UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3991318441

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.

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.

0653/31/M/J/12

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

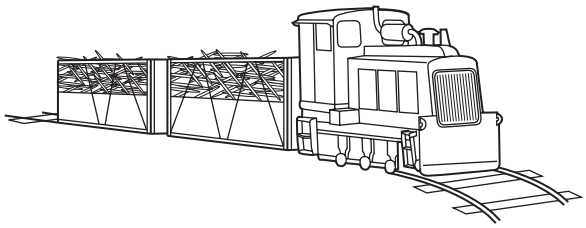


Fig. 1.1

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.

0653/31/M/J/12

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]

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

0653/31/M/J/12

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]

For Examiner's Use

1 a (iii) It takes the train 5 minutes to travel 1 km. Calculate the power output of the engine.

State the formula that you use and show your working. 0653/31/M/J/12

formula used

working

..... [2]

1 (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.

0653/31/M/J/12

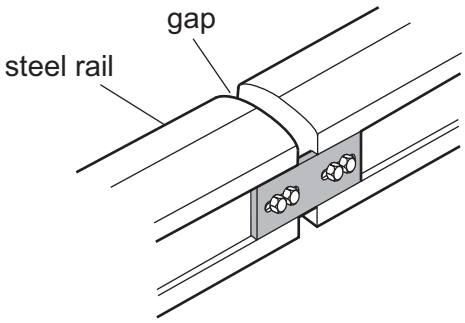


Fig. 1.2

Suggest a reason for leaving these small gaps.

.....

.....

..... [2]

For Examiner's Use

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

0653/31/M/J/12

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

.....

[1]

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

0653/31/M/J/12

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

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

0653/31/M/J/12

P Group .....

Q Group .....

R Group .....

explanation .....

.....

[2]

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

0653/31/M/J/12

element .....

explanation .....

.....

[1]

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

0653/31/M/J/12

element .....

explanation .....

.....

[1]

For Examiner's Use

2 (c) Most metallic elements occur combined with non-metals in the Earth's crust. For thousands of years, humans have carried out chemical reactions to extract metals from 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. 0653/31/M/J/12

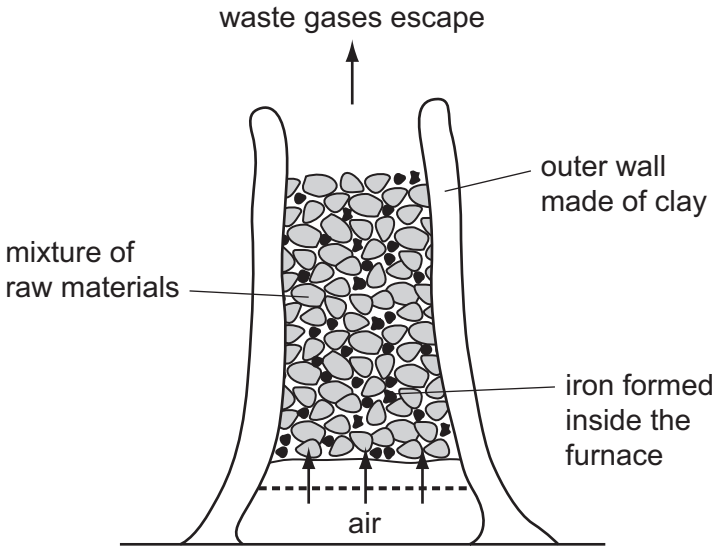


Fig. 2.1

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.

2 c (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. 0653/31/M/J/12

Explain briefly why this material is used.

name of material .....

reason this material is used .....

..... [2]

2 c (ii) Iron is extracted from iron ore when a gaseous oxide of carbon reacts with iron oxide. 0653/31/M/J/12

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

..... [2]

For Examiner's Use

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.

0653/31/M/J/12

.....

.....

..... [2]

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

0653/31/M/J/12

..... [1]

For Examiner's Use

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.

3 (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.

0653/31/M/J/12

.....

.....

