Cambridge IGCSE

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CO-ORDINATED SCIENCES 0973/41

Paper 4 (Extended) **October/November 2019**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 32.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **30** printed pages and **2** blank pages.

Cambridge Assessment International Education

1 (a) Complete the sentence to define the term *anaerobic respiration*.

Anaerobic respiration is the .... reactions in cells that break down

nutrient molecules to release .... without using ....

[3]

(b) Describe one advantage of using **aerobic** respiration rather than anaerobic respiration.

....

.... [1]

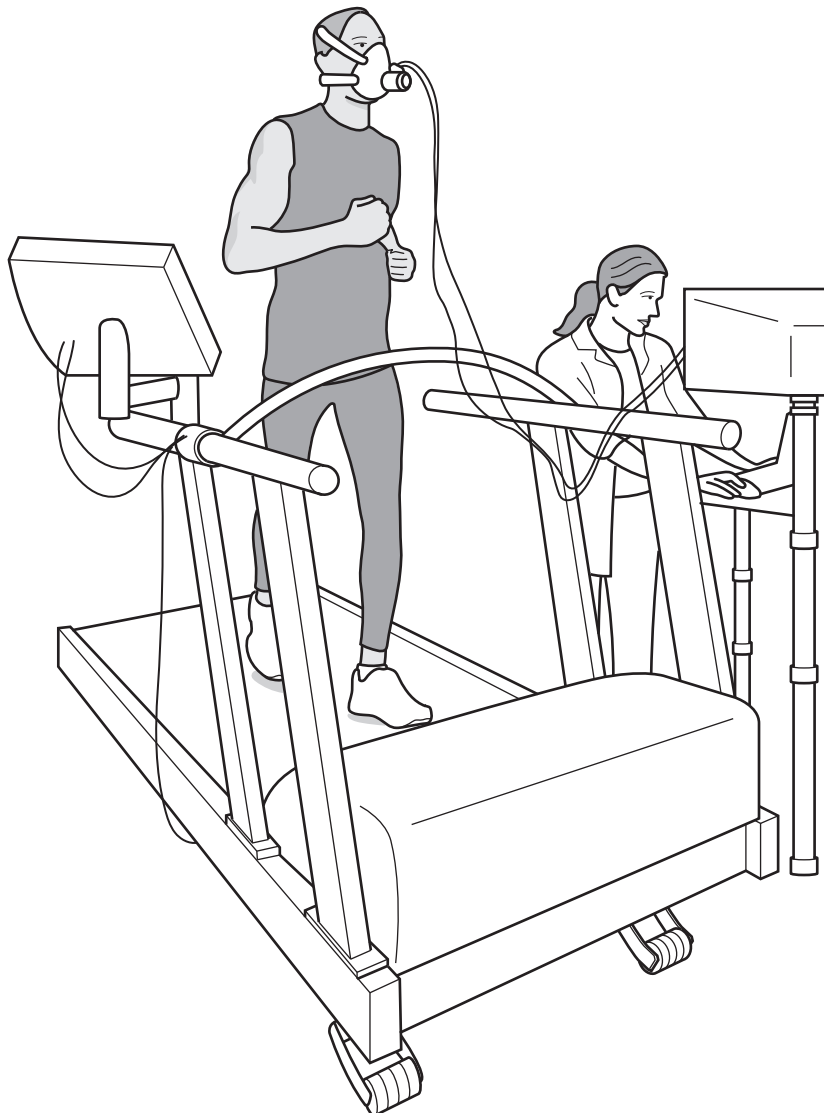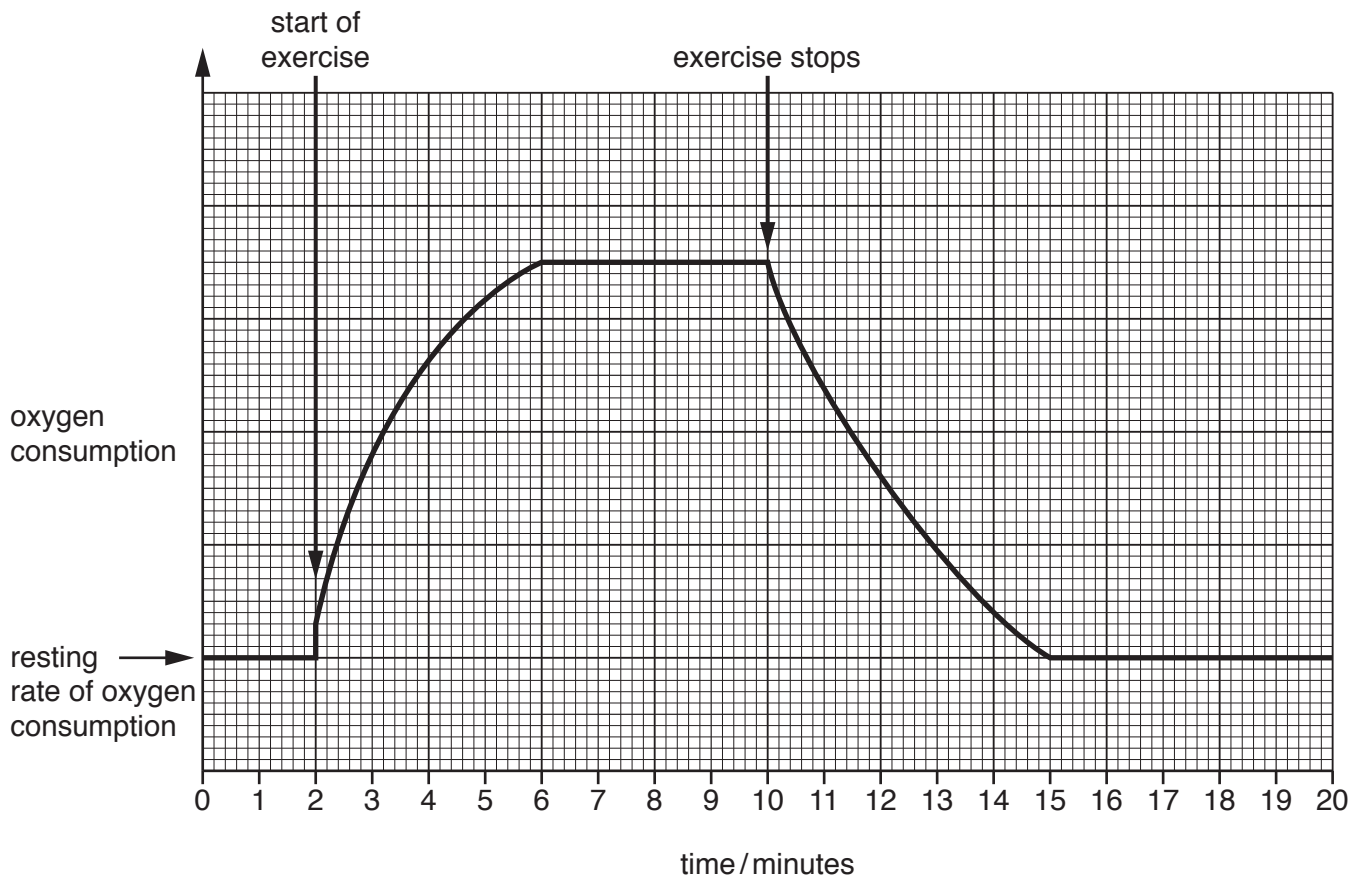(c) Fig. 1.1 shows a scientist monitoring the oxygen consumption of an athlete running on a treadmill.

