Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

CO-ORDINATED SCIENCES **0654/41**

Paper 4 (Extended) **October/November 2018**

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 28.

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.

DC (ST/JG) 153921/4

1 Fig. 1.1 shows a simplified diagram of the carbon cycle.

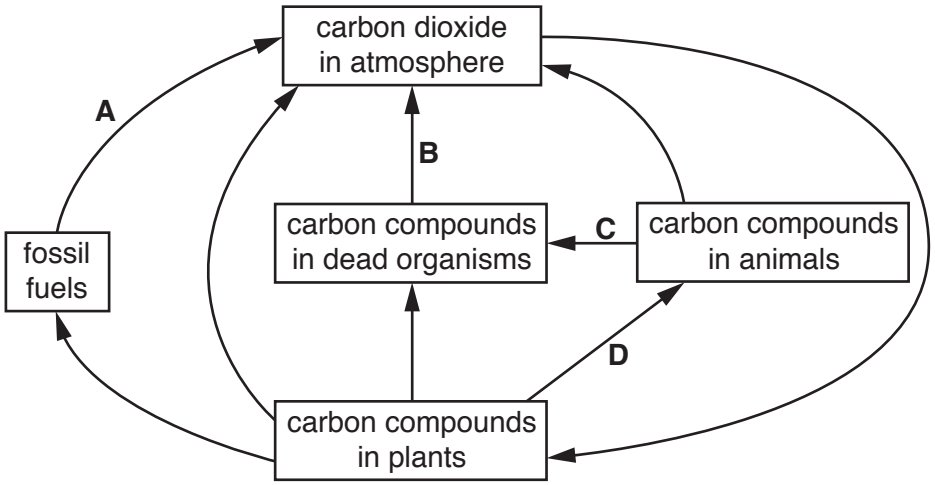


Fig. 1.1

(a) (i) Name the organisms responsible for the process labelled **B** in Fig. 1.1.

.....[1]

(ii) Explain why only **some** of the carbon taken in by animals in the process labelled **D** in Fig. 1.1 is passed to the carbon compounds in dead organisms in the process labelled **C** in Fig. 1.1.

.....

.....

.....[2]

(iii) Name the process labelled **D** in Fig. 1.1.

.....[1]

(b) There is a widespread increase in the process labelled **A** in Fig. 1.1.

(i) Name process **A**.

.....[1]

(ii) Describe how an increase in process **A** affects the temperature of the Earth.

.....

.....

.....

.....[2]

(c) Suggest **and** explain one way to increase the removal of carbon dioxide from the atmosphere.

.....

.....

.....[2]

2 Diamonds, limestone and sand are found in the Earth's crust.

The main compound in limestone is calcium carbonate, and the main compound in sand is silicon(IV) oxide.

(a) A scientist tests a piece of rock by adding dilute hydrochloric acid. See Fig. 2.1.

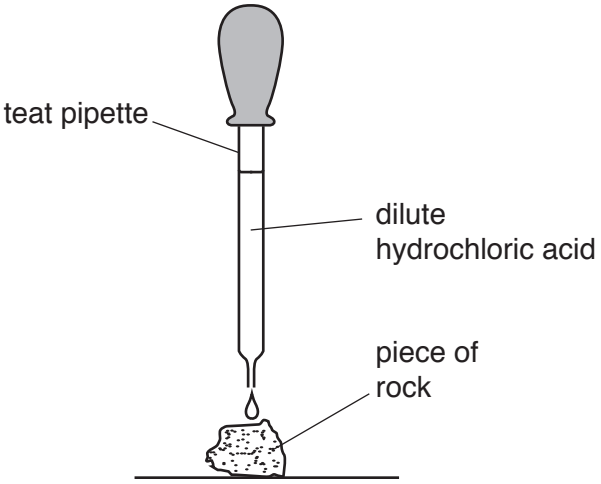


Fig. 2.1

(i) If the piece of rock is limestone, describe what is seen when the acid is added.

.....[1]

(ii) Complete the **word** equation for the reaction between hydrochloric acid and calcium carbonate.

hydrochloric acid	+	calcium carbonate	→		+		+	

[2]

(b) Table 2.1 shows what happens to the masses of limestone and of sand when they are heated strongly for several minutes.

