



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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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	
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3	
4	
5	
6	
7	
8	
9	
Total	

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



- 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.

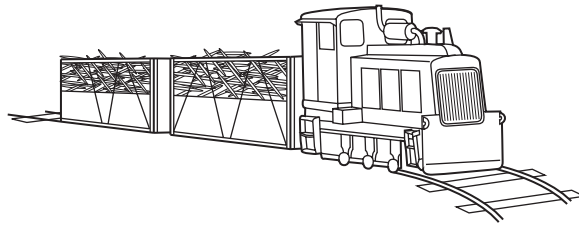


Fig. 1.1

- (a) The 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 engine.

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.

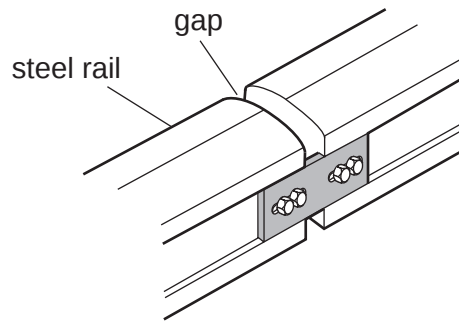


Fig. 1.2

Suggest a reason for leaving these small gaps.

.....

 [2]

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

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Use

(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 crust. For thousands of years, humans have carried out chemical reactions to extract metals from their ores.

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

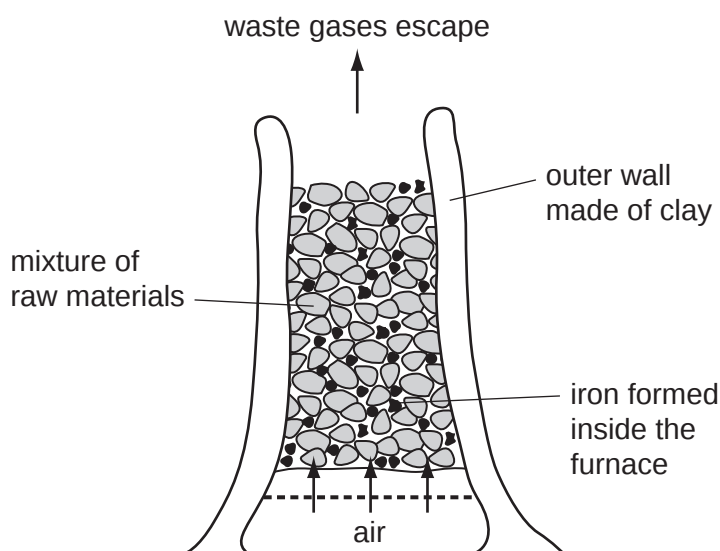


Fig. 2.1

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.

*For
Examiner's
Use*

.....

.....

..... [2]

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

..... [1]

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

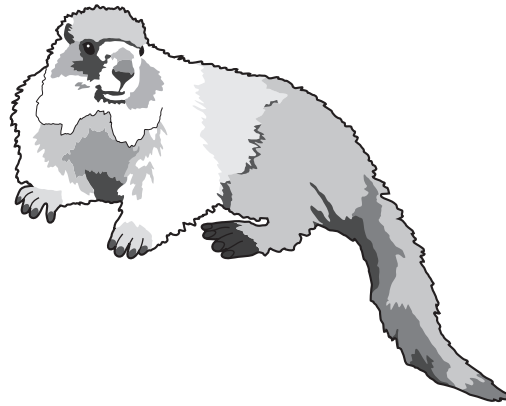


Fig. 3.1

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]

