Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8933990991

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **28** pages. Any blank pages are indicated.

1 **(a)** Fig. 1.1 is a photograph of an insect-pollinated flower.

Fig. 1.1

(i) Identify the parts labelled **A**, **B** and **C** in Fig. 1.1.

A .....

B .....

C .....

[3]

(ii) Describe two **visible** pieces of evidence from Fig. 1.1 that suggest this is an insect-pollinated flower.

1 .....

.....

2 .....

.....

[2]

(iii) Describe two ways the pollen from the flower in Fig. 1.1 would be different from pollen in a wind-pollinated flower.

1 .....

2 .....

[2]

(b) Pollen contains the male gametes.

State one way the chromosome number in the nuclei of a gamete is different from that of a zygote.

..... [1]

(c) A zygote is produced after fertilisation.

State where fertilisation occurs in a plant.

..... [1]

(d) Many plants are capable of both asexual and sexual reproduction.

Complete Table 1.1 to show the **disadvantages** of asexual and sexual reproduction in plants by placing ticks (✓) in the correct boxes.

One has been done for you.

Table 1.1

	less genetic diversity	more energy is used finding a partner	no or less evolution	usually takes a longer length of time
asexual	✓			
sexual				

[2]

[Total: 11]

2 Hydrogen peroxide solution slowly decomposes to make water and oxygen gas.

(a) (i) Write the word equation for this reaction.

..... [1]

(ii) Manganese(IV) oxide is a catalyst for this reaction.

Describe what is meant by a catalyst.

.....

.....

..... [2]

(b) A student investigates the decomposition of hydrogen peroxide solution.

Fig. 2.1 shows the student's experiment.

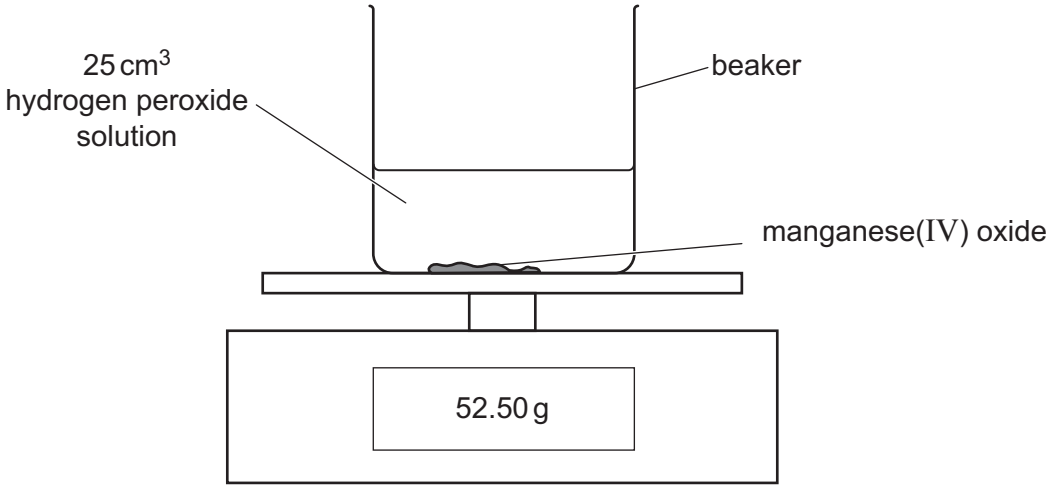


Fig. 2.1

Fig. 2.2 shows a graph of the student's results.

