



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

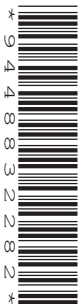
--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--



CO-ORDINATED SCIENCES

Paper 2 (Core)

0654/21

May/June 2015

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 an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **29** printed pages and **3** blank pages.

1 A scientific research station is based in the Arctic. Research scientists are working outside the research station.

(a) Fig. 1.1 shows a coat worn by the scientists. The coat is designed to keep them warm. The coat is made from layers of different materials.

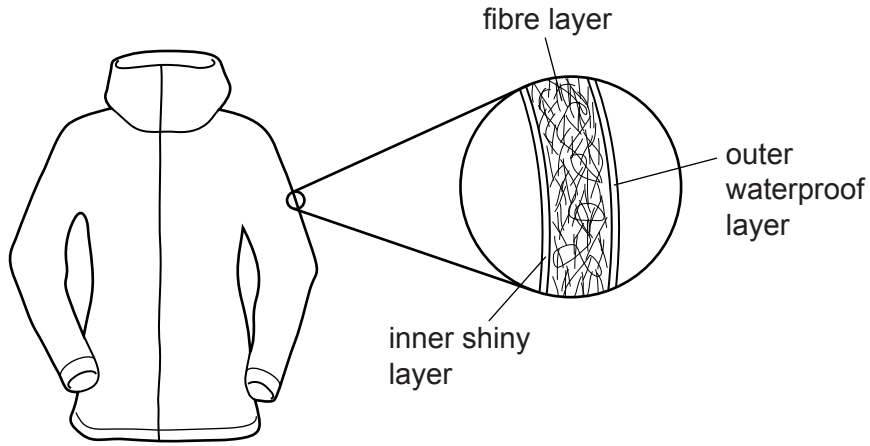


Fig. 1.1

Explain why the fibre layer reduces the thermal energy transfer from a scientist's body.

.....
.....
..... [2]

(b) The scientist carries a nylon tent. As he walks, the nylon material gains a static charge.

Explain what happens to cause the nylon to become charged.

.....
.....
.....
..... [2]

(c) In the Arctic, harmful ultraviolet radiation is able to reach the surface of the Earth. The scientists at the research station are exposed to this ultraviolet radiation. Ultraviolet radiation is ionising radiation.

(i) State **one** danger to human beings of being exposed to large quantities of ultraviolet radiation.

..... [1]

(ii) Ultraviolet radiation is part of the electromagnetic spectrum.

Name **one** other radiation which is part of the electromagnetic spectrum. State a use for this radiation.

radiation

use [1]

- 2 Fig. 2.1 shows apparatus used to study the change in temperature when magnesium reacts with excess dilute hydrochloric acid.

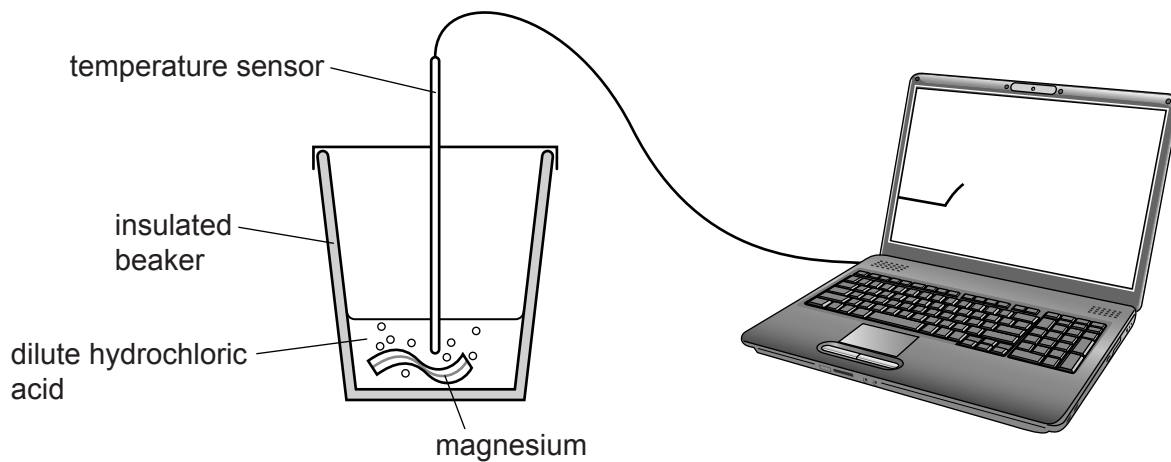


Fig. 2.1

A graph of the results of the experiment is shown in Fig. 2.2.

Point **S** on the graph shows the time that the magnesium is added to the acid.

Point **E** shows the highest temperature measured during the experiment.

