balanced symbol equation for the complete combustion of ethene, C_2H_4 , in oxygen.



[2]

[Total: 11]

3 Fig. 3.1 shows a boy swimming in a swimming pool.

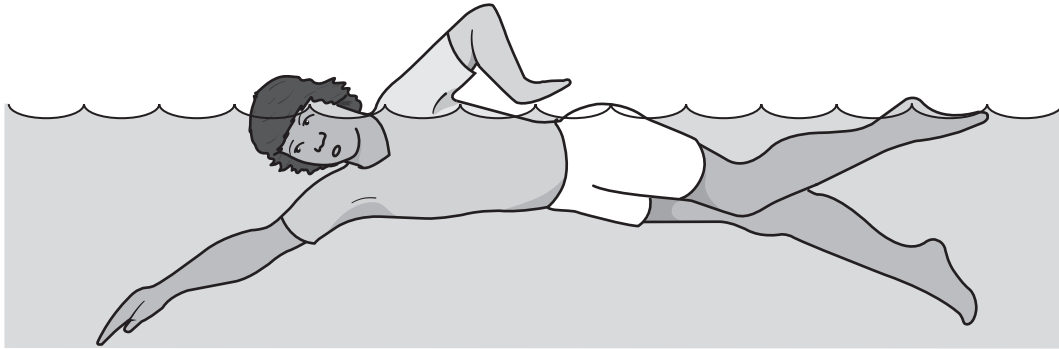


Fig. 3.1

He swims at a constant speed.

- (a) (i) On Fig. 3.1 draw a force arrow to show the force pushing the swimmer through the water. [1]

- (ii) A gravitational force of 600 N acts on the boy.

Suggest why the boy does not sink to the bottom of the pool as a result of this force.

.....
 [1]

- (b) The boy dives into the pool and swims.

Fig. 3.2 shows a speed–time graph for the boy.

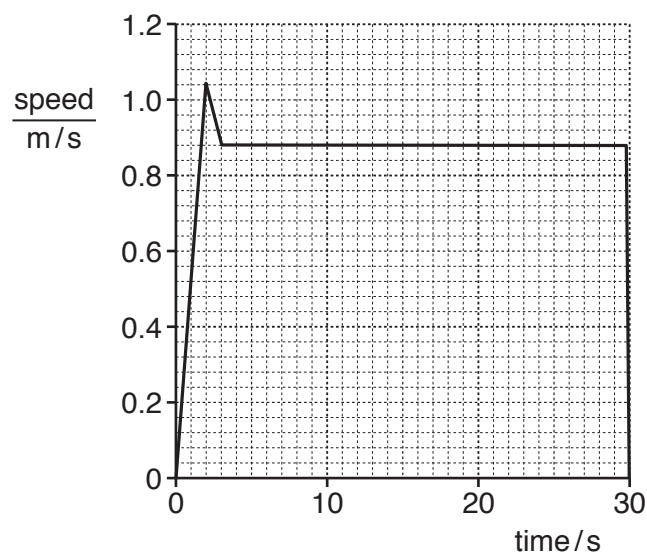


Fig. 3.2

- (i) The boy dives from the side of the pool at time = 0 s on the graph and hits the water at time = 2 s.

Describe the motion of the boy during the dive.

.....
 [2]

- (ii) Suggest why the boy's speed slowed down between time = 2 s and time = 3 s.

.....
 [1]

- (iii) The mass of the boy is 60 kg.

Use data from Fig. 3.2 to calculate the kinetic energy of the swimmer at time = 20 s.

Show your working.

kinetic energy = ... J [2]

- (iv) The boy takes 30 s to swim 25 m.

Calculate the average speed of the swimmer.

Show your working.

average speed = ... m/s [2]

[Total: 9]

4 Plants need a supply of mineral ions which they get from water in the soil.

(a) (i) State why plants need magnesium ions.

..... [1]

(ii) Describe the effect on plants if they are deficient in magnesium ions.

..... [1]

(b) Farmers add fertilisers containing nitrate ions to their land. Some of these nitrate ions enter lakes. This can lead to eutrophication.

Use words from the list to complete the flow diagram about eutrophication.