Fig. 1.1

Oxygen consumption is the volume of oxygen used by the body per minute.

The graph in Fig. 1.2 shows the oxygen consumption of the athlete before, during and after exercise.

Fig. 1.2

(i) Explain the results between 2–6 minutes.

....

....

....

....

.... [3]

(ii) Calculate the length of time it takes for the oxygen consumption of the athlete to return to the resting rate after exercise stops.

.... minutes [1]

(iii) Explain why oxygen consumption does **not** return to resting rate immediately after exercise stops.

....

....

.... [2]

[Total: 10]

2 (a) Fig. 2.1 is a pie chart which shows the composition of clean air.

other gases

oxygen

.............%

nitrogen
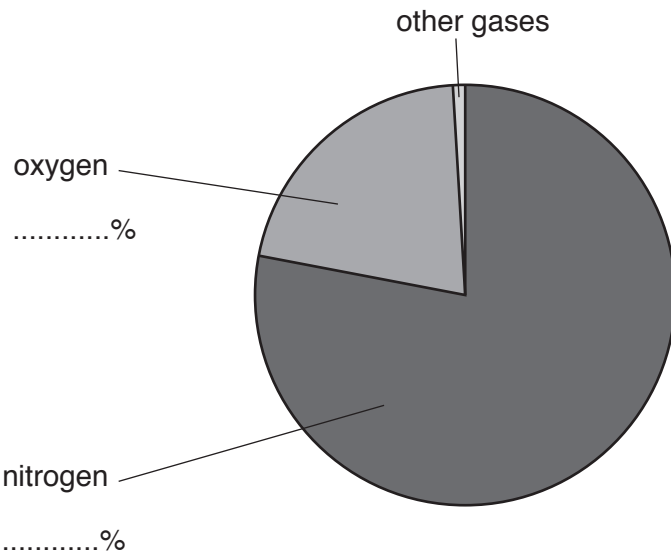
.............%

Fig. 2.1

Complete Fig. 2.1 to show the percentages of oxygen and of nitrogen in clean air.   [2]

(b) Fig. 2.2 shows the electronic structure of a nitrogen atom.
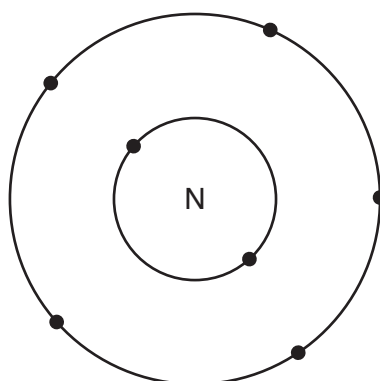
Fig. 2.2

(i) Draw the dot-and-cross diagram to represent the bonding in a nitrogen molecule, N_2.

