UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

4369159917

CO-ORDINATED SCIENCES **0654/21**

Paper 2 (Core) **May/June 2012**

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 a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
Total	

This document consists of **28** printed pages and **4** blank pages.

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For Examiner's Use

1 Sugar cane is a food crop grown in Australia. It is harvested and then transported on small trains to the processing plant.

Fig. 1.1 shows one of the trains carrying sugar cane.

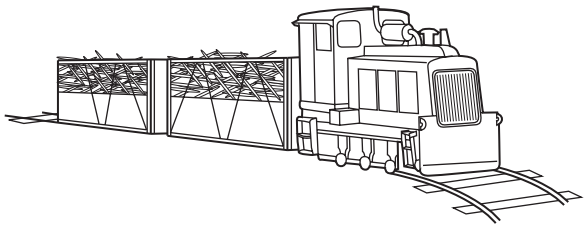


Fig. 1.1

(a) The train travels a distance of 25 km in 2 hours.

Calculate the average speed of the train.

State the formula that you use and show your working.

formula used

working

..... km / h [2]

(b) The engine is powered by oil. The oil is burned to change water into steam. The steam is used to make parts of the engine move.

(i) What kind of energy is stored in the oil?

..... [1]

(ii) The engine is 30 % efficient in converting the energy stored in the oil into movement energy. The rest of the stored energy is lost in different ways.

State **one** of these ways.

..... [1]

[Turn over

(c) The track for the train is composed of short lengths of steel rail with small gaps left between them as shown in Fig. 1.2.

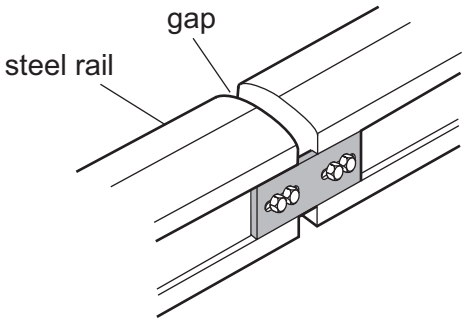


Fig. 1.2

Suggest a reason for leaving these small gaps.

.....

.....

..... [2]

(d) Sugar can be fermented and turned into ethanol. Ethanol is now used as a fuel for cars.

(i) Give **one** reason, other than cost, why people might use ethanol rather than petrol in their cars.

..... [1]

(ii) Sugar is a carbohydrate, but ethanol is not.

Name the **three** chemical elements contained in both sugar and ethanol.

..... [1]

For Examiner's Use

(e) The farm on which the sugar cane is grown uses a wind turbine to produce electrical power. Table 1.1 shows the electrical power generated for different wind speeds.

Table 1.1

wind speed / km per hour	0	3	5	8	10	12	15	20
power generated / W	0	0	150	500	1000	1100	1200	1200

(i) Suggest the lowest wind speed needed to generate power.

..... km / h [1]

(ii) State the maximum power that this wind turbine can produce.

..... W [1]

(iii) State **one** disadvantage of using only a wind turbine as the source of electrical power.

.....

..... [1]

(iv) Complete the sentence to show the energy transfer taking place when the wind turbine generates power.

..... energy is transferred to ..... energy. [2]