For
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Use

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

For
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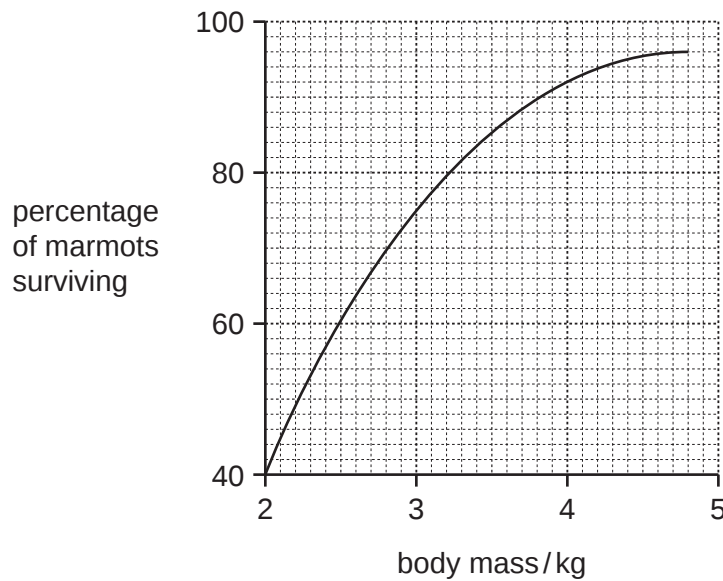


Fig. 3.2

- (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 (during summer) between 1976 and 2006.

For
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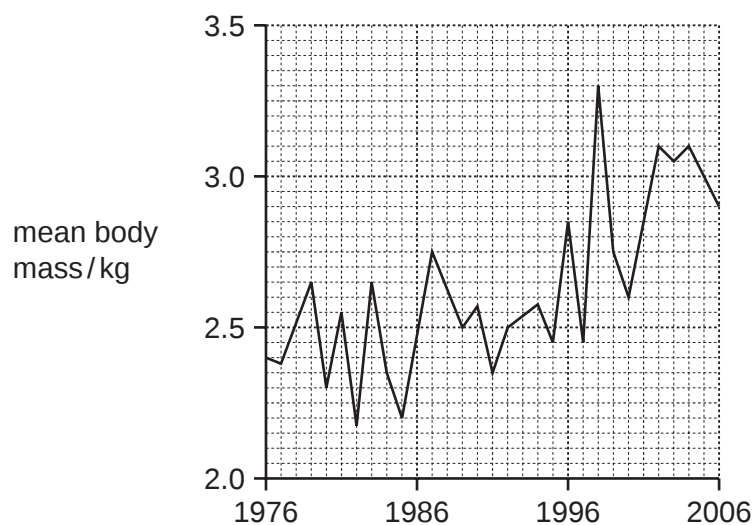


Fig. 3.3

- (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 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.

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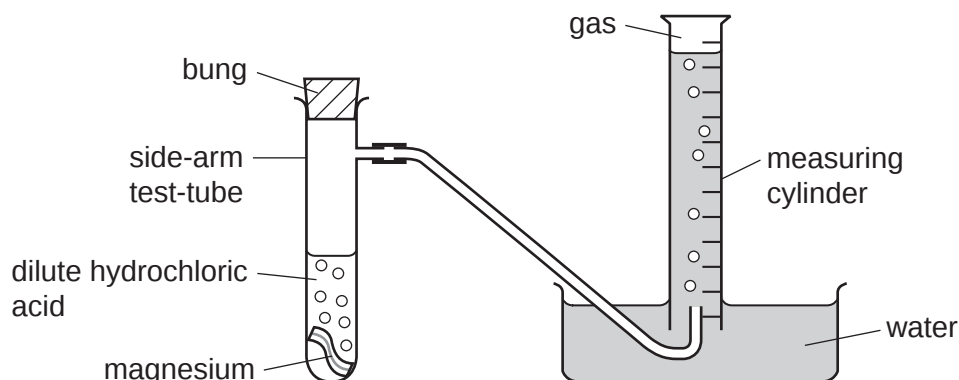


Fig. 4.1

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**.