Include only outer shell electrons.

[2]

(ii) Explain why nitrogen molecules are much less reactive than nitrogen atoms.

....

....

.... [2]

(c) At high temperature nitrogen reacts with magnesium to form magnesium nitride.

(i) Explain why magnesium nitride is an ionic compound, but nitrogen atoms are covalently bonded in nitrogen molecules.

....

....

....

.... [2]

(ii) The melting point of magnesium nitride is very high.

Explain why ionic compounds have high melting points.

....

....

.... [2]

(iii) Magnesium nitride contains magnesium ions, Mg^{2+}, and nitride ions, N^{3-}.

Deduce the formula of magnesium nitride.

Explain your answer.

formula ....

explanation ....

.... [2]

[Total: 12]

3 (a) Fig. 3.1 shows a potato being baked in the oven of an electric cooker.
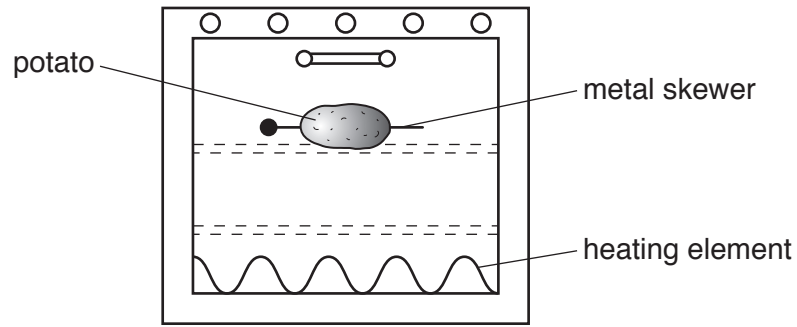

Fig. 3.1

The potato has a metal skewer (a long metal pin) pushed through it.

(i) The air in the oven is heated by the heating element.

On Fig. 3.1 draw an arrow to show how the **heated** air moves inside the oven. [1]

(ii) Name the main method of thermal energy transfer in the heated air.

.... [1]

(iii) The metal skewer transfers heat to the inside of the potato by conduction.

Describe the process of conduction in a solid, using ideas about particle vibration.

....

....

....

.... [2]
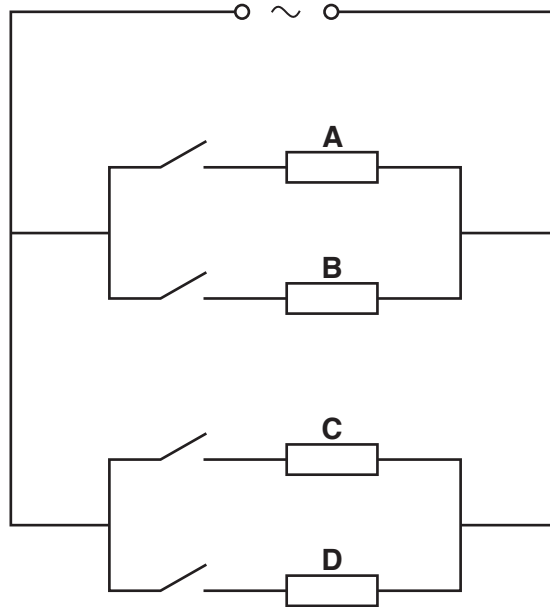
(b) The cooker has four electric hotplates, **A**, **B**, **C** and **D**. These are each connected in parallel with each other across the mains voltage supply.

Each hotplate is operated by a separate switch.

Each hotplate has a resistance of 60 Ω.

Fig. 3.2 shows the circuit. The hotplates are represented by resistor symbols.

Fig. 3.2

(i) Show that the combined resistance of hotplates **A** and **B** connected in parallel is 30 Ω.

[2]

(ii) State the combined resistance of hotplates **C** and **D** connected in parallel.

.... Ω [1]

(c) A saucepan containing water is placed on a hotplate.

When the temperature of the water reaches the boiling point of water, the water boils.

(i) State the boiling point of water.

.... °C [1]

(ii) When the water boils, the liquid water turns into steam.

Describe the differences between liquid water and steam in terms of:

- the forces and distances between the molecules
- the motion of the molecules.