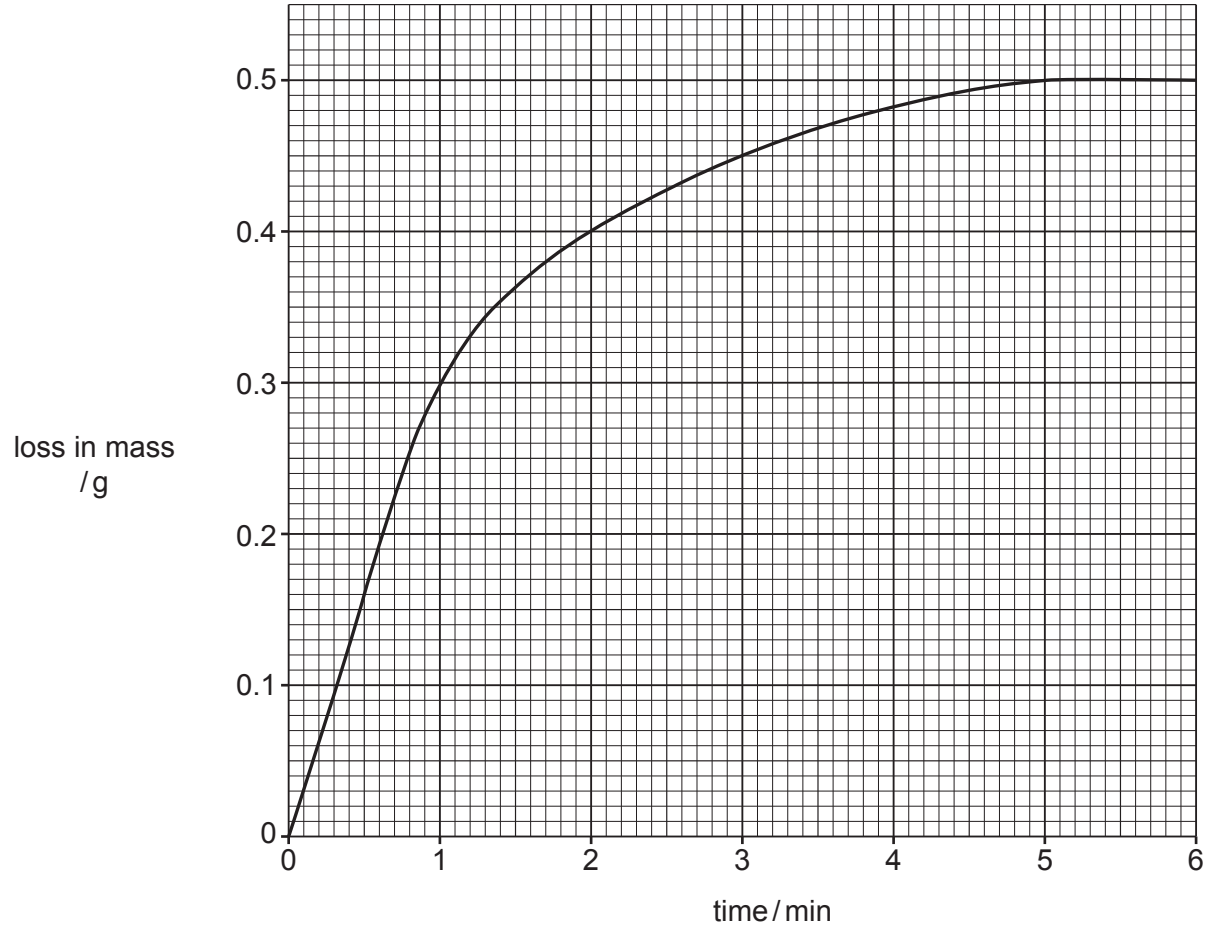


Fig. 2.2

(i) State the loss in mass after 2 minutes.

loss in mass = ... g [1]

(ii) State what happens to the rate of the reaction between 1 and 4 minutes.

..... [1]

(c) The student wants to increase the rate of the decomposition of the hydrogen peroxide solution.

He does not want to change the **catalyst** or the **volume** of the hydrogen peroxide solution.

Describe **and** explain **one** way that the student can use to increase the rate of the reaction.

Explain your answer in terms of collisions between particles.

.....

.....

.....

..... [3]

[Total: 8]

3 Fig. 3.1 shows a kettle and the label on the bottom of the kettle. The kettle contains a heating element inside its base.

The kettle is made of white plastic.

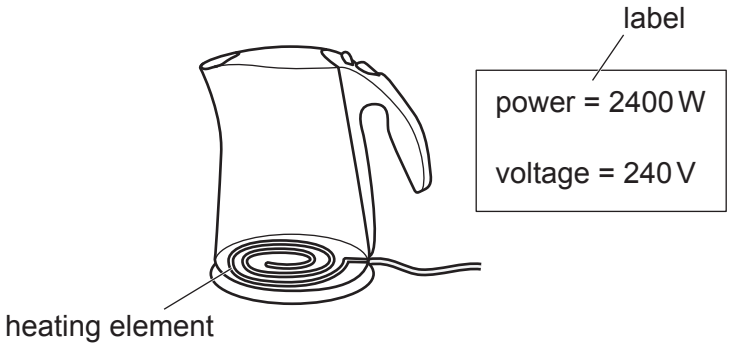


Fig. 3.1

(a) Explain, in terms of thermal energy transfer, why the kettle is:

(i) made of plastic.

.....

..... [1]

(ii) white.

.....

..... [1]

(b) (i) The kettle is filled with cold water and switched on.

Describe, in terms of density changes, how the heating element heats up all of the water.

.....

.....

.....

.....

.....

