UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **October/November 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 **29** printed pages and **3** blank pages.

For Examiner's Use

1 **(a)** Complete Table 1.1 by choosing one of the words from the list to match each statement.

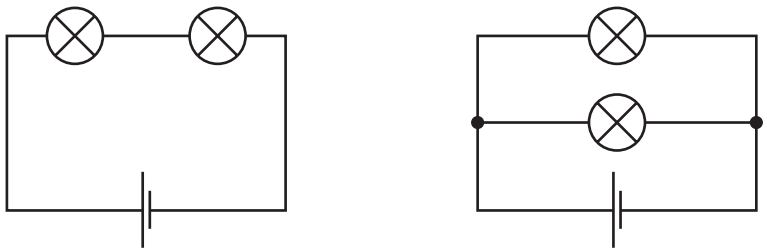
ammeter	**ampere**	**circuit**	**coulomb**	**electron**
ohm	**relay**	**volt**	**voltmeter**	**watt**

Table 1.1

statement	word
a complete loop of conductors	
the unit of electrical charge	
an instrument that measures potential difference	
a device used in switching on circuits	

[2]

(b) Fig. 1.1 shows two circuits **A** and **B**. All the lamps and both cells are the same.



circuit **A** circuit **B**

Fig. 1.1

(i) One lamp is unscrewed from circuit **A**.

State what happens to the other lamp.

Explain your answer.

.....

.....

..... [1]

For Examiner's Use

(ii) Explain why lights in a house are connected in parallel and not in series.

.....

.....

..... [2]

(iii) The resistance of each lamp is 1.2 Ω.

Calculate the combined resistance of the two lamps in circuit **B**.

State the formula that you use and show your working.

formula used

working

..... [3]

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For Examiner's Use

2 **(a)** Fig. 2.1 shows part of the carbon cycle.

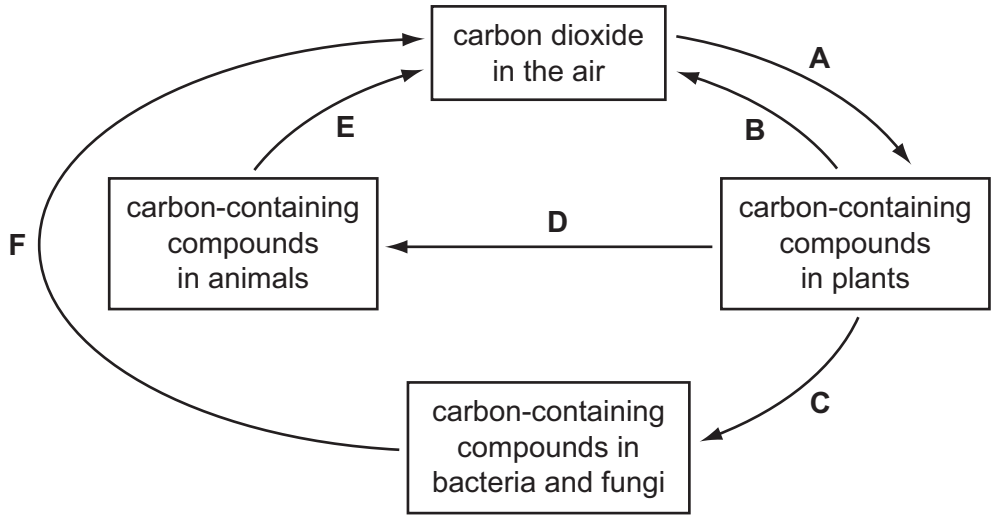


Fig. 2.1

(i) State the letter or letters, **A**, **B**, **C**, **D**, **E** or **F**, that represent

photosynthesis, ...

respiration. ..... [2]

(ii) Name **one** carbon-containing compound in plants.

..... [1]

(iii) State the approximate percentage of carbon dioxide in the air.

..... [1]

(b) Earthworms play an important part in the carbon cycle. They are decomposers.

Describe the role of decomposers in the carbon cycle.

.....

.....

