Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES **0654/21**

Paper 2 (Core) **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.

CAMBRIDGE International Examinations

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.

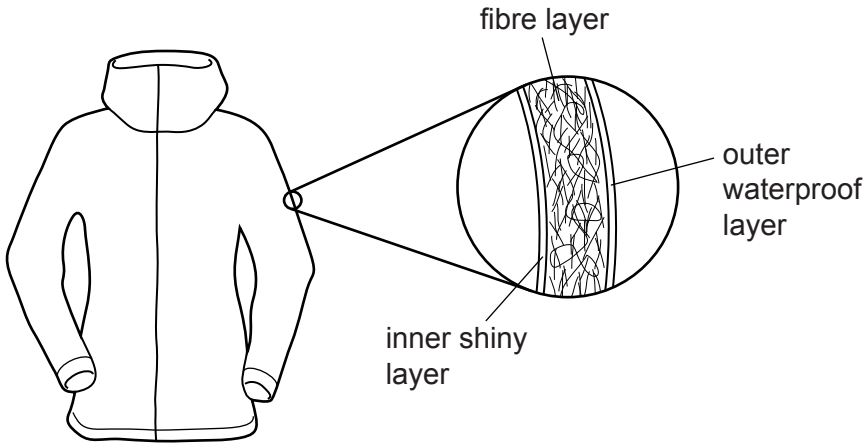


Fig. 1.1

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.

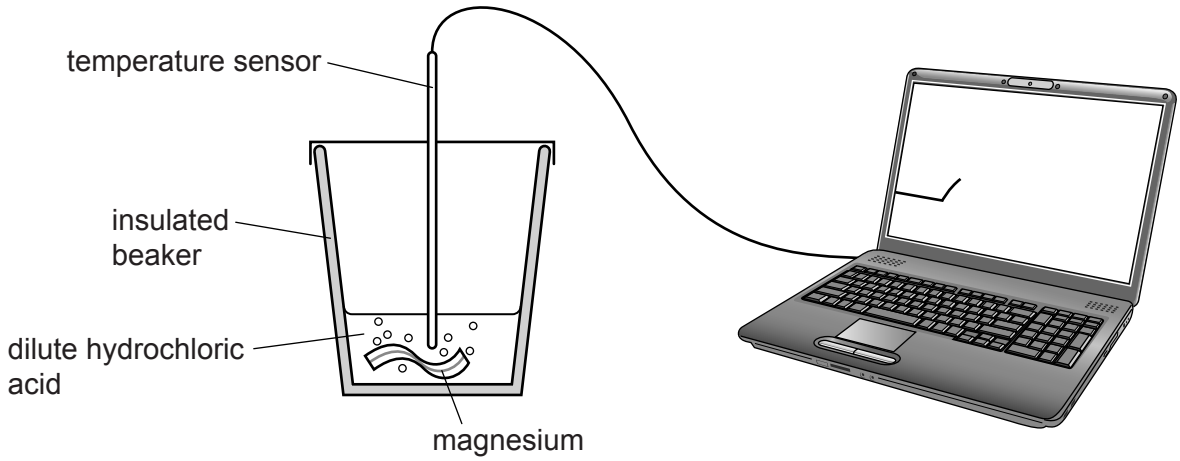


Fig. 2.1

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.