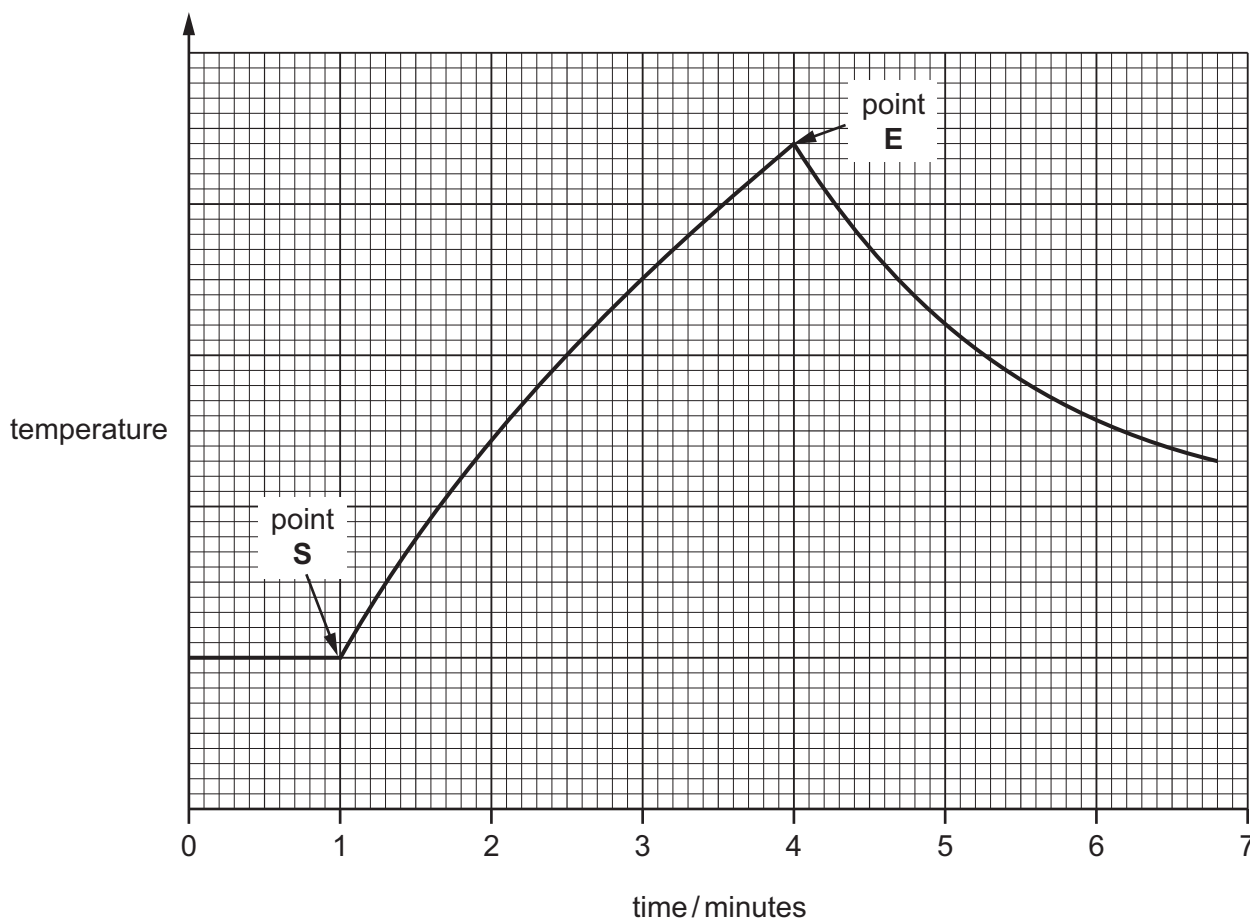


Fig. 2.2

- (a) (i) State the word that is used to describe a chemical reaction that causes an increase in temperature.

..... [1]

- (ii) Suggest why point **E** shows the time at which the reaction between magnesium and the acid has finished.

.....
..... [1]

- (iii) Use the graph to find the time from the start to the end of the reaction.

Show your working.

..... minutes [1]

- (iv) The experiment shown in Fig. 2.1 is repeated using the same-sized piece of magnesium but with a more concentrated solution of hydrochloric acid.

State how and explain why the time taken for the reaction would be different from your answer to (iii).

.....
.....
..... [2]

- (v) Describe the effect that a change in the temperature of dilute hydrochloric acid has on the rate of the reaction with magnesium.

.....
..... [1]

(b) During the reaction between magnesium and dilute hydrochloric acid a gas is given off.

Name this gas, and describe a test for it.

name

test

..... [2]

(c) The experiment in Fig. 2.1 is repeated by adding copper instead of magnesium to dilute hydrochloric acid.

State and explain the temperature change, if any, which is observed.

.....

.....

..... [2]

3 (a) Fig. 3.1 shows the human gas exchange system.

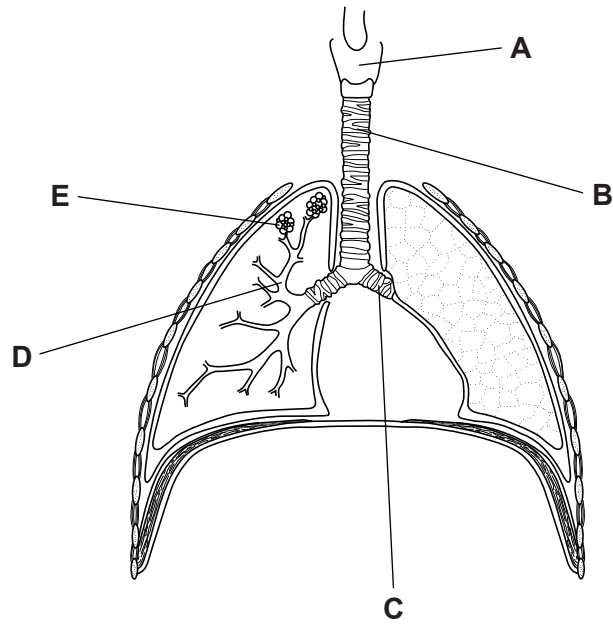


Fig. 3.1

(i) Name the structures labelled **A** to **E**.

- A**
- B**
- C**
- D**
- E**

[5]

(ii) State the part of the lungs in which most of the gas exchange occurs.

..... [1]

- (b) Fig. 3.2 shows apparatus that can be used to compare the composition of inspired and expired air.