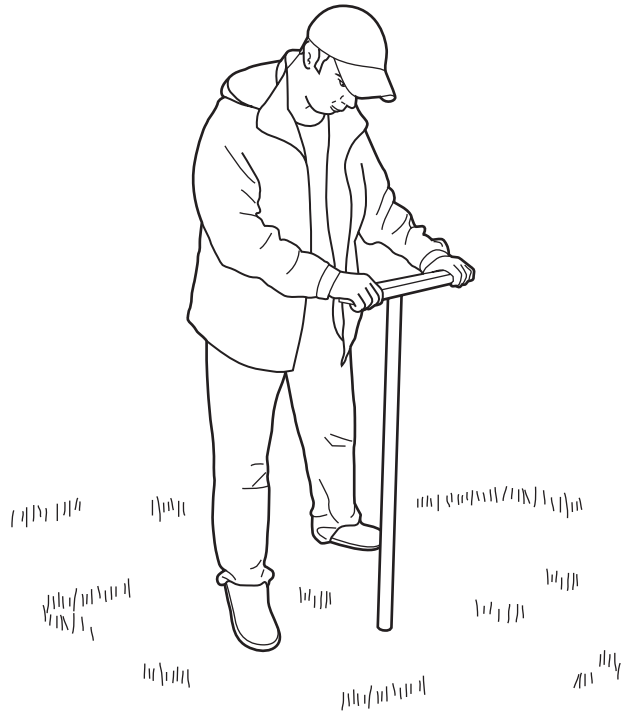
.....

..... [2]

(c) In Florida, USA, some people collect earthworms by vibrating the soil.

A wooden post is pushed into the ground, and then a heavy object is pulled across the top of the post to make it vibrate. The vibrations travel through the soil.

Earthworms respond to the vibrations by crawling out of their burrows onto the soil surface, where they can be caught.



A student investigated the effect of different frequencies of vibrations on the numbers of earthworms that emerged from the soil. Fig. 2.2 shows his results.

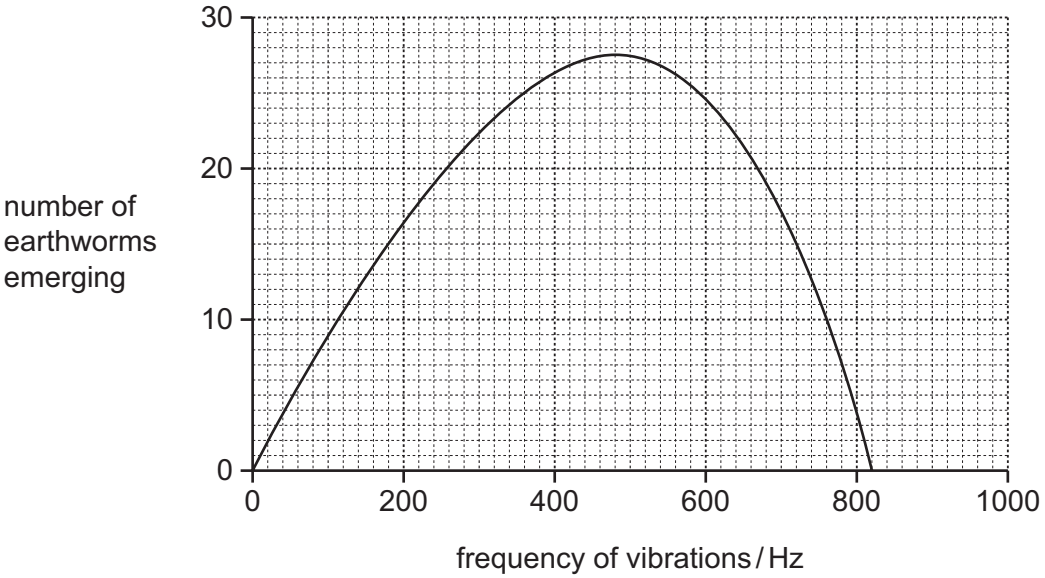


Fig. 2.2

For Examiner's Use

(i) Describe the effect of different frequencies of vibrations on the numbers of earthworms emerging.

.....

.....

.....

..... [2]

(ii) Moles are predators that live underground and eat earthworms. When moles burrow through the ground, they produce vibrations of around 500 Hz.

The response of earthworms to vibrations is controlled by their genes.

Suggest how natural selection may have caused the response of earthworms to vibrations to evolve.

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..... [4]

For Examiner's Use

3 **(a)** Fig. 3.1 shows how a digital pH meter is used to measure the pH of some liquids.