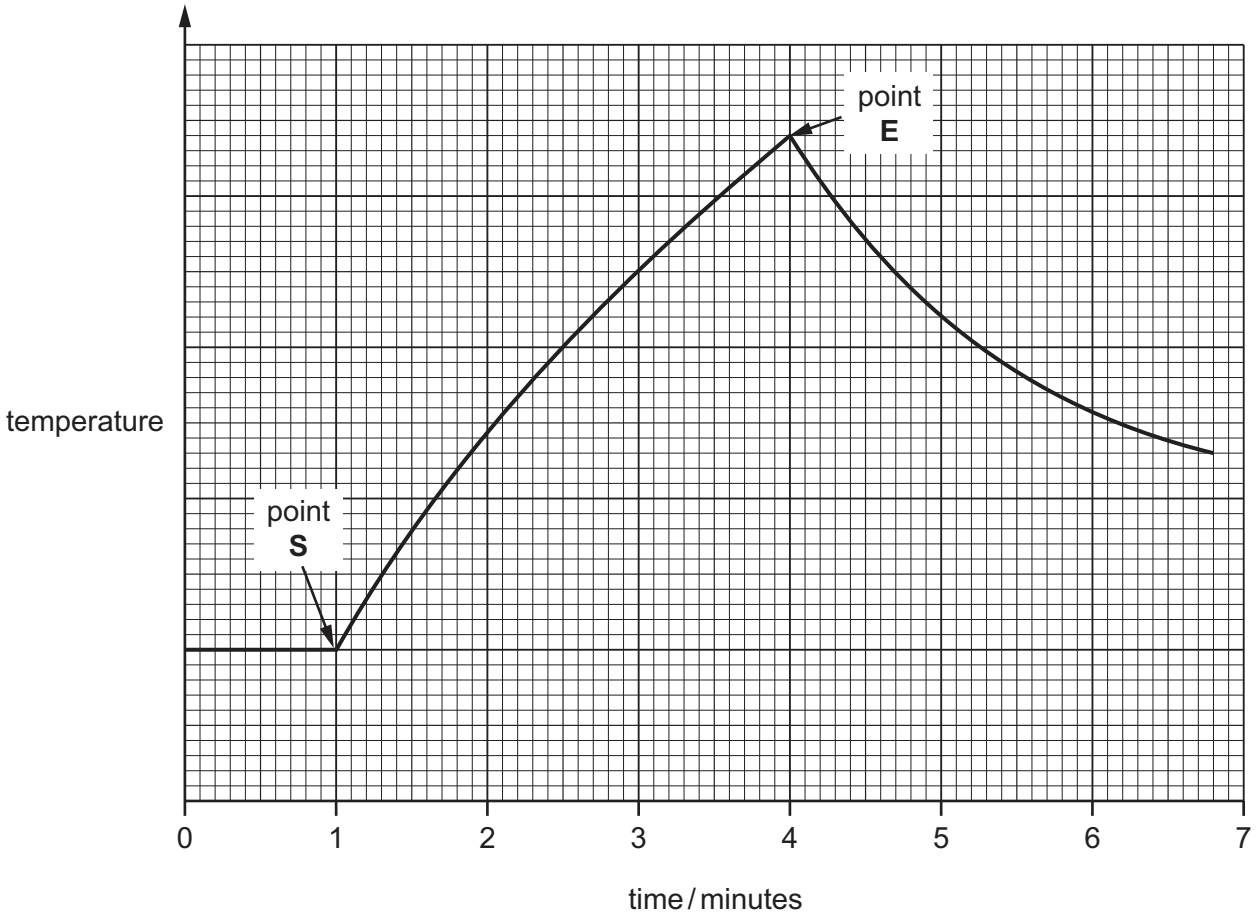


Fig. 2.2

(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]

[Turn over

(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.

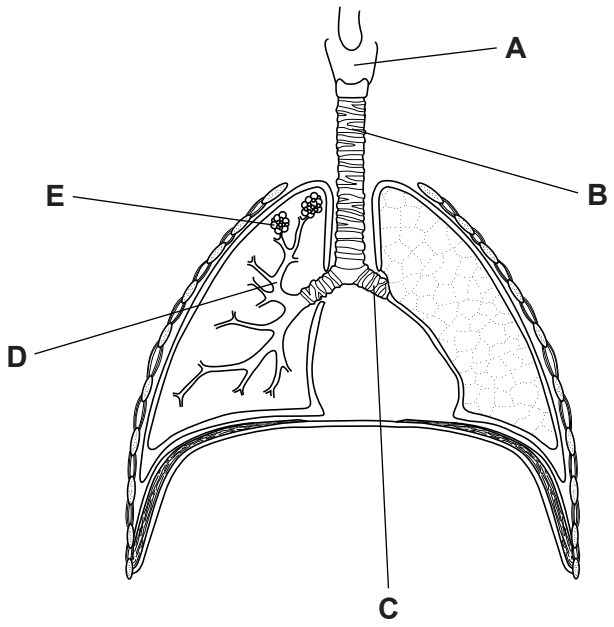


Fig. 3.1

(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.