Each word may be used once, more than once or not at all.

consumers death decomposition decrease growth
increase producers

increase in availability of nitrate ions



increase in of producers



increase in decomposition after death of



..... in aerobic respiration by decomposers



..... in dissolved oxygen



death of organisms in the water.

[4]

- (c) A student investigates transpiration in leaves.

He attaches a piece of blue cobalt chloride paper to the upper surface of a leaf. Another piece is attached to the lower surface.

Cobalt chloride paper changes colour from blue to pink when water is present.

The cobalt chloride paper on the lower surface of the leaf turns pink before the cobalt chloride paper on the upper surface.

- (i) Explain the result in terms of leaf structure.

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

- (ii) The experiment is repeated in a warmer environment. The cobalt chloride paper on the lower surface turns pink more quickly than before.

Explain in detail why this happens.

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

[Total: 10]

5 (a) Magnesium is an element in Group II of the Periodic Table, shown on page 20.

(i) An atom of magnesium has a nucleon number of 24.

Deduce the number of protons and the number of neutrons in this atom.

number of protons

number of neutrons

[1]

(ii) Complete Fig. 5.1 to show the electronic structure of a magnesium atom.

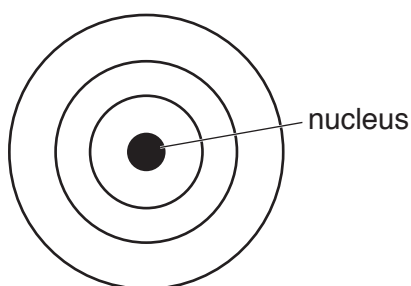


Fig. 5.1

[2]

(b) Magnesium is produced by the electrolysis of magnesium chloride.

(i) Before magnesium chloride is electrolysed it must be melted.

Explain, in terms of particles and energy changes, what happens to a solid as it is melting.

.....

 [1]

(ii) Magnesium chloride consists of magnesium ions, Mg^{2+} , and chloride ions, Cl^- .

Name the electrode at which magnesium forms when molten magnesium chloride is electrolysed.

..... [1]

(iii) Describe how magnesium ions are changed into magnesium atoms during electrolysis.

.....

 [2]

- (c) A student investigates the reaction between dilute hydrochloric acid and excess magnesium carbonate powder.

Fig. 5.2 shows the apparatus she uses.

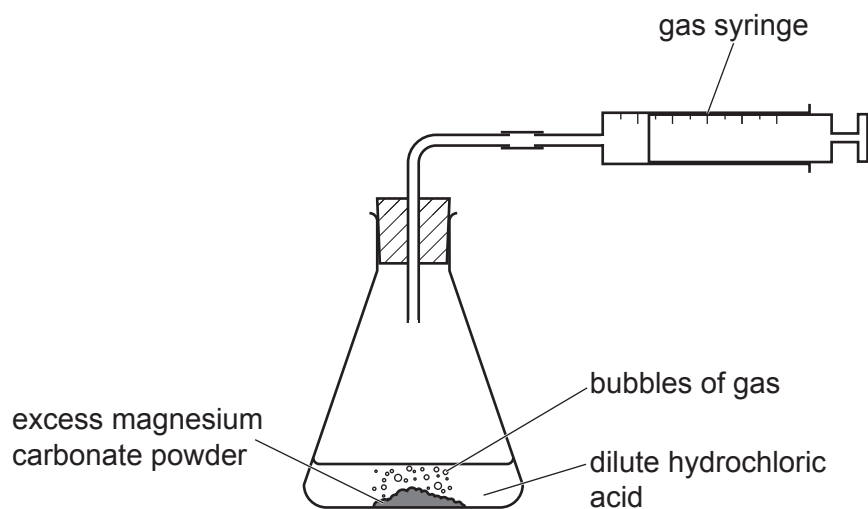


Fig. 5.2

- (i) Name the salt formed during this reaction.

..... [1]

- (ii) Carbon dioxide is released during this reaction. State the chemical test and the positive result for carbon dioxide.

test

positive result

..... [2]

[Total: 10]

- 6 (a) Fig. 6.1 shows a cylinder of compressed air (air at high pressure) used by a scuba diver in the sea.



Fig. 6.1

The diver opens a valve on the cylinder to let the compressed air escape into her face mask.

