Cambridge O Level

CANDIDATE
NAME

CENTRE
NUMBER

CANDIDATE
NUMBER

COMBINED SCIENCE **5129/21**

Paper 2 **October/November 2020**

2 hours 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **24** pages. Blank pages are indicated.

[Turn over

1 When it is heated, concentrated nitric acid decomposes to produce nitrogen dioxide, water and oxygen.

The equation for the reaction is shown.

$$4HNO_3 \longrightarrow 4NO_2 + 2H_2O + O_2$$

The relative molecular mass of nitric acid is 63.

[A_r: O, 16; N, 14; H, 1]

(a) (i) Calculate the relative molecular mass, M_r, of nitrogen dioxide.

M_r = ... [1]

(ii) Complete the following sentences.

252 g of nitric acid produces .... g of nitrogen dioxide and .... g of oxygen.

12.6 g of nitric acid produces .... g of nitrogen dioxide.

[3]

(b) Describe a test to show that oxygen is given off in the reaction.

State the result of the test.

test ....

result ....

....
[2]

(c) Nitrogen dioxide is an atmospheric pollutant produced in car engines.

Explain how nitrogen dioxide in the air causes buildings to erode.

....

.... [2]

[Total: 8]

2 Table 2.1 shows how the count rate of a radioactive substance varies with time.

Table 2.1

time / hours	0	2	4	6	8	10
count rate / counts per minute	160	112	80	56	40	28

(a) Determine the half-life of the radioactive substance.

half-life = ... hours [1]

(b) The radioactive substance can be described using nuclide notation.

$$^{A}_{Z}X$$

When an alpha-particle is emitted, the number *A* decreases by four.

State and explain what happens to *Z* when an alpha-particle is emitted.

....

.... [2]

(c) The radioactive substance also emits gamma radiation.

Describe the nature of gamma radiation.

....

.... [2]

[Total: 5]

3 Use words or phrases from the list to complete the sentences about the lungs.

Each word may be used once, more than once, or not at all.

alveoli   **carbon dioxide**   **capillaries**   **decreases**

increases   **length**   **nitrogen**   **oxygen**

red blood cells   **volume**   **water vapour**

When a person exercises, the number of breaths they take per minute

.... and the .... of each breath increases.

This happens because the person needs to take in more .... and

excrete more ....

If a person lives where the air is polluted, the particles they breathe in get deposited on the

surface of the .... and so they will not be able to absorb as much

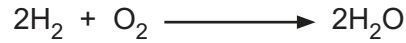... from the air.

[6]

4 An atom of hydrogen is represented by the symbol $^1_1$H.

(a) State how this atom of hydrogen differs from atoms of all the other elements.

....

.... [1]

(b) Hydrogen reacts with oxygen to produce water.

The equation for the reaction is shown.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Complete Fig. 4.1 to show the outer shell electrons in a molecule of water.
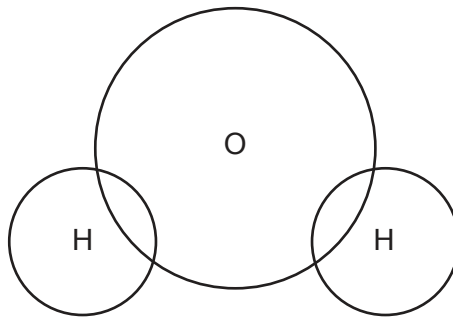

Fig. 4.1

[2]

(c) (i) Complete the following sentence about water.

Sodium chloride dissolves in water to produce a solution of sodium chloride. The water

acts as the ....

[1]

(ii) The boiling point of pure water is 100 °C.

State the effect of adding sodium chloride on the boiling point of water.

.... [1]

[Total: 5]

5 **(a)** Fig. 5.1 shows a section through a root hair cell.

A ....

B ....
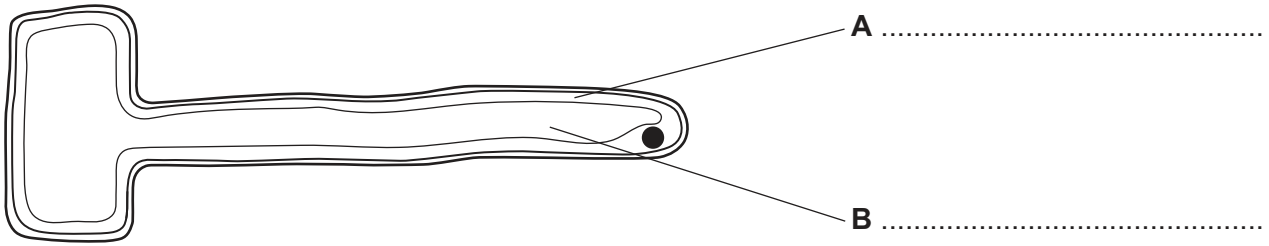
Fig. 5.1

    (i) On Fig. 5.1, name the structures **A** and **B**. [2]

   (ii) State a function of:

     •   the nucleus ....

