Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0123456789

CO-ORDINATED SCIENCES **0654/04**

Paper 4 Theory (Extended) **For Examination from 2019**

SPECIMEN PAPER

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 or graphs.
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 26.

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 **25** printed pages and **1** blank page.

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[Turn over

1 Table 1.1 shows some information about three elements **A**, **B** and **C**.

Table 1.1

element	group number in Periodic Table	number of outer electrons in one atom	reactive or unreactive
A	1		
B	7		reactive
C		8	

(a) Complete Table 1.1. [3]

(b) The diagrams, **D**, **E** and **F**, in Fig. 1.1 show the structures of three materials.

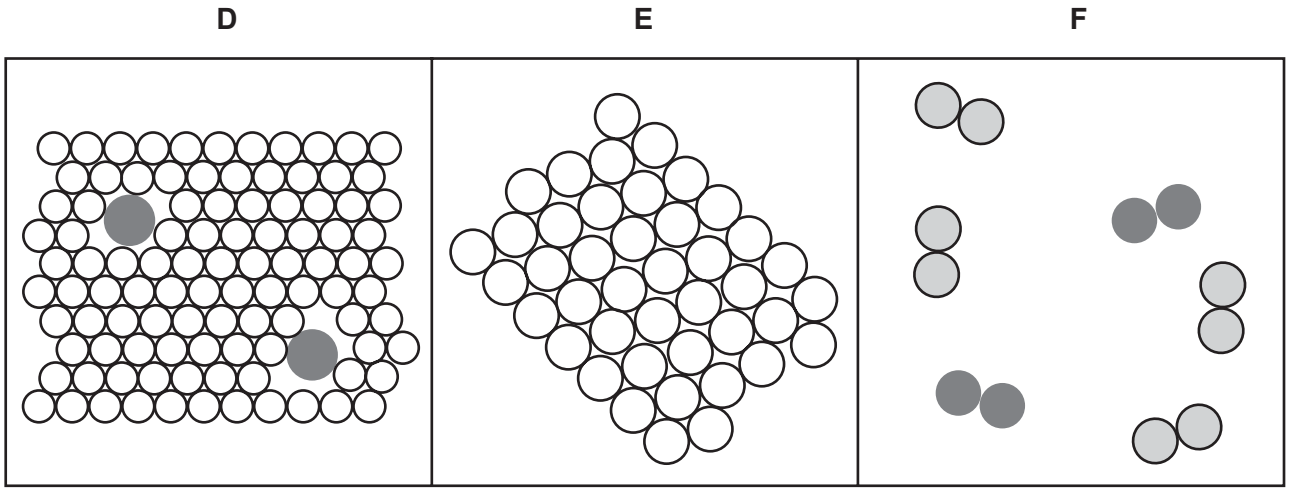

Fig. 1.1

Deduce which diagram shows an alloy.

Explain your answer.

diagram .....

explanation .....

.....

.....

[2]

(c) Fig. 1.2 shows a small piece of sodium reacting with ethanol to form hydrogen gas at 25 °C.

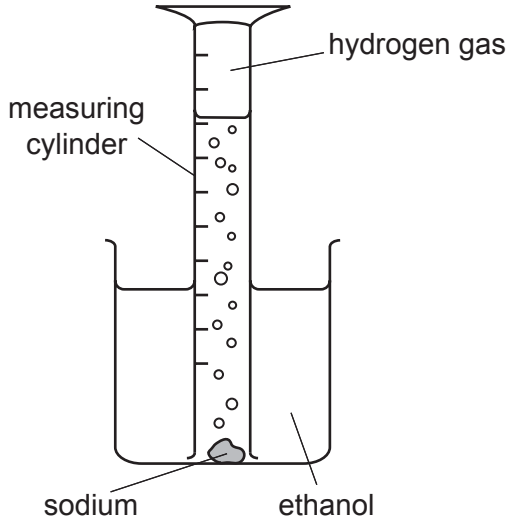

Fig. 1.2

(i) The total volume of hydrogen gas produced by the reaction is 8.4 cm^3.

Calculate the number of moles of hydrogen gas in 8.4 cm^3.

The molar gas volume at 25 °C is 24 dm^3.

Show your working.

number of moles = ... [2]

(ii) The experiment is repeated at a temperature of 10 °C.

State how reducing the temperature affects the rate of reaction.

Explain your answer in terms of collisions between particles.

.....

.....

.....