..... [3]

(ii) Calculate the current in the heating element.

State the unit for your answer.

current = ... unit = ... [3]

(iii) Show that the resistance of the heating element is 24 Ω.

[1]

(iv) The heating element is connected in parallel with a 12 Ω resistor.

Calculate the combined resistance of the heating element and the resistor.

resistance = ... Ω [2]

[Total: 11]

4 **(a)** Table 4.1 shows the forest area in two different continents, **A** and **B**, in 1990 and 2010.

Table 4.1

continent	total forest area / thousand km^2	
	in 1990	in 2010
A	9460	8640
B	9890	10050

(i) Compare the total forest area for continents **A** and **B** between the years 1990 and 2010.

Use comparative data from Table 4.1 in your answer.

.....

.....

.....

.....

.....

..... [3]

(ii) The change to the total forest area for continent **A** may affect the animals living in the forest.

Describe three ways the animals may be affected.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(iii) Explain two ways that deforestation causes the carbon dioxide concentration in the atmosphere to increase.

1 .....

.....

2 .....

.....

[2]

(b) Plants in a forest will compete for light.

Auxin is a hormone that is responsible for the chemical control of shoot growth.

Complete the sentences to describe how auxin causes shoots to grow towards the light.

Auxin is made in the shoot ..... and moves and spreads through the plant.

It collects on the ..... side of the shoot.

Auxin stimulates cell .....so this side will grow more.

This results in the shoot bending towards the light.

This growth response to light is called ..... .

[4]

[Total: 12]

5 Different methods can be used to extract metals from their ores.

The method used depends on how reactive each metal is.

(a) Draw a line to link the **reactivity** of each metal to the **method of extracting** it from the ore.

Use each method **only once**.

reactivity of metal	method of extracting
reactive metal e.g. aluminium	extracted from the ground as the metal
less reactive metal e.g. copper	heating with carbon
very unreactive metal e.g. gold	electrolysis

[2]

(b) Fig. 5.1 shows a blast furnace. It is used to extract iron from iron ore.

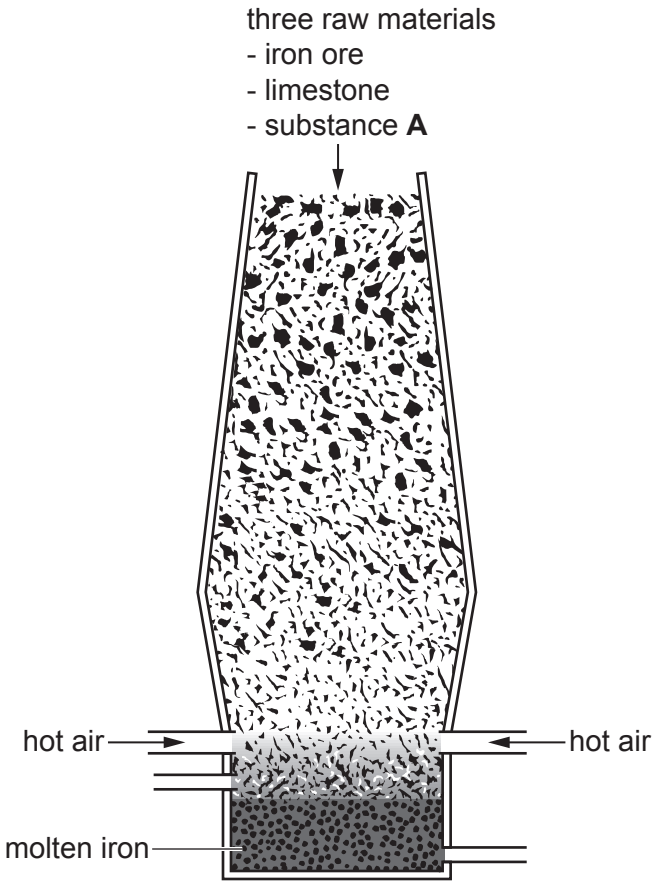


Fig. 5.1

(i) State the name of an ore that contains iron.

Choose from the list.

bauxite
hematite
malachite
marble

..... [1]

(ii) Three raw materials are added to the top of the blast furnace.

These are iron ore, limestone and substance **A**.

State the name of substance **A**.

..... [1]

(iii) Inside the blast furnace, iron ore, Fe_2O_3, reacts with carbon monoxide, CO.

Iron, Fe, and carbon dioxide, CO_2, are made.

Write the balanced symbol equation for this reaction.

..... [2]

(iv) In the blast furnace iron(III) ions, Fe^{3+}, are changed into iron.