          ....

     •   the cell wall. ....

          ....

          [2]

  (iii) Describe **one** way in which the root hair cell is adapted to its function.

     ....

     .... [1]

(b) A student grows plants of type **W** in soil containing a low concentration of nitrogen-containing ions.

He then grows more plants of type **W** in soil containing a high concentration of nitrogen-containing ions.

He repeats the investigation with plants of type **X**.

When the plants are mature he measures:
- the average length of the root hairs
- the average number of root hairs per unit area.

The results are shown in Table 5.1:

Table 5.1

plant	concentration of nitrogen-containing ions	average length of root hairs / micrometres	average number of root hairs per unit area
W	low	175	25
	high	150	34
X	low	225	28
	high	55	38

(i) State how the concentration of the nitrogen-containing ions affects the **length** of the root hair cells.

....

.... [1]

(ii) State how the concentration of nitrogen-containing ions affects the **number** of root hair cells per unit area.

....

.... [1]

(iii) Suggest a reason for the pattern in the results shown in Table 5.1.

....

.... [1]

(iv) Explain why plants need nitrogen-containing ions for healthy growth of leaves.

....

.... [1]

[Total: 9]

6   A plastic block is attached to a spring and partly immersed in a liquid as shown in Fig. 6.1.

The block is then removed from the liquid causing the length of the spring and the level of the liquid to change as shown in Fig. 6.2.
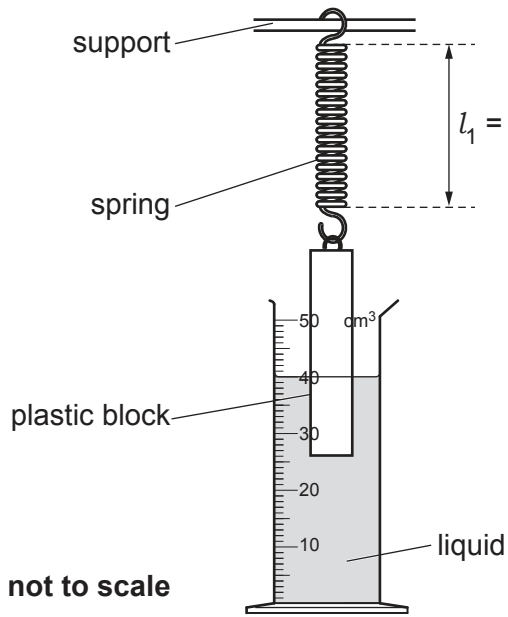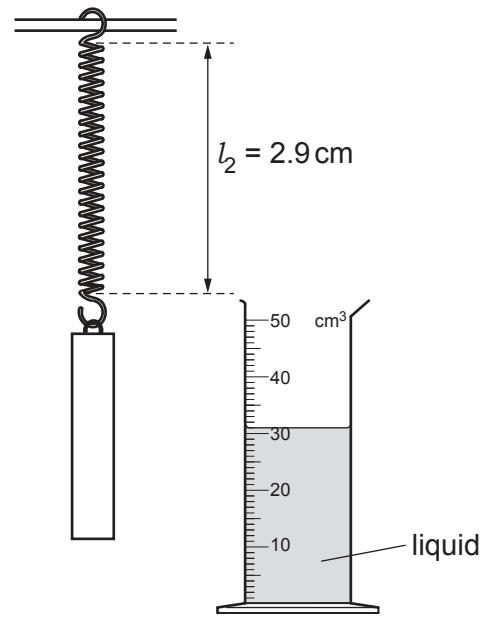

| **Fig. 6.1** | **Fig. 6.2** |

(a)   Calculate the change in the length of the spring.

change in length = ... cm [1]

(b)   Determine the volume of the part of the plastic block immersed in the liquid.

Use the readings on the measuring cylinders in Fig. 6.1 and Fig. 6.2.

.... cm^3 [2]

(c)   The density of the plastic is $0.9 \, g/cm^3$.

The volume of the plastic block is $18 \, cm^3$.