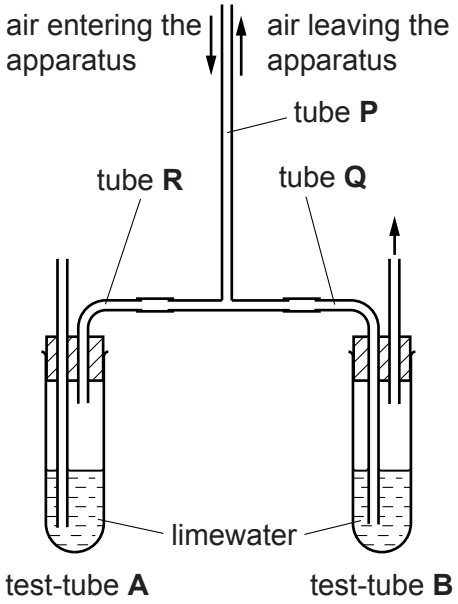


Fig. 3.2

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]

[Turn over

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

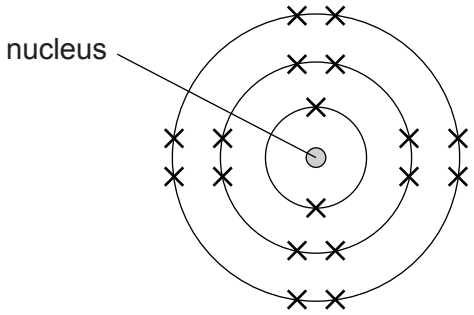


Fig. 4.1

(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.

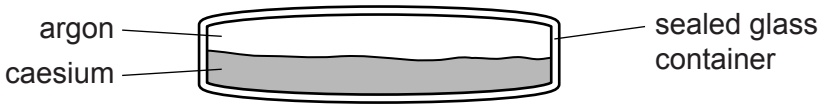


Fig. 4.2

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.

device	most useful energy given out
electric drill	kinetic energy
radio	light energy
torch	sound energy
	thermal energy

[3]

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

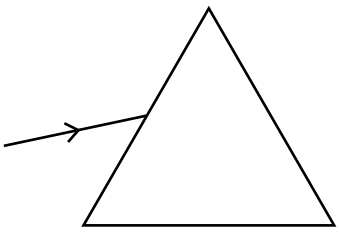


Fig. 5.1

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.

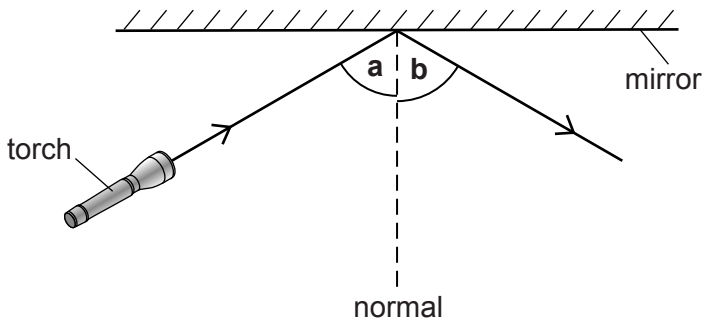


Fig. 5.2

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 5 Ω.

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.

