UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER			

COMBINED SCIENCE   **0653/31**

Paper 3 (Extended)   **May/June 2012**

1 hour 15 minutes

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 24.

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	
Total	

This document consists of **23** printed pages and **1** blank page.

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

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

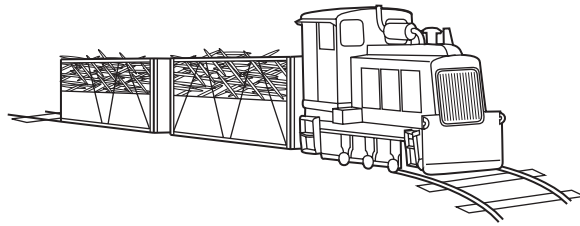Fig. 1.1 shows one of the trains carrying sugar cane.

Fig. 1.1

(a) The mass of the engine and empty trucks is 20 000 kg and the mass of the sugar cane transported is 10 000 kg.

The train travels at a speed of 0.5 m/s.

(i) Calculate the kinetic energy of the loaded train.

State the formula that you use and show your working.

formula used

working

.... [2]

(ii) To travel at this speed, a driving force of 1 000 000 N is needed.

Calculate the work done by the engine of the train when it travels 1 km.

State the formula that you use and show your working.

formula used

working

.... [2]

(iii) It takes the train 5 minutes to travel 1 km. Calculate the power output of the e   *For
                                                                                                    ...iner's*

State the formula that you use and show your working.

formula used

working

.... [2]

(b) 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.
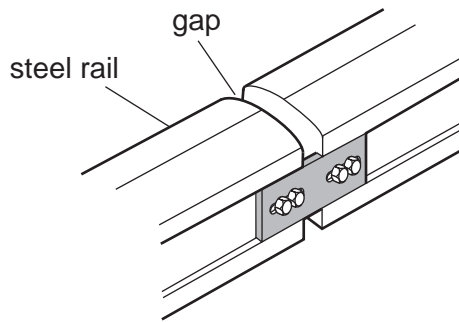

Fig. 1.2

Suggest a reason for leaving these small gaps.

....

....

.... [2]

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

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

   .... [1]

   (b) The electronic structures (configurations) of atoms of three elements, **P**, **Q** and **R** are shown below.

           P   2,8,1   **Q**   2,8   **R**   2,7

   (i) Use the electronic structures to state and explain the group numbers in the Periodic Table that contain elements **P**, **Q** and **R**.

   P   Group ....

   Q   Group ....

   R   Group ....

   explanation ....

   .... [2]

   (ii) State and explain which of the elements, **P**, **Q** or **R**, is the least reactive.

   element ....

   explanation ....

   .... [1]

   (iii) State and explain which **one** of the elements, **P**, **Q** or **R**, is a good conductor of electricity.

   element ....

   explanation ....

   .... [1]

(c) Most metallic elements occur combined with non-metals in the Earth's cru~~...~~ thousands of years, humans have carried out chemical reactions to extract metals their ores.

Fig. 2.1 shows a cross-section through a shaft furnace which was a simple reaction vessel used by ancient civilisations to extract iron.

waste gases escape

outer wall
made of clay

mixture of
raw materials

iron formed
inside the
furnace

air
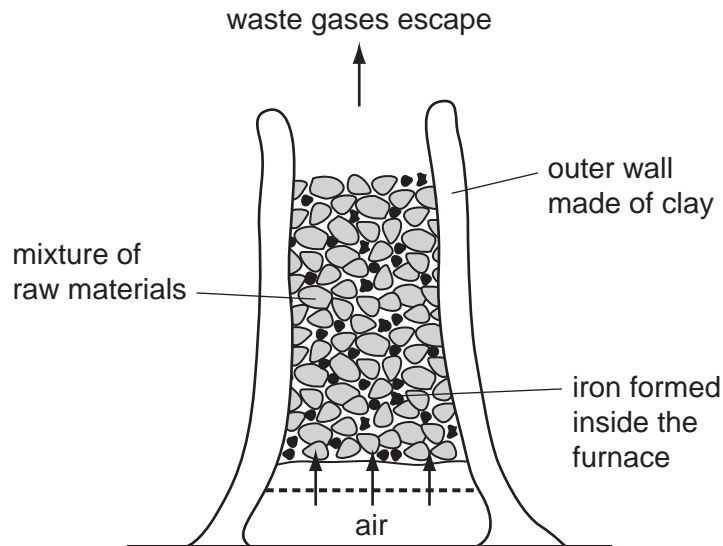
Fig. 2.1

In this shaft furnace the mixture of raw materials consisted of charcoal and iron ore. Charcoal contains mainly carbon, and iron ore contains iron oxide.