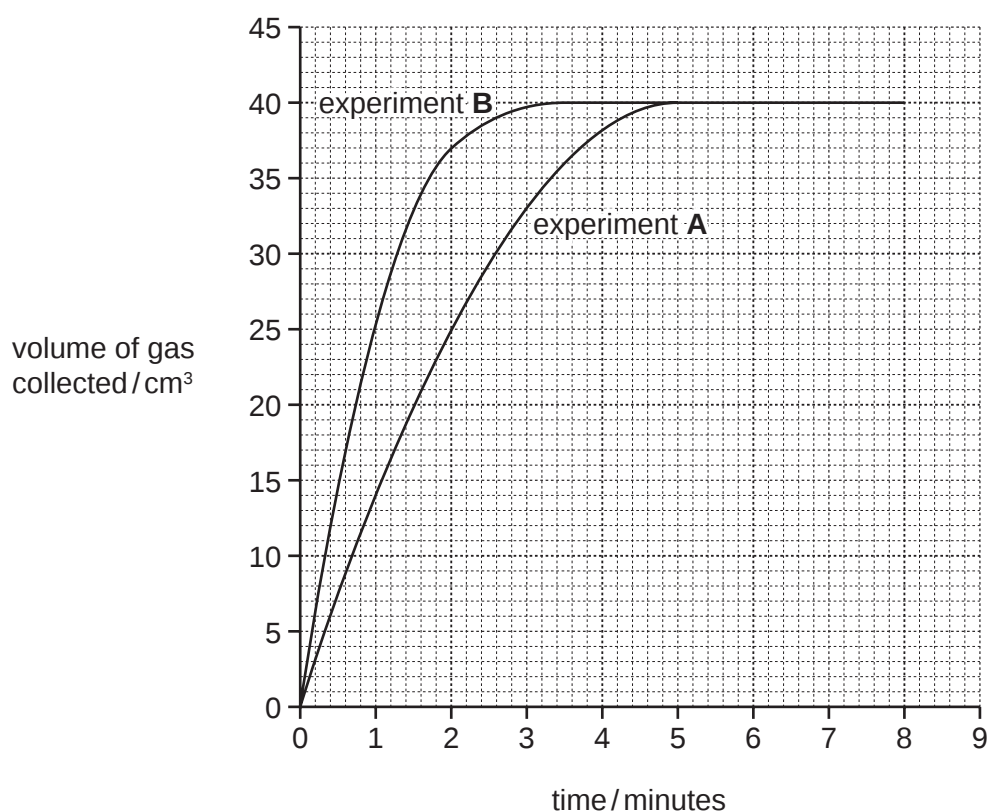


Fig. 4.2

- (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 using:

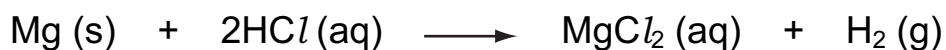
$$\text{average rate of reaction} = \frac{\text{maximum volume of gas collected}}{\text{minimum time taken to collect maximum volume}}$$

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

Show your working and state the units.

..... [3]

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



- (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 0.0016 m.

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Use

- (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]

- (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 a microscope.