..... [3]

[Total: 10]

2 Fig. 2.1 shows an insect-pollinated flower cut through lengthways.

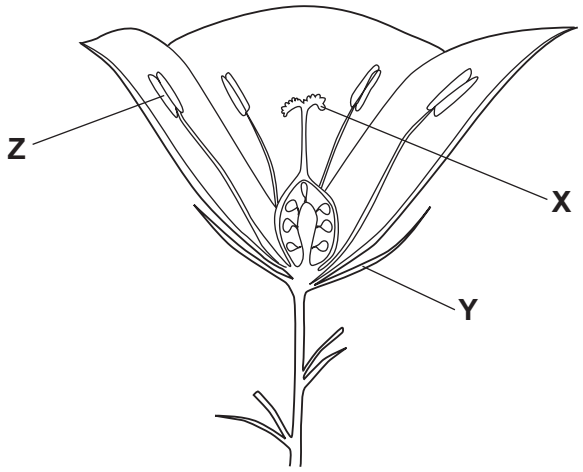

Fig. 2.1

(a) Name the structures labelled **X** and **Y**.

X .....

Y .....

[2]

(b) State the function of the part labelled **Z**.

.....

..... [1]

(c) On Fig. 2.1, use a label line and the letter **W** to label the part of the flower where fertilisation occurs. [1]

(d) State two ways, shown in Fig. 2.1, in which **this** flower is adapted for pollination by insects.

1. .....

2. .....

[2]

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(e) Plants absorb water by osmosis into their root hair cells.

(i) Explain how the structure of the root hair cells is related to this function.

.....

.....

..... [2]

(ii) State **one** other function of root hair cells.

..... [1]

[Total: 9]

3 **(a)** **(i)** Sound travels at approximately 300 m/s in air.

Circle the best estimate of the speed of sound in water.

10 m/s 50 m/s 300 m/s 1500 m/s [1]

(ii) State the range of frequencies that a healthy human ear can detect.

..... [1]

(b) Blue light waves have a frequency of 6.7×10^{14} Hz. The speed of light is 3.0×10^{8} m/s.

(i) Calculate the wavelength of blue light waves.

Show your working.

wavelength = ... m [2]

(ii) Blue light refracts when it passes from air into a block of glass.

State how the following properties of blue light change, if at all, when the light enters glass.

wavelength .....

frequency .....

speed .....

[3]

(iii) Blue light enters the glass at an angle of 45°.

The refractive index of the glass n = 1.5.

Calculate the angle of refraction of the blue light.

..... [2]

[Total: 9]

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4 **(a)** The ionic half-equation when zinc atoms form zinc ions is shown.

$$Zn \rightarrow Zn^{2+} + 2e^{-}$$

(i) Write an ionic half-equation for a metal that is more reactive than zinc.

..... → ..... + ... [1]

(ii) When zinc is added to aqueous lead nitrate the zinc becomes coated with a black deposit of lead.

The ionic half-equation for the reaction is shown.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

Write an ionic half-equation for the reaction between aqueous copper(II) nitrate and zinc.

..... [2]

(b) The reactivity series can be written as a list of ionic half-equations.

$Zn \rightarrow Zn^{2+} + 2e^{-}$ ↑
$Fe \rightarrow Fe^{2+} + 2e^{-}$ |
$Pb \rightarrow Pb^{2+} + 2e^{-}$ | increasing strength of metal atom as a reducing agent
$Cu \rightarrow Cu^{2+} + 2e^{-}$ |

(i) Deduce which ion is the best oxidising agent.

..... [1]

(ii) Give the ion(s) in the list that can oxidise lead metal.

..... [1]

(c) Zinc is used in galvanising, as a method of rust prevention.

(i) Explain how galvanising prevents rusting.

.....

.....

.....

.....

.....

..... [3]

(ii) State **one** other method of rust prevention.

..... [1]

[Total: 9]

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5 Some washing powders contain enzymes that digest fats. These enzymes help to remove greasy stains in clothing.

(a) Name the type of enzyme that digests fats.

..... [1]

(b) The graph in Fig. 5.1 shows the effect of temperature on the activity of two different fat-digesting enzymes from different washing powders.