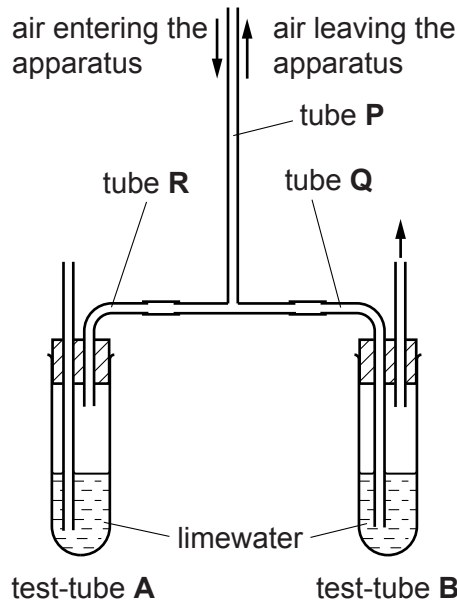


Fig. 3.2

A person breathes slowly in and out of the apparatus at tube P for half a minute, as shown in Fig. 3.2.

- (i) On Fig. 3.2, draw two arrows to show the directions of air flow in tubes Q and R while the person is breathing in and out through the apparatus. [1]
- (ii) As the person breathes in and out, the composition of the air flowing **into the apparatus** through tube P is different from the air **leaving the apparatus** through tube P.

State **two** of these differences for the air leaving the apparatus.

- 1
- 2 [2]

- (iii) Describe what you would expect to observe in the limewater in test-tube A and in test-tube B after half a minute.

test-tube A

test-tube B [2]

- (iv) Assume that the change that you predicted in (b)(iii) occurs. State what could then be concluded from this experiment.

.....

..... [1]

4 Table 4.1 shows information about four materials.

Table 4.1

name	chemical formula	element, compound or mixture
argon	Ar	element
aspirin (a pain killer)	$C_9H_8O_4$	compound
oxygen	O_2	element
sea water	–	mixture

(a) (i) State **one** reason why oxygen is described as an element.

.....
 [1]

(ii) Compounds and mixtures both contain elements.

Describe **two** ways in which a compound and a mixture are different.

difference 1

 difference 2
 [2]

(b) (i) State the total number of atoms shown in the formula for aspirin in Table 4.1.

..... [1]

(ii) Suggest **one** reason why the manufacturers of aspirin must make sure that it is as pure as possible before it is sold to the public.

.....
 [1]

- (c) Fig. 4.1 shows a diagram of an atom of argon, with a proton number of 18 and nucleon number of 40.

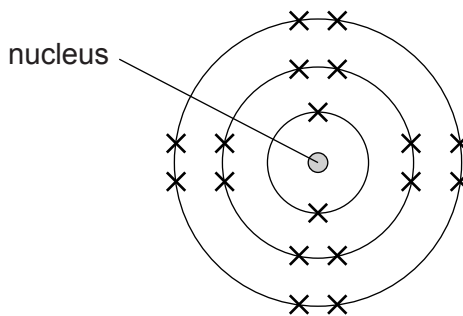


Fig. 4.1

- (i) Explain why the nucleon number is larger than the proton number.

.....
 [1]

- (ii) Most of the argon atoms in the Earth's atmosphere have a nucleon number of 40.

Most of the argon atoms in space have a nucleon number of 36.

Explain why both types of atoms are argon but can have different nucleon numbers.

.....

 [2]

- (iii) Caesium is a very reactive metal in Group 1 of the Periodic Table.

Fig. 4.2 shows how caesium may be safely stored.

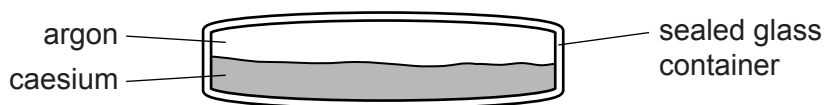


Fig. 4.2

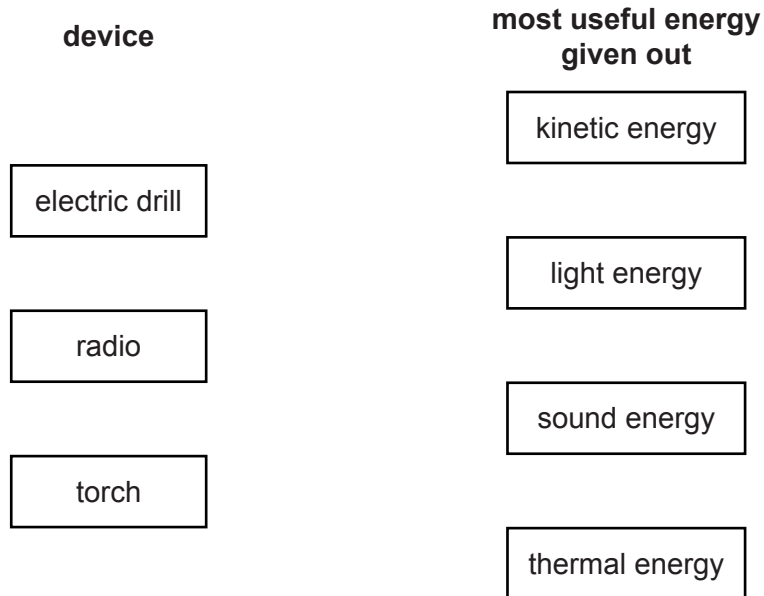
Explain why argon, rather than a cheaper gas such as air, is suitable for the use shown in Fig. 4.2.

.....

 [2]

- 5 (a) An electric drill, a radio and a torch (flashlight) all transform electrical energy into other forms of energy.