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Examiner's
Use

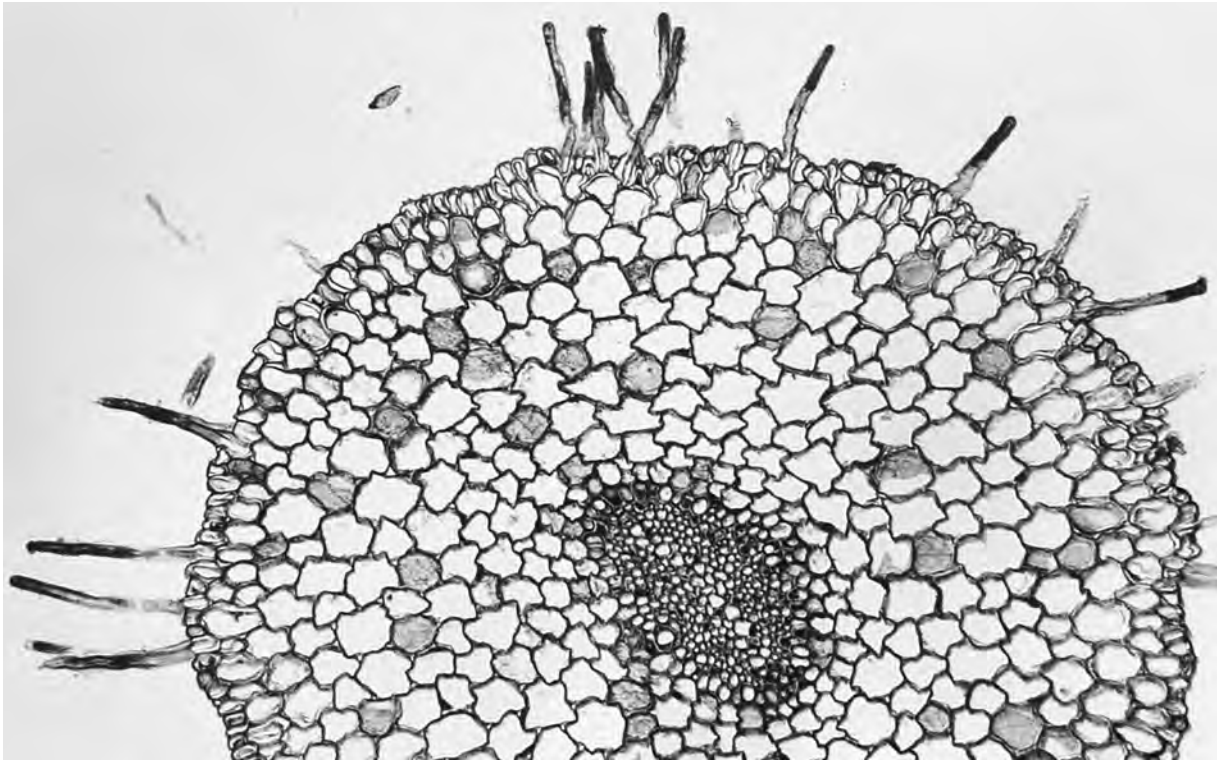


Fig. 6.1

- (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 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. 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 change in potential difference across a lamp affects the current flowing through it.

For
Examiner's
Use

[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 temperature (20 °C).

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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

- (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]

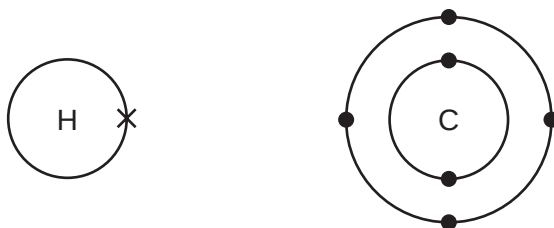
- (ii) Charged particles are transferred between the rod and cloth.

Name the charged particles transferred. [1]

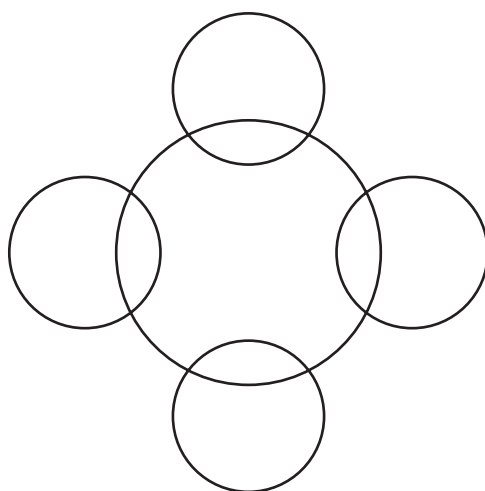
- 8 Hydrocarbons are compounds that contain carbon and hydrogen only.