Nowadays iron is extracted from iron ore in a blast furnace.

(i) Name another raw material, which is added to a modern blast furnace but which is **not** present in the shaft furnace in Fig. 2.1.

Explain briefly why this material is used.

name of material ....

reason this material is used ....

.... [2]

(ii) Iron is extracted from iron ore when a gaseous oxide of carbon reacts with iron oxide.

Write a **word** chemical equation for this reaction.

.... [2]

(d) (i) Suggest, in terms of relative reactivity, why a mixture of aluminium oxide and carbon does **not** produce any metallic aluminium in a blast furnace.

....

....

.... [2]

(ii) Name the process that is used to extract aluminium from aluminium oxide.

.... [1]

For
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3 Marmots are herbivorous mammals. Fig. 3.1 shows a marmot.
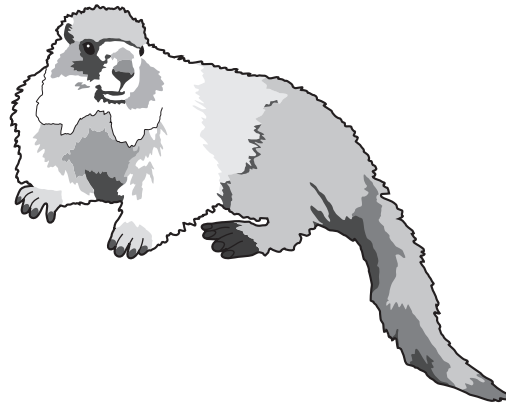
Fig. 3.1

A study has been carried out into the marmots living in Colorado, USA.

The winters in this part of Colorado are so cold that the marmots would not be able to find enough food to eat. Instead, they allow their body temperature to drop much lower than normal and stay inactive for many months. This is called hibernation. They do not eat while they are hibernating. They emerge from hibernation in spring.

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

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

....

....

.... [2]

(b) Fig. 3.2 shows the percentage of marmots with different body masses that s̶ through the winter.

For iner's
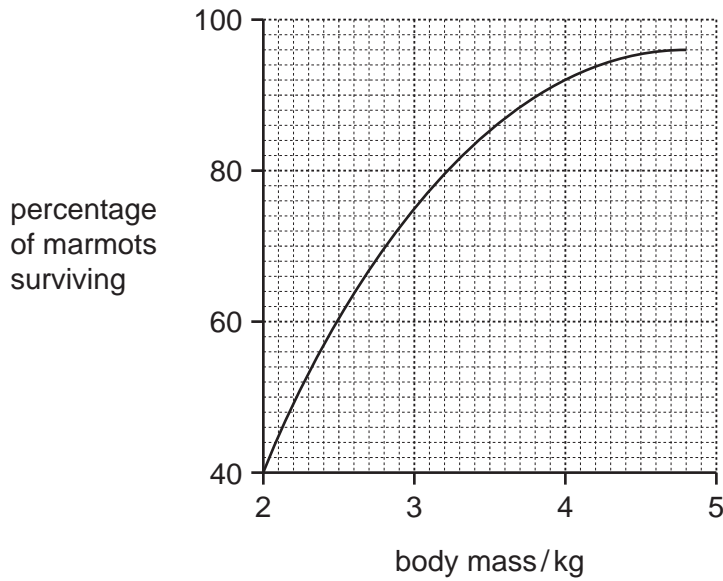
Fig. 3.2

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

....

....

.... [2]

(ii) 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.

Explain how human activities, other than the combustion of fossil fuels, are thought to contribute to global warming.

....

....

....