..... [2]

For Examiner's Use

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

0653/31/M/J/12

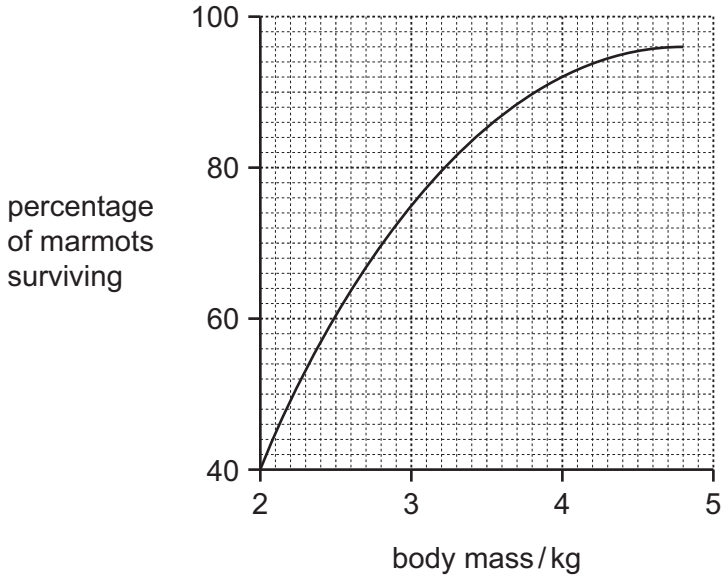


Fig. 3.2

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

0653/31/M/J/12

.....

.....

..... [2]

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

0653/31/M/J/12

.....

..... [1]

3 (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.

0653/31/M/J/12

.....

.....

.....

.....

..... [3]

For Examiner's Use

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

0653/31/M/J/12

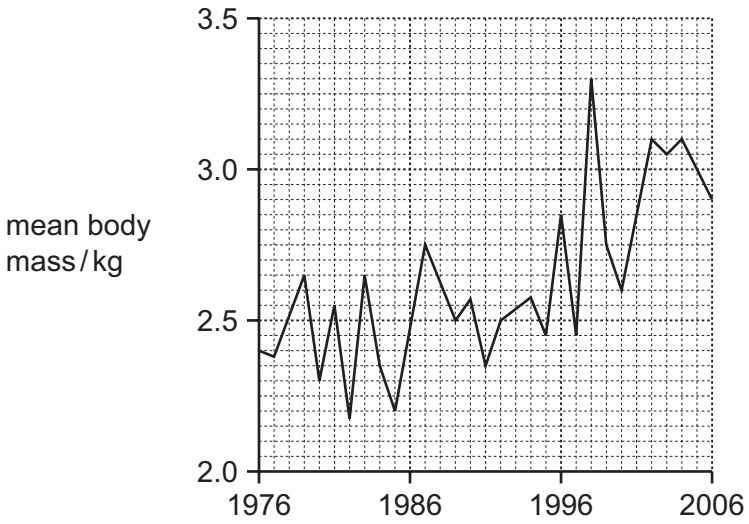


Fig. 3.3

3 d (i) Describe the general trend shown in Fig. 3.3. 0653/31/M/J/12

.....

..... [1]

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

0653/31/M/J/12

.....

..... [1]

For Examiner's Use

4 Fig. 4.1 shows the apparatus a student used to investigate the effect of changing the acid 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.