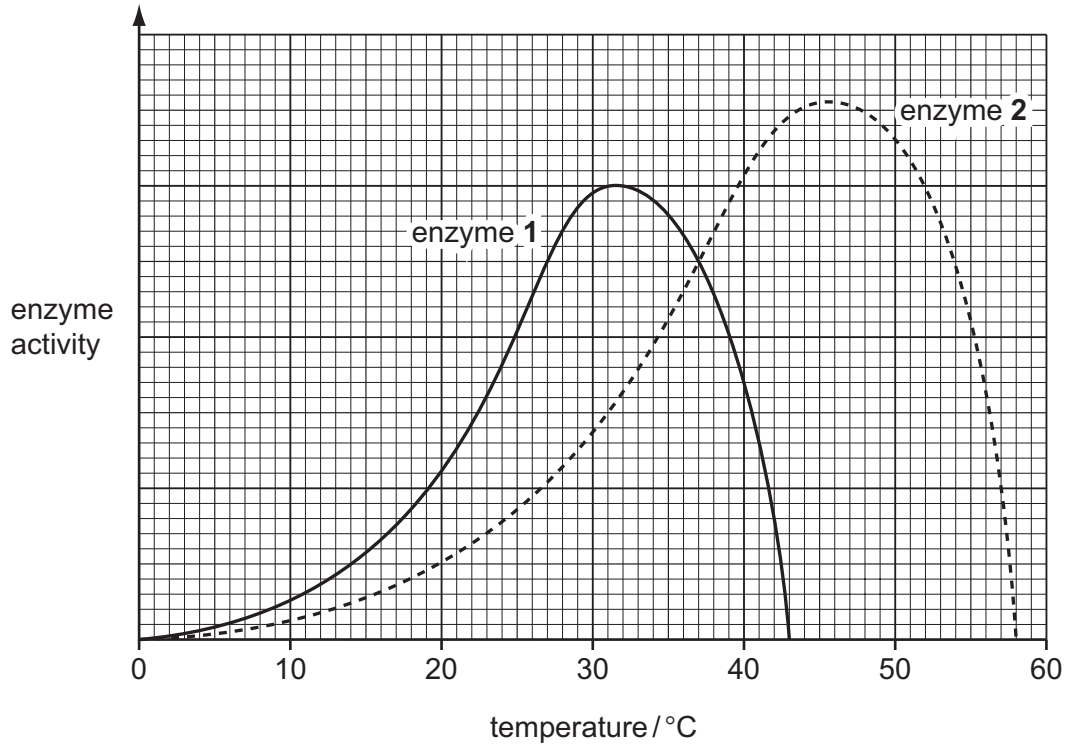

Fig. 5.1

(i) State the temperature at which both enzymes are working and have the same activity.

temperature ..... °C [1]

(ii) Explain why both enzymes work very slowly at 10 °C.

.....

.....

..... [2]

(iii) Explain why the enzymes do not work at all above 60 °C.

.....

.....

..... [2]

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(c) Most washing machines have a standard programme that washes clothes at 40 °C. Some machines also have an 'ECO' programme that washes at 30 °C. These low temperature wash programmes take longer to wash the clothes.

(i) State whether or not the 'ECO' programme is better for the environment.

Explain your answer.

.....

.....

..... [2]

(ii) Suggest which of the two enzymes in Fig. 5.1 should be in a washing powder designed for use with an 'ECO' programme.

Explain your answer.

enzyme .....

explanation .....

.....

.....

[1]

[Total: 9]