The balanced half-equation is shown.

$$Fe^{3+} + 3e^- \rightarrow Fe$$

Iron(III) ions gain electrons.

State the name of the process when electrons are gained.

..... [1]

(v) Iron(III) ions, Fe^{3+}, react with sulfate ions, SO_4^{2-} to make iron(III) sulfate.

Determine the formula of iron(III) sulfate.

..... [1]

(c) Calcium carbonate, $CaCO_3$, is used to remove acidic impurities in the blast furnace.

Calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

The balanced symbol equation for the reaction is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

1000 kg of calcium carbonate are heated.

Calculate the mass of carbon dioxide gas made.

Show your working.

[A_r: C, 12; Ca, 40; O, 16]

mass of carbon dioxide gas = ... kg [2]

[Total: 10]

6 **(a)** A sprinter runs a 200 m race in 25 seconds.

(i) Calculate the average speed of the sprinter.

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

(ii) The sprinter has a mass of 90 kg.

Calculate the average kinetic energy of the sprinter.

average kinetic energy = ... J [2]

(b) Fig. 6.1 shows the forces acting on the sprinter during the race.

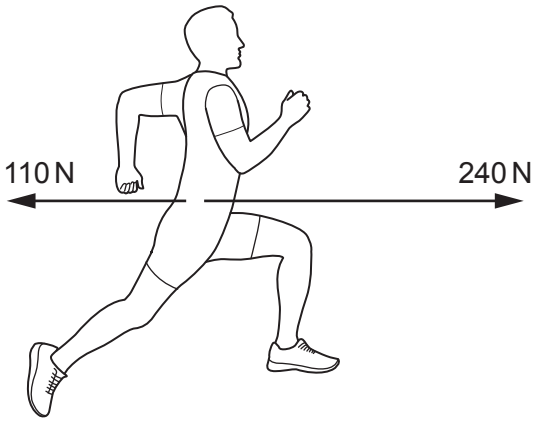


Fig. 6.1

(i) Calculate the resultant force acting on the sprinter.

resultant force = ... N [1]

(ii) Describe how these forces would change the motion of the sprinter.

.....

.....

.....

..... [2]

[Total: 7]

7 Fig. 7.1 is a diagram of a cross-section through human skin.

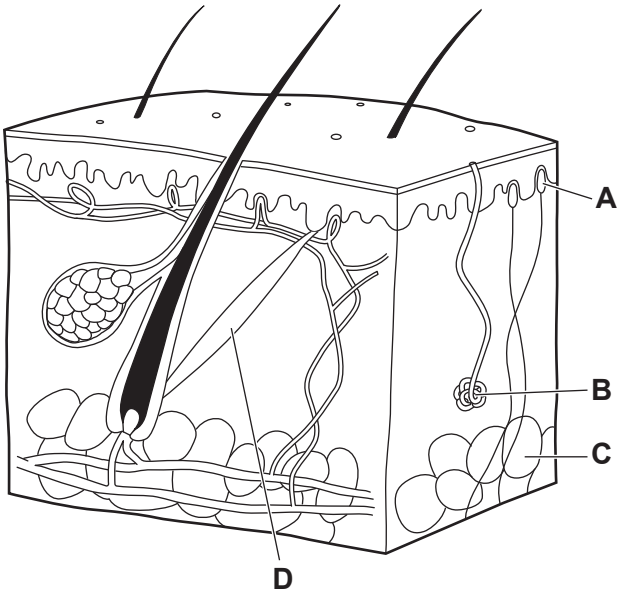


Fig. 7.1

(a) The boxes on the left show the letters in Fig. 7.1.

The boxes on the right show the names of some of the parts of the skin.

Draw lines to link each letter in Fig. 7.1 to its correct name.

letter in Fig. 7.1	name
A	fatty tissue
B	hair erector muscle
C	receptor
D	sweat gland

[3]

(b) Fig. 7.2 shows blood vessels in the skin during warm conditions.

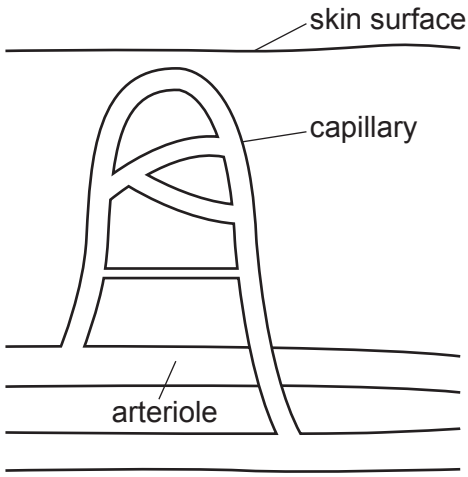


Fig. 7.2

(i) Describe the role of arterioles and capillaries in temperature control when the body gets too hot. Include the name of the process in your answer.