0653/31/M/J/12

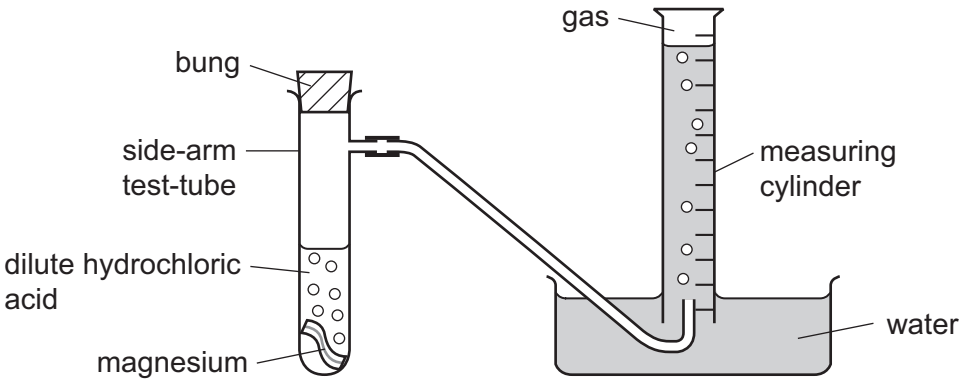


Fig. 4.1

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.

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

0653/31/M/J/12

1 .....

2 ..... [1]

For Examiner's Use

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

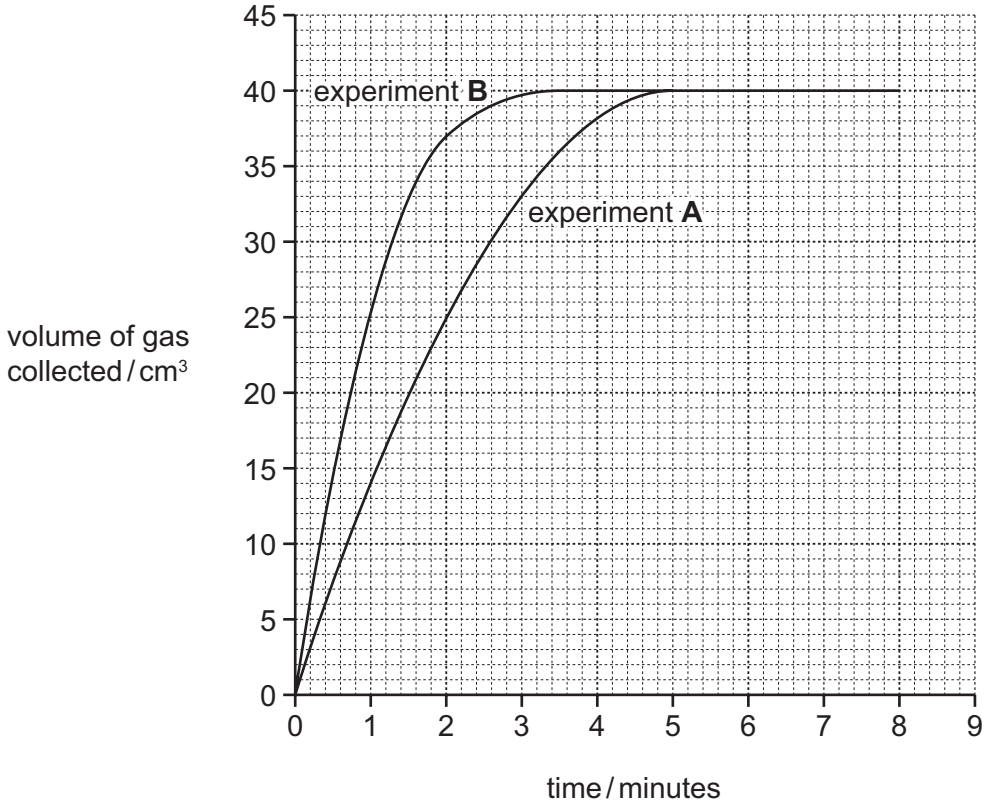


Fig. 4.2

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

0653/31/M/J/12

Explain your answer.

experiment .....

explanation .....

.....

..... [1]

For Examiner's Use

4 b (ii) The student was told that he could calculate the average rate of reaction using:

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

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

Show your working and state the units.

0653/31/M/J/12

..... [3]

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

0653/31/M/J/12

$$Mg\,(s) + 2HCl\,(aq) \longrightarrow MgCl_2\,(aq) + H_2\,(g)$$

4 c (i) What is meant by the state symbol (aq) in this equation?

0653/31/M/J/12

..... [1]

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

0653/31/M/J/12

.....

.....