2 The bar chart in Fig. 2.1 shows the approximate composition of unpolluted air.

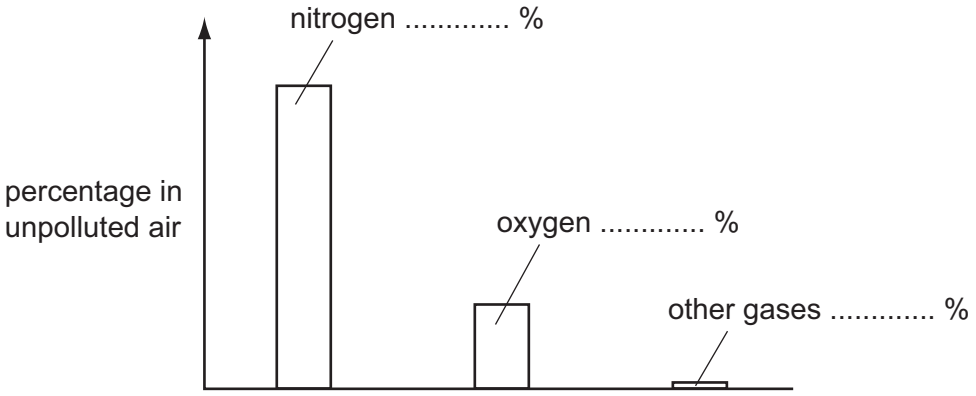


Fig. 2.1

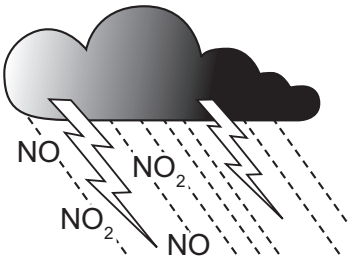
(a) (i) Complete the bar chart in Fig. 2.1 by labelling the approximate percentages of nitrogen, oxygen and other gases. [2]

(ii) Name **one gaseous compound** that exists in unpolluted air.

..... [1]

(b) Nitrogen and oxygen exist in the air in the form of the diatomic molecules, N_2 and O_2.

When lightning passes through the air, the gaseous compounds nitric oxide, NO, and nitrogen dioxide, NO_2, are formed.



(i) Explain why nitrogen and oxygen are described as chemical elements.

.....

..... [1]

(ii) Suggest and explain the type of chemical bonding in nitric oxide and nitrogen dioxide.

type of bonding .....

explanation .....

..... [2]

For Examiner's Use

(iii) A student carried out an experiment to investigate what happened to the acidity of rainwater during a thunderstorm.

His results are shown in Table 2.1.

Table 2.1

description of sample	pH
pure water obtained in a science laboratory	7
rainwater collected when no thunderstorm was occurring	5
rainwater collected during a thunderstorm	4

What conclusions can the student make from these results?

.....

.....

.....

..... [3]