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	$\begin{array}{c} \text{C} \\ \\ \text{H} \end{array}$

[2]

- (b) In many countries, ethanol, $\text{C}_2\text{H}_6\text{O}$, 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.

..... [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 only one direction. You may use a diagram as part of your explanation.

For
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.....

.....

.....

.....

..... [3]

Copyright Acknowledgements:

Question 6 Photograph

© B23WP8 cross section of a radish root; Biodisc/Visuals Unlimited/Alamy.

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DATA SHEET
The Periodic Table of the Elements

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7 Li Lithium	9 Be Beryllium													11 B Boron	12 C Carbon	14 N Nitrogen	16 O Oxygen	19 F Fluorine	20 Ne Neon																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
23 Na Sodium	24 Mg Magnesium													27 Al Aluminium	28 Si Silicon	31 P Phosphorus	32 S Sulfur	35.5 Cl Chlorine	40 Ar Argon																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	70 Ga Gallium	73 Ge Germanium	75 As Arsenic	79 Se Selenium	80 Br Bromine	84 Kr Krypton																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	101 Ru Ruthenium	101 Rh Rhodium	103 Pd Palladium	106 Ag Silver	108 Cd Cadmium	112 In Indium	115 Sn Tin	119 Sb Antimony	122 Te Tellurium	127 I Iodine	131 Xe Xenon	136 Ba Barium																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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Lutetium	201 La Lanthanum	202 Ce Cerium	203 Pr Praseodymium	204 Nd Neodymium	205 Pm Promethium	206 Sm Samarium	207 Eu Europium	208 Gd Gadolinium	209 Tb Terbium	210 Dy Dysprosium	211 Ho Holmium	212 Er Erbium	213 Tm Thulium	214 Yb Ytterbium	215 Lu Lutetium	216 La Lanthanum	217 Ce Cerium	218 Pr Praseodymium	219 Nd Neodymium	220 Pm Promethium	221 Sm Samarium	222 Eu Europium	223 Gd Gadolinium	224 Tb Terbium	225 Dy Dysprosium	226 Ho Holmium	227 Er Erbium	228 Tm Thulium	229 Yb Ytterbium	230 Lu Lutetium	231 La Lanthanum	232 Ce Cerium	233 Pr Praseodymium	234 Nd Neodymium	235 Pm Promethium	236 Sm Samarium	237 Eu Europium	238 Gd Gadolinium	239 Tb Terbium	240 Dy Dysprosium	241 Ho Holmium	242 Er Erbium	243 Tm Thulium	244 Yb Ytterbium	245 Lu Lutetium	246 La Lanthanum	247 Ce Cerium	248 Pr Praseodymium	249 Nd Neodymium	250 Pm Promethium	251 Sm Samarium	252 Eu Europium	253 Gd Gadolinium	254 Tb Terbium	255 Dy Dysprosium	256 Ho Holmium	257 Er Erbium	258 Tm Thulium	259 Yb Ytterbium	260 Lu Lutetium	261 La Lanthanum	262 Ce Cerium	263 Pr Praseodymium	264 Nd Neodymium	