Draw **one** straight line from each device to the most useful form of energy that it produces.



[3]

- (b) Fig. 5.1 shows a ray of white light from a torch passing into a prism.

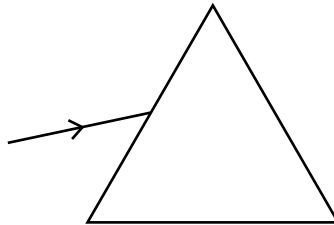


Fig. 5.1

Complete the diagram to show what happens to the light as it passes through and out of the prism. [2]

(c) A ray of light from a torch is reflected by a mirror. This is shown in Fig. 5.2.

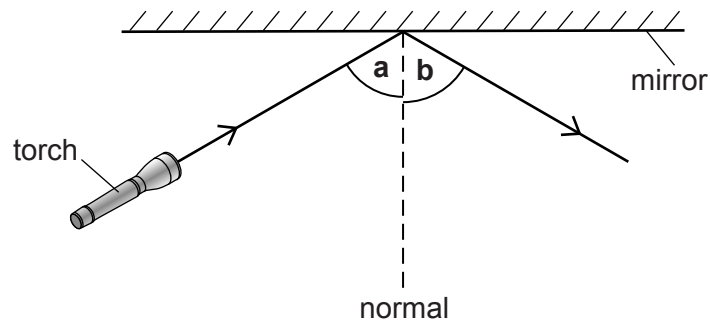


Fig. 5.2

Angle **a** has a value of 60° .

Name angle **b** and write down its value.

name

value

[2]

(d) A torch contains three cells, a switch and a lamp connected in series.

(i) Using the correct symbols, draw a circuit diagram to show three cells, a switch and a lamp.

Label the lamp **L**.

[2]

- (ii) A voltmeter is used to measure the potential difference across the lamp.

Draw the symbol for a voltmeter on your circuit in (i) so that the voltmeter is measuring the potential difference across the lamp. [2]

- (iii) When the torch is lit, the current flowing through the lamp is 0.9 A.

The resistance of the lamp is 5Ω .

Calculate the potential difference across the lamp.

State the formula that you use and show your working.

formula

working

potential difference = V [2]

6 Plants need to absorb nitrate and magnesium ions from the soil.

(a) Describe the functions of nitrate and magnesium ions in plant cells.

nitrate ions

.....

magnesium ions

.....

[2]

(b) Two groups of wheat plants of the same variety were grown in two different fields, field **A** and field **B**. The two fields were next to each other, and with the same conditions except for the amount of fertiliser added to the soil.

- Field **A** had regularly been treated with extra nitrate and magnesium ions over the previous five years.
- Field **B** had not been treated with any extra nitrate or magnesium during this time.

In each field, the height of the wheat plants was measured over a period of 120 days, and the final wheat yield was also measured. Fig. 6.1 shows the results.

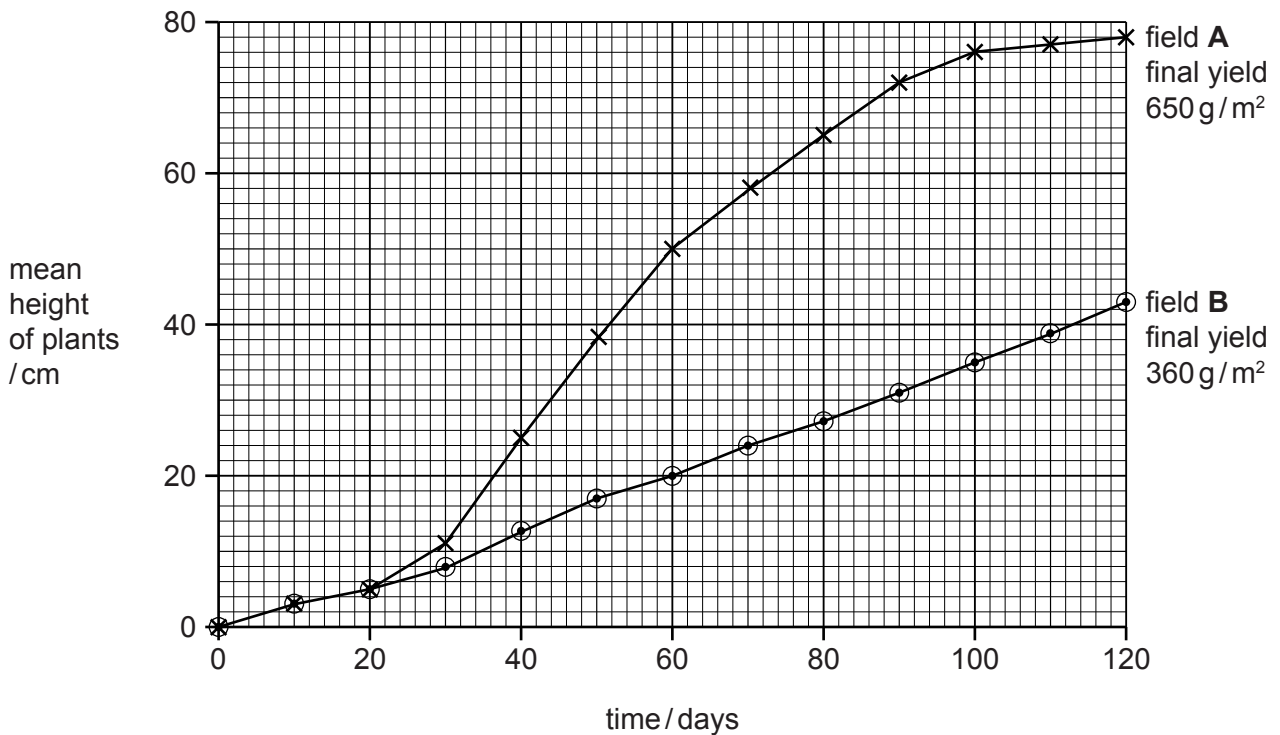


Fig. 6.1

(i) Compare the change in heights of the wheat plants in field **B** with those in field **A** for the first 20 days,

.....
..... [1]

next 100 days.