- (i) Describe how the forces and distances between the molecules in the air change as the air leaves the cylinder.

forces

.....

distances

.....

[2]

- (ii) As the air leaves the cylinder, the temperature of the air decreases slightly.

Describe what happens to the motion of the molecules in the air.

..... [1]

- (b) The diver returns to her boat after a dive. On the boat, she hangs up her wet diving suit to dry.

Describe how the weather conditions will affect evaporation from the wet diving suit.

Explain your answer in terms of water molecules escaping from the surface of the diving suit.

.....

.....

.....

.....

..... [3]

- (c) The wind causes waves on the sea. Fig. 6.2 shows a boat anchored and going up and down as the waves pass.

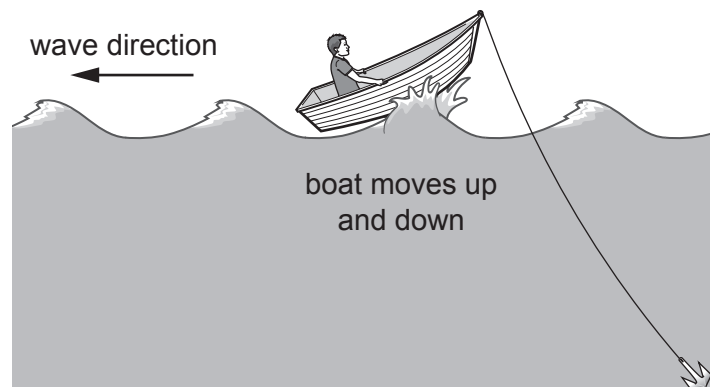


Fig. 6.2

Between each wave the boat moves a vertical distance of 2 m from the top of a wave to the bottom of a wave.

The speed of the waves is 3 m/s.

The time taken for the boat to go from the top of one wave to the top of the next wave is 5 s.

- (i) Determine the amplitude of these waves.

amplitude = ... m [1]

- (ii) Determine the frequency of the waves.

frequency = ... Hz [1]

- (iii) Calculate the wavelength of these waves.

Show your working.

wavelength = ... m [2]

[Total: 10]

- 7 (a) Enzymes are proteins that function as biological catalysts.

Fig. 7.1 shows a representation of an enzyme molecule and some possible substrate molecules.

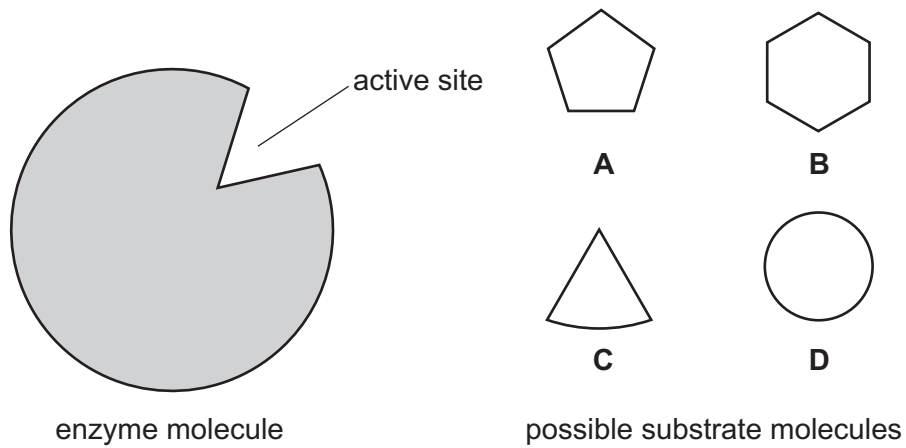


Fig. 7.1

State the letter of the correct substrate for the enzyme shown in Fig. 7.1.

Explain your answer.

letter

explanation

.....

.....

[2]

(b) Fig. 7.2 shows the effect of temperature on enzyme activity for an enzyme.