Calculate the mass of the plastic block.

mass = ... g [2]

[Total: 5]

7 Bromine is a diatomic element in Group VII of the Periodic Table.

(a) State the name given to the elements in Group VII of the Periodic Table.

.... [1]

(b) Explain the meaning of the term *diatomic*.

....

.... [1]

(c) A solution of bromine in water is used to distinguish between an unsaturated hydrocarbon and a saturated hydrocarbon.

State what is observed when bromine solution is added to:

• a saturated hydrocarbon ....

....

• an unsaturated hydrocarbon. ....

....
[2]

(d) Bromine solution reacts with potassium iodide solution but not potassium chloride solution.

(i) Name the products when bromine solution is added to potassium iodide solution.

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

(ii) Suggest why bromine solution does **not** react with potassium chloride solution.

....

.... [1]

[Total: 7]

8 Fig. 8.1 shows a method used to generate electric power.

Cold water is pumped down to hot rocks deep in the Earth's crust.

Steam and hot water then rise up to pass through a turbine attached to a generator.
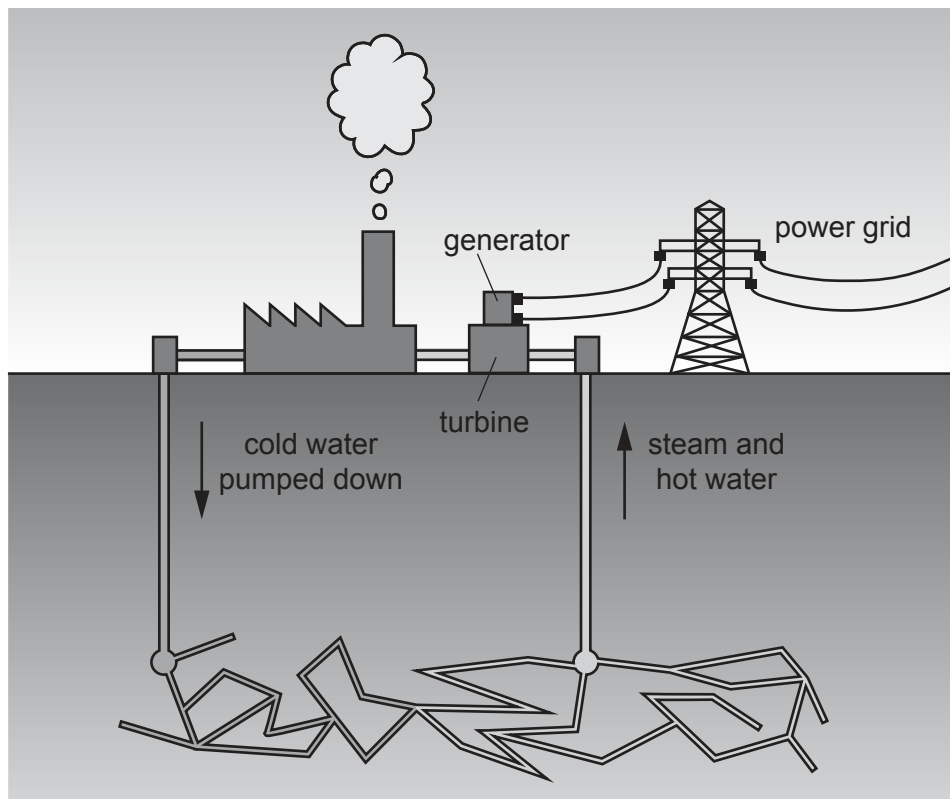

Fig. 8.1

(a) Name the energy source shown in Fig. 8.1.

.... [1]

(b) Put **one** tick in each column to complete the sentences about how energy is transferred when generating this power.

	energy is transferred from rock to water as…	energy is transferred from steam to turbine as…	energy is transferred from generator to power grid as…
… chemical energy			
… electrical energy			
… kinetic energy			
… thermal energy			

[3]

(c) The generator supplies a nearby factory with 5.0×10^6 W of power.

Calculate the time taken to supply 9.0×10^7 J of energy to the factory.

time = ... s [2]

[Total: 6]

9 (a) Define the term *enzyme*.

....

....