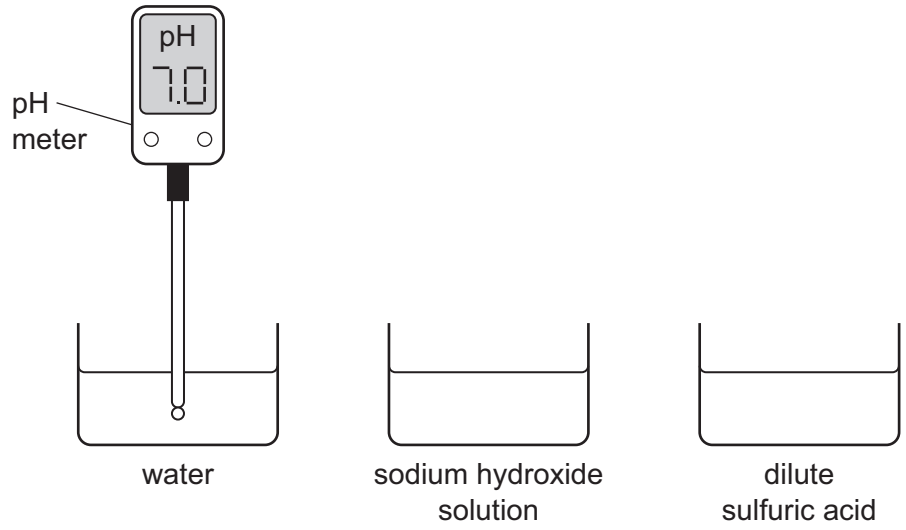


Fig. 3.1

(i) Complete Table 3.1 by suggesting suitable pH values for the different liquids.

Table 3.1

liquid	pH
water	7.0
sodium hydroxide solution	
dilute sulfuric acid	

[1]

(ii) Suggest **one** advantage of using a digital pH meter rather than a piece of litmus paper to assess the acidity of an aqueous solution.

.....

..... [1]

For Examiner's Use

(iii) Dilute acids are aqueous solutions that contain dissolved ions.

Table 3.2 shows the names of the ions in two common acids.

Table 3.2

name of dilute acid	names of dissolved ions
hydrochloric acid	hydrogen ions and chloride ions
sulfuric acid	hydrogen ions and sulfate ions

A student is given an unlabelled beaker which is known to contain either dilute hydrochloric acid or dilute sulfuric acid.

Describe a chemical test that a student could use to find out which acid the beaker contains.

.....

.....

..... [2]

(b) When a reactive metal is added to a dilute acid, the metal reacts and dissolves and hydrogen gas is given off.

(i) When magnesium reacts with dilute hydrochloric acid, magnesium **atoms** are oxidised by hydrogen **ions**.

The balanced ionic equation for this redox reaction is shown below.

$$Mg(s) + 2H^+(aq) \longrightarrow Mg^{2+}(aq) + H_2(g)$$

Explain, in terms of the transfer of electrons, why this reaction is described as redox.

.....

.....

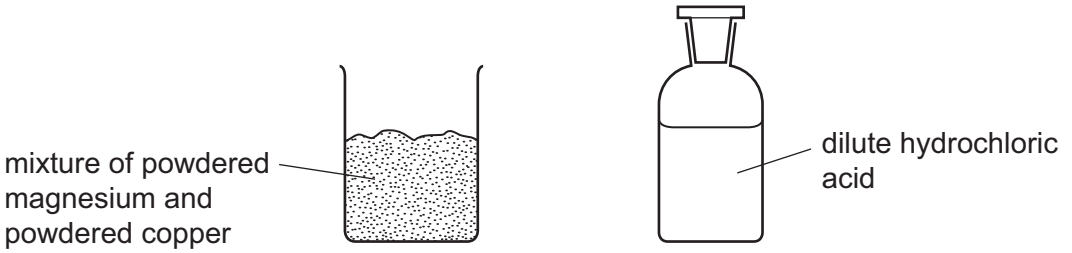
..... [2]

For Examiner's Use

(ii) Unreactive metals do **not** react in dilute acid.

A student is given a mixture of powdered magnesium and powdered copper.

Describe and explain how the student could use dilute hydrochloric acid and usual laboratory apparatus to obtain a sample of copper from this mixture.