For Examiner's Use

3 Fig. 3.1 shows part of a section across a root from a radish plant, photographed through a microscope.

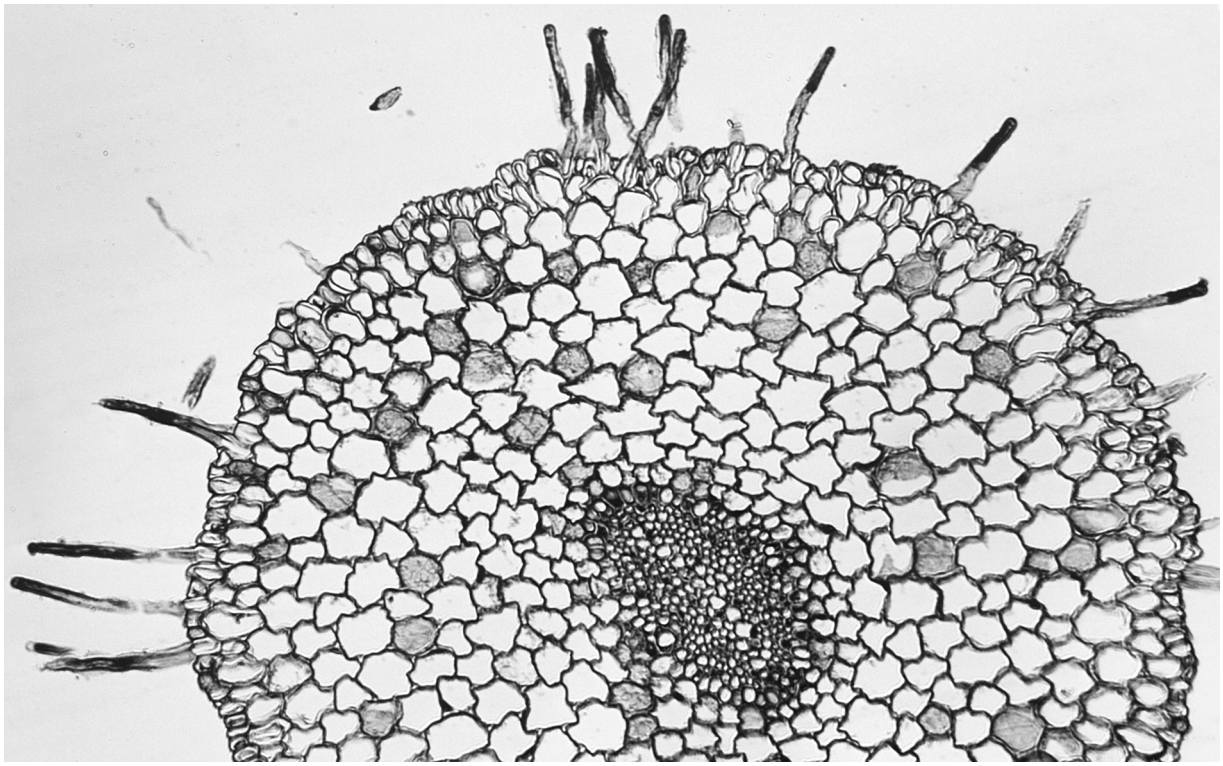


Fig. 3.1

(a) **On Fig. 3.1**, use a label line to label a root hair cell. [1]

(b) Root hair cells absorb substances from the soil.

Name **two** substances that root hair cells absorb from the soil.

1 .....

2 ..... [2]

(c) A complete radish plant was placed with the lower part of its root standing in water. A soluble red dye was added to the water. After a while, the veins in the leaves of the radish plant became red.

(i) Name the tissue in the radish plant through which the coloured water was transported from the roots to the leaves.

..... [1]

(ii) **On Fig. 3.1**, write the letter **A**, to show the position of this tissue in the root. [1]

(d) The cells in the radish root are plant cells.

Complete Table 3.1 to show which structures are present in plant cells and which are present in animal cells.

Use a tick (✓) to show that the structure is present. Use a cross (✗) to show that the structure is not present.

You should place either a tick or a cross in every space in the table.

Table 3.1

structure	plant cells	animal cells
cell membrane		
cell wall		
nucleus		
vacuole containing sap		

[4]

For Examiner's Use

4 **(a)** A bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.0016 m.

This sound is outside the audible frequency range for humans.

(i) State the approximate audible frequency range for humans.

..... Hz [1]

(ii) State the meaning of the terms *frequency* and *wavelength*, when describing a wave. You may use a diagram if it helps your explanation.

frequency

.....

.....

.....

wavelength

.....

.....

.....

[2]

For Examiner's Use

(b) A girl shouts and waves to another girl in the school playground.

Fig. 4.1

The sound energy and the light energy both travel from one girl to the other by wave motion.

(i) State whether sound waves and light waves are transverse or longitudinal.

Sound waves are ..... .

Light waves are ..... . [2]

(ii) Explain why sound waves will **not** travel through a vacuum.

..... [1]

(iii) If the first girl now makes another sound with a smaller amplitude than the original sound wave, what change would the second girl notice?

..... [1]

(iv) The girls could have communicated with each other using their mobile phones (cell phones).

Name the type of electromagnetic wave used to communicate between mobile phones.

..... [1]

For Examiner's Use

5 Marmots are herbivorous mammals. Fig. 5.1 shows a marmot.

Fig. 5.1

(a) Define the term *herbivore*.

.....

..... [2]

(b) A study has been carried out on the marmots living in Colorado, USA.

The winters in this part of Colorado are very cold. The marmots hibernate (sleep) in burrows in winter. They do not eat while they are hibernating. They wake up in spring.

Before they hibernate, marmots build up large fat stores beneath their skin.

(i) Suggest and explain what marmots must do in order to build up large fat stores in their bodies.

.....

.....

..... [2]

Fig. 5.2 shows the percentage of marmots with different body masses that survive through the winter.