265 Pm Promethium	266 Sm Samarium	267 Eu Europium	268 Gd Gadolinium	269 Tb Terbium	270 Dy Dysprosium	271 Ho Holmium	272 Er Erbium	273 Tm Thulium	274 Yb Ytterbium	275 Lu Lutetium	276 La Lanthanum	277 Ce Cerium	278 Pr Praseodymium	279 Nd Neodymium	280 Pm Promethium	281 Sm Samarium	282 Eu Europium	283 Gd Gadolinium	284 Tb Terbium	285 Dy Dysprosium	286 Ho Holmium	287 Er Erbium	288 Tm Thulium	289 Yb Ytterbium	290 Lu Lutetium	291 La Lanthanum	292 Ce Cerium	293 Pr Praseodymium	294 Nd Neodymium	295 Pm Promethium	296 Sm Samarium	297 Eu Europium	298 Gd Gadolinium	299 Tb Terbium	300 Dy Dysprosium	301 Ho Holmium	302 Er Erbium	303 Tm Thulium	304 Yb Ytterbium	305 Lu Lutetium	306 La Lanthanum	307 Ce Cerium	308 Pr Praseodymium	309 Nd Neodymium	310 Pm Promethium	311 Sm Samarium	312 Eu Europium	313 Gd Gadolinium	314 Tb Terbium	315 Dy Dysprosium	316 Ho Holmium	317 Er Erbium	318 Tm Thulium	319 Yb Ytterbium	320 Lu Lutetium	321 La Lanthanum	322 Ce Cerium	323 Pr Praseodymium	324 Nd Neodymium	325 Pm Promethium	326 Sm Samarium	327 Eu Europium	328 Gd Gadolinium	329 Tb Terbium	330 Dy Dysprosium	331 Ho Holmium	332 Er Erbium	333 Tm Thulium	334 Yb Ytterbium	335 Lu Lutetium	336 La Lanthanum	337 Ce Cerium	338 Pr Praseodymium	339 Nd Neodymium	340 Pm Promethium	341 Sm Samarium	342 Eu Europium	343 Gd Gadolinium	344 Tb Terbium	345 Dy Dysprosium	346 Ho Holmium	347 Er Erbium	348 Tm Thulium	349 Yb Ytterbium	350 Lu Lutetium	351 La Lanthanum	352 Ce Cerium	353 Pr Praseodymium	354 Nd Neodymium	355 Pm Promethium	356 Sm Samarium	357 Eu Europium	358 Gd Gadolinium	359 Tb Terbium	360 Dy Dysprosium	361 Ho Holmium	362 Er Erbium	363 Tm Thulium	364 Yb Ytterbium	365 Lu Lutetium	366 La Lanthanum	367 Ce Cerium	368 Pr Praseodymium	369 Nd Neodymium	370 Pm Promethium	371 Sm Samarium	372 Eu Europium	373 Gd Gadolinium	374 Tb Terbium	375 Dy Dysprosium	376 Ho Holmium	377 Er Erbium	378 Tm Thulium	379 Yb Ytterbium	380 Lu Lutetium	381 La Lanthanum	382 Ce Cerium	383 Pr Praseodymium	384 Nd Neodymium	385 Pm Promethium	386 Sm Samarium	387 Eu Europium	388 Gd Gadolinium	389 Tb Terbium	390 Dy Dysprosium	391 Ho Holmium	392 Er Erbium	393 Tm Thulium	394 Yb Ytterbium	395 Lu Lutetium	396 La Lanthanum	397 Ce Cerium	398 Pr Praseodymium	399 Nd Neodymium	400 Pm Promethium	401 Sm Samarium	402 Eu Europium	403 Gd Gadolinium	404 Tb Terbium	405 Dy Dysprosium	406 Ho Holmium	407 Er Erbium	408 Tm Thulium	409 Yb Ytterbium	410 Lu Lutetium	411 La Lanthanum	412 Ce Cerium	413 Pr Praseodymium	414 Nd Neodymium	415 Pm Promethium	416 Sm Samarium	417 Eu Europium	418 Gd Gadolinium	419 Tb Terbium	420 Dy Dysprosium	421 Ho Holmium	422 Er Erbium	423 Tm Thulium	424 Yb Ytterbium	425 Lu Lutetium	