..... [2]

BLANK PAGE

Please turn over for Question 5.

For Examiner's Use

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

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

State the approximate audible frequency range for humans. 0653/31/M/J/12

..... [1]

5 a (ii) State the meaning of the terms *frequency* and *wavelength*, when describing a wave. You may use a diagram if it helps your explanation. 0653/31/M/J/12

frequency

.....

.....

.....

wavelength

.....

.....

.....

[2]

5 a (iii) Calculate the speed of the sound wave produced by the bat. 0653/31/M/J/12

State the formula that you use and show your working.

formula used

working

..... [2]

For Examiner's Use

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

Describe what this means in terms of air particles.

0653/31/M/J/12

.....

.....

..... [2]

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

0653/31/M/J/12

Fig. 5.1

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

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

0653/31/M/J/12

Sound waves are ..... .

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

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

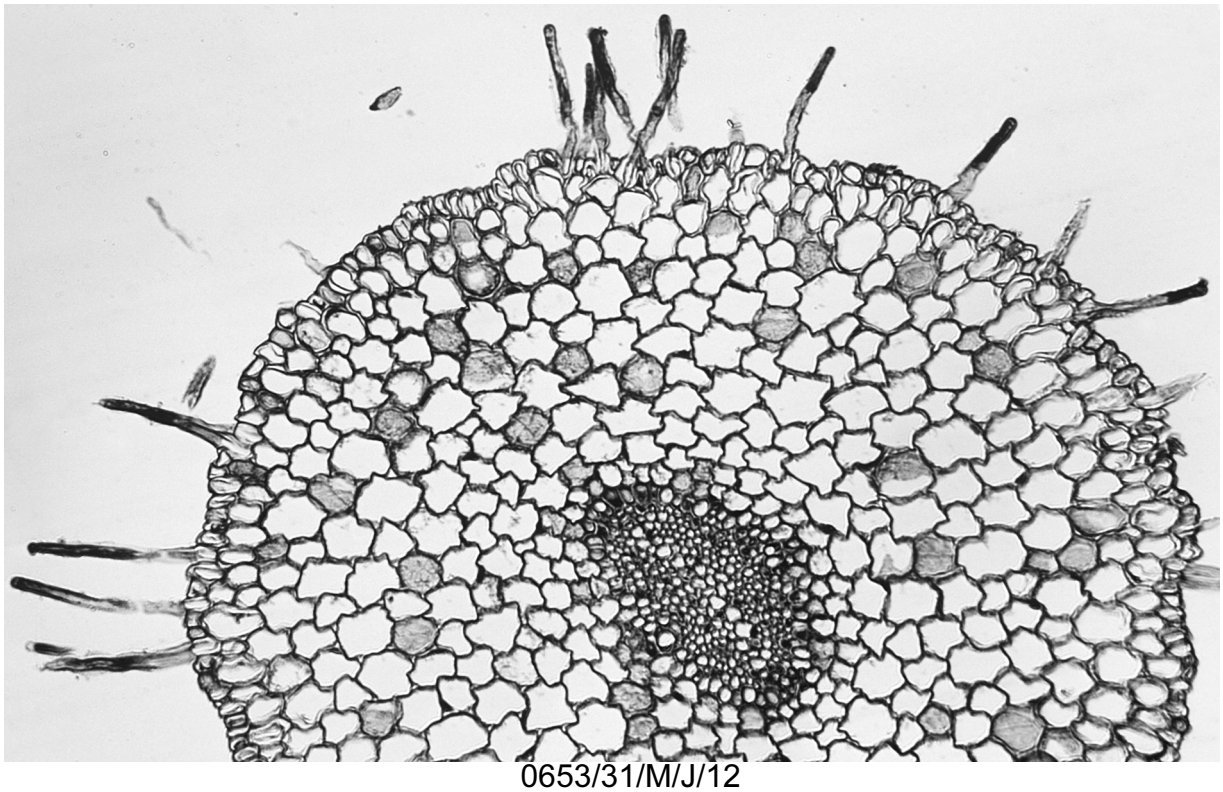
Name the type of electromagnetic wave used to communicate between mobile phones.