.... [2]

(b) Fig. 9.1 shows how the activity of an enzyme is affected by temperature.
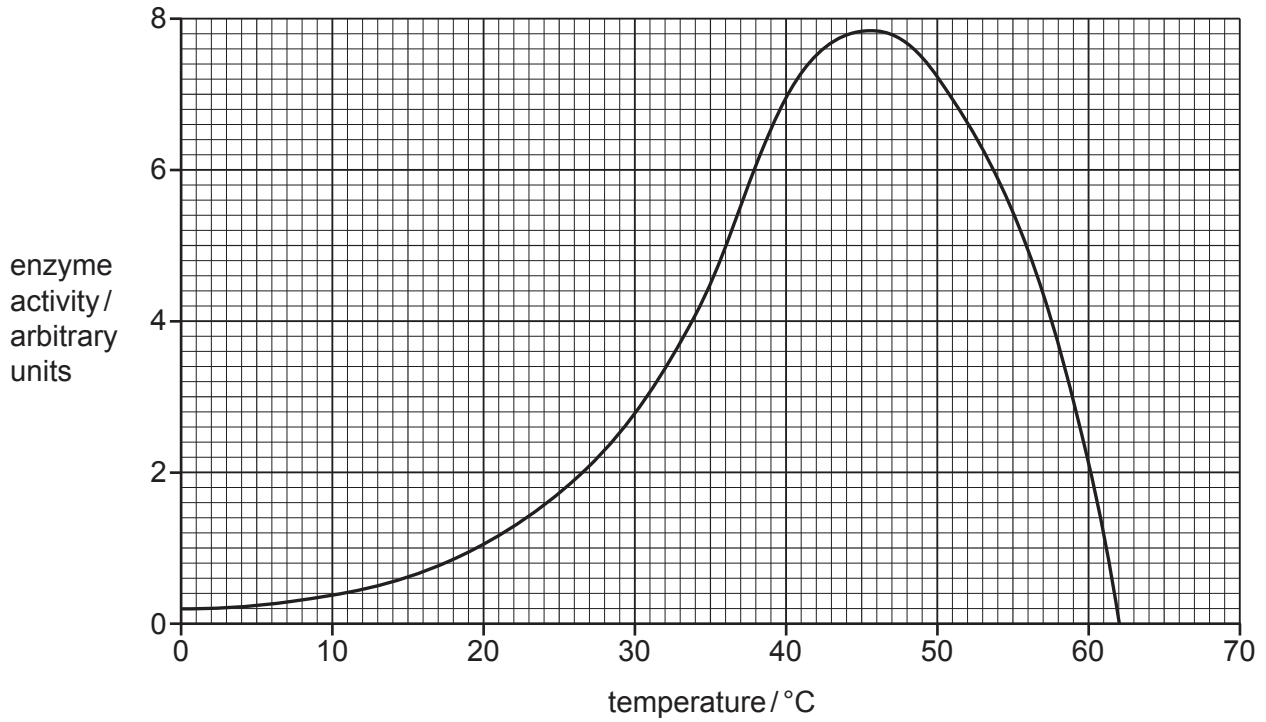
Fig. 9.1

(i) Describe how the enzyme activity changes with temperature.

....

....

....

....

....

....

.... [4]

(ii) Name another factor that affects the activity of an enzyme in a similar way.

.... [1]

(c) Enzymes are active in germinating seeds.

Describe the importance of enzymes during germination.

....

....

....

.... [2]

[Total: 9]

10 The following is a list of substances.

aluminium   **calcium carbonate**   **carbon monoxide**   **copper**

hydrogen   **magnesium**   **potassium oxide**   **zinc carbonate**

Descriptions of properties of some substances are shown in Table 10.1.

Complete Table 10.1 by selecting the substance from the list that matches the property.

Each substance may be used once, more than once or not at all.

Table 10.1

property	substance
mixes with zinc to make brass	
resistant to corrosion due to an oxide layer	
burns to produce an acidic oxide	
reacts with dilute nitric acid to produce a salt and water **only**	
removes acidic impurities in the blast furnace	
can be extracted from its oxide by heating with carbon	

[6]