.....

.....

.....

.....

.....

..... [3]

(ii) State one response by the body to a decrease in internal body temperature.

..... [1]

(iii) Name the term used to describe the mechanism used to return internal body temperature to a normal level.

..... [1]

(c) Adrenaline is a hormone that can also affect the skin and blood flow.

Describe two ways that adrenaline affects the blood.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

8 The fractional distillation of petroleum makes useful fractions.

Three of the fractions made are petrol, fuel oil and refinery gas.

Refinery gas contains ethane, C_2H_6.

(a) Draw the structure of an ethane molecule.

Show all the covalent bonds.

[1]

(b) Ethane burns in oxygen to make carbon dioxide and water.

The balanced symbol equation is shown.

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

The reaction is **exothermic**.

Use the axes shown in Fig. 8.1 to draw and label the energy level diagram for this reaction.

Label:

- the energy of the reactants and the products
- the energy change in the reaction
- the activation energy of the reaction.

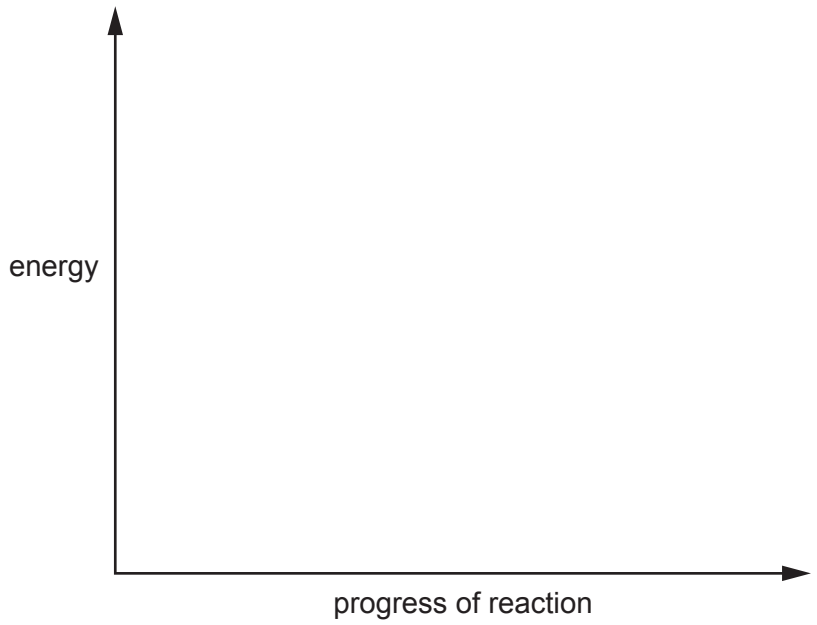


Fig. 8.1

[3]

(c) Fractional distillation makes too much fuel oil and not enough petrol.

Cracking is a process that breaks large molecules into smaller molecules.

Some fractions are cracked.

Suggest why cracking is useful.

.....

.....

..... [2]

(d) During cracking, dodecane, $C_{12}H_{26}$, can make octane, C_8H_{18}, and ethene, C_2H_4.

Write the balanced symbol equation for this reaction.

..... [2]

(e) Ethene is changed into poly(ethene) in a polymerisation reaction.

Polymerisation changes many small molecules into larger long chain molecules.

$$\text{small molecules} \xrightarrow{\text{polymerisation}} \text{larger long chain molecules}$$

State the name of the small molecules used in polymerisation.

Choose from the list.

alkane
monomer
nylon
polymer

..... [1]

(f) Fig. 8.2 shows the structure of a small molecule called propene.

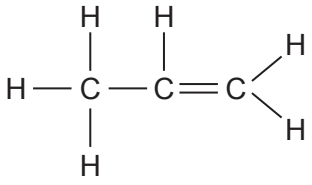


Fig. 8.2

Propene is an alkene. It is unsaturated.

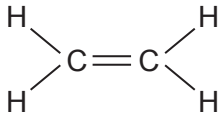
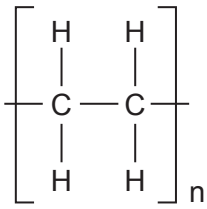
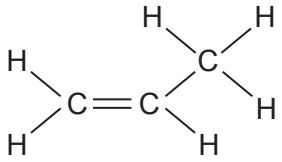
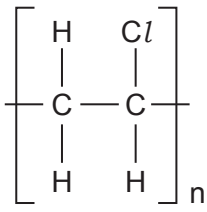
Explain why propene is unsaturated.