....

....

....

....

.... [3]

[Total: 11]

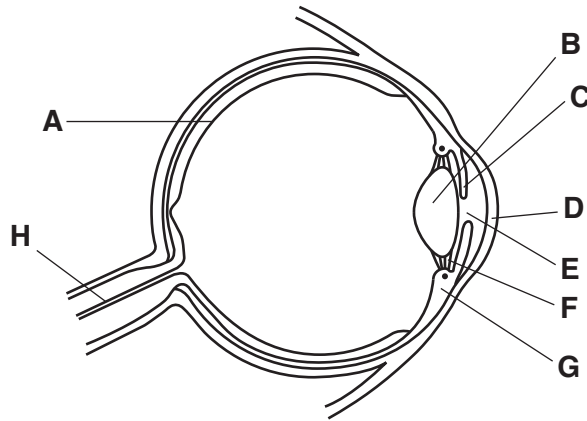**4** Fig. 4.1 shows a section through the eye.

Fig. 4.1

(a) Draw an **X** on Fig. 4.1 to show the position of the blind spot. [1]

(b) Table 4.1 shows some of the parts of the eye, the letters of the parts in Fig. 4.1 and their functions.

Table 4.1

part of the eye	letter in Fig. 4.1	function
cornea	**D**	refracts light entering the eye
	C	
lens		
		carries impulse to brain
		contains light receptor cells

Complete Table 4.1.

One row has been done for you. [4]

(c) A person changes their focus from a near object to a **distant** object.

Describe the changes that take place in the following parts of the eye.

ciliary muscle ....

suspensory ligaments ....

lens ....
[3]

[Total: 8]

5 **(a)** Limestone consists mainly of calcium carbonate.

Explain why farmers use limestone to improve soil.

.... [1]

(b) Calcium carbonate is heated to produce calcium oxide.

The equation for this reaction is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

Complete the following sentence using words from the list.

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

chemical   nuclear   oxidation   reduction   thermal

The reaction is endothermic because .... energy is taken in by the

reactant to produce products with greater .... energy.   [2]

(c) (i) Complete the general equation for the reaction between an acid and a base.

acid + base → .... + ...   [1]

(ii) Explain how protons (H⁺) are involved in the reaction between an acid and a base.

....

.... [1]

(d) An alkali is a base dissolved in water.

A student investigates the reactions of four oxides with acids and alkalis.

Table 5.1 shows his results.

Table 5.1

oxide	reactions	type of oxide
aluminium oxide	reacts with both acids and alkalis	
copper oxide	reacts with acids	
nitrous oxide	no reaction with either acids or alkalis	
sulfur dioxide	reacts with alkalis	*acidic oxide*

He correctly classifies sulfur dioxide as an acidic oxide.

Classify the other oxides by completing Table 5.1. [3]

(e) Copper metal can be extracted from copper oxide, CuO, by heating with carbon.

Carbon dioxide is also formed.

Write the balanced equation for this reaction. Include all of the state symbols.

.... [3]

(f) Explain why calcium cannot be extracted from calcium oxide by heating with carbon.

....

....

.... [1]

[Total: 12]

6   (a)   An iron magnet picks up two iron nails as shown in Fig. 6.1.

Fig. 6.1

Explain why the nails do not hang vertically.

....

....

.... [2]

(b)   An isotope of iron has a nuclide notation $^{60}_{26}$Fe and decays by beta particle emission to an isotope of cobalt.

   (i)   State what is meant by the term *isotope*.

....

.... [1]

   (ii)   Use nuclide notation to complete the symbol equation for this β-decay process.

$$^{60}_{26}\text{Fe} \rightarrow \text{...................} + \text{...................}$$ [2]

(c)   An iron wire of length 0.50 m has a cross sectional area of $4.0 \times 10^{-5}\,\text{m}^2$ and a resistance of $1.21 \times 10^{-3}\,\Omega$.

Calculate the resistance of an iron wire of length 0.25 m that has a cross sectional area of $8.0 \times 10^{-5}\,\text{m}^2$.

resistance = ... Ω [3]

(d) A block of iron is on a bench.

The surface of the block of iron in contact with the bench has an area of $144\,cm^2$.

The mass of the block of iron is $13.6\,kg$.

Calculate the pressure exerted by the block of iron on the bench in N/cm^2.

gravitational field strength = $10\,N/kg$

pressure = ... N/cm^2 [3]

[Total: 11]

7 **(a)** Lipase is a digestive enzyme.

A student investigates the action of lipase on fats present in milk.

He uses an indicator that turns pink in alkaline solutions and colourless in acidic solutions.

- He adds a few drops of indicator to a test-tube containing milk. The indicator remains colourless.

- He adds sodium carbonate solution to the milk. The indicator now turns pink.

- He then adds lipase to the mixture.