Table 2.1

substance	mass before heating / g	mass after heating / g
limestone	10.0	5.6
sand	5.0	5.0

Explain the results shown in the table.

limestone .....

.....

sand .....

.....

[2]

(c) Fig. 2.2 shows the arrangement of atoms in diamond and in silicon(IV) oxide.

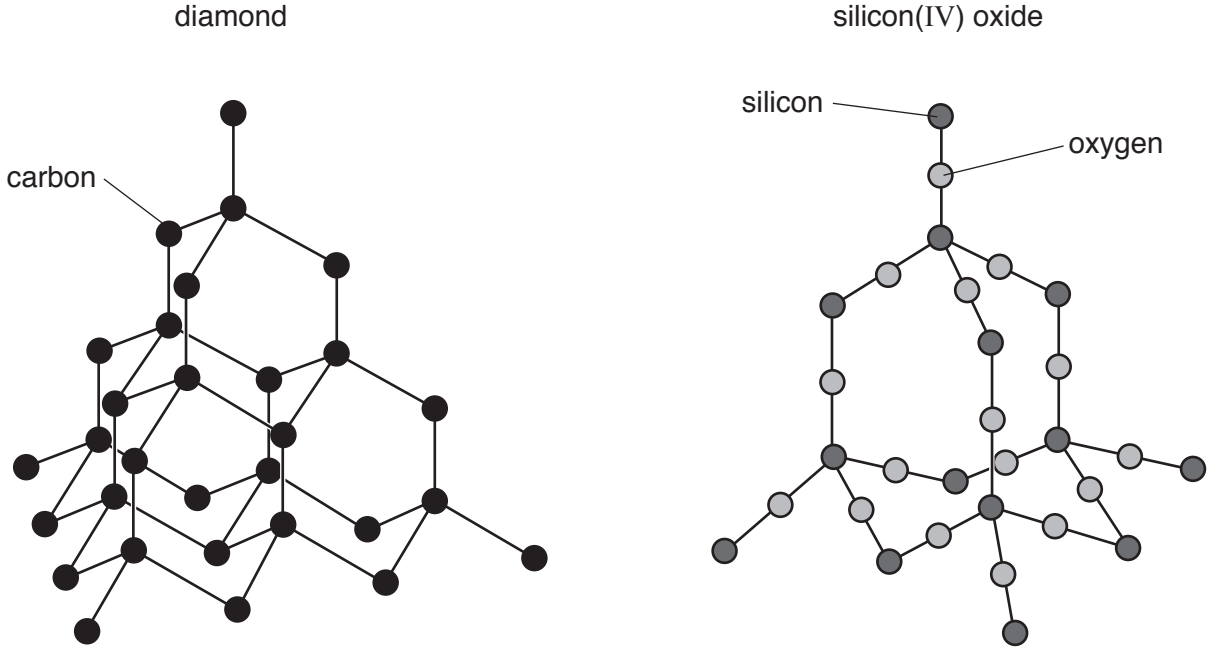


Fig. 2.2

(i) State the term used to describe the structure of diamond.

.....[1]

(ii) The simplest chemical formula used to represent silicon(IV) oxide is SiO_2.

Use this formula to describe the composition of silicon(IV) oxide.

.....

.....[1]

(iii) Use Fig. 2.2 to explain why silicon(IV) oxide has a very high melting point.

.....

.....

.....[2]

(iv) Diamond is used to make jewellery.

State **one other** use of diamond.

.....[1]

3 **(a)** A torch (flashlight) contains four cells connected in series and two lamps **X** and **Y** connected in parallel. Each lamp has a separate switch.

(i) Draw a circuit diagram for the torch using electrical circuit symbols.

[3]

(ii) The current passing through lamp **X** is 0.5 A. The resistance of lamp **X** is 12 Ω.

Calculate the total potential difference supplied by the four cells.

State the formula you use and show your working.

formula

working

potential difference = ... V [2]

(iii) Calculate the charge passing through lamp **X** in two minutes.