..... [1]

(g) Table 8.1 shows the structures of some small molecules and long chain molecules.

Complete Table 8.1.

Table 8.1

name of small molecule	structure of small molecule	structure of long chain molecule
ethene		
propene		
chloroethene		

[2]

[Total: 12]

9 **(a)** Fig. 9.1 represents a straight piece of wire carrying a current passing through a sheet of paper.

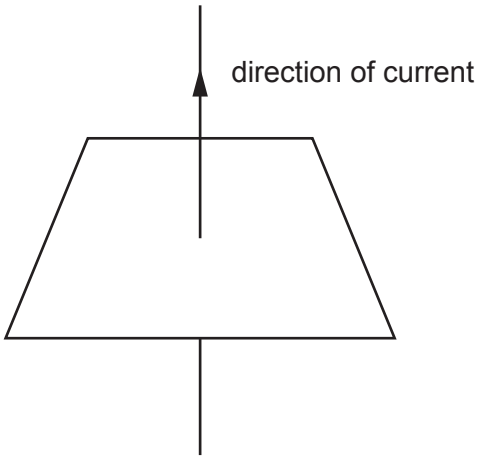


Fig. 9.1

(i) On Fig. 9.1, draw **two** field lines to show the shape and direction of the magnetic field around the wire. [2]

(ii) State what effect reversing the direction of the current would have on the magnetic field.

.....

..... [1]

(b) Fig. 9.2 shows the wire placed into the magnetic field of a permanent magnet.

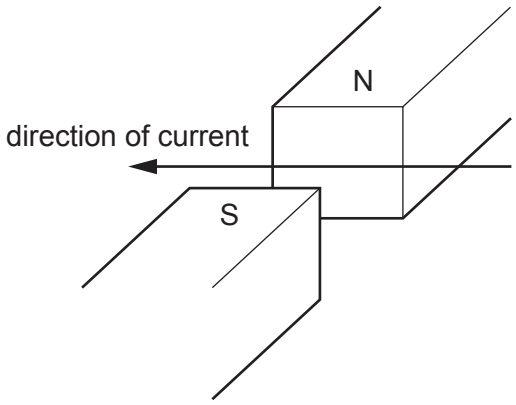


Fig. 9.2

(i) State the direction of the force acting on the wire.

..... [1]

(ii) Suggest two changes that would increase the size of the force acting on the wire.

1 .....

.....

2 .....

.....

[2]

(c) Fig. 9.3 shows an electric motor.

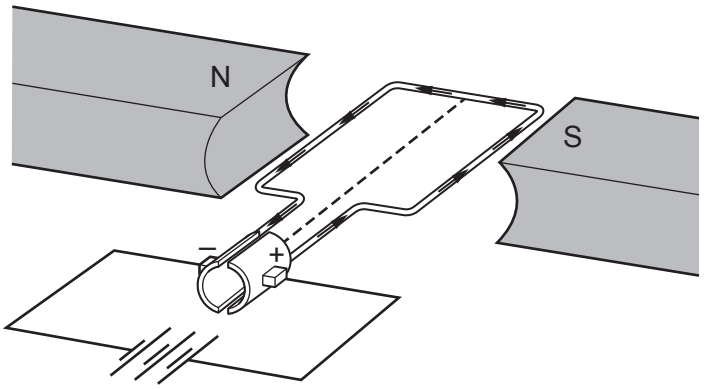


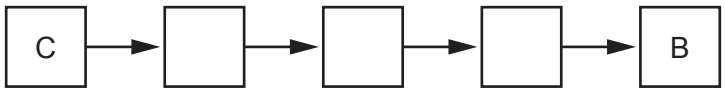
Fig. 9.3

(i) The following statements explain what causes the coil in Fig. 9.3 to rotate.

The statements are in the wrong order.

A A current flows through the coil.
B The coil experiences a force and starts to spin.
C The power supply applies a potential difference across the coil.
D This causes a magnetic field to be induced around the coil.
E This interacts with the permanent magnetic field.

Arrange the statements into the correct order.



[2]

(ii) On Fig 9.3, label the split-ring commutator with a cross (**X**). [1]

(iii) Describe how the split-ring commutator allows the coil to keep on turning.

.....

..... [1]

(d) A simple a.c. generator produces an alternating voltage.

Fig 9.4 shows how the voltage from the generator varies with time in the form of a wave.