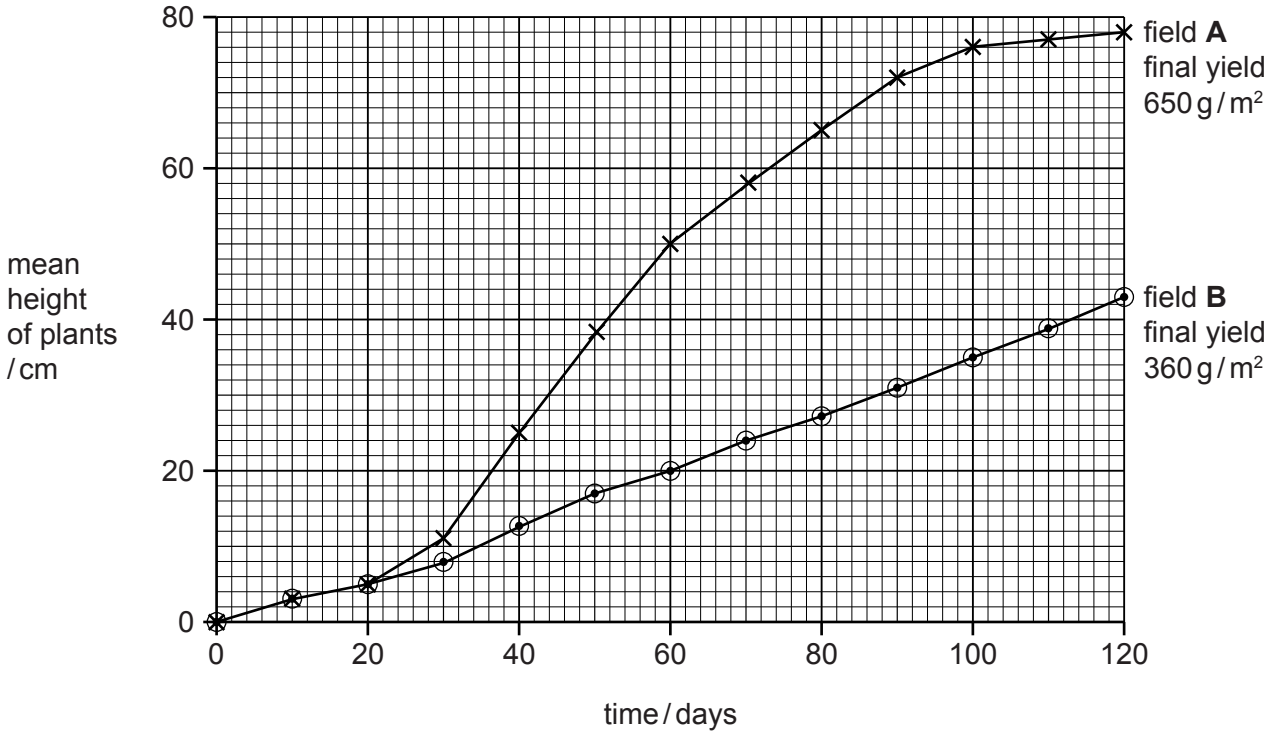


Fig. 6.1

(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/m^2 [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**.

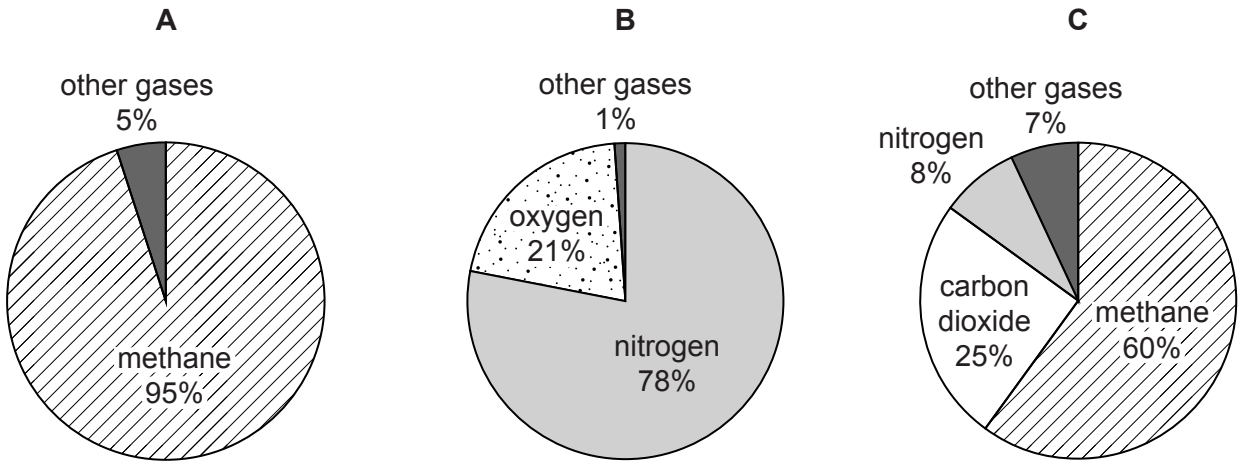


Fig. 7.1

(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]

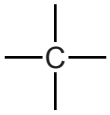
(iv) As well as methane, natural gas contains other kinds of hydrocarbons.

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.