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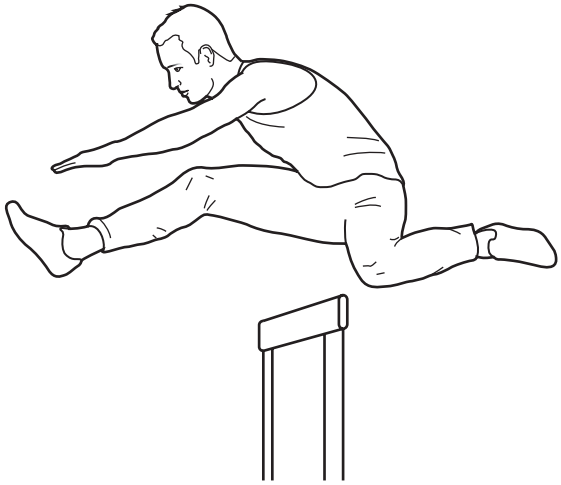
..... [3]

For Examiner's Use

4 **(a)** An athlete of mass 60 kg jumps 1.3 metres vertically.



Calculate the work done by the athlete to achieve this height.

State the formula that you use and show your working. The gravitational field strength of the Earth is 10 N / kg.

formula used

working

..... [3]

(b) Using your answer to part **(a)**, state the gain in potential energy of the athlete when he jumps 1.3 metres.

..... [1]

(c) The work done in jumping vertically was completed in 0.5 s.

Calculate the power developed.

State the formula that you use and show your working.

formula used

working

..... [2]

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For Examiner's Use

5 Fig. 5.1 shows apparatus that can be used to measure the rate of respiration of germinating seeds.

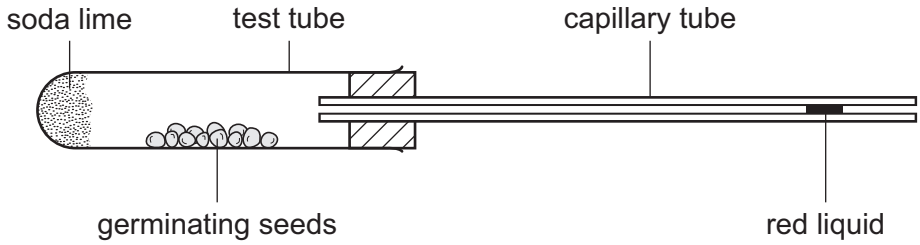

Fig. 5.1

The soda lime absorbs carbon dioxide from the air inside the apparatus.

(a) As the seeds respire, they use oxygen. This reduces the volume of gas inside the apparatus. The faster they respire, the faster the red liquid moves towards the left.

(i) Write the balanced equation for aerobic respiration.

..... [2]

(ii) Use the equation to explain why the liquid would **not** move if there was **no** soda lime in the apparatus.

.....

.....

.....

..... [2]

(b) An experiment was carried out to investigate the effect of temperature on the rate of respiration of the germinating seeds.

Four sets of the apparatus shown in Fig. 5.1 were set up and labelled **A**, **B**, **C** and **D**. Each set of apparatus contained either germinating or dead seeds.

The distance moved by the red liquid in five minutes was measured for each set.

The results are shown in Table 5.1.

Table 5.1

set	contents	temperature / °C	distance moved by red liquid in 5 minutes / mm
A	germinating seeds	0	3
B	germinating seeds	10	6
C	germinating seeds	20	12
D	dead seeds	20	0

(i) Explain why it was important to include set **D** in the experiment.

.....

..... [1]

(ii) Suggest why the liquid may have moved very slightly in set **D**.

.....

..... [1]

(iii) With reference to Table 5.1, describe the effect of temperature on the rate of respiration of germinating seeds.

.....

.....

..... [2]

(iv) Predict and explain the results you would expect if the apparatus was set up with germinating seeds at a temperature of 60 °C.

For Examiner's Use

predicted results .....

explanation .....

.....

..... [2]

6 Some types of firework are made by filling a cardboard tube with firework mixture. Firework mixture is made from several solid substances which have been powdered and mixed together.

Fig. 6.1 shows a typical firework.