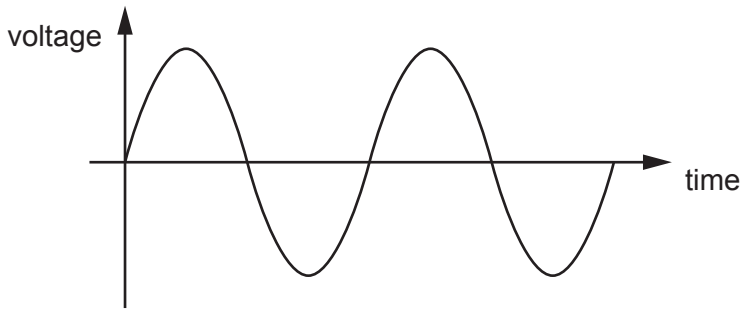


Fig. 9.4

(i) On Fig. 9.4, draw a double headed arrow (⟷) to show the time taken for the coil in the generator to complete one full rotation. [1]

(ii) The size of the voltage from the generator is indicated by the amplitude of the wave in Fig. 9.4.

On Fig. 9.4, draw the voltage output of the generator with a smaller voltage. [1]

[Total: 12]

10 (a) The percentage of oxygen in inspired air, in expired air when resting and in expired air during exercise is different.

Table 10.1 shows these differences.

Table 10.1

percentage of oxygen		
in inspired air	in expired air when resting	in expired air during exercise
20	16	14

The percentage of oxygen in expired air when resting and expired air during exercise is different.

(i) Calculate the difference.

.....% [1]

(ii) Explain this difference.

.....

.....

.....

..... [2]

(b) Exercise increases the rate of breathing.

Describe one other effect of exercise on the pattern of breathing.

.....

..... [1]

(c) An increase in the concentration levels of one gas in the blood causes the increase in breathing rate.

Name this gas.

..... [1]

(d) Alveoli is the gas exchange surface in humans.

Name two structures that air must pass through before it reaches the alveoli during inspiration.

1 .....

2 .....

[2]

[Total: 7]

11 Fig. 11.1 shows an outline of the Periodic Table.

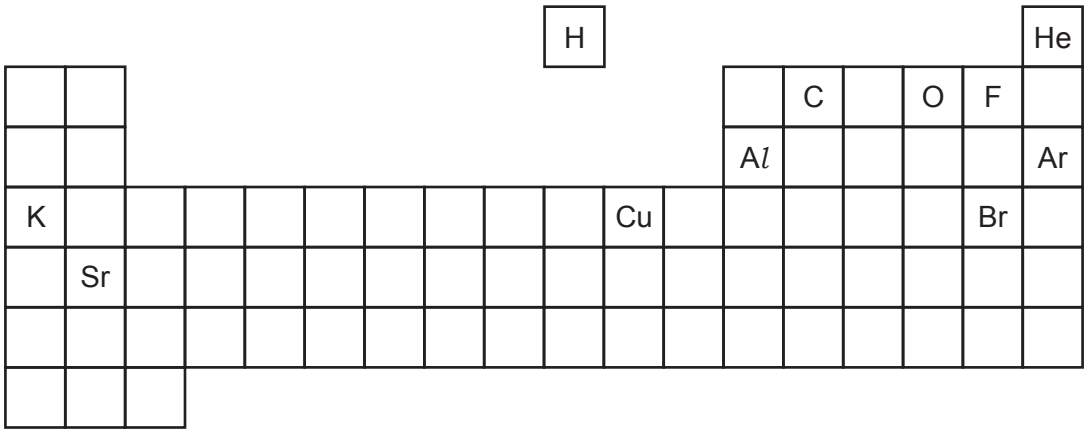


Fig. 11.1

(a) Draw a line to link each **element** to its correct **description**.

Use each description **only once**.

element	description
	an element with 8 electrons in its outer shell
He	
	an element with an electronic structure of 2
Al	
	an element in Group 3 and Period 3
Ar	
	an element in Group 6 and Period 3

[3]

(b) Argon is a gas used in lamps.

Explain why.

..... [1]

(c) The nucleus of a carbon atom contains six protons.

State the charge on a proton.

..... [1]

(d) Potassium metal reacts with the non-metal bromine to form potassium bromide.

Potassium bromide is an ionic compound.

Describe how metallic and non-metallic elements form ionic bonds.

.....

.....

.....

..... [3]

(e) The electronic structure of carbon is 2.4.

The electronic structure of oxygen is 2.6.

The atoms in a molecule of carbon dioxide, CO_2, are held together by covalent bonds.

Draw the dot-and-cross diagram to show the bonding in carbon dioxide.