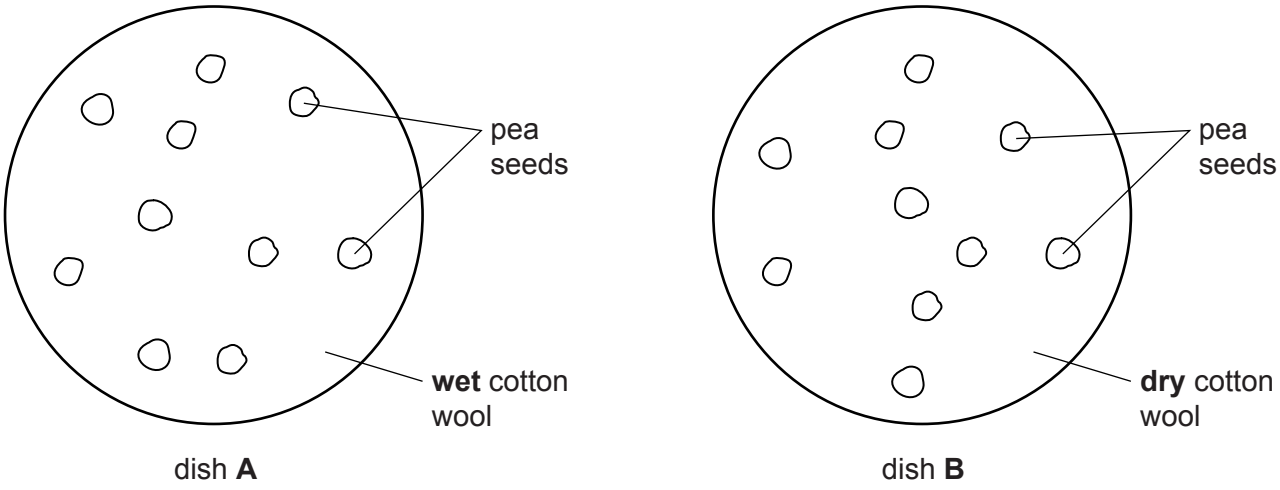


Fig. 8.1

(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.

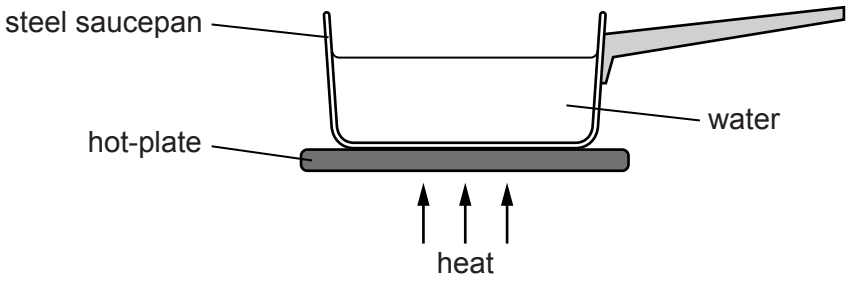


Fig. 9.1

(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/cm^3.

Calculate the volume in cm^3 of steel used to make the saucepan.

State the formula that you use and show your working.

formula

working

volume = ... cm^3 [3]

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

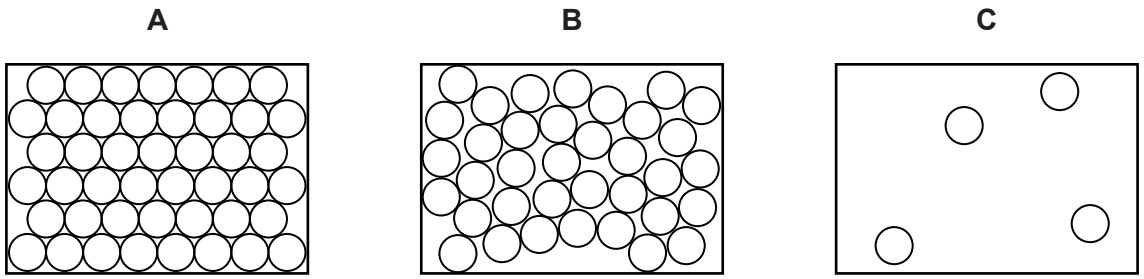


Fig. 9.2

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.