For Examiner's Use

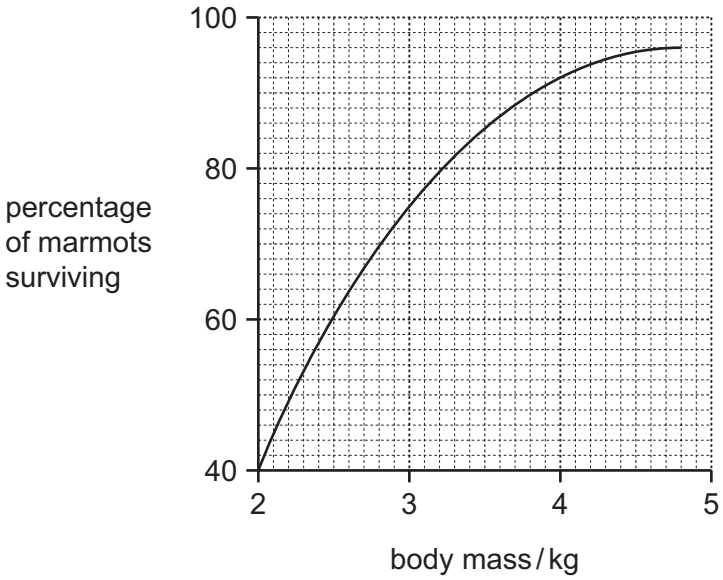


Fig. 5.2

(ii) Describe the relationship between a marmot's body mass and its chance of surviving the winter.

.....

.....

..... [2]

(iii) Suggest how a layer of fat beneath the skin can reduce heat transfer from a hibernating marmot's body to its surroundings.

.....

..... [1]

(c) In the last twenty years, spring has been arriving earlier in the year in Colorado. This is a result of global warming.

Name **two** gases that contribute to global warming.

1 .....

2 ..... [2]

(d) Fig. 5.3 shows the mean body mass of the marmots on the first day of August (summer) between 1976 and 2006.

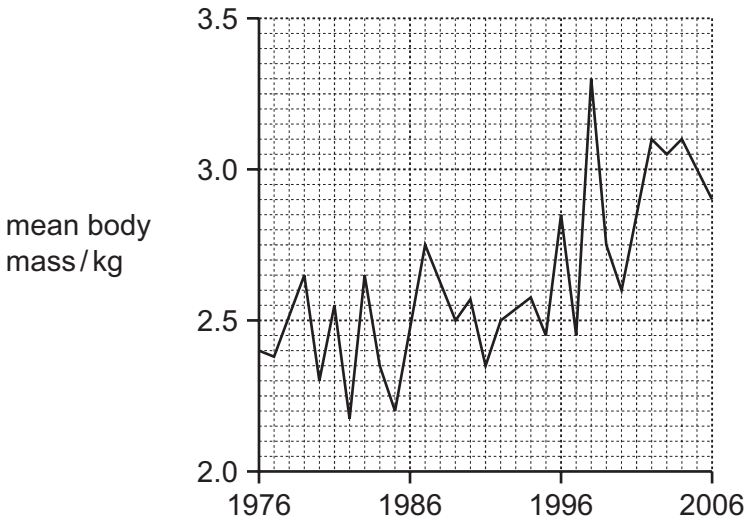


Fig. 5.3

(i) Describe the general trend shown in Fig. 5.3.

.....

..... [1]

(ii) Suggest how the earlier arrival of spring could be responsible for this trend.

.....

..... [1]

6 Fig. 6.1 shows some of the apparatus and substances a student used to investigate the rate of reaction between magnesium and dilute hydrochloric acid. In this reaction hydrogen gas is given off.