0653/31/M/J/12

..... [1]

For Examiner's Use

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



0653/31/M/J/12

Fig. 6.1

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

0653/31/M/J/12

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

0653/31/M/J/12

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

..... [1]

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

0653/31/M/J/12

.....

.....

..... [2]

For Examiner's Use

6 (c) A complete radish plant was placed with the lower part of the 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.

0653/31/M/J/12

..... [1]

6 c (ii) **On Fig. 6.1**, write the letter **A** to show the position of this tissue in the root. [1]

0653/31/M/J/12

6 c (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.

0653/31/M/J/12

Explain why these water droplets were not red.

.....

.....

..... [2]

For Examiner's Use

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

0653/31/M/J/12

[3]

7 **a (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.

0653/31/M/J/12

Calculate the resistance of the lamp.

State the formula that you use and show your working.

formula used

working

..... [2]

For Examiner's Use

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

Table 7.1

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

7 b **(i)** Which wire, **B** or **D**, will have the greater resistance? 0653/31/M/J/12

Explain your answer.

wire .....

..... [1]

7 b **(ii)** Which wire, **A** or **E**, will have the greater resistance? 0653/31/M/J/12

Explain your answer.

wire .....

..... [1]

7 **(c)** A plastic rod is rubbed with a cloth. 0653/31/M/J/12

The rod becomes charged.

There are two types of electric charge.

7 c **(i)** State the names of these charges. 0653/31/M/J/12

1 .....

2 ..... [1]

7 c **(ii)** Charged particles are transferred between the rod and cloth. 0653/31/M/J/12

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

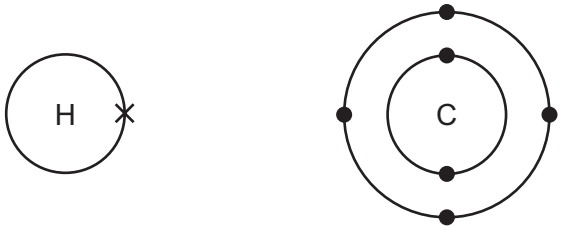
For Examiner's Use

8 Hydrocarbons are compounds that contain carbon and hydrogen only.

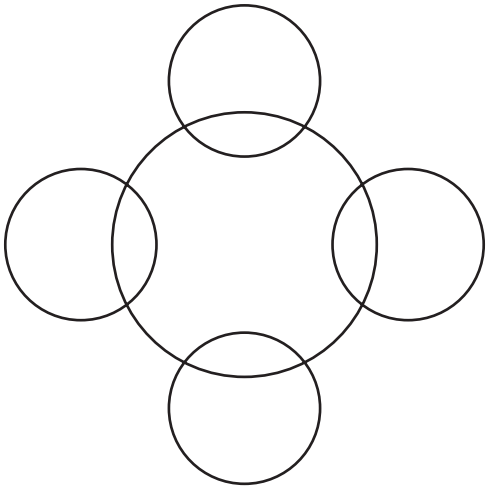
The hydrocarbon that contains the simplest molecules is methane.

8 (a) (i) The diagrams below show an atom of carbon and an atom of hydrogen.

0653/31/M/J/12



Complete the covalent bonding diagram of a molecule of methane to show how the bonding electrons are arranged.



[2]

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

0653/31/M/J/12

ethane	H—C
ethene	C | H

[2]

For Examiner's Use

8 **(b)** In many countries, ethanol, C_2H_6O , is added to hydrocarbon fuels such as gasoline.

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

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

0653/31/M/J/12

.....

[2]

9 (a) Define the term *hormone*.

0653/31/M/J/12

For Examiner's Use

.....

.....

.....

.....

..... [3]

9 (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.

0653/31/M/J/12

.....

.....

.....

..... [2]

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

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

0653/31/M/J/12

..... [1]

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

For Examiner's Use

.....

.....

.....

.....

..... [3]

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 = 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.).