State the formula you use and show your working.

formula

working

charge = ... C [2]

(b) Fig. 3.1 shows a torch shining at a plane mirror.

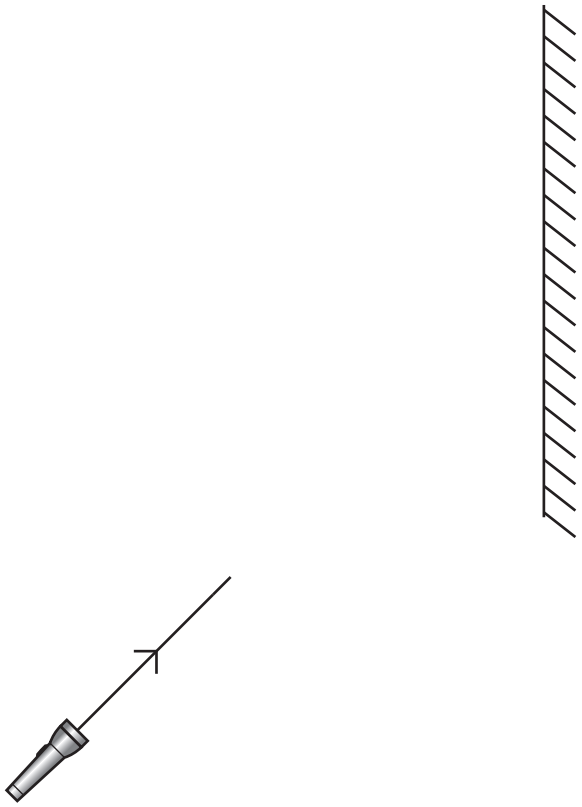


Fig. 3.1

A ray of light reflects off the mirror.

(i) Complete Fig. 3.1 to show the ray of light reflecting off the mirror. [2]

(ii) On Fig. 3.1, mark and label the angle of incidence with the letter ***i***. [1]

(iii) The angle of incidence is 45°.

State the angle of reflection. Explain your answer.

angle of reflection .....°

explanation .....

.....

[1]

4 **(a)** HIV is a sexually transmitted infection. HIV infects one type of white blood cell.

Fig. 4.1 shows how the number of these white blood cells changes after a person has been infected with HIV and not received treatment.

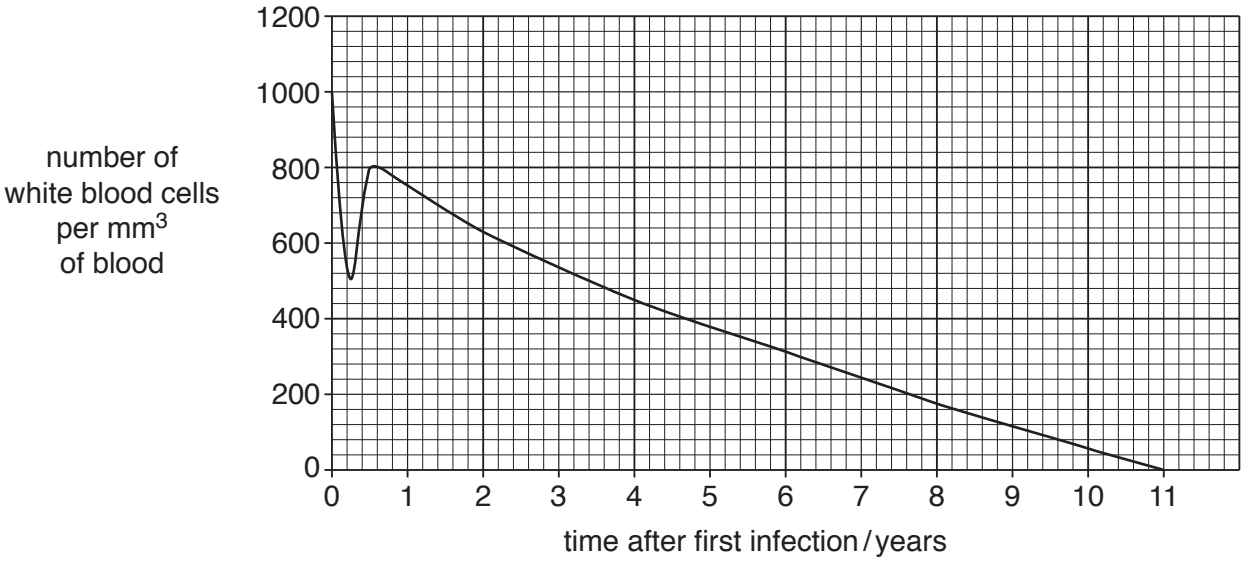


Fig. 4.1

(i) Describe the results shown in Fig. 4.1.