11 Fig. 11.1 shows how the voltage output of a simple a.c. generator varies with time.
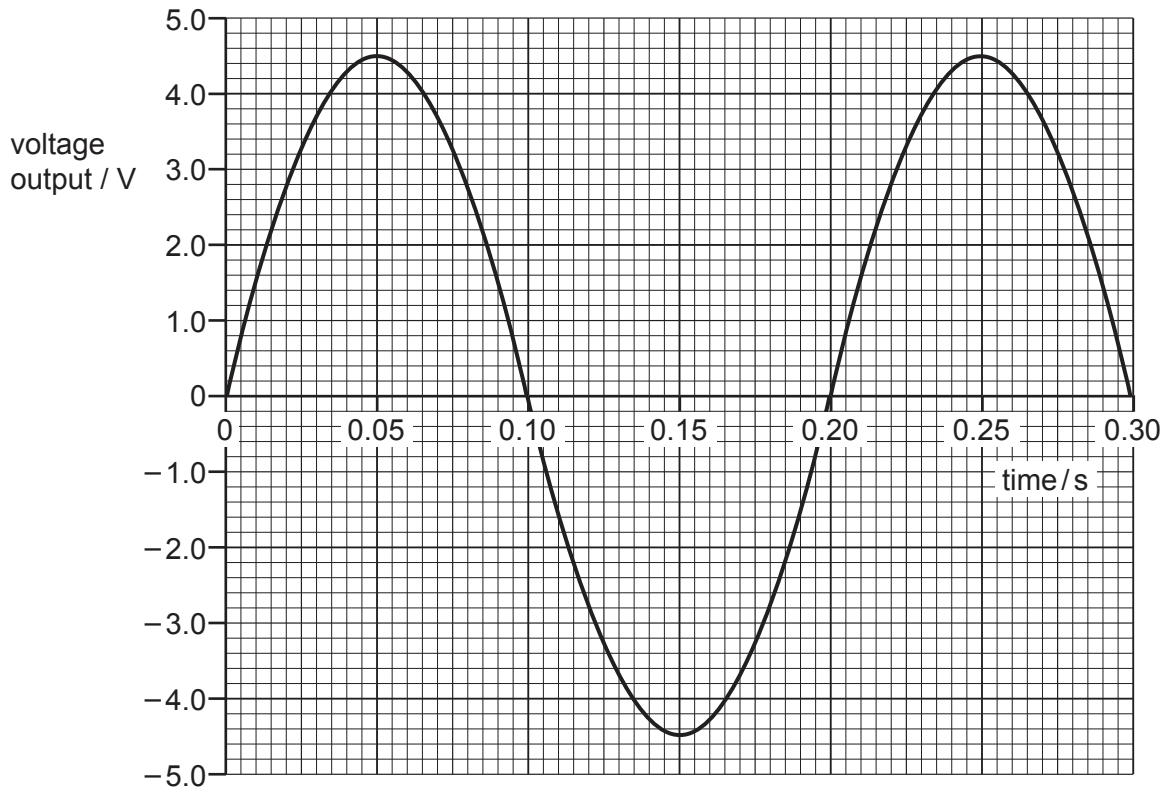
Fig. 11.1

(a) Use Fig. 11.1 to determine the maximum voltage output.

voltage output = ... V [1]

(b) The simple a.c. generator contains slip rings.

State **one** other component of the a.c. generator.

.... [1]

(c) Explain why the voltage output is negative between 0.10 s and 0.20 s and positive between 0.20 s and 0.30 s.

....

.... [2]

[Total: 4]

12 Different parts of the digestive system and associated organs have specific functions.

On Fig. 12.1 draw **one** straight line from each part to a function it carries out.

part	function
anus	absorption
ileum	assimilation
liver	egestion
mouth	ingestion
oesophagus	peristalsis

Fig. 12.1

[5]

13 Fig. 13.1 shows a lamp connected to an electrical circuit in a home.
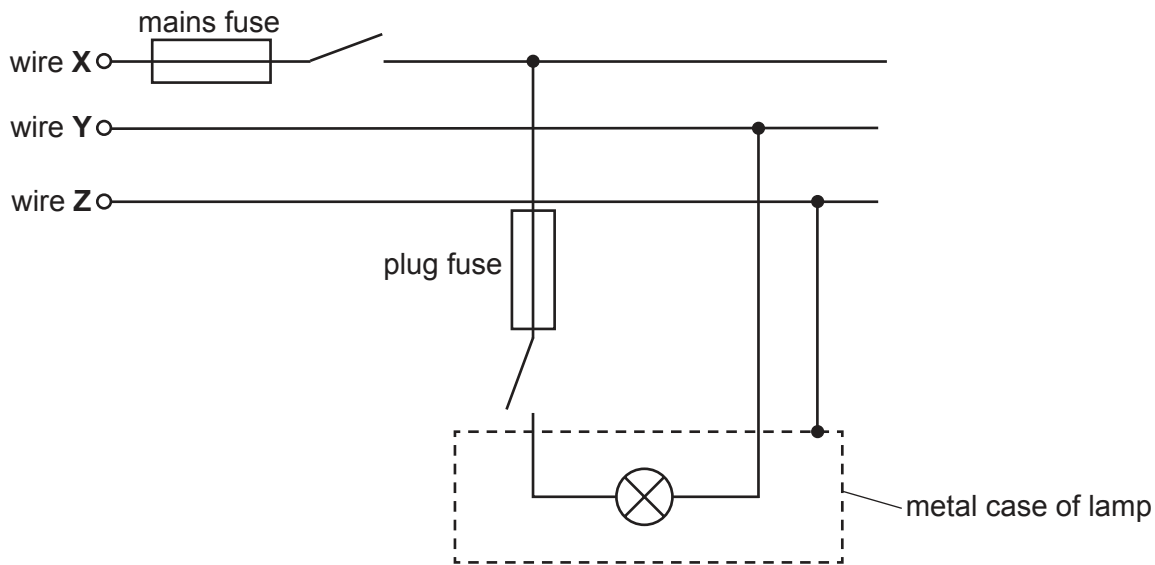
Fig. 13.1