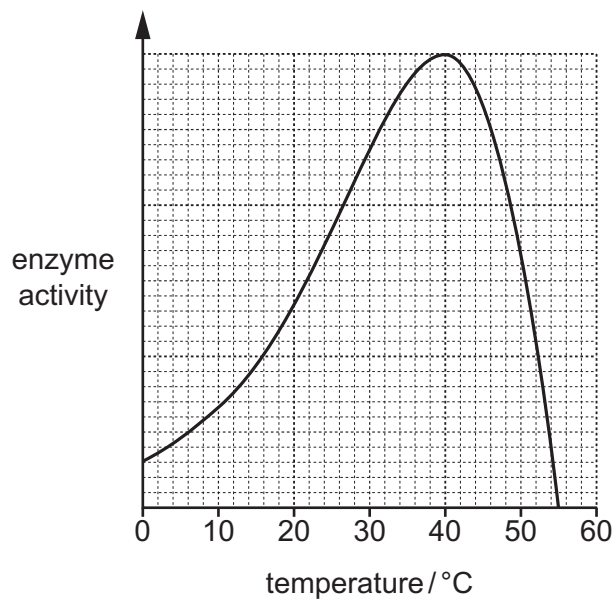


Fig. 7.2

(i) State the optimum temperature of the enzyme.

optimum temperature = ... °C [1]

(ii) Explain in detail why the enzyme activity decreases at higher temperatures.

.....

 [3]

(c) The enzymes secreted by the human digestive system are responsible for the chemical digestion of food.

Define the term *chemical digestion*.

.....

 [2]

[Total: 8]

- 8 (a) Complete the sentence:

An electric current in a metal is a flow of , which carry
negative [2]

- (b) A battery has an e.m.f. of 24 V.

- (i) Use the formula $E = IVt$ to calculate the energy E transferred from the battery when a current of 50 A flows for 1 hour.

Show your working.

energy = ... J [2]

- (ii) Calculate the electric charge that flows when a current of 25 A flows for 60 s.

Show your working and state the unit of your answer.

charge = ... unit [3]

- (c) The battery is used to operate the starter motor on a truck.

The battery is also used to operate the lights on the truck.

The starter motor must have its own switch and operate independently from the lights.

Fig. 8.1 shows part of the electrical circuit of the truck.

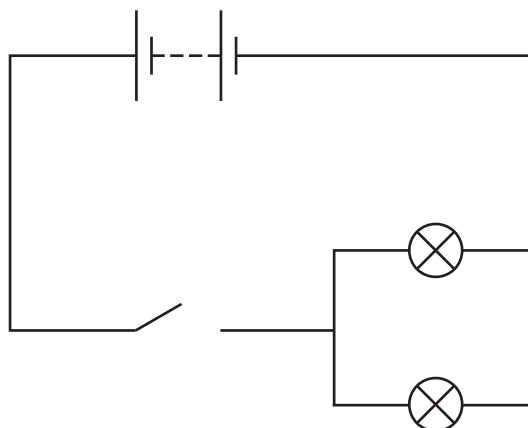


Fig. 8.1

The symbol for the starter motor is



On Fig. 8.1, complete the circuit diagram to show how the starter motor and a switch should be included in this circuit. [1]

[Total: 8]

- 9 (a) Rubidium and caesium are Group I metals.

In the Periodic Table, there is a trend in the properties of the Group I metals.

Rubidium melts at 39 °C.

Caesium is a solid at 20 °C.

- (i) Suggest the melting point of caesium.

..... °C [1]

- (ii) Describe the trend in the reaction of Group I metals with water.

.....
 [1]

- (b) Iron is extracted from its ore in a blast furnace.

Explain why Group I metals cannot be extracted from their ores by reduction with carbon in a blast furnace.

.....
 [1]

- (c) Table 9.1 shows the elements in Period 2 of the Periodic Table and their electronic structures.

Table 9.1

group	I	II	III	IV	V	VI	VII	VIII
element	Li lithium	Be beryllium	B boron	C carbon	N nitrogen	O oxygen	F fluorine	Ne neon
electronic structure	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8

- (i) Describe the relationship between group number and the number of outer shell electrons.

.....
 [1]

- (ii) Describe the trend in the metallic character of the elements within Period 2.

.....
 [1]

[Total: 5]

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The Periodic Table of Elements

Group																				
I	II											III	IV	V	VI	VII	VIII			
												1 H hydrogen 1								
																			</	

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 dm³ at room temperature and pressure (r.t.p.).