.....

.....

.....[2]

(ii) Explain the results between 1 year and 11 years in Fig. 4.1.

.....

.....[1]

(b) Describe in detail how white blood cells defend against disease.

.....

.....

.....

.....[3]

(c) State **one** function of each of the following components of blood.

platelets .....

red blood cells .....

[2]

5 Iodine is an element in Group VII of the Periodic Table.

A copy of the Periodic Table is shown on page 28.

(a) Describe the trend in the physical state of the elements chlorine, fluorine, bromine and iodine at room temperature (20 °C).

.....

.....

.....[2]

(b) State the number of electrons in the outer shell of an iodine atom.

Explain your answer.

number of electrons .....

explanation .....

.....
[2]

(c) Seawater contains iodide ions, I^-.

(i) Explain, in terms of protons and electrons, why an iodine atom is neutral but an iodide ion has an electrical charge of –1.

.....

.....

.....[2]

(ii) Iodine can be produced by passing chlorine through seawater.

Complete the **balanced ionic equation** for the reaction producing iodine.

Cl_2 + ... I^- $\longrightarrow$ ..... + ... [2]

(d) Fig. 5.1 shows apparatus used to electrolyse aqueous potassium iodide, KI.

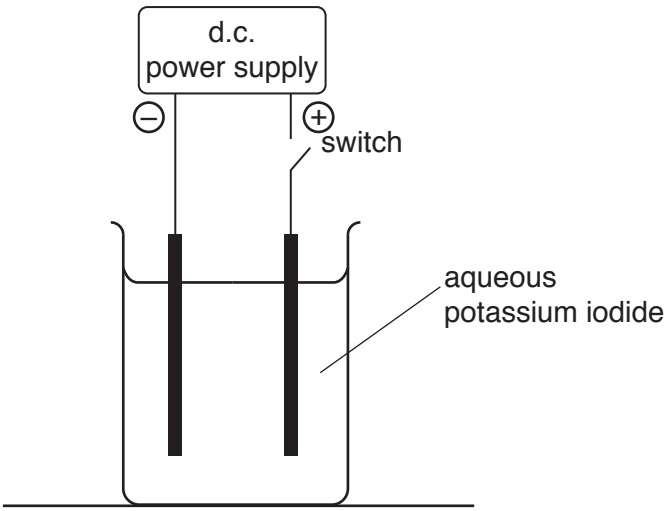


Fig. 5.1

When the switch is closed, a colourless gas is produced at the cathode.

Iodine is produced at the anode.

(i) Identify the colourless gas.

.....[1]

(ii) Use ideas about atoms, ions and the transfer of electrons to explain the formation of iodine during the electrolysis of aqueous potassium iodide.

.....

.....

.....[2]

6 **(a)** Fig. 6.1 shows a bat emitting ultrasound waves to detect obstacles and prey.