For Examiner's Use

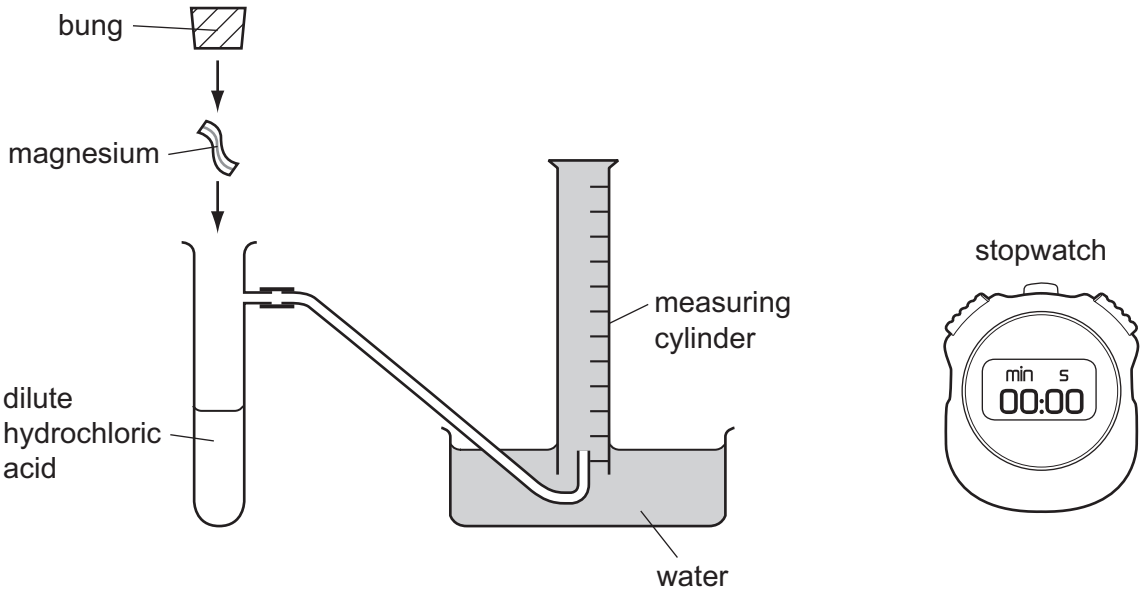


Fig. 6.1

(a) Fig. 6.1 shows the apparatus just before the student started his experiment to measure the rate of reaction.

Describe briefly how the student should proceed and the measurements he should make.

.....

.....

.....

..... [3]

(b) The student repeated the experiment using hydrochloric acid which had a higher concentration. He kept all of the other variables which could affect the rate constant.

Predict and explain briefly how the measurements the student made in the second experiment would be different from those he made in the first.

.....

.....

..... [2]

(c) The reaction between magnesium and dilute hydrochloric acid also produces the ionic compound magnesium chloride.

In crystals of this compound, two chloride ions combine with one magnesium ion.

(i) Describe, in terms of electrons, what happens when a metal atom such as magnesium is converted into an ion.

.....

..... [1]

(ii) State the chemical formula of magnesium chloride.

..... [1]

(d) (i) In the early days of photography, a mixture of chemicals including magnesium powder was burned to provide a flash of brilliant white light.

Suggest why the magnesium had to be in the form of a fine powder.

.....

.....

..... [2]

(ii) Some alloys of aluminium contain magnesium.

Describe **two** properties of aluminium alloys and explain why these properties make them suitable materials for making aircraft parts.

property 1 .....

reason .....

property 2 .....

reason .....

[4]

For Examiner's Use

7 **(a)** State and describe **one** use of radioactive isotopes in medicine.

.....

.....

..... [2]

(b) Alpha, beta and gamma radiations are three types of radioactive emission.

State which of these radiations is described by each statement below.

This form of radiation can pass through lead. .....

This form of radiation consists of nuclei of helium atoms. .....

This form of radiation is part of the electromagnetic spectrum. .....

This form of radiation is the most ionising. .....

[2]

(c) Describe how ionising radiation can be dangerous to humans.

.....

.....

..... [2]

[Turn over

For Examiner's Use

8 An element is a substance that is made of atoms which have the same proton number. Most atoms contain protons, neutrons and electrons.

The elements are shown in the Periodic Table.

(a) The chemical symbol of an atom of the element chlorine is shown below.

$$^{35}_{17}Cl$$

The nucleon number of this atom is 35.

(i) Name the part of an atom that contains the protons and neutrons.

..... [1]

(ii) State the number of neutrons in this chlorine atom.

..... [1]

(iii) Explain whether or not the nucleon number of all chlorine atoms is also 35.

.....

.....

..... [2]

(iv) Name the element whose atoms do **not** usually contain any neutrons.

..... [1]

(b) Table 8.1 shows Period 2 of the Periodic Table.