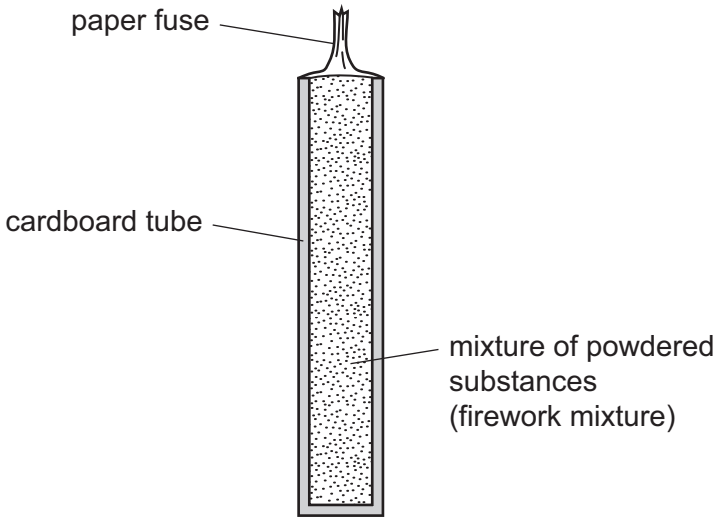

Fig. 6.1

When the paper fuse is lit, exothermic chemical reactions occur inside the firework.

(a) Explain, in terms of rate of reaction, why firework mixture is a powder.

.....

.....

..... [2]

(b) Some firework mixtures contain aluminium which is oxidised to produce aluminium oxide.

When aluminium is oxidised, aluminium atoms are converted into aluminium ions.

(i) The electron configuration of an aluminium **atom** is **2**,**8**,**3**.

Explain why the electrical charge of an aluminium **ion** is +3.

.....

.....

.....

..... [2]

For Examiner's Use

(ii) A student suggested the symbolic equation below for the formation of aluminium oxide.

$$2Al + 3O_2 \longrightarrow Al_2O_3$$

State and explain whether or not this equation is balanced.

.....

.....

..... [2]

(c) The firework mixture contained in the firework in Fig. 6.1 contains the compound potassium perchlorate, $KClO_4$.

When potassium perchlorate is heated, a colourless gas is given off which re-lights a glowing splint.

Suggest why the firework mixture needs to contain potassium perchlorate.

.....

.....

..... [2]

For Examiner's Use

7 **(a)** State which type of electromagnetic wave

(i) can be detected by the human eye, ... [1]

(ii) is used in a remote control for a television, ... [1]

(iii) is strongly absorbed by the water in cells. ..... [1]

(b) Three types of nuclear radiation are alpha, beta and gamma. Each of these can be identified by its behaviour in electric and magnetic fields.

Describe how you could identify alpha, beta and gamma radiations by their deflections in an electric field.

Explain your answer. You may use a diagram to help your explanation.

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..... [5]

For Examiner's Use

(c) In a nuclear power station, nuclear fuel such as uranium releases energy by the process of nuclear fission.

(i) State what happens to the uranium atoms.

.....

[1]

(ii) At a nuclear power station, technicians work close to radioactive sources.

State **one** way in which these workers could be harmed by radiation emitted from radioactive sources.

.....

.....

[1]

(iii) State **two** ways in which these workers could be protected from the radiation.

1 .....

2 .....

[2]

For Examiner's Use

8 Fig. 8.1 shows the male reproductive system.

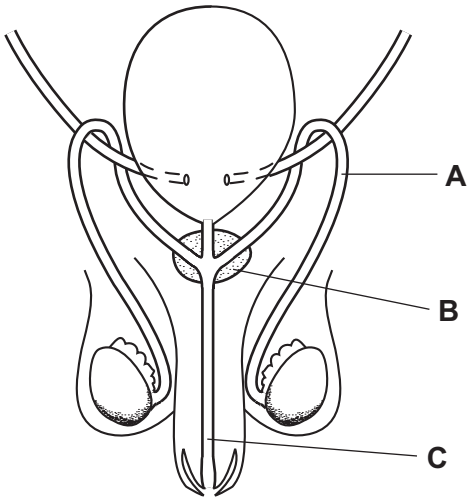

Fig. 8.1

(a) (i) State the functions of parts **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) On Fig. 8.1, use a label line and the letter **S** to indicate where male gametes are made. [1]

(b) Describe **three** ways in which human male gametes differ from human female gametes.

1 .....

2 .....

3 ..... [3]

(c) Male gametes and female gametes have a haploid nucleus.