You only need to include the outer shell electrons.

[2]

[Total: 10]

12 Fig. 12.1 shows the arrangement of molecules in samples of a solid, a liquid and a gas.

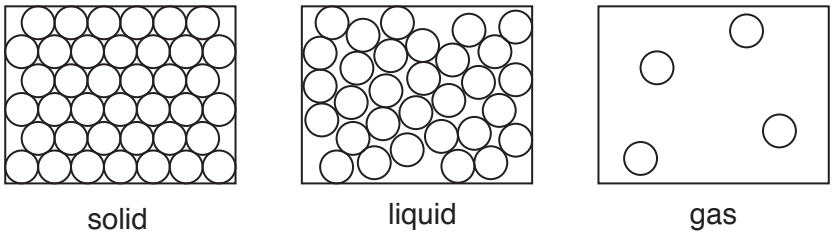


Fig. 12.1

(a) Some statements about the structure and properties of matter are given.

Place a tick (✓) next to all of the statements that describe the structure or properties of a **solid**.

There are no forces between molecules.	☐
Forces between molecules are strong.	☐
It has a fixed volume.	☐
It can be compressed.	☐
Molecules can only vibrate.	☐
Molecules are free to move.	☐

[3]

(b) Fig. 12.2 shows a syringe filled with a gas similar to the sample shown in Fig. 12.1.

The syringe is attached to a pressure gauge which measures the pressure of the gas.

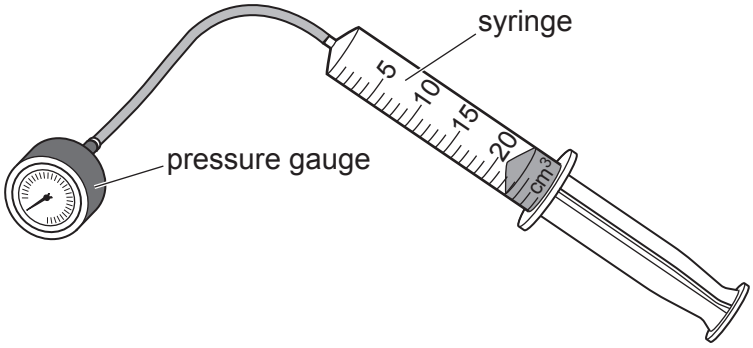


Fig. 12.2

Describe what causes the pressure in the sample of gas in terms of molecular motion.

.....

.....

.....

..... [2]

(c) A student conducts an investigation into how the pressure of the gas changes with volume.

The temperature of the gas remains constant.

Fig. 12.3 shows the results of the student's investigation.

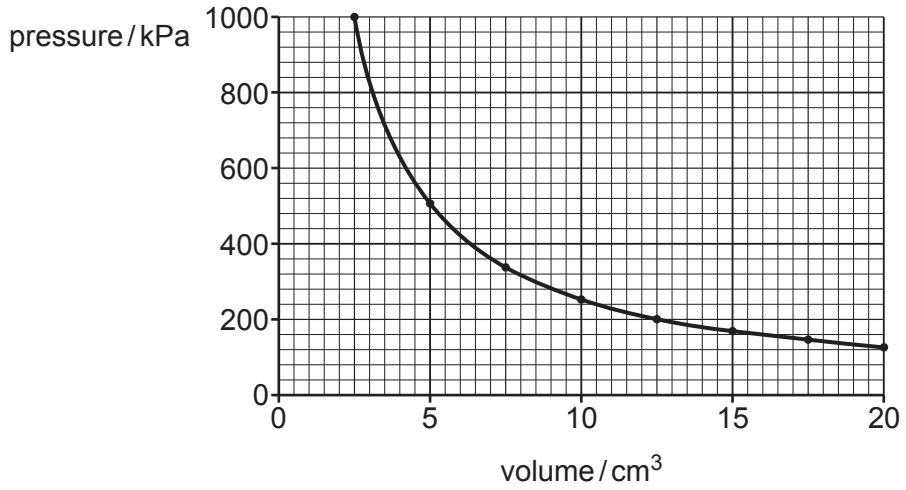


Fig. 12.3

(i) Use Fig. 12.3 to determine the volume of the sample of gas when the pressure is 500 kPa.

volume = ... cm^3 [1]

(ii) The mass of the sample of gas is 2.45 g.

Calculate the density of the sample of gas when the pressure is 500 kPa.

density = ... g/cm^3 [2]

(d) Explain why increasing the temperature of a sample of gas, while keeping the volume constant, causes an increase in pressure.

.....

.....

.....

..... [2]

[Total: 10]

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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.).