(a) Name wire **X** and explain why a fuse is connected in this wire.

name ....

explanation ....

....
[3]

(b) Explain why wire **Z** is connected to the metal case of the lamp.

....

.... [2]

(c) All the wires are insulated.

State one hazard of damaged insulation.

.... [1]

(d) The lamp has a resistance of 240 Ω.

The potential difference across the lamp is 120 V.

Calculate the current in the lamp.

current = ... A [2]

[Total: 8]

14 Salts are formed when acids react with alkalis.

(a) Name the acid and the alkali used to make potassium nitrate.

acid ....

alkali ....
[1]

(b) Potassium nitrate is an ionic substance and is soluble in water.

State **one** other property of potassium nitrate.

.... [1]

(c) Fig. 14.1 shows the solubility of potassium nitrate in 100 g of water at different temperatures.
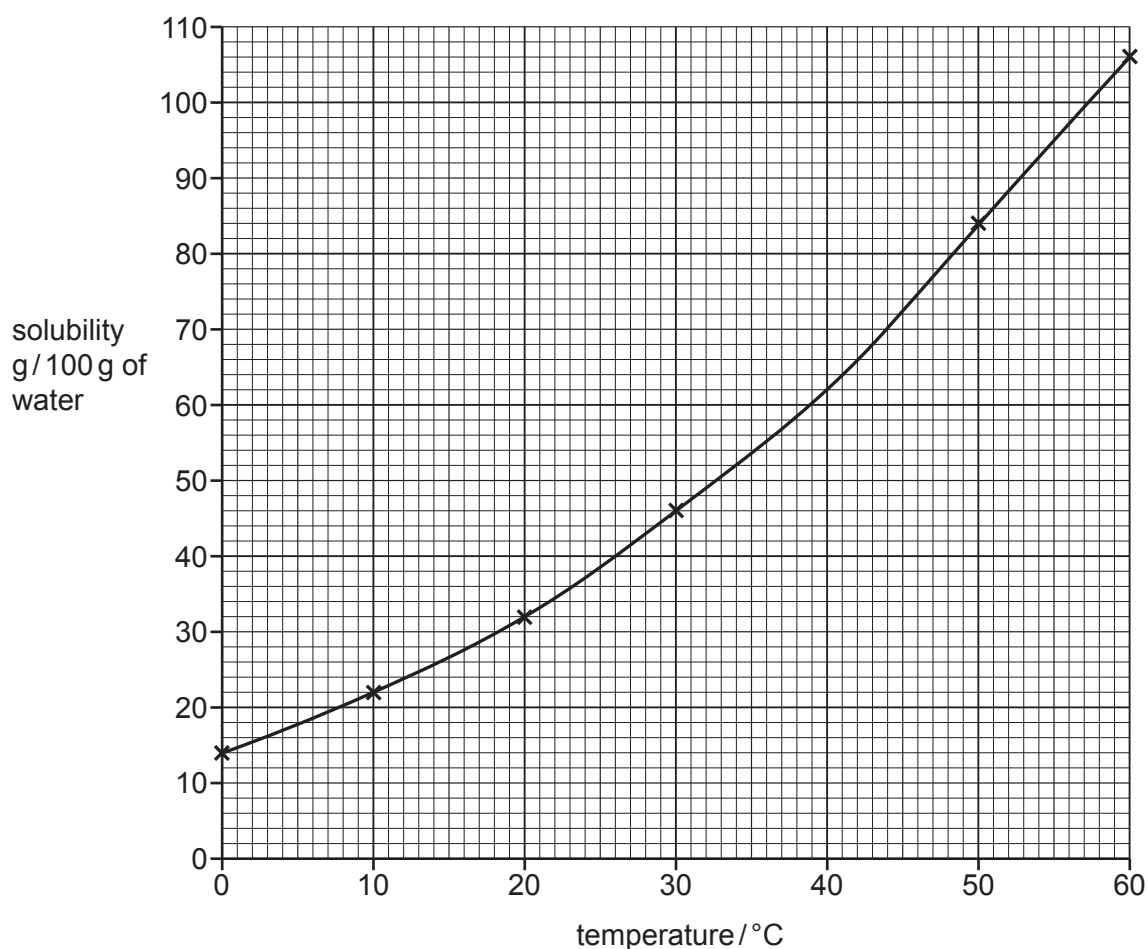
Fig. 14.1