Explain why it is important that gametes have a haploid nucleus.

.....

.....

.....

..... [2]

(d) HIV is the virus that causes AIDS. HIV can be passed from one person to another during sexual intercourse.

For Examiner's Use

Outline how HIV affects the immune system of a person with HIV / AIDS.

.....

.....

.....

..... [2]

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For Examiner's Use

9 In 1774 the chemist Carl Scheele reacted concentrated hydrochloric acid with manganese dioxide. One of the products of this reaction was a pale green gas which Scheele believed to be a compound containing oxygen.

All attempts by Scheele and other chemists to decompose this green gas were unsuccessful. In 1810 the green gas was named chlorine.

(a) Explain which information in the passage above suggests that chlorine is an element.

.....

.....

..... [2]

(b) Chlorine is produced in the chemical industry by electrolysis.

A simplified diagram of one type of electrolysis cell used to produce chlorine is shown in Fig. 9.1.

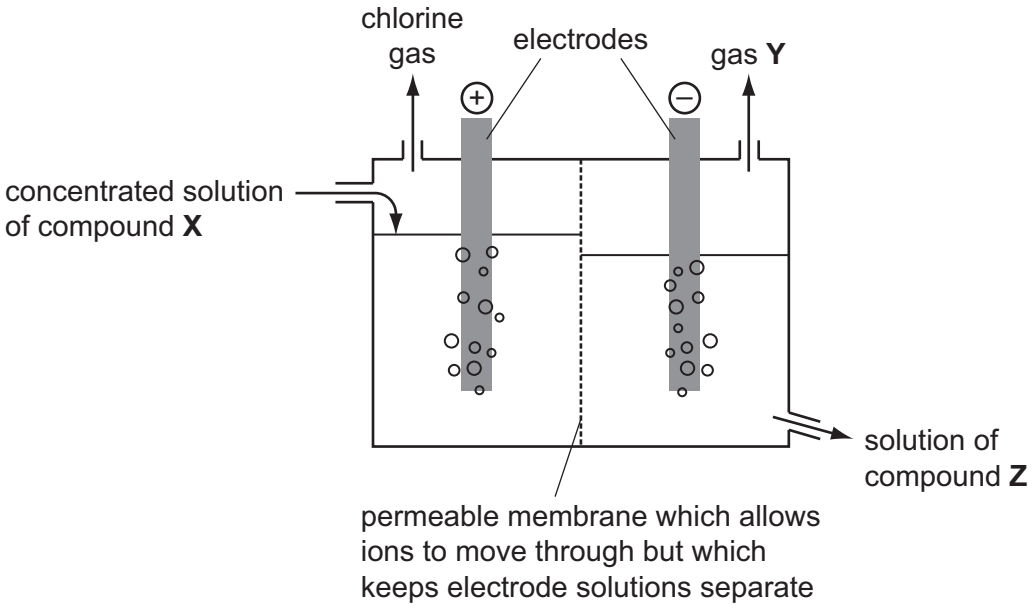


Fig. 9.1

(i) Name substances **X**, **Y** and **Z** in Fig. 9.1.

X .....

Y .....

Z ..... [3]

(ii) Fig. 9.2 shows how the electrons are arranged in a chlorine atom.

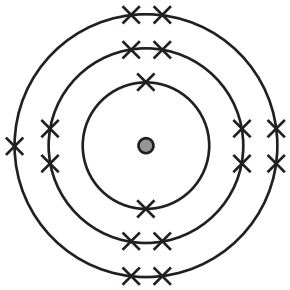


Fig. 9.2

In chlorine gas, the atoms form molecules which have the formula, Cl_2.

Draw a diagram to show how the **outer** electrons are arranged in a molecule of chlorine.

[2]

(c) A student plans to produce some chlorine gas by repeating the reaction used by Scheele. She researches the balanced symbolic equation for the reaction and finds that it is

$$4HCl(aq) + MnO_2(s) \longrightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g).$$

The student decides to react 1.74 g of manganese dioxide with excess hydrochloric acid.

(i) Calculate the number of moles of manganese dioxide in 1.74 g.

Show your working.

..... [2]

(ii) Calculate the volume of chlorine gas, measured at room temperature and pressure, which the student might expect to be produced in her experiment.

For Examiner's Use

The volume of one mole of chlorine, measured at room temperature and pressure, is 24 dm^3.