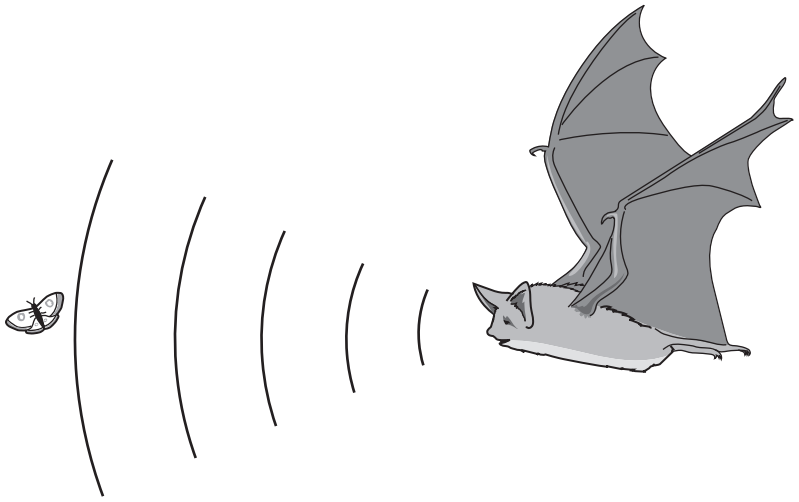


Fig. 6.1

(i) Ultrasound waves are sound waves with a frequency higher than humans can hear.

The range of frequencies emitted by a bat is from 2000 Hz to 110 000 Hz.

State whether a bat emits any frequencies audible to a human.

Explain your answer.

.....

.....

.....[1]

(ii) A bat emits a pulse of ultrasound of wavelength 9×10^{-3} m.

The speed of sound in air is 330 m / s.

Calculate the frequency of the ultrasound pulse.

State the formula you use and show your working.

formula

working

frequency = ... Hz [2]

(iii) Ultrasound waves pass through the air as a series of rarefactions and compressions.

Describe the difference between a compression and a rarefaction.

.....

.....[1]

(iv) Describe, in terms of compressions, what is meant by the *wavelength* of the ultrasound wave.

.....

.....[1]

(b) Some bats can detect ultraviolet radiation. Ultraviolet radiation is part of the electromagnetic spectrum.

(i) State the speed at which all electromagnetic waves travel in a vacuum. State the units of your answer.

speed = ... units ..... [1]

(ii) Fig. 6.2 shows an incomplete electromagnetic spectrum.

On Fig. 6.2, place ultraviolet in the correct position.

γ-rays			visible light		microwaves	radio waves

Fig. 6.2 [1]

(iii) State where, in the electromagnetic spectrum shown in Fig. 6.2, the waves with the highest frequencies are found.

.....[1]

(c) A bat flies at 9 m / s.

(i) Calculate the time it takes the bat to fly 200 m at this speed.

State the formula you use and show your working.

formula

working

time = ... s [2]

(ii) The mass of the bat is 200 g.

Calculate the kinetic energy of the bat when moving at 9 m / s.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

7 Fig. 7.1 shows two plants, **A** and **B**, of the same species.

Fig. 7.1

(a) Plant **A** is healthy and plant **B** has an ion deficiency causing stunted growth.

(i) Suggest the name of the ion that is deficient in plant **B**.

.....[1]

(ii) Explain why this ion deficiency causes stunted growth.

.....

.....[1]

[Turn over

(b) Fertilisers can prevent ion deficiencies in plants.

Overuse of fertilisers can cause the eutrophication of bodies of water.

Describe **and** explain the changes that occur during eutrophication to:

(i) the plants on the surface of the water

.....[1]

(ii) the plants under the surface of the water

.....

.....

.....[1]

(iii) the bacteria in the water

.....

.....

.....[1]

(iv) the oxygen content of the water.

.....

.....

.....[1]

(c) Describe how plant roots obtain sugar from the leaves.

.....

.....

.....[2]

8 **(a)** Iron is a metal in the fourth period of the Periodic Table.

Name the collection of metals in the fourth period that contains iron.

.....[1]

(b) Iron is a catalyst for the industrial process that produces ammonia.

(i) Name the industrial process that produces ammonia.

.....[1]

(ii) State the gaseous elements that combine to make ammonia.

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

(iii) Define the term *catalyst*.

.....

.....[1]

(c) Potassium oxide reacts with pure water.

Iron oxide does not react with pure water.

(i) Suggest the pH of the mixture formed after potassium oxide reacts with water.

Explain your answer.

pH .....

explanation .....

.....

[1]

(ii) State the pH of the mixture of iron oxide and water.

.....[1]

(d) Polluted air can cause acid rain.

(i) Name **one** gaseous oxide, other than carbon dioxide, that causes acid rain.

.....[1]

(ii) Acid rain reacts slowly with metals and with limestone.

Suggest **one** reason for this low rate of reaction.