.... [3]

(d) Fig. 3.3 shows the mean body mass of the marmots on the first day of August (the start of summer) between 1976 and 2006.
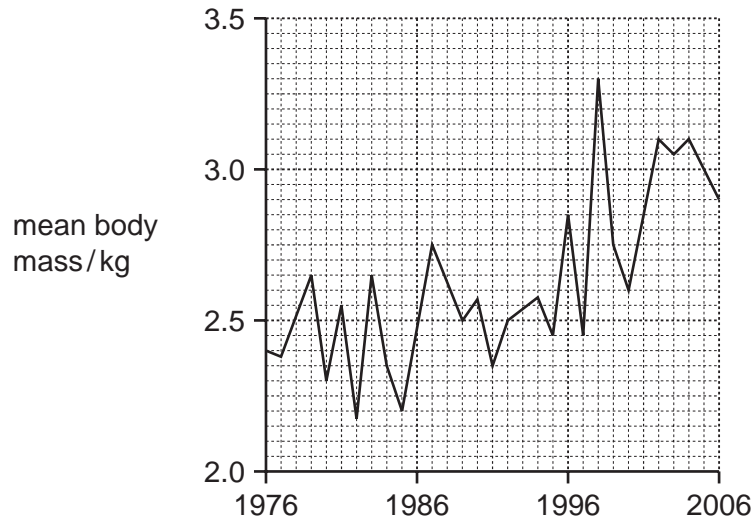
Fig. 3.3

(i) Describe the general trend shown in Fig. 3.3.

....

.... [1]

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

....

.... [1]

4 Fig. 4.1 shows the apparatus a student used to investigate the effect of changing the concentration on the rate of reaction between excess dilute hydrochloric acid and magnesium. At the start of the experiment the measuring cylinder contained no gas and was full of water.
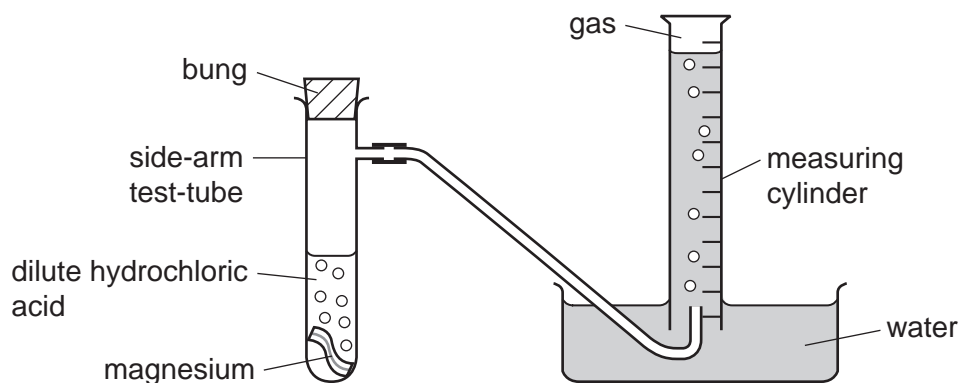
Fig. 4.1

To carry out his investigation the student used the following method.

- He dropped the magnesium into the dilute acid.

- He immediately placed the bung into the side-arm test-tube and started a stopclock.

- He measured the volume of gas in the measuring cylinder every half minute, for eight minutes.

He carried out two experiments, **A** and **B**, in which the only variable that he changed was the concentration of the hydrochloric acid.

(a) State **two** other variables that the student needed to keep the same in experiments **A** and **B**.

1 ....

2 .... [1]