- He times how long it takes the indicator to go colourless.
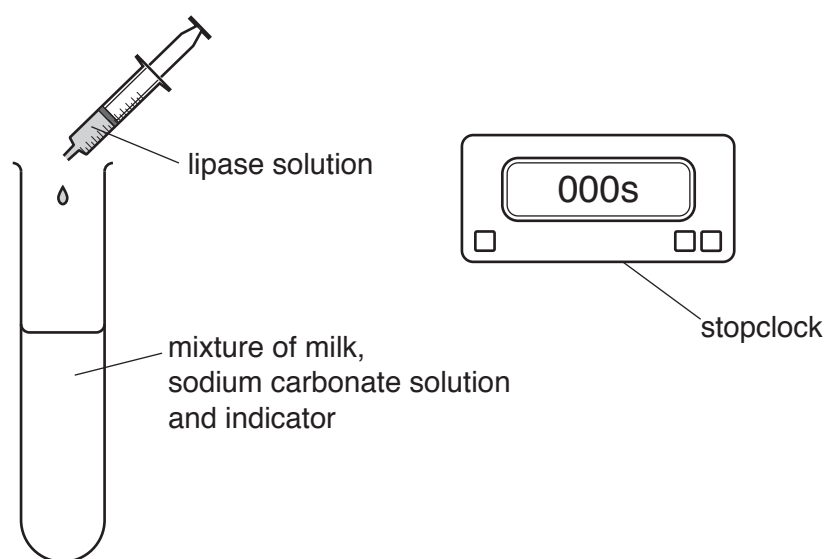
Fig. 7.1 shows the apparatus.

lipase solution

000s

stopclock

mixture of milk, sodium carbonate solution and indicator

Fig. 7.1

(i) Suggest why sodium carbonate is added to the mixture.

....

.... [1]

(ii) It takes 240 seconds for the mixture to turn colourless and become acidic.

Explain why the mixture becomes acidic.

....

....

....

.... [2]

(iii) The investigation is repeated at a temperature of 80 °C.

Explain the effect this would have on the result.

....

....

....

....

.... [3]

(b) Fig. 7.2 is a diagram of the alimentary canal and associated organs.
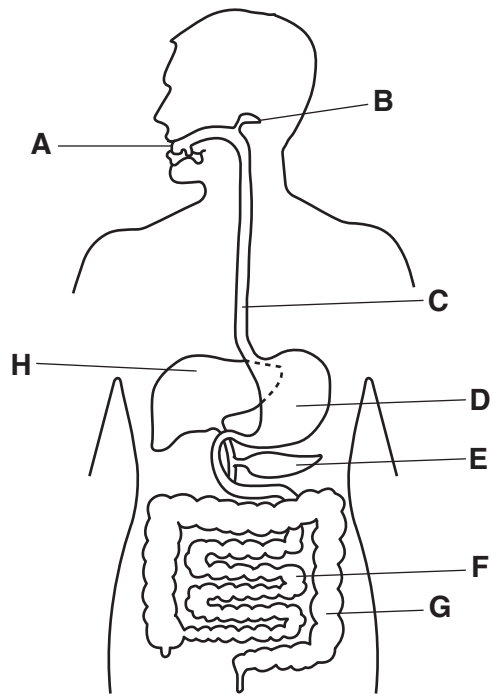
Fig. 7.2

(i) Use the letters in Fig. 7.2 to identify:

- **two** structures where amylase is secreted

.... and ....

- a structure with very acidic conditions.

....

[2]

 [Turn over

(ii) State two reasons why acidic conditions are needed in parts of the digestive system.

1 ....

....

2 ....

....

[2]

[Total: 10]

8 A petrol engine in a car uses a mixture of air and gasoline.

Gasoline is a mixture of hydrocarbons.

(a) State the products of complete combustion of a hydrocarbon.

.... [2]

(b) When a petrol engine burns hydrocarbons, the harmful products carbon monoxide and nitrogen monoxide form and are present in the exhaust gases.

Cars have a catalytic converter which changes harmful gases into less harmful gases.

Fig. 8.1 shows the position of the catalytic converter in a car.

exhaust gases

catalytic converter
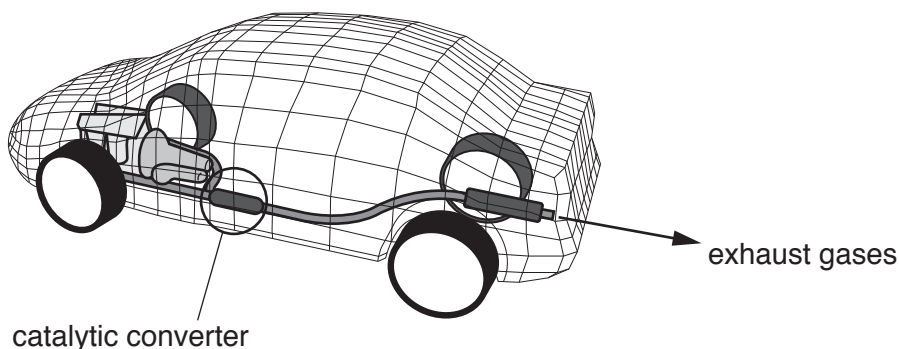
Fig. 8.1

(i) In a catalytic converter carbon monoxide is oxidised.