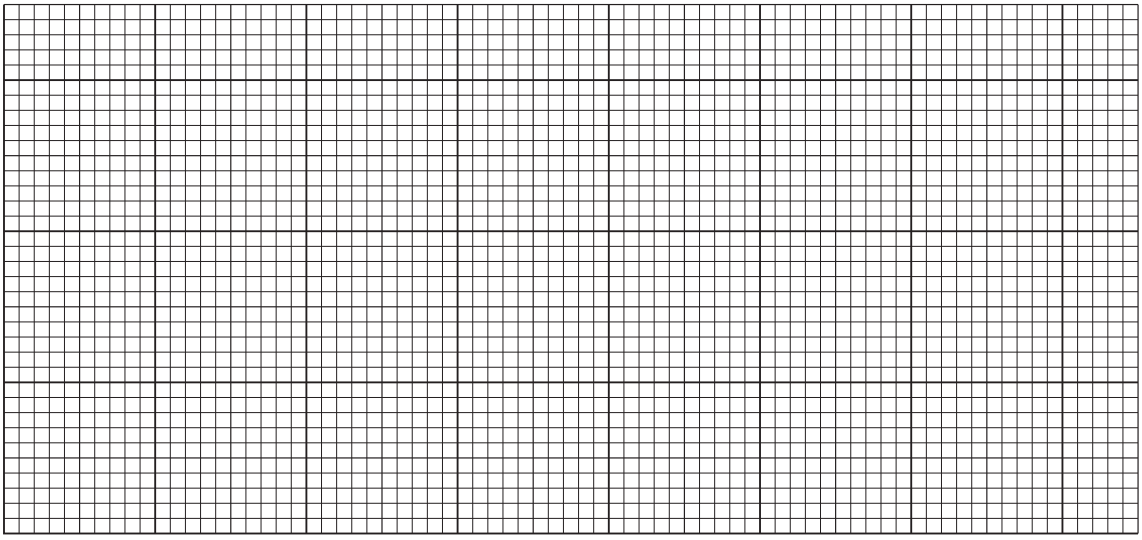
Show your working.

..... [3]

For Examiner's Use

10 (a) On the grid below, draw a wave with an amplitude of 2 cm and a wavelength of 4 cm.

On your diagram, clearly label the amplitude and the wavelength.



[3]

(b) (i) Two sound waves, **A** and **B**, have the same frequency. **A** has a greater amplitude than **B**.

What difference would you hear?

..... [1]

(ii) Two sound waves, **X** and **Y**, have the same amplitude but **X** has a greater frequency than **Y**.

What difference would you hear?

..... [1]

For Examiner's Use

(iii) The speed of sound was calculated for sound passing through a solid, a liquid, a gas and a vacuum.

The values recorded were

0 m / s 330 m / s

1500 m / s 5000 m / s.

Write the values in the correct boxes in Table 10.1.

Table 10.1

	speed of sound / m / s
vacuum	
solid	
liquid	
gas	

[2]

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

Explain what is meant by *compressions* and *rarefactions*. You may use a diagram to help your explanation.

.....

.....

..... [2]

(c) Energy travels to the Earth from the Sun.

State whether this transfer of energy is by conduction, convection or radiation.

Explain your answer.

.....

.....

..... [2]

(d) Many bush fires are caused by pieces of glass that have been carelessly thrown away.

Fig. 10.1 shows parallel rays of light passing through a piece of glass. The piece of glass acts as a lens and focuses the light on the ground.

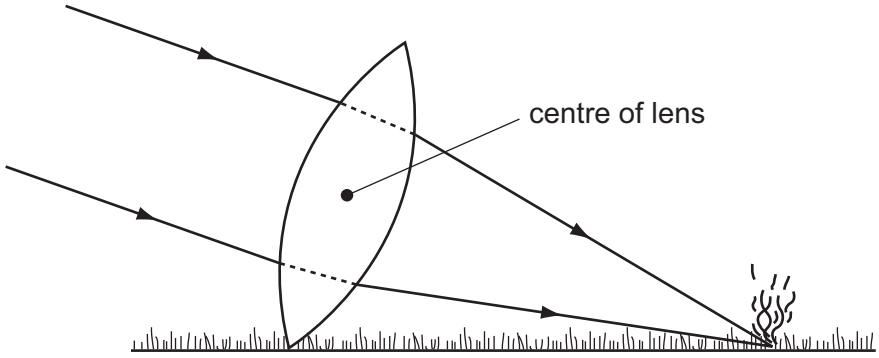


Fig. 10.1

(i) On Fig. 10.1, use the letter **P** to label the principal focus of the piece of glass. [1]

(ii) Measure the focal length of the piece of glass in Fig. 10.1.