(b) Fig. 4.2 shows the results the student obtained for experiments **A** and **B**.
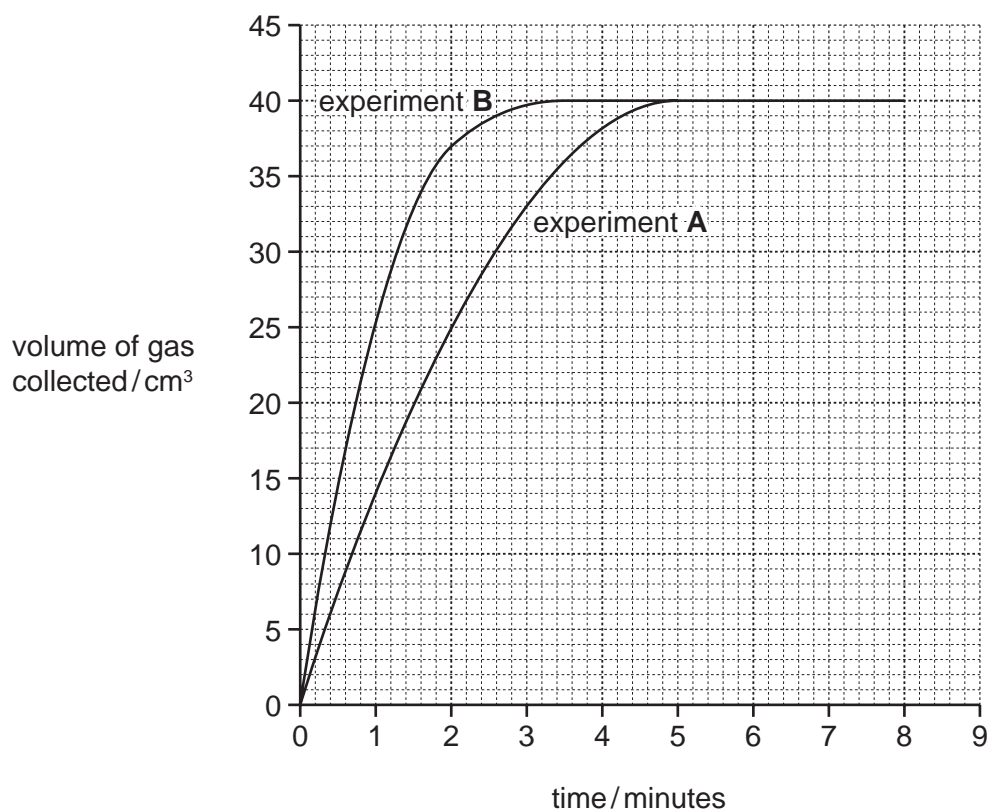
Fig. 4.2

(i) In which experiment, **A** or **B**, did the student use hydrochloric acid which had the higher concentration?

Explain your answer.

experiment ....

explanation ....

....

.... [1]

(ii) The student was told that he could calculate the average rate of reaction usi

$$\text{average rate of reaction} = \frac{\text{maximum volume of gas collected}}{\text{minimum time taken to collect maximum volume}}$$

Use the information in Fig. 4.2 to calculate the average rate of reaction for experiment **A**.

Show your working and state the units.

.... [3]

(c) The balanced symbolic equation for the reaction between hydrochloric acid and magnesium is shown below.

$$Mg\ (s)\ +\ 2HCl\ (aq)\ \longrightarrow\ MgCl_2\ (aq)\ +\ H_2\ (g)$$
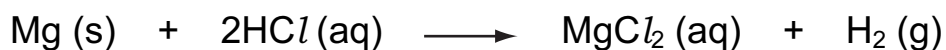
(i) What is meant by the state symbol (aq) in this equation?

.... [1]

(ii) Suggest why the reaction in both experiments **A** and **B** above produced the same volume of gas.

....

....

.... [2]

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Please turn over for Question 5.

5 **(a)** A bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.00

   (i) This sound is outside the audible frequency range for humans.

   State the approximate audible frequency range for humans.

   .... [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]

   (iii) Calculate the speed of the sound wave produced by the bat.

   State the formula that you use and show your working.

      formula used

      working

   .... [2]

For
iner's

(iv) Sound travels through the air by a series of compressions and rarefactions.

Describe what this means in terms of air particles.

....

....

.... [2]

(b) A girl shouts and waves to another girl in the school playground as shown in Fig. 5.1.

Fig. 5.1

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) 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]