State the product of this oxidation.

.... [1]

(ii) In a catalytic converter nitrogen monoxide (NO) is reduced to nitrogen.

State **one** harmful effect of nitrogen oxides on the environment.

.... [1]

(iii) A catalyst works by reducing activation energy in a reaction.

Explain what is meant by the *activation energy*.

....

.... [1]

(c) Octane and butane are in the same homologous series.

(i) Describe what is meant by *homologous series*.

....

....

.... [2]

(ii) Complete Fig. 8.2 to show the structure of a butane molecule.

$$H-C$$
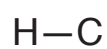
Fig. 8.2

[2]

[Total: 9]

9 **(a)** An aircraft has a mass of 400 000 kg.

Calculate the kinetic energy of the aircraft when the aircraft is travelling at 50 m/s.

kinetic energy = ... kJ [2]

(b) The pilot says that the **velocity** of the aircraft is 50 m/s. The co-pilot says that the **speed** of the aircraft is 50 m/s.

State the difference between the terms *velocity* and *speed*.

....

.... [1]

(c) Fig. 9.1 shows an aircraft passenger pulling her suitcase.

Fig. 9.1

The passenger pulls the suitcase with a horizontal force of 15 N for 150 m.

(i) State the formula that relates force, work done and distance moved.

.... [1]

(ii) Calculate the work done on the suitcase by the passenger.

State the unit of your answer.

work = ... unit .... [2]

[Total: 6]

10 (a) A student investigates the effect of temperature on the rate of transpiration.

The apparatus in Fig. 10.1 is used to measure the rate of water uptake by a plant shoot. This is approximately equal to the rate of transpiration.
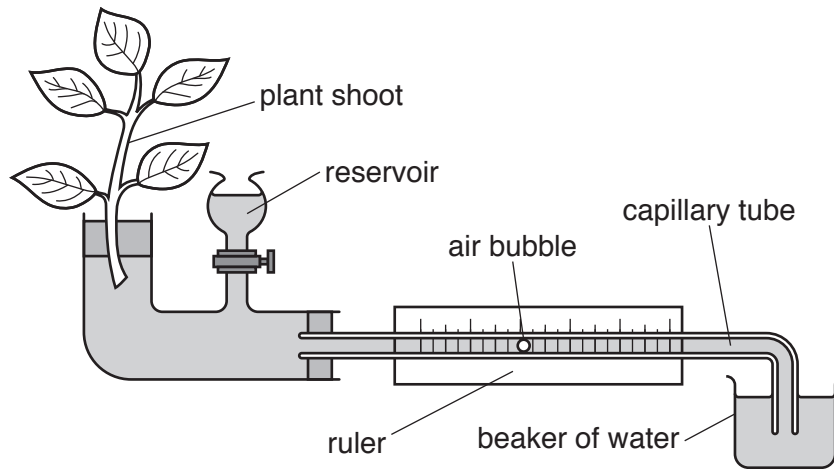

Fig. 10.1

The rate of water uptake is determined by measuring the distance travelled by the air bubble in a set time.

(i) At 30 °C the air bubble travels 8 mm in 2 minutes.

Calculate the rate of water uptake.

.... mm / min [1]

(ii) The student repeats the investigation at different temperatures.
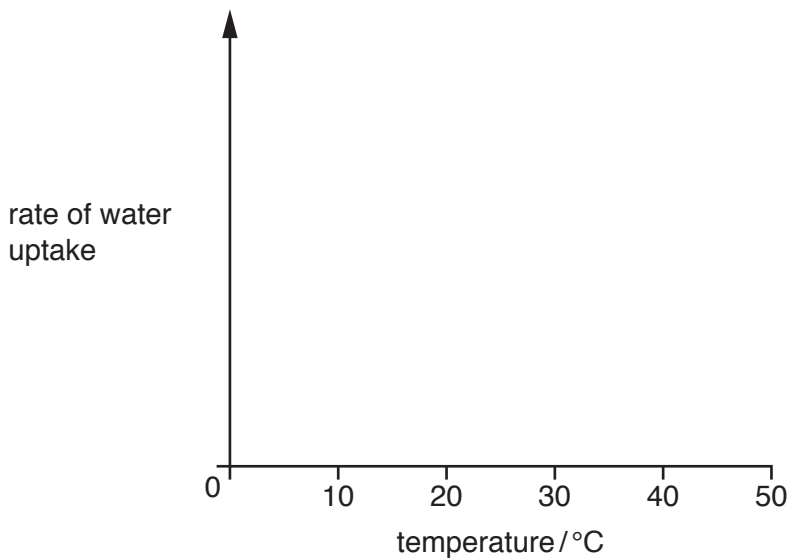
Sketch a line on Fig 10.2 to show the expected results.