Table 8.1

	I	II	III	IV	V	VI	VII	0
Period 2	**X**						**Y**	**Z**

The element represented by **X** is a solid at room temperature, and the elements represented by **Y** and **Z** are gases.

(i) Suggest **one** difference, other than physical state at room temperature, between the properties of elements **X** and **Y**.

.....

..... [1]

(ii) Suggest **one** difference between the chemical properties of elements **Y** and **Z**.

.....

..... [1]

(c) Fig. 8.1 shows a simple lime kiln which is used to produce lime (calcium oxide) from limestone (calcium carbonate).

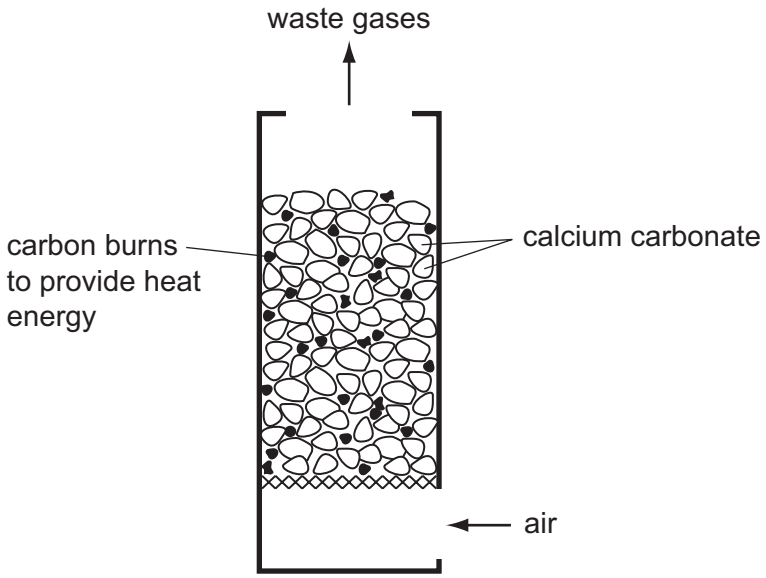


Fig. 8.1

(i) Suggest **two** reasons why the mixture of waste gases from the lime kiln contains a large amount of carbon dioxide.

1 .....

.....

2 .....

.....

[2]

(ii) Suggest and explain why a farmer would add lime to soil.

.....

.....

..... [2]

For Examiner's Use

9 **(a)** One of the characteristics of living organisms is sensitivity, which is the ability to respond to changes in the environment.

List **four** other characteristics of all living things.

1 .....

2 .....

3 .....

4 .....

[2]

(b) In many organisms, hormones help them to respond to changes in their environment.

Define the term *hormone*.

.....

.....

.....

.....

..... [3]

(c) Adrenaline is sometimes called the 'fright, flight or fight' hormone. It is produced when a person is frightened.

One effect of adrenaline is to increase a person's pulse rate. This means that oxygen and glucose are delivered more rapidly to their leg muscles.

Explain how this could help a person to run away from the thing that has frightened them.

.....

.....

.....

..... [2]

(d) Plants are able to respond to light.

For Examiner's Use

Name and describe the response of a plant shoot to light that is coming from only one side.

name of response .....

description .....

..... [2]

10 (a) A student investigated how the change in potential difference across a lamp affected the current flowing through it.

She used wires to connect the components shown in Fig. 10.1 to make a suitable circuit.

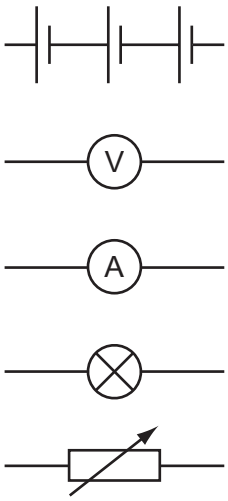


Fig. 10.1

(i) Using the correct symbols from Fig. 10.1, draw a diagram to show the circuit she made.

[3]

(ii) Explain why a variable resistor is used in the circuit.

.....