6 Fig. 6.1 shows part of a section across a root from a radish plant, photographed through microscope.
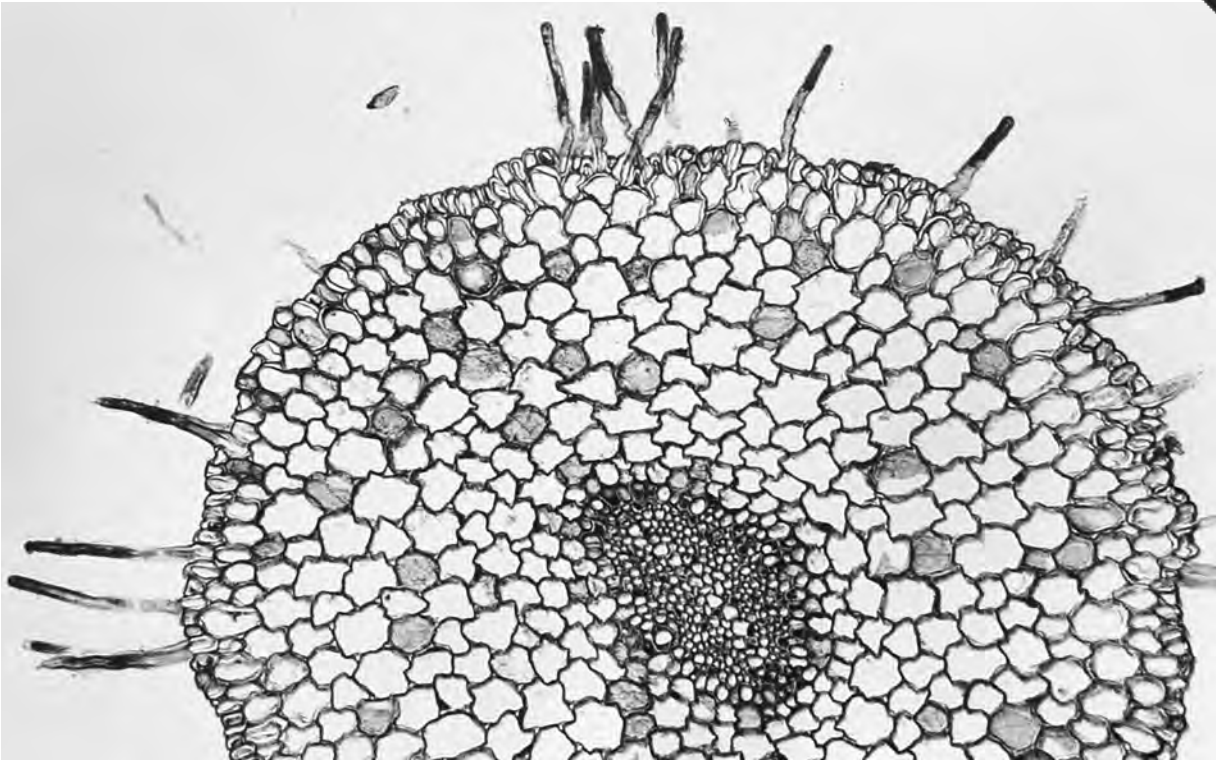
Fig. 6.1

(a) **On Fig. 6.1**, use a label line to label a root hair cell. [1]

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

   (i) State **one** other function of root hair cells.

   .... [1]

   (ii) Explain how root hair cells are adapted for their functions.

   ....

   ....

   .... [2]
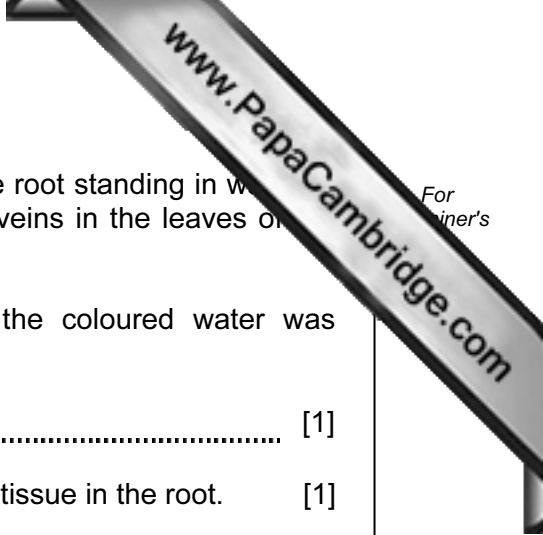
(c) A complete radish plant was placed with the lower part of the root standing in w~~ater~~. soluble red dye was added to the water. After a while, the veins in the leaves o~~f the~~ radish plant became red.

  (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. 6.1**, write the letter **A** to show the position of this tissue in the root.   [1]

  (iii) Water was drawn up through the radish plant because water vapour was constantly escaping from its leaves. A plastic bag was placed over the leaves of the radish plant, and the water vapour formed colourless droplets of liquid water on the bag as it condensed.

Explain why these water droplets were not red.