Fig. 10.2

[2]

(iii) Suggest a reason for the shape of your graph in **(a)(ii)**.

....

.... [1]

(b) Describe the mechanism that moves water up the xylem.

....

....

....

....

.... [3]

(c) Fig. 10.3 shows a photograph of a plant cell undergoing cell division by mitosis.
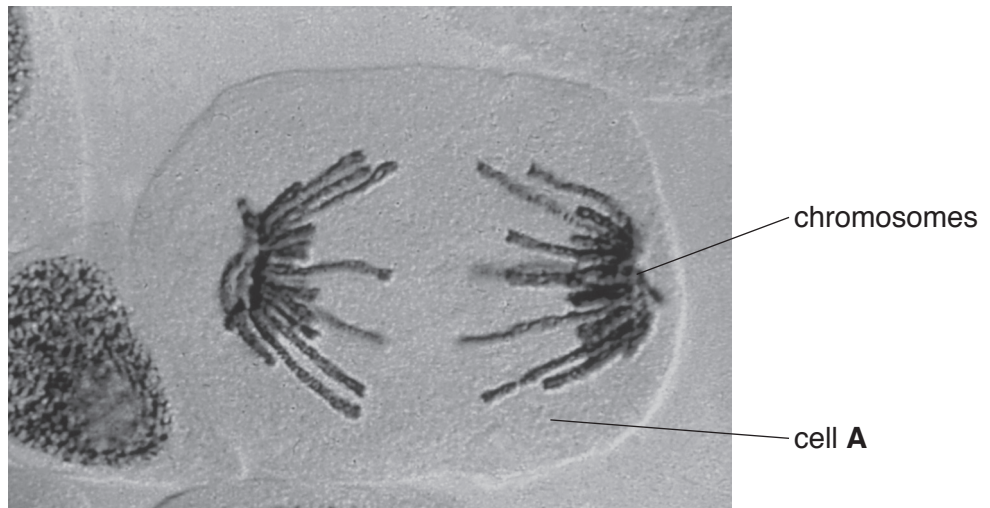
Fig. 10.3

(i) State where chromosomes are found in a cell.

.... [1]

(ii) Complete the sentence about the chromosomes in cell **A**.

The chromosomes on the left-hand side of the cell are genetically ....
to the chromosomes on the right-hand side of the cell. [1]

(d) One of the roles of mitosis is growth.

State two **other** roles of mitosis.

1 ....

....

2 ....

....

[2]

(e) State how the number of chromosomes in a cell produced by meiosis is different to the number of chromosomes in a cell produced by mitosis.

....

.... [1]

[Total: 12]

11 (a) Table 11.1 contains data about some elements.

Table 11.1

element	relative molecular mass	colour	physical state at room temperature
fluorine	38		
chlorine	71	greenish-yellow	gas
bromine	160	red-brown	liquid

(i) Predict the colour and physical state of fluorine at room temperature.

Explain your answers.

colour ....

physical state ....

explanation ....

....
[3]

(ii) Explain why the relative molecular mass of fluorine is 38.

[A_r: F,19]

....

.... [1]

 [Turn over

(b) Fig. 11.1 shows a gas jar filled with nitrogen over a gas jar filled with bromine gas. The gases are separated by a glass plate.

nitrogen gas
(colourless)

glass plate

bromine gas
(brown)
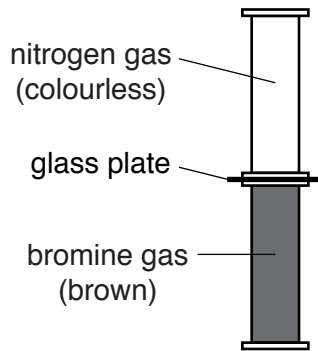
Fig. 11.1

The glass plate is removed.

Fig. 11.2 shows the colour changes in the gas jars after 15 minutes and after 30 minutes.

nitrogen gas
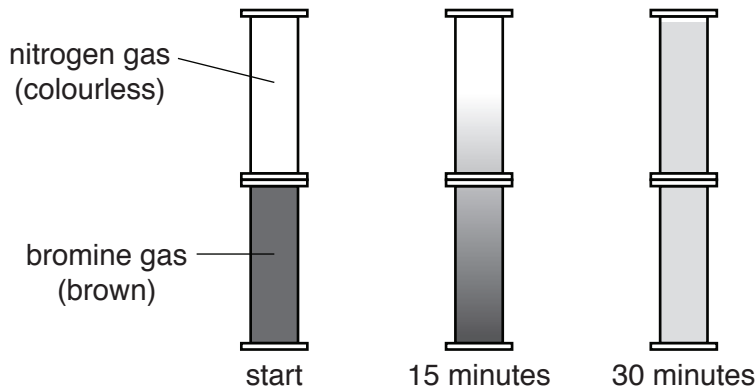(colourless)

bromine gas
(brown)

start   15 minutes   30 minutes

Fig. 11.2

(i) Describe the process that causes the effect in Fig. 11.2.