Explain your answer using ideas about particles.

reason .....

.....

explanation .....

.....

.....

[2]

9 (a) (i) The nuclear fuel used in a power station is plutonium-239.

$^{239}_{94}Pu$ decays by α-emission to produce an isotope of uranium.

Use the correct nuclide notation to write a **symbol equation** for this decay process.

$$^{239}_{94}Pu \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}U + {}^{\cdots\cdots}_{\cdots\cdots}He$$ [2]

(ii) Explain why an α-radiation source that has been swallowed is more dangerous to humans than the same source held close to the skin outside the body.

.....

.....[1]

(b) Electricity is generated in a nuclear power station by nuclear **fission**.

Nuclear **fusion** occurs in the Sun to release energy.

Describe the difference between nuclear fission and nuclear fusion.

.....

.....

.....[2]

(c) There is a generator in the power station.

Fig. 9.1 shows a simple electrical generator.

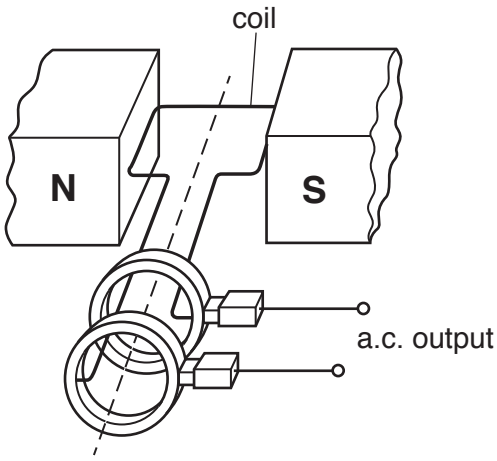


Fig. 9.1

Electricity is generated when the coil is turned.

(i) Describe how turning the coil induces a voltage.

.....

.....[1]

(ii) Explain why turning the coil induces an **alternating** voltage.

.....

.....[1]

(iii) On the grid in Fig. 9.2, sketch a graph of voltage output against time for the generator, when the coil is rotating at constant speed.

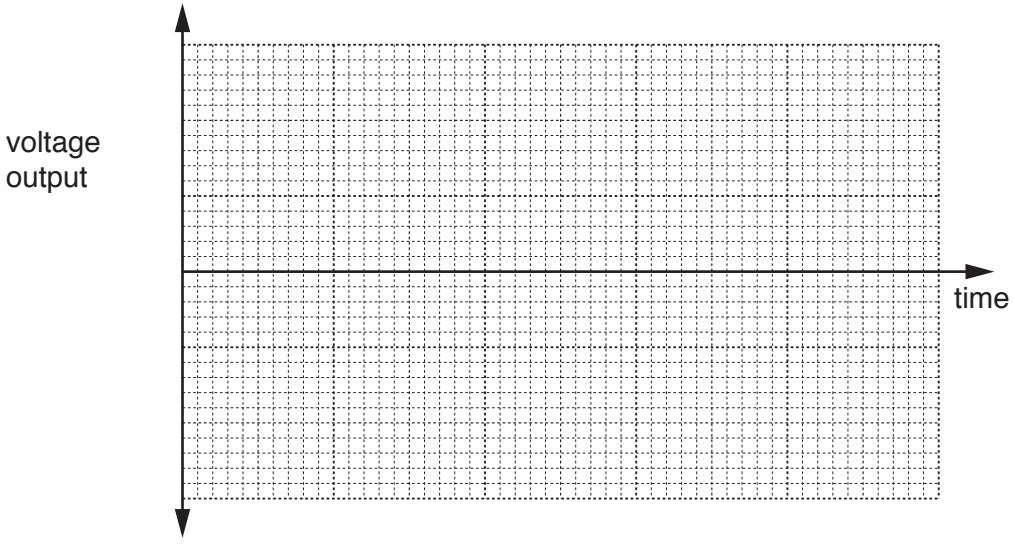


Fig. 9.2

[2]