.....
.....
..... [2]

(ii) Calculate the difference between the final yields in fields **A** and **B**.

difference = g/m² [1]

(iii) State the conclusion that can be drawn from the results of this experiment.

.....
..... [1]

(c) Apart from mineral ions, name **two** other substances that the wheat plants would need to absorb from their environment for growth.

State the source of each of these substances.

substance 1

source

substance 2

source

[4]

7 (a) Natural gas is a mixture containing mainly methane.

Natural gas does **not** react with limewater.

The three charts in Fig. 7.1 show the compositions of three gaseous mixtures **A**, **B** and **C**.

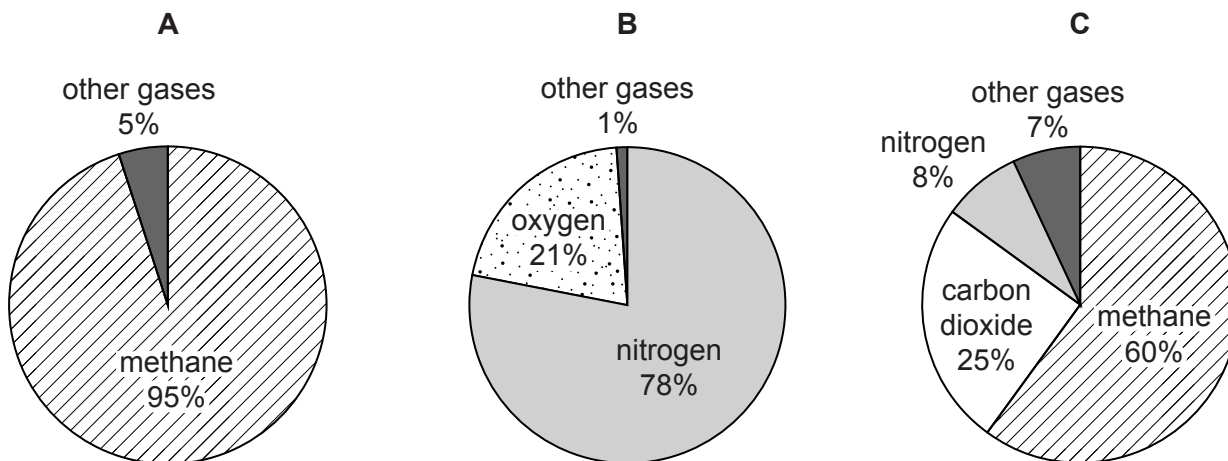


Fig. 7.1

(i) Name gas mixture **B**.

..... [1]

(ii) Deduce which gas mixture, **A** or **C**, is natural gas.

gas

explanation

.....

..... [2]

(iii) When methane undergoes complete combustion, carbon dioxide is produced.

Name the carbon compound formed when the combustion of methane is incomplete.

..... [1]

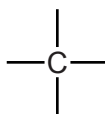
- (iv) As well as methane, natural gas contains other kinds of hydrocarbons.

One of these hydrocarbons is made of molecules that contain **two** carbon atoms and **six** hydrogen atoms.

Name this hydrocarbon and complete the diagram of one of its molecules.

name

molecular diagram



[3]

- (b) Very large amounts of ethanol are made in the chemical industry.

- (i) Complete the word equation for the production of ethanol.



[2]

- (ii) State **one** use for ethanol.

..... [1]

8 (a) A student did an experiment to investigate whether water is needed for pea seeds to germinate. Fig. 8.1 shows her experiment.

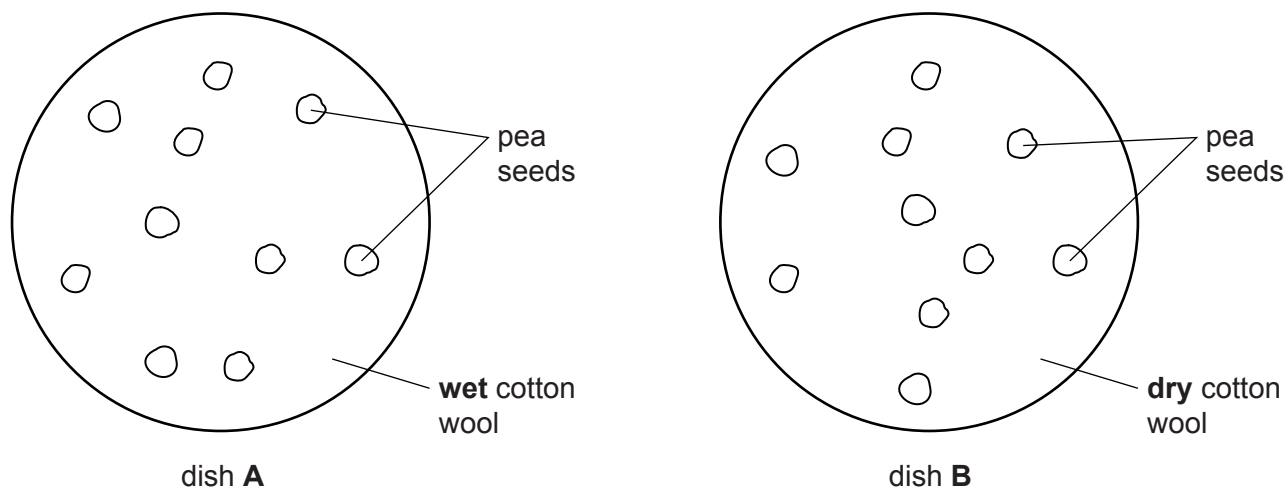


Fig. 8.1

(i) Name **two** other environmental conditions, apart from water, that would affect the germination of these seeds.