..... [1]

For Examiner's Use

(iii) During the investigations, she measured the voltage across the lamp as 3.0 V and the current passing through the lamp as 0.3 A.

Calculate the resistance of the lamp.

State the formula that you use and show your working.

formula used

working

..... Ω [2]

(b) Table 10.1 shows some information about six pieces of wire, all at room temperature (20 °C).

Table 10.1

wire	metal composition	length / cm	cross-sectional area / mm^2
A	copper	10	0.5
B	nichrome	10	0.5
C	copper	20	0.5
D	nichrome	20	0.5
E	copper	10	1.0
F	copper	20	1.0

(i) Which wire, **B** or **D**, will have the greater resistance?

Explain your answer.

.....

..... [1]

(ii) Which wire, **A** or **E**, will have the greater resistance?

Explain your answer.

.....

..... [1]

For Examiner's Use

(c) A plastic rod is rubbed with a cloth. The rod becomes charged.

There are two types of electric charge.

(i) State the names of these charges.

1 .....

2 ..... [1]

(ii) Charged particles are transferred between the rod and cloth.

Name the charged particles transferred. ..... [1]

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Please turn over for Question 11.

For Examiner's Use

11 (a) Fig. 11.1 shows part of the human gas exchange system.

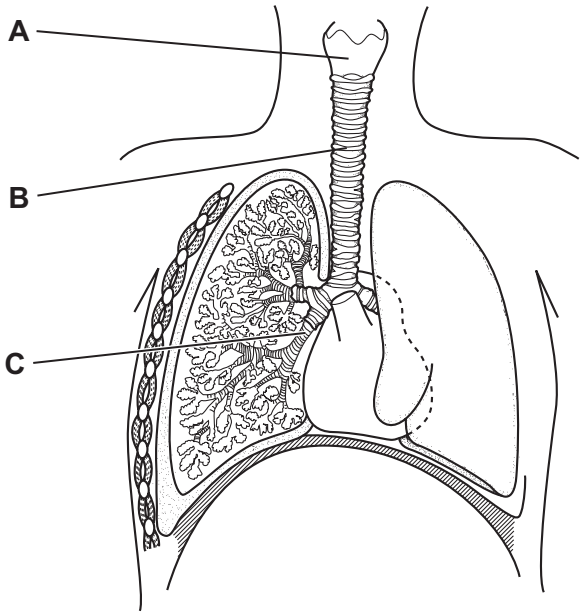


Fig. 11.1

Name the structures labelled **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(b) State **two** ways in which the composition of expired air differs from the composition of inspired air.

1 .....

2 ..... [2]

(c) A person with cystic fibrosis makes very thick mucus. This can form a thick covering over the inner surfaces of the alveoli in the lungs. This makes it difficult for oxygen to move from the alveoli into the blood.

(i) Name the process by which oxygen moves from the alveoli into the blood.

..... [1]

(ii) Name the blood vessel that transports blood from the lungs to the heart.

..... [1]

For Examiner's Use

(d) Cystic fibrosis is caused by a recessive allele **f**. The normal allele, **F**, is dominant.

A couple who were both heterozygous for cystic fibrosis wanted to have children.

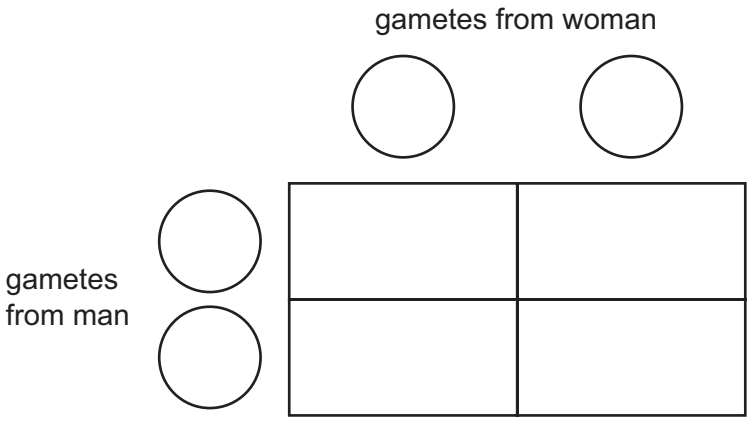
(i) State the probability that their first child would have cystic fibrosis.