Explain this process in terms of movement of molecules.

process ....

explanation ....

....

....
[2]

(ii) Predict how the results of the experiment would be different if chlorine is used instead of bromine.

....

.... [1]

[Total: 7]

12 (a) Ultrasound is very high frequency sound.

A submarine uses ultrasound to determine the distance to the sea bed. Pulses of ultrasound are sent out through the water.

The ultrasound pulses reflect off the sea bed and are detected in the submarine 1.2 seconds later.

Ultrasound waves travel through water at a speed of 1500 m/s.

(i) Calculate the distance of the sea bed below the submarine.

distance = ... m [2]

(ii) The wavelength of ultrasound is 5 cm.

Show that the frequency of the ultrasound is 30 000 Hz.

[2]

(iii) Ultrasound waves travel as a series of compressions and rarefactions.

Fig. 12.1 shows the positions of some compressions and rarefactions of an ultrasound wave.

Fig. 12.1

On Fig. 12.1 label a compression with the letter **C** and a rarefaction with the letter **R**. [1]

(b) Submarines use periscopes to view ships on the surface of the sea.

Fig. 12.2 shows an incomplete simple periscope.
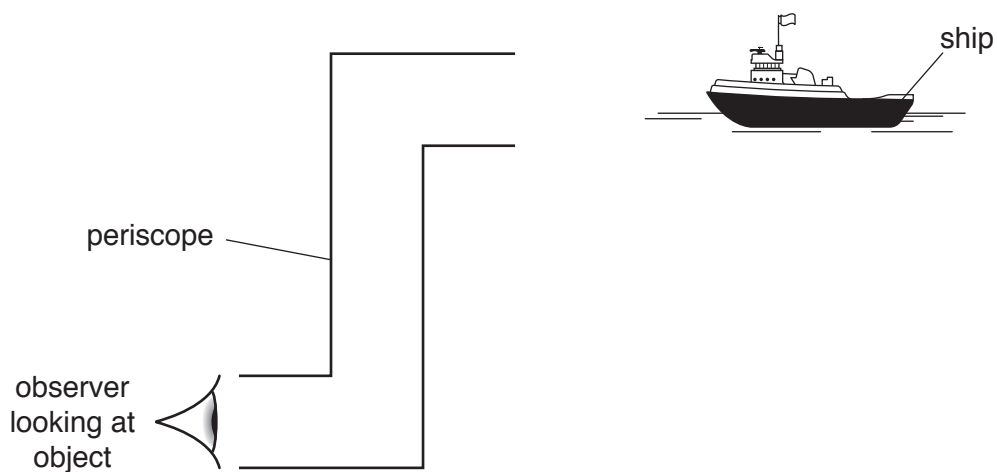
Fig. 12.2

On Fig. 12.2, draw:

- two plane mirrors in position so that a ray of light from the ship passing through the periscope will be reflected by both mirrors to the observer's eye
- the path of this ray of light from the ship, through the periscope, to the observer's eye.

[3]

(c) The submarine has a generator to generate electricity.

Fig. 12.3 shows a simple generator.
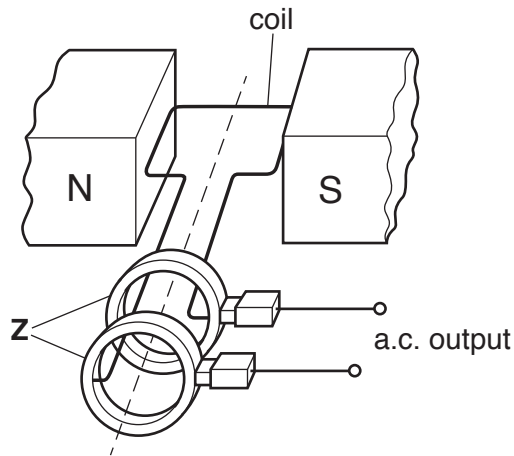
Fig. 12.3

(i) Name the parts of the generator labelled **Z** on Fig. 12.3.

.... [1]

(ii) Explain why a rotating-coil generator produces an alternating current.

....

....

....

.... [3]

[Total: 12]

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The Periodic Table of Elements

Group

Key

atomic number
atomic symbol
name
relative atomic mass

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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* flerovium –		116 Lv livermorium –		

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

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