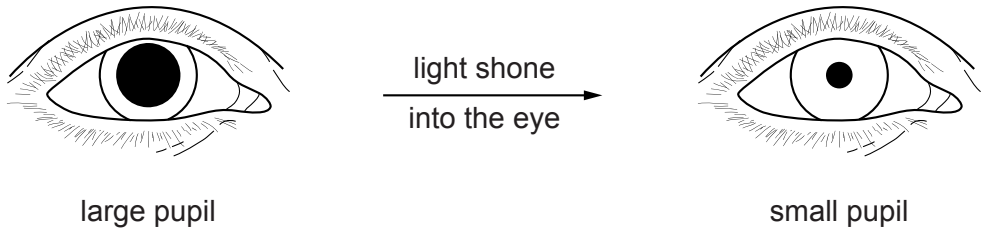


Fig. 10.1

(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]

[Turn over

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.

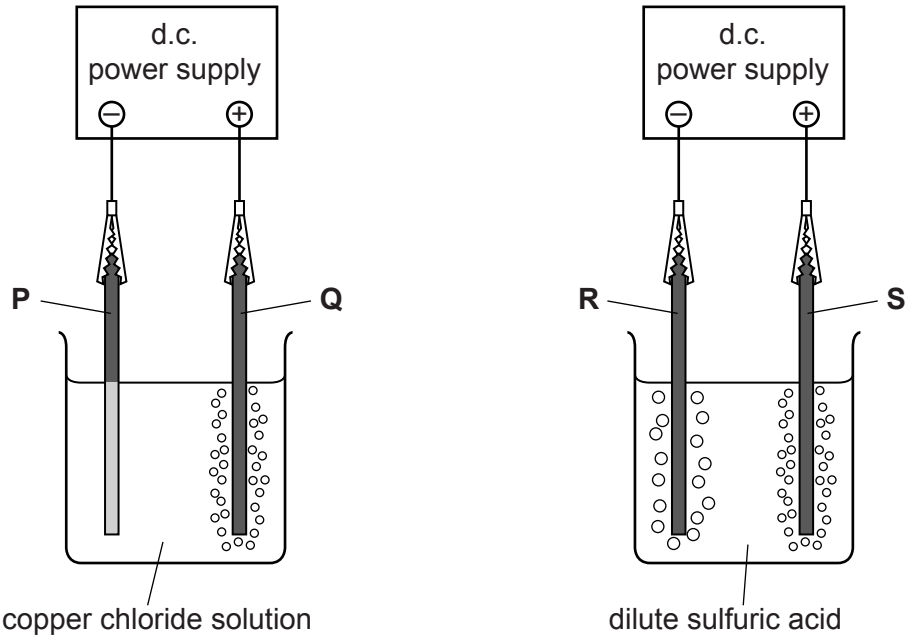


Fig. 11.1

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.

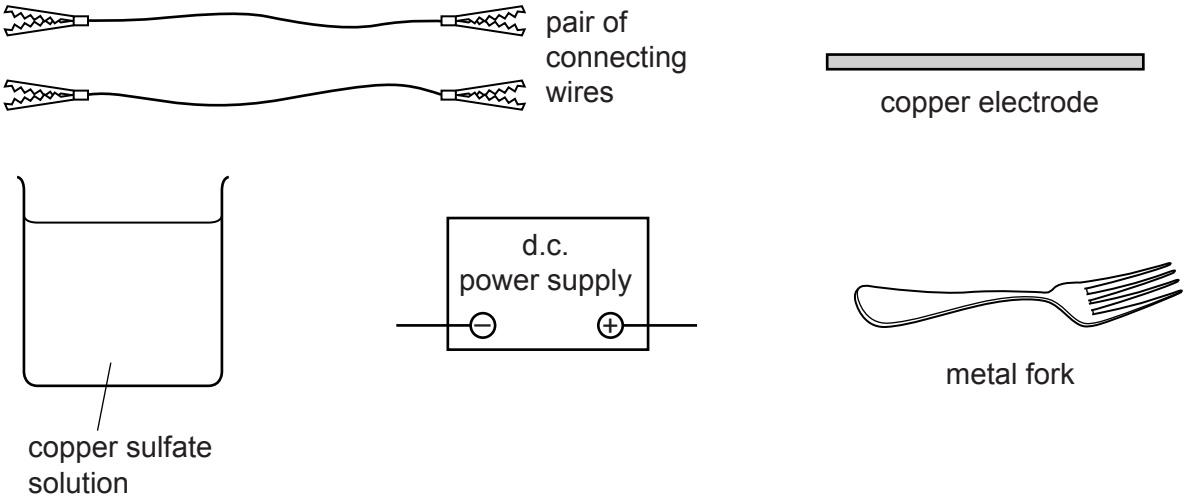


Fig. 11.2

(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.