..... mm [1]

(iii) The glass acting as a lens produces a real image of the Sun.

Explain what is meant by the term *real image*.

.....

..... [1]

For Examiner's Use

11 Humans require a wide range of nutrients to provide a balanced diet.

(a) List **two** groups of **organic** substances that humans require in their diet.

1 .....

2 ..... [2]

(b) Outline the symptoms that a person may develop if their diet is deficient in

(i) vitamin D, ...

..... [1]

(ii) iron. .....

..... [1]

(c) Describe the use of microorganisms in the manufacture of yoghurt.

.....

.....

.....

.....

.....

..... [3]

12 (a) (i) Name the **two** elements which are combined together in most of the compounds found in petroleum (crude oil).

1 .....

2 ..... [1]

(ii) Draw **four** straight lines to connect each process or reaction in the left hand column with its meaning in the right hand column.

type of process or reaction	process or reaction
reaction that produces ethane from ethene and hydrogen	addition
reaction that causes protein molecules to break up into amino acids	catalytic cracking
reaction that produces unsaturated compounds	fractional distillation
process that simplifies a complex mixture	hydrolysis

[2]

(b) Fig. 12.1 shows apparatus that a student uses to investigate what happens when gaseous decane, $C_{10}H_{22}$, is heated in the presence of a catalyst.

The catalyst is made of small pieces of aluminium oxide which are heated strongly.

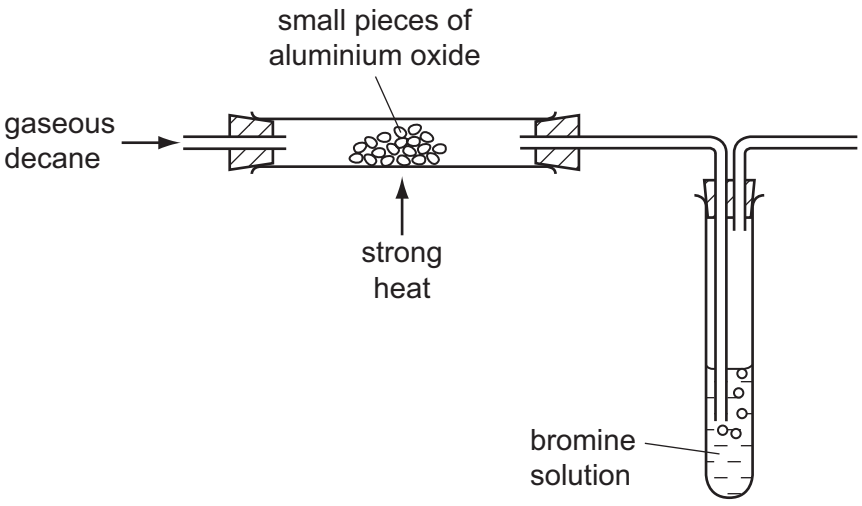


Fig. 12.1

When the gaseous decane passes through the heated catalyst, the solution of bromine rapidly changes colour from orange to colourless.

(i) Explain why this observation shows that decane has undergone a chemical reaction.

.....

.....

.....

.....

..... [3]

(ii) Explain why the products of the reaction do not include any aluminium compounds.

.....

..... [1]

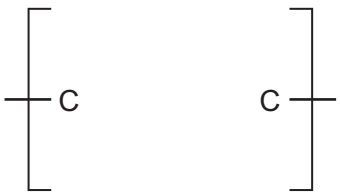
(iii) Suggest why the catalyst needs to be heated.

.....

..... [1]

(c) When ethene, C_2H_4, is heated and pressurised in the presence of a catalyst, it is converted into a white compound which becomes solid when it cools.

(i) Complete the diagram below to show a small section of one of the molecules in the white solid.



[2]

(ii) Suggest why it is **not** possible to state an exact value of the relative molecular mass of the molecules in the white solid.

.....

..... [1]

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).