....

....

.... [2]

7 **(a)** **(i)** Draw a circuit diagram that a student could use to investigate how the cha
potential difference across a lamp affects the current flowing through it.

[3]

(ii) During his investigations, the student 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

.... [2]

(b) Table 7.1 shows some information about six pieces of wire, all at room temp (20 °C).

Table 7.1

wire	metal composition	length/cm	cross-sectional area/mm²
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.

  wire ....

  .... [1]

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

  Explain your answer.

  wire ....

  .... [1]

(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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iner's

8   Hydrocarbons are compounds that contain carbon and hydrogen only.

The hydrocarbon that contains the simplest molecules is methane.

(a) (i)   The diagrams below show an atom of carbon and an atom of hydrogen.
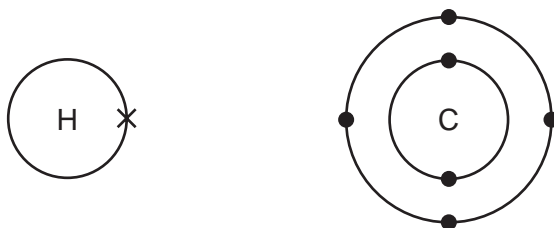
Complete the covalent bonding diagram of a molecule of methane to show how the bonding electrons are arranged.
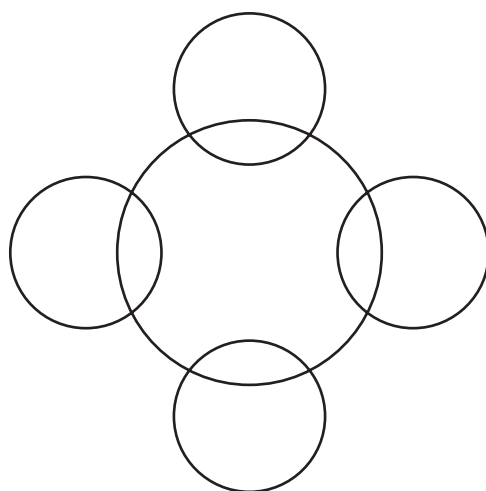
[2]

(ii)   Complete the molecular structure diagrams below to show molecules of the hydrocarbons ethane and ethene.

ethane	H—C
ethene	C | H

[2]

(b) In many countries, ethanol, C_2H_6O , is added to hydrocarbon fuels such as gaso

The products of complete combustion of ethanol are the same as those
hydrocarbons such as methane.

Suggest the **word** chemical equation for the complete combustion of ethanol.

.... [2]

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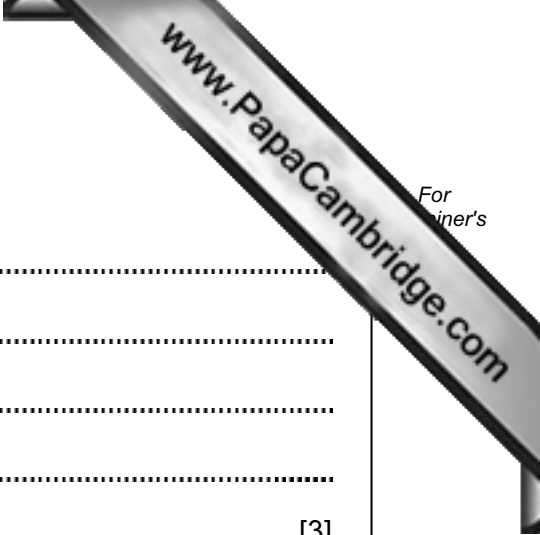
9 **(a)** Define the term *hormone*.

....

....

....

....

.... [3]

(b) 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.

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

....

....

....

.... [2]

(c) Plants also produce hormones. One plant hormone is auxin. Auxin helps plant shoots to respond to light coming from only one direction.

   (i) State the correct term for the growth response of a plant to light coming from only one direction.

.... [1]

(ii) Explain how auxin helps a plant shoot respond to light coming from on̶ direction. You may use a diagram as part of your explanation.

....

....

....

....

.... [3]

DATA SHEET
The Periodic Table of the Elements

Group

I	II	III	IV	V	VI	VII	0
							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

H — Hydrogen 1

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 †															

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

| 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 | 231 **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 |

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