426 La Lanthanum	427 Ce Cerium	428 Pr Praseodymium	429 Nd Neodymium	430 Pm Promethium	431 Sm Samarium	432 Eu Europium	433 Gd Gadolinium	434 Tb Terbium	435 Dy Dysprosium	436 Ho Holmium	437 Er Erbium	438 Tm Thulium	439 Yb Ytterbium	440 Lu Lutetium	441 La Lanthanum	442 Ce Cerium	443 Pr Praseodymium	444 Nd Neodymium	445 Pm Promethium	446 Sm Samarium	447 Eu Europium	448 Gd Gadolinium	449 Tb Terbium	450 Dy Dysprosium	451 Ho Holmium	452 Er Erbium	453 Tm Thulium	454 Yb Ytterbium	455 Lu Lutetium	456 La Lanthanum	457 Ce Cerium	458 Pr Praseodymium	459 Nd Neodymium	460 Pm Promethium	461 Sm Samarium	462 Eu Europium	463 Gd Gadolinium	464 Tb Terbium	465 Dy Dysprosium	466 Ho Holmium	467 Er Erbium	468 Tm Thulium	469 Yb Ytterbium	470 Lu Lutetium	471 La Lanthanum	472 Ce Cerium	473 Pr Praseodymium	474 Nd Neodymium	475 Pm Promethium	476 Sm Samarium	477 Eu Europium	478 Gd Gadolinium	479 Tb Terbium	480 Dy Dysprosium	481 Ho Holmium	482 Er Erbium	483 Tm Thulium	484 Yb Ytterbium	485 Lu Lutetium	486 La Lanthanum	487 Ce Cerium	488 Pr Praseodymium	489 Nd Neodymium	490 Pm Promethium	491 Sm Samarium	492 Eu Europium	493 Gd Gadolinium	494 Tb Terbium	495 Dy Dysprosium	496 Ho Holmium	497 Er Erbium	498 Tm Thulium	499 Yb Ytterbium	500 Lu Lutetium	501 La Lanthanum	502 Ce Cerium	503 Pr Praseodymium	504 Nd Neodymium	505 Pm Promethium	506 Sm Samarium	507 Eu Europium	508 Gd Gadolinium	509 Tb Terbium	510 Dy Dysprosium	511 Ho Holmium	512 Er Erbium	513 Tm Thulium	514 Yb Ytterbium	515 Lu Lutetium	516 La Lanthanum	517 Ce Cerium	518 Pr Praseodymium	519 Nd Neodymium	520 Pm Promethium	521 Sm Samarium	522 Eu Europium	523 Gd Gadolinium	524 Tb Terbium	525 Dy Dysprosium	526 Ho Holmium	527 Er Erbium	528 Tm Thulium	529 Yb Ytterbium	530 Lu Lutetium	531 La Lanthanum	532 Ce Cerium	533 Pr Praseodymium	534 Nd Neodymium	535 Pm Promethium	536 Sm Samarium	537 Eu Europium	538 Gd Gadolinium	539 Tb Terbium	540 Dy Dysprosium	541 Ho Holmium	542 Er Erbium	543 Tm Thulium	544 Yb Ytterbium	545 Lu Lutetium	546 La Lanthanum	547 Ce Cerium	548 Pr Praseodymium	549 Nd Neodymium	550 Pm Promethium	551 Sm Samarium	552 Eu Europium	553 Gd Gadolinium	554 Tb Terbium	555 Dy Dysprosium	556 Ho Holmium	557 Er Erbium	558 Tm Thulium	559 Yb Ytterbium	560 Lu Lutetium	561 La Lanthanum	562 Ce Cerium	563 Pr Praseodymium	564 Nd Neodymium	565 Pm Promethium	566 Sm Samarium	567 Eu Europium	568 Gd Gadolinium	569 Tb Terbium	570 Dy Dysprosium	571 Ho Holmium	572 Er Erbium	573 Tm Thulium	574 Yb Ytterbium	575 Lu Lutetium	576 La Lanthanum	577 Ce Cerium	578 Pr Praseodymium	579 Nd Neodymium	580 Pm Promethium	581 Sm Samarium	582 Eu Europium	583 Gd Gadolinium	584 Tb Terbium	585 Dy Dysprosium	586 Ho Holmium	