10 Fig. 10.1 shows a diagram of an alveolus with its blood capillary.

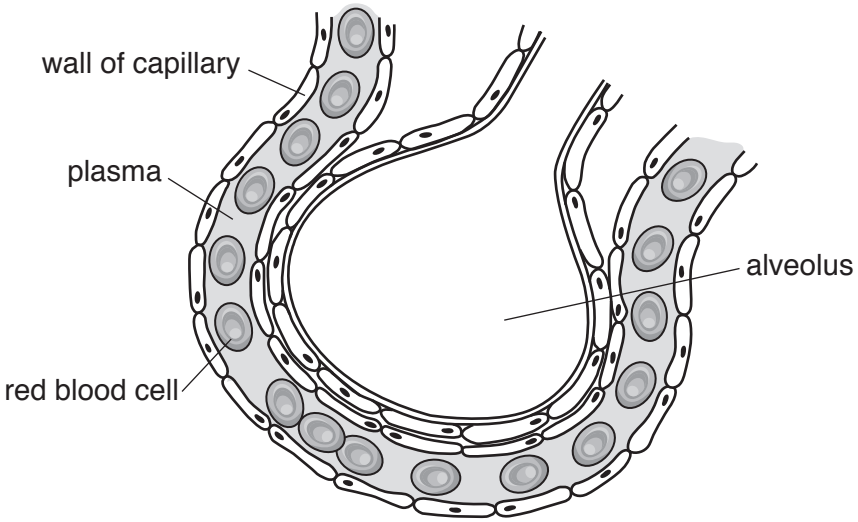


Fig. 10.1

(a) Gases are exchanged across the alveoli by the process of diffusion.

(i) Add an arrow labelled **X** to show the pathway of diffusion of oxygen into the blood. [1]

(ii) Add an arrow labelled **Y** to show the pathway of diffusion of carbon dioxide into the alveolus. [1]

(iii) Describe two **visible** features in Fig. 10.1 that show the alveolus is an efficient gas exchange surface.

1 .....

2 .....
[2]

(b) The gas exchange system supplies the oxygen required for respiration.

Use words from the list to complete the definition of the term *respiration*.

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

energy **enzyme** **glycogen** **insulin**

living **nutrient** **oxygen**

Respiration is defined as the chemical reactions that break down .....

molecules in ..... cells to release ..... . [3]

11 Petroleum contains hydrocarbons.

(a) Name **one** fraction obtained from petroleum **and** state its use.

fraction .....

use .....
[1]

(b) Most of the hydrocarbons in petroleum are alkanes.

Complete Table 11.1 by stating the names of the alkanes next to their chemical formulae.

Table 11.1

formula of alkane	name of alkane
CH_4	
C_3H_8	
C_4H_{10}	

[2]

(c) Alkenes are produced by heating alkanes strongly in the presence of a catalyst.

The equation shows a reaction in which two different alkenes are produced from an alkane.

$$C_{15}H_{32} \longrightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$$

(i) Name the process that produces alkenes from alkanes.

.....[1]

(ii) Calculate the mass of ethene, C_2H_4, that is obtained from 42.4 g of the alkane $C_{15}H_{32}$ by completing steps **1**, **2** and **3**.

Show your working.

step 1
Show that 0.2 moles of the alkane $C_{15}H_{32}$ has a mass of 42.4 g.
[A_r : C, 12; H, 1]

.....

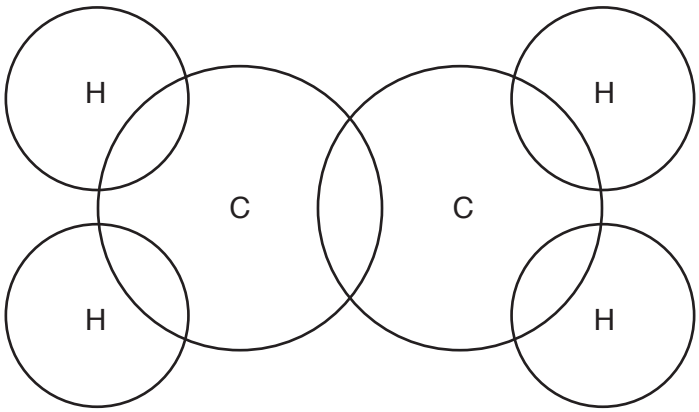
step 2
State the number of moles of ethene obtained from 0.2 moles of $C_{15}H_{32}$.