6 Fig. 6.1 shows the speed-time graph for a car travelling along a straight road.

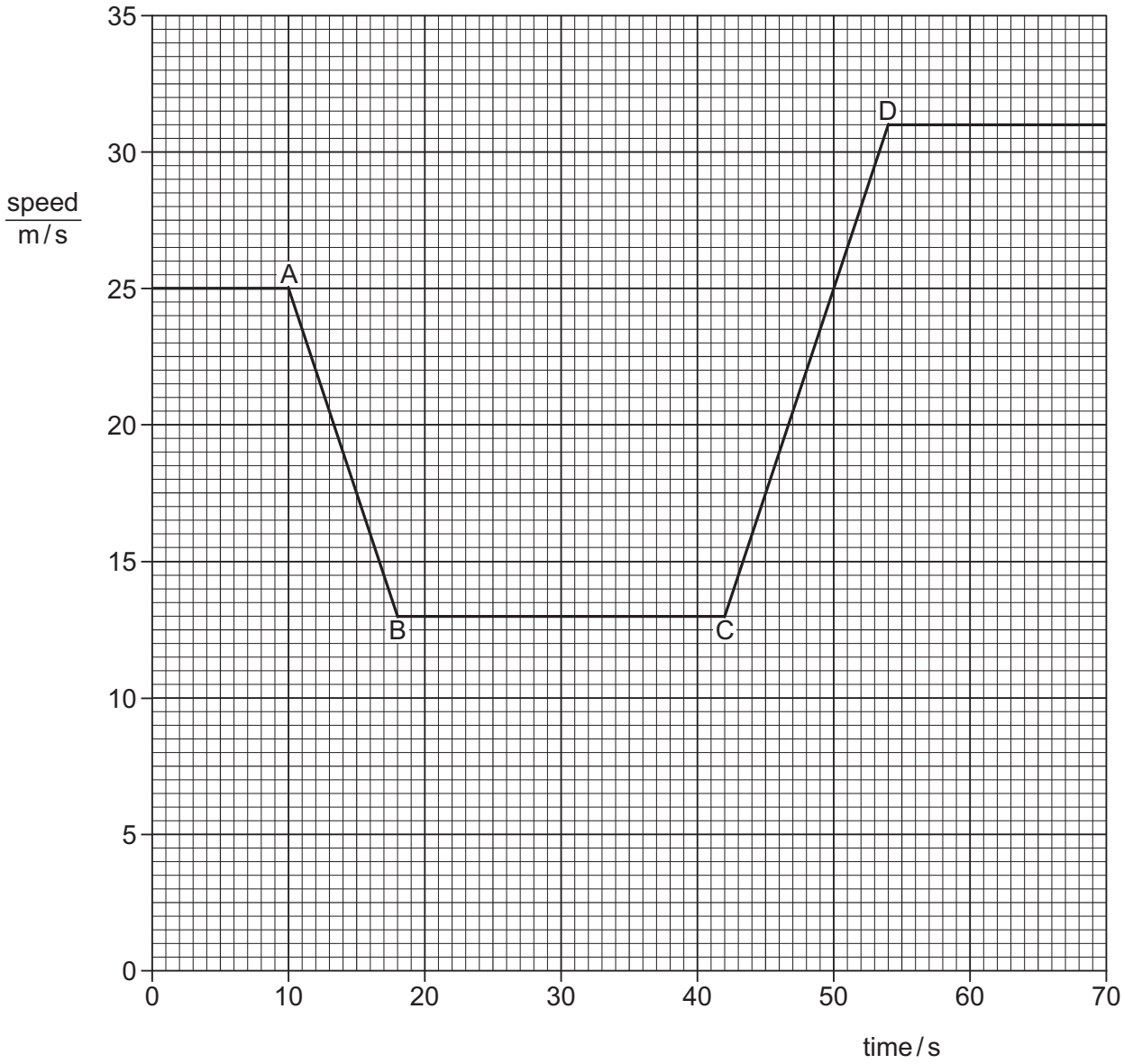

Fig. 6.1

(a) The car accelerates between points **C** and **D**.

Define the term *acceleration*.

.....

..... [2]

(b) Calculate the acceleration of the car between points **C** and **D**.

Show your working.

acceleration = ... m/s^2 [2]

[Total: 4]

7 Ammonia is manufactured by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) State the meaning of the symbol ⇌.

..... [1]

(b) Describe the sources of the Haber process reactants, nitrogen and hydrogen.

nitrogen .....

.....

hydrogen .....

.....

.....

[3]

(c) Name the catalyst used in the Haber process.

..... [1]

(d) Ammonia can also be produced by a reaction involving ammonium salts, as shown by the equation.

$$NH_4Cl(aq) + NaOH(aq) \rightarrow NH_3(g) + H_2O(l) + NaCl(aq)$$

Give the name of the type of reaction shown by this equation.

..... [1]

[Total: 6]

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Question 8 starts on page 14

8 The corncob from a sweetcorn (maize) plant is shown in Fig. 8.1.

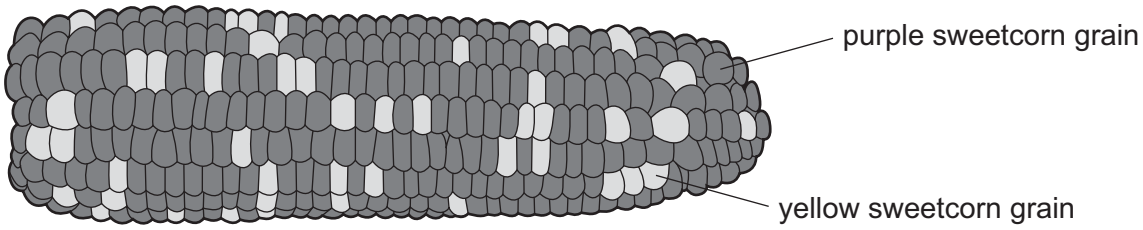

Fig. 8.1

Each of the individual sweetcorn grains on the corncob results from the fertilisation of a different female nucleus by a different male nucleus from a pollen grain.

(a) State the type of cell division that produces a haploid nucleus in a pollen grain from a diploid nucleus.

..... [1]

(b) Some of the sweetcorn grains are purple (dark) in colour and others yellow (light) in colour.

The variation in grain colour is an example of discontinuous variation.

Explain why this variation is described as *discontinuous*.

.....

.....

..... [2]

(c) The allele for purple colour (G) is dominant and the allele for yellow colour (g) is recessive.

Name the term used to describe the genotype gg.

..... [1]

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(d) Complete the genetic diagram below to show the result of crossing a heterozygous purple-grained sweetcorn plant with a yellow-grained sweetcorn plant.

parental phenotypes purple × yellow

parental genotypes Gg × gg

parental gametes .... + ...

offspring genotypes .....

offspring phenotypes .....

phenotypic ratio: .....

[4]

(e) Explain the advantages of sexual reproduction in a species.

.....

.....

.....

..... [2]

[Total: 10]

9 Coal is burned in a power station to generate electricity.

Fig. 9.1 is a scale diagram to show the energy transfers in a coal-burning power station.