1

2

[2]

(ii) Predict and explain what the result of this experiment would be.

.....

.....

..... [2]

(b) (i) Name the part of the pea flower in which these seeds develop.

..... [1]

(ii) Many plants produce seeds that taste bitter. Explain why it would be an advantage to the plant to produce bitter-tasting seeds.

.....

.....

..... [2]

- 9 (a) A cook places a steel saucepan containing water onto the hot-plate of an electric cooker.

The saucepan and water are shown in Fig. 9.1.

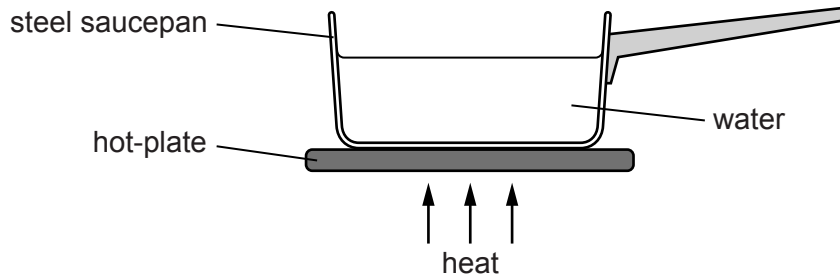


Fig. 9.1

- (i) Thermal energy can be transferred by conduction, convection and radiation.

State the main process that transfers thermal energy through

the steel saucepan,

.....

the water.

.....

[1]

- (ii) The saucepan is made from steel. State **one** difference between the magnetic properties of iron and steel.

.....

..... [1]

- (iii) The mass of the steel used to make the pan is 0.80 kg. The density of steel is 7.9 g/cm³.

Calculate the volume in cm³ of steel used to make the saucepan.

State the formula that you use and show your working.

formula

working

volume = cm³ [3]

(b) Fig. 9.2 shows three different ways in which particles may be arranged in substances.

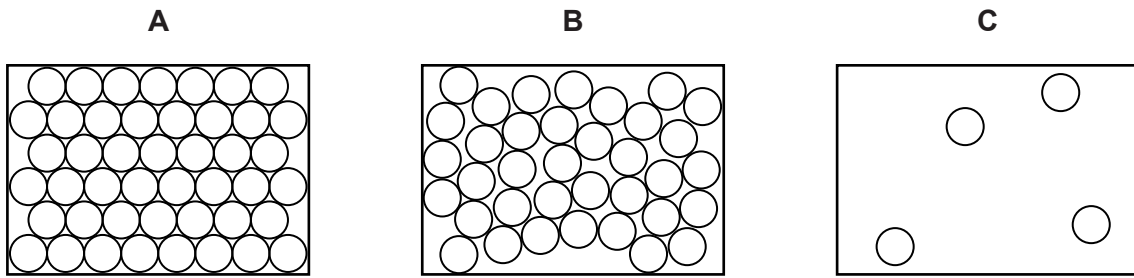


Fig. 9.2

State which diagram best represents the way particles are arranged in the liquid water in the saucepan.

Explain your answer.

diagram

explanation

..... [1]

(c) When the saucepan and water rests on the cooker, the saucepan exerts a pressure on the surface of the cooker.

State the **two** quantities that would need to be known to enable the pressure to be calculated.

..... and [2]

10 When a bright light is shone into a person's eye, the pupil of the eye gets smaller. This is shown in Fig. 10.1.

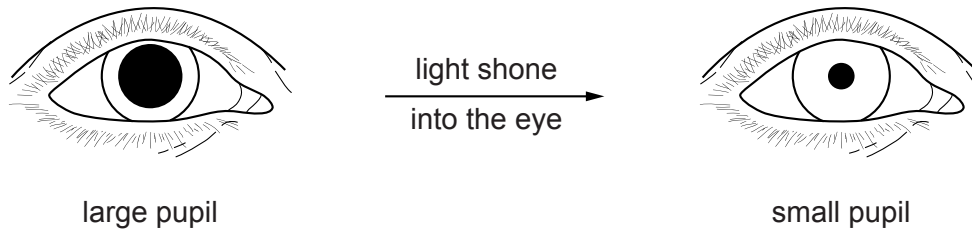


Fig. 10.1

(a) The response shown in Fig. 10.1 is rapid and automatic.

(i) Give the name for a response of this type.

..... [1]

(ii) State the stimulus that brings about this response.

..... [1]

(b) The pupil response depends on nerve cells (neurones).

Sensory neurones carry nerve impulses from receptors in the eye towards the central nervous system.

Name the types of nerve cell that

(i) carry nerve impulses from the central nervous system to the muscles in the eye,

..... [1]

(ii) connect one nerve cell to another in the central nervous system.

..... [1]

(c) Suggest what would happen if a person's eye failed to respond to a bright light in this way.

.....

..... [1]

11 (a) Fig. 11.1 shows two electrolysis reactions.

In one of the reactions, the electrolyte is aqueous copper chloride and in the other the electrolyte is dilute sulfuric acid.