587 Er Erbium	588 Tm Thulium	589 Yb Ytterbium	590 Lu Lutetium	591 La Lanthanum	592 Ce Cerium	593 Pr Praseodymium	594 Nd Neodymium	595 Pm Promethium	596 Sm Samarium	597 Eu Europium	598 Gd Gadolinium	599 Tb Terbium	600 Dy Dysprosium	601 Ho Holmium	602 Er Erbium	603 Tm Thulium	604 Yb Ytterbium	605 Lu Lutetium	606 La Lanthanum	607 Ce Cerium	608 Pr Praseodymium	609 Nd Neodymium	610 Pm Promethium	611 Sm Samarium	612 Eu Europium	613 Gd Gadolinium	614 Tb Terbium	615 Dy Dysprosium	616 Ho Holmium	617 Er Erbium	618 Tm Thulium	619 Yb Ytterbium	620 Lu Lutetium	621 La Lanthanum	622 Ce Cerium	623 Pr Praseodymium	624 Nd Neodymium	625 Pm Promethium	626 Sm Samarium	627 Eu Europium	628 Gd Gadolinium	629 Tb Terbium	630 Dy Dysprosium	631 Ho Holmium	632 Er Erbium	633 Tm Thulium	634 Yb Ytterbium	635 Lu Lutetium	636 La Lanthanum	637 Ce Cerium	638 Pr Praseodymium	639 Nd Neodymium	640 Pm Promethium	641 Sm Samarium	642 Eu Europium	643 Gd Gadolinium	644 Tb Terbium	645 Dy Dysprosium	646 Ho Holmium	647 Er Erbium	648 Tm Thulium	649 Yb Ytterbium	650 Lu Lutetium	651 La Lanthanum	652 Ce Cerium	653 Pr Praseodymium	654 Nd Neodymium	655 Pm Promethium	656 Sm Samarium	657 Eu Europium	658 Gd Gadolinium	659 Tb Terbium	660 Dy Dysprosium	661 Ho Holmium	662 Er Erbium	663 Tm Thulium	664 Yb Ytterbium	665 Lu Lutetium	666 La Lanthanum	667 Ce Cerium	668 Pr Praseodymium	669 Nd Neodymium	670 Pm Promethium	671 Sm Samarium	672 Eu Europium	673 Gd Gadolinium	674 Tb Terbium	675 Dy Dysprosium	676 Ho Holmium	677 Er Erbium	678 Tm Thulium	679 Yb Ytterbium	680 Lu Lutetium	681 La Lanthanum	682 Ce Cerium	683 Pr Praseodymium	684 Nd Neodymium	685 Pm Promethium	686 Sm Samarium	687 Eu Europium	688 Gd Gadolinium	689 Tb Terbium	690 Dy Dysprosium	691 Ho Holmium	692 Er Erbium	693 Tm Thulium	694 Yb Ytterbium	695 Lu Lutetium	696 La Lanthanum	697 Ce Cerium	698 Pr Praseodymium	699 Nd Neodymium	700 Pm Promethium	701 Sm Samarium	702 Eu Europium	703 Gd Gadolinium	704 Tb Terbium	705 Dy Dysprosium	706 Ho Holmium	707 Er Erbium	708 Tm Thulium	709 Yb Ytterbium	710 Lu Lutetium	711 La Lanthanum	712 Ce Cerium	713 Pr Praseodymium	714 Nd Neodymium	715 Pm Promethium	716 Sm Samarium	717 Eu Europium	718 Gd Gadolinium	719 Tb Terbium	720 Dy Dysprosium	721 Ho Holmium	722 Er Erbium	723 Tm Thulium	724 Yb Ytterbium	725 Lu Lutetium	726 La Lanthanum	727 Ce Cerium	728 Pr Praseodymium	729 Nd Neodymium	730 Pm Promethium	731 Sm Samarium	732 Eu Europium	733 Gd Gadolinium	734 Tb Terbium	735 Dy Dysprosium	736 Ho Holmium	737 Er Erbium	738 Tm Thulium	739 Yb Ytterbium	740 Lu Lutetium	7

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

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.).