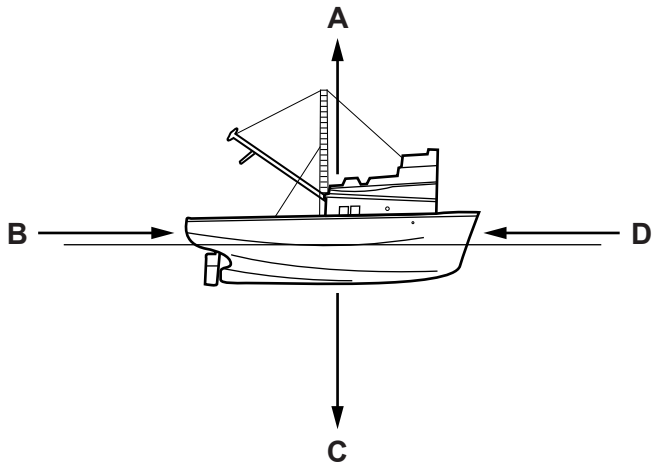


Fig. 13.1

(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 120 m below the surface.

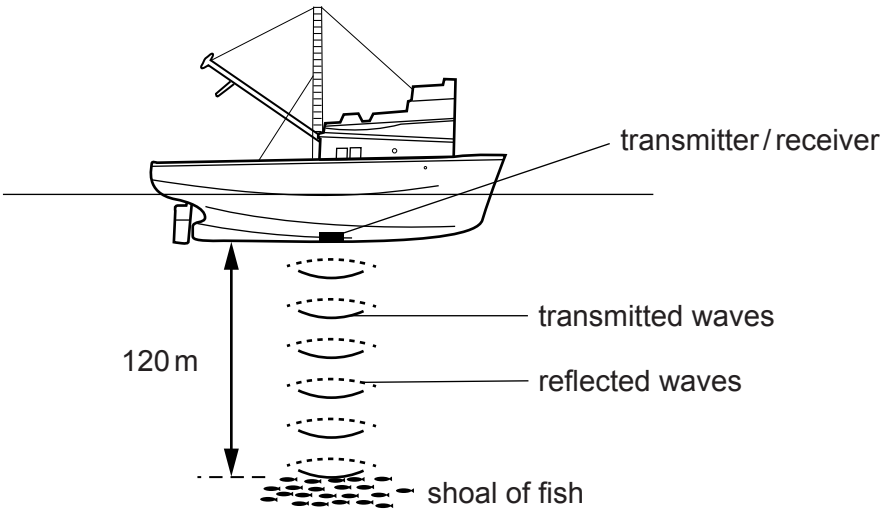


Fig. 13.2

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

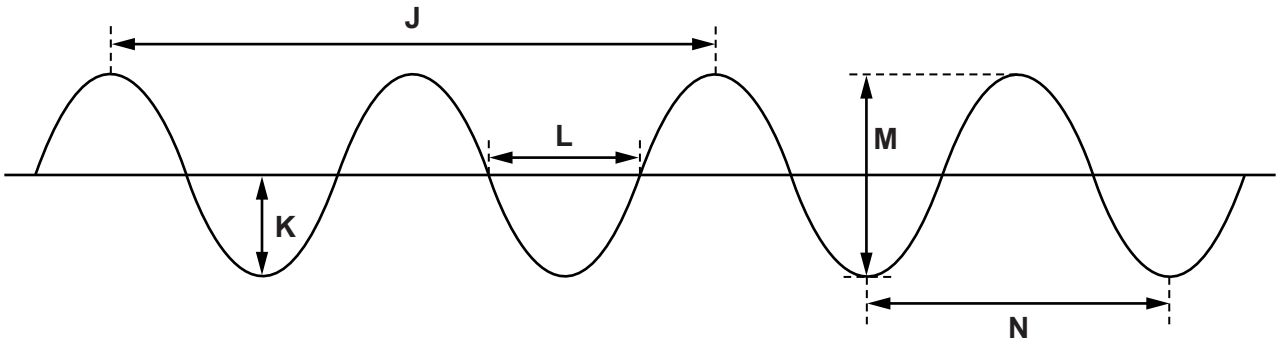


Fig. 13.3

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]

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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	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

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

Key: a above **X**, b below

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).