..... [1]

(ii) Complete the genetic diagram to explain your answer to **(i)**.

genotype of parents **Ff** .....

gametes ○ and ○ ○ and ○



[4]

12 Millions of tonnes of hydrocarbons are burnt every year to provide energy.

(a) Name the raw material that provides hydrocarbons. ..... [1]

(b) Fig. 12.1 shows apparatus a student used to investigate the products of complete combustion of the gaseous hydrocarbon methane, CH_4.

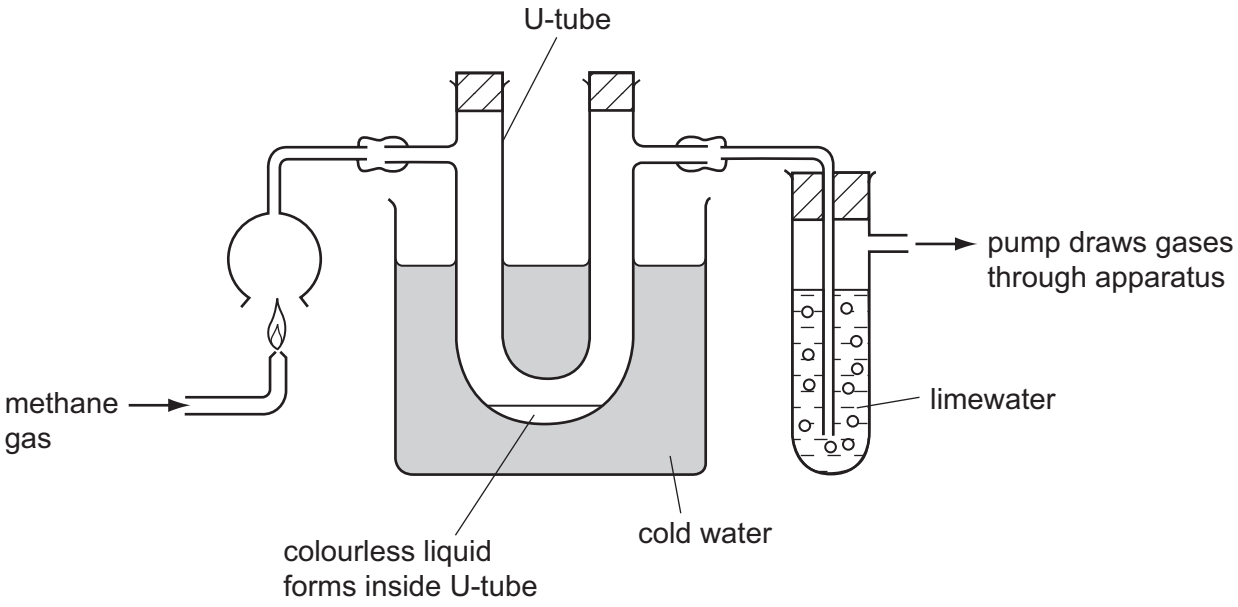


Fig. 12.1

Before the methane gas is ignited, the limewater appears as a colourless solution and the U-tube contains no liquid.

(i) Describe how the appearance of the limewater changes after the methane is ignited, and name the compound that causes this change.

change in appearance .....

name of compound ..... [2]

(ii) Name the colourless liquid that forms inside the U-tube.

..... [1]

(iii) State and explain briefly whether or not the observations made in the experiment shown in Fig. 12.1 would be different if ethanol was burned instead of methane.

.....

..... [1]

(c) In the chemical industry, large quantities of ethanol are made from ethene.

Name the compound that reacts with ethene to form ethanol.

..... [1]

(d) Ethene is a colourless gas. When ethene is heated and pressurised the white solid poly(ethene) is formed.

(i) Name the type of reaction which occurs when poly(ethene) is formed from ethene.

..... [1]

(ii) Describe briefly how ethene molecules are converted into molecules of poly(ethene). You may use a diagram to help your explanation.

.....

.....

..... [2]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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