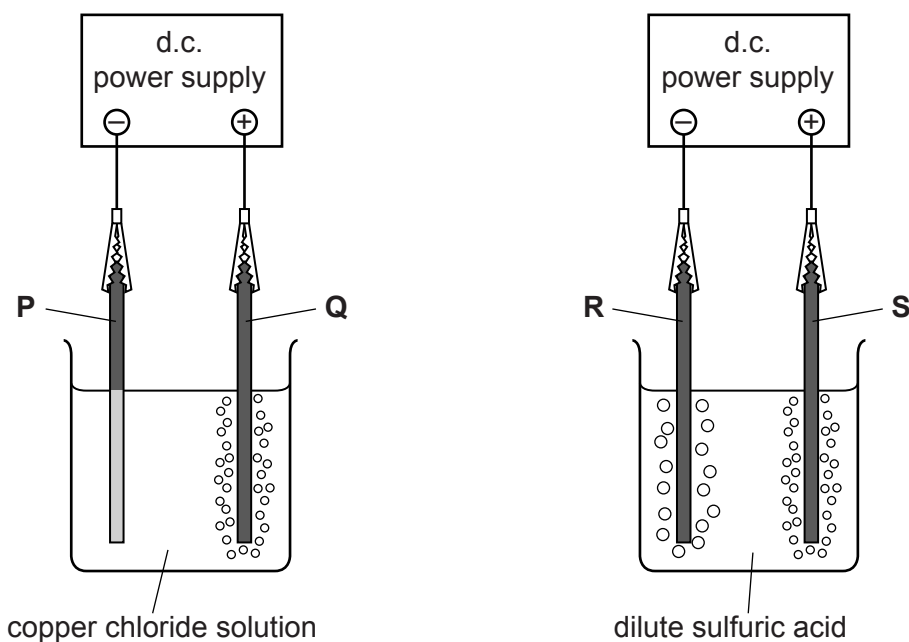


Fig. 11.1

Name the elements that are produced at each of the electrodes **P**, **Q**, **R** and **S** in Fig. 11.1.

electrode **P**

electrode **Q**

electrode **R**

electrode **S**

[4]

- (b) Fig. 11.2 shows apparatus and materials that can be used to produce a thin deposit of copper onto the surface of a metal fork.

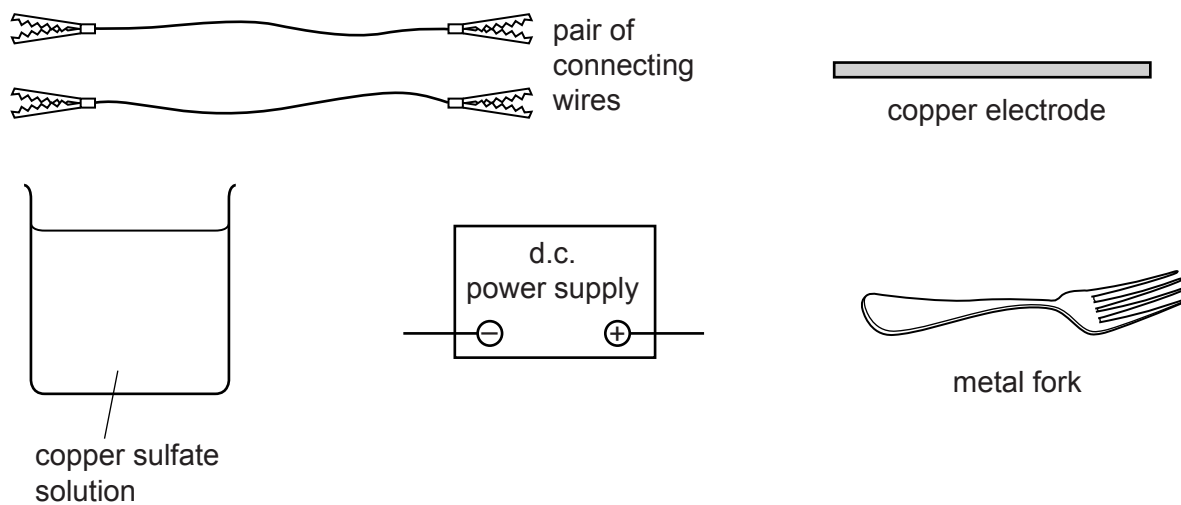


Fig. 11.2

- (i) In the space below re-draw the apparatus and materials to show how they can be used to copper plate one end of the metal fork.

[3]

(ii) Table 11.1 shows the mass of the fork at the start and end of the process.

Table 11.1

mass of fork at the start/g	mass of fork at the end/g
25.1	25.2

Explain the result shown in Table 11.1.

.....
 [1]

(c) Copper is a transition metal.

Table 11.2 shows some properties of metals.

Write a tick (✓) in the column on the right to show those properties that are typical of transition metals but **not** of alkali metals, e.g. sodium.

Table 11.2

property	
compounds usually have colours other than white	
good conductors of electricity	
good conductors of heat	
often used as catalysts	
malleable	
very reactive	

[2]

12 (a) Give **two** examples of fossil fuels.

1

2 [2]

(b) Fossil fuels are non-renewable. Explain what is meant by *non-renewable*.

.....

..... [1]

(c) Many governments are making efforts to reduce the use of fossil fuels.

Suggest **two** ways in which the use of fossil fuels can be reduced.

1

2 [2]

13 (a) Fig. 13.1 shows four of the forces, **A**, **B**, **C** and **D** acting on a fishing boat.