Use Fig. 14.1 to:

(i) determine the solubility of potassium nitrate in 100 g of water at 40 °C

solubility = ... g / 100 g of water [1]

(ii) estimate the amount of solid potassium nitrate produced when a solution containing 106 g of potassium nitrate in 100 g of water at 60 °C is cooled to 40 °C.

amount of solid potassium nitrate produced = ... g [1]

[Total: 4]

15 Fig. 15.1 shows part of the carbon cycle.

On Fig. 15.1 name the four processes **A**, **B**, **C** and **D**.

carbon dioxide in the air

process **A**: ....

process **D**:

....

carbon compounds in animals

process **C**:

....

process **B**: ....

carbon compounds in plants
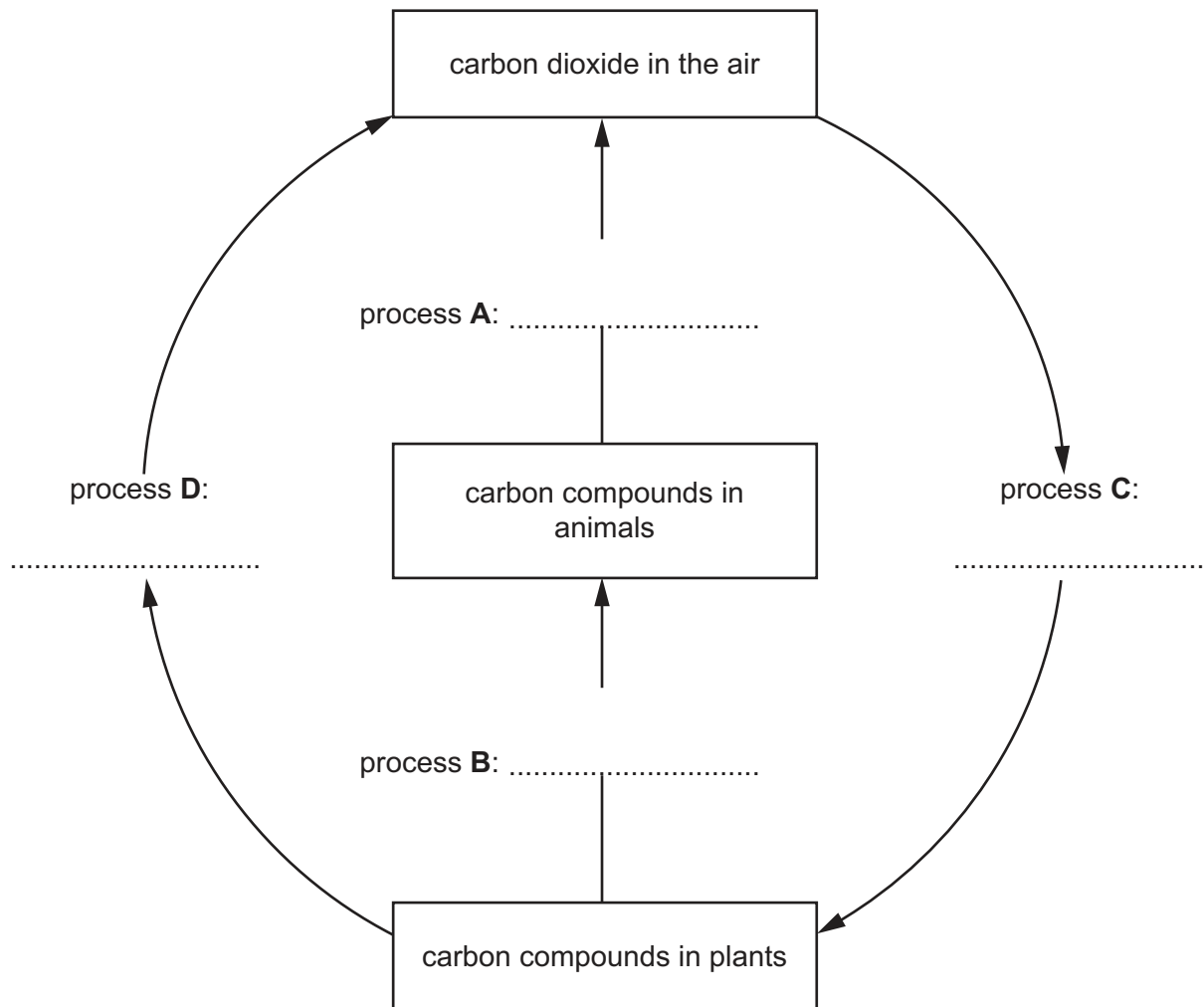
Fig. 15.1

[4]

16   A sheet of rubber can be used to gather rainwater, as shown in Fig. 16.1.
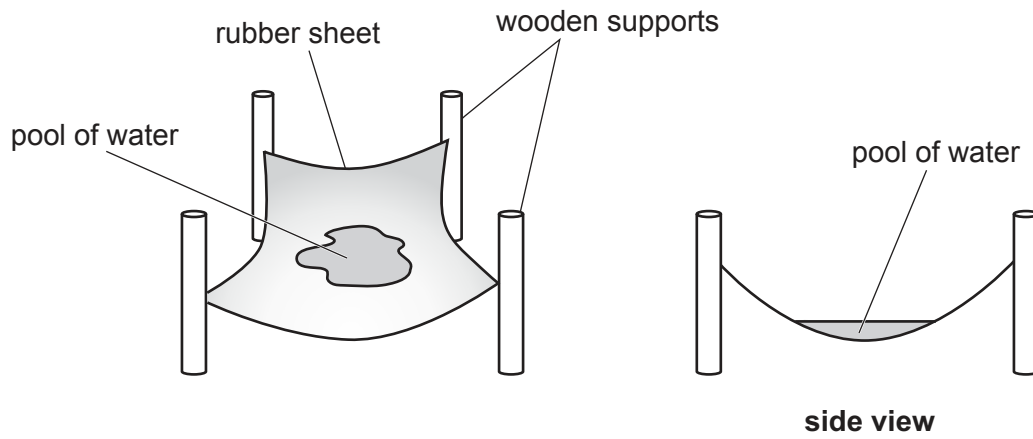
Fig. 16.1

(a) Describe one effect of the weight of the water on the rubber sheet.

.... [1]

(b) A container is filled with water from the pool.

A force of 12.0 N is used to lift the container through a height of 0.7 m.

Calculate the work done.

work done = ... J [2]

(c) A sample of the rubber sheet material is tested.

The load–extension graph is shown in Fig. 16.2.
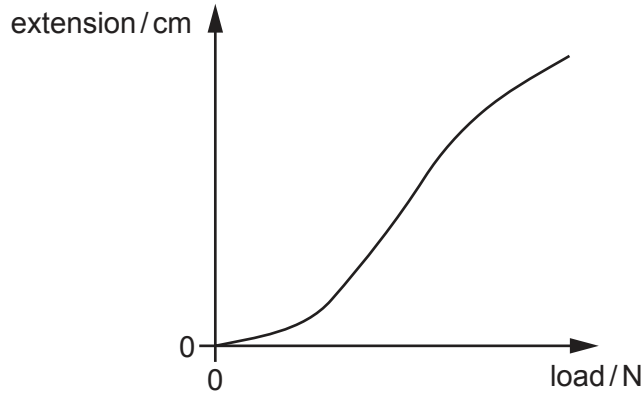
Fig. 16.2

The material remains elastic throughout the test.

(i) Describe how the material is tested.

....

.... [1]

(ii) Describe how the extension of the rubber material changes with load as shown on the graph in Fig. 16.2.

....

.... [1]

(iii) State what happens to the rubber material when the load is removed.

.... [1]

[Total: 6]

17 Petroleum is separated into useful fractions by fractional distillation.

(a) Explain why petroleum can be separated by fractional distillation.

.... [1]

(b) Complete Table 17.1 by naming the fractions to match the use.

Table 17.1

use of fraction	fraction
fuel for oil stoves	
making waxes and polishes	

[2]

[Total: 3]

The Periodic Table of Elements

Group

I	II												III	IV	V	VI	VII	VIII
							1 H hydrogen 1											2 He helium 4
3 Li lithium 7	4 Be beryllium 9				**Key**								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24				atomic number **atomic symbol** name relative atomic mass								13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65		31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112		49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201		81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –			114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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