number of moles = ...

step 3
Use your result in **step 2** to calculate the mass of ethene obtained.
(M_r ethene = 28)

mass of ethene = ... g
[4]

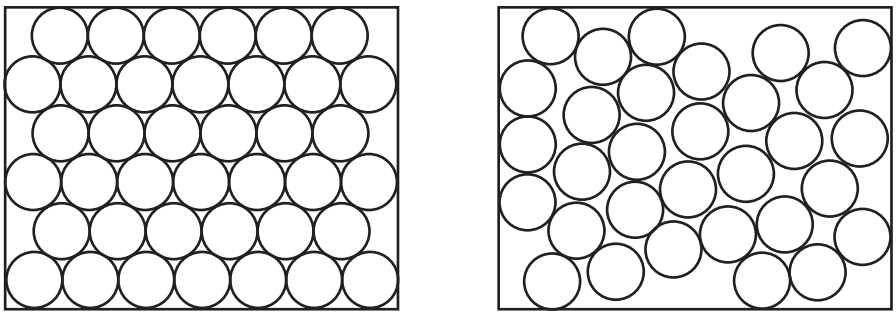
(d) Complete the dot-and-cross diagram to show the covalent bonding in an ethene molecule.



[2]

12 Ice is made by freezing some water in the freezing compartment of a refrigerator.

(a) Fig. 12.1 shows how particles are arranged in a solid and in a liquid.



solid **liquid**

Fig. 12.1

Choose words from the list to complete the sentences to describe the differences between a solid and a liquid.

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

all **irregular** **most** **none** **regular** **stronger** **weaker**

The arrangement of particles in a solid is ..... but in a liquid the arrangement is ..... . The forces between the particles are ..... in a solid than in a liquid. In a solid .....of the particles are touching. [2]

(b) Ice from the freezing compartment of the refrigerator melts at 0 °C.

Explain, in terms of molecules, why energy is needed to melt the ice even though the temperature remains at 0 °C.

Use the term *latent heat of fusion* in your answer.

.....

.....

.....[2]

(c) Fig. 12.2 shows the refrigerator with a freezing compartment at the top.

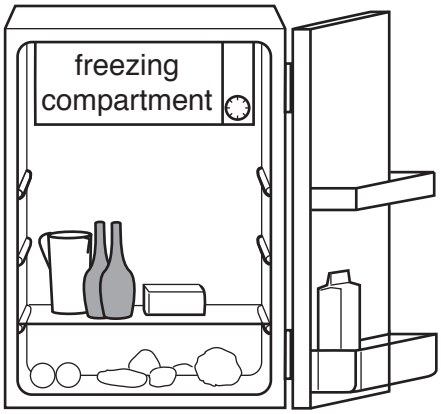


Fig. 12.2

Describe how the freezing compartment enables all of the air in the refrigerator to be cooled.

.....

.....

.....[2]

(d) The mass of air in the refrigerator is 0.25 kg. The air in the refrigerator is cooled from 20 °C to 5 °C.

The specific heat capacity of air is 1.01 J/(kg °C).

Calculate the energy removed from the air when it is cooled.

State the formula you use and show your working.

formula

working

energy = ...J [2]

13 (a) Table 13.1 shows a comparison of nervous control with hormonal control.

Complete Table 13.1 to compare nervous control with hormonal control. You do **not** need to give details of exact speeds or durations.

Table 13.1

	nervous control	hormonal control
how the information is carried		hormones in the blood
speed of transmission of information		
duration of response		

[3]

(b) Adrenaline is a hormone that is released by the body during stressful situations.

One of the effects of adrenaline is to increase the pulse rate.

(i) Name the target organ affected by adrenaline which causes pulse rate to increase.

.....[1]

(ii) Describe **one other** effect of adrenaline on the body.

.....

.....[1]

(iii) Draw a circle around the organ that destroys the hormone adrenaline.

bladder **brain** **heart** **kidney**

liver **skin**

[1]

(c) Name **two** hormones released by the pancreas.

1 .....

2 .....

[2]

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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.).