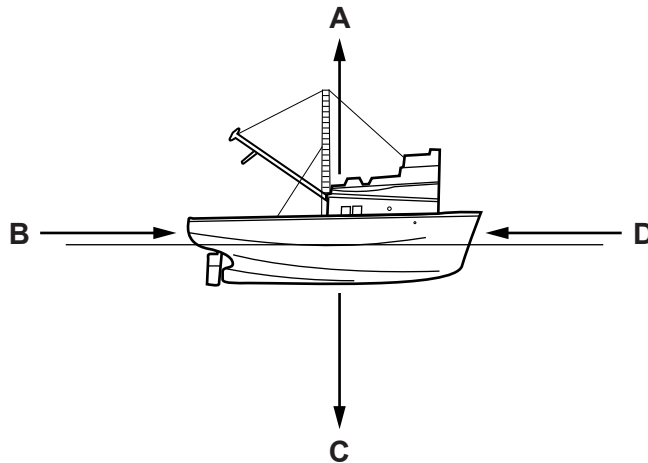


Fig. 13.1

- (i) Complete the sentences using the letters **A**, **B**, **C** or **D**. Each letter may be used once, more than once or not at all.

Initially, the fishing boat is at rest because forces and are balanced, and also forces and are balanced.

The fishing boat begins to move forwards when forces and are unbalanced. [2]

- (ii) Compare the size and direction of forces **B** and **D** when the fishing boat moves forward at a steady speed.

.....
 [2]

- (b) Fig. 13.2 shows the fishing boat using ultrasound waves to detect a shoal of fish 120m below the surface.

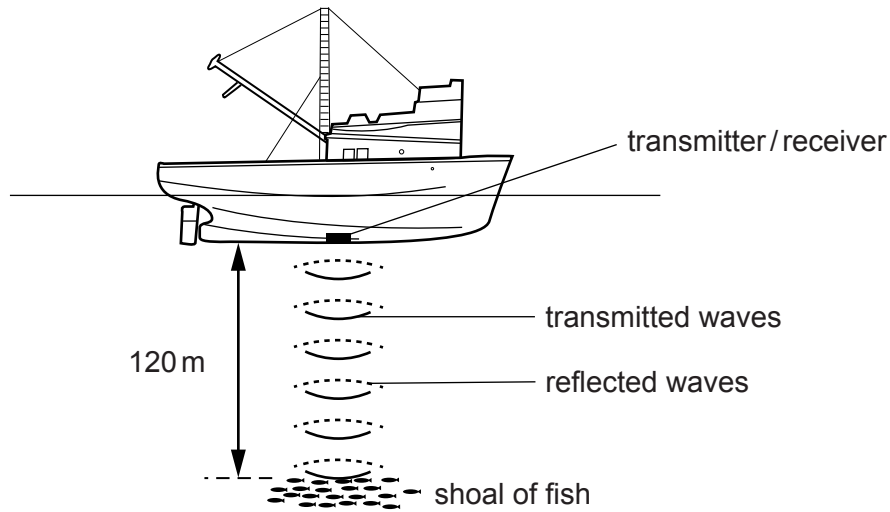


Fig. 13.2

- (i) The speed of ultrasound waves in water is 1500m/s.

Short pulses of ultrasound are sent out from the boat and the echo from the fish is detected by the boat.

Calculate the time taken between the ultrasound waves being emitted and the detection of the echo.

State the formula that you use and show your working.

formula

working

time = s [2]

- (ii) State the approximate human range of audible frequencies.

from Hz to Hz [1]

- (iii) State why humans cannot hear ultrasound waves.

.....
 [1]

(c) Fig. 13.3 shows a diagram, which represents water waves on the ocean.

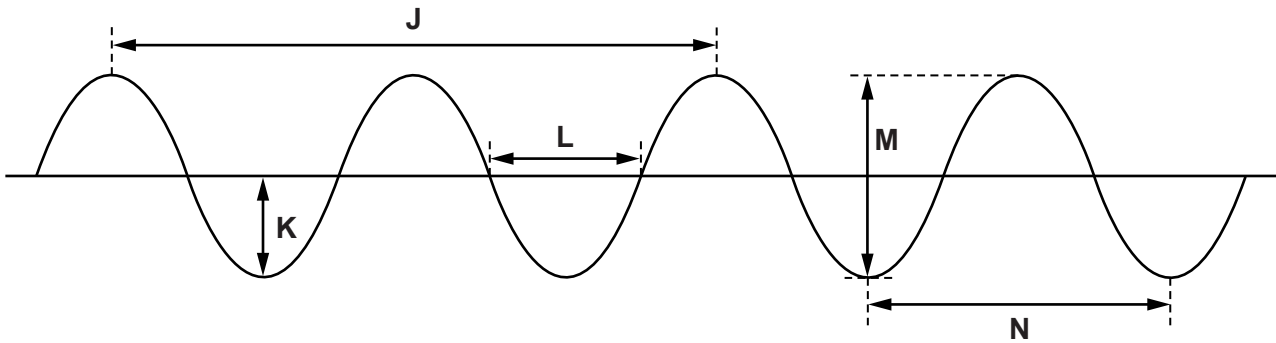


Fig. 13.3

State which measurement, **J**, **K**, **L**, **M** or **N**, is

- (i) the amplitude of the wave, [1]
- (ii) the wavelength of the wave. [1]

(d) The power of ocean waves can be used as a source of energy.

- (i) Suggest how the motion of the waves could be converted into electrical energy.

.....

 [2]

- (ii) Excluding the use of fossil fuels, suggest **two** other sources for generating electricity.

..... and [1]

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	96 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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86	
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †																

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

a
X
b

a = relative atomic mass
X = atomic symbol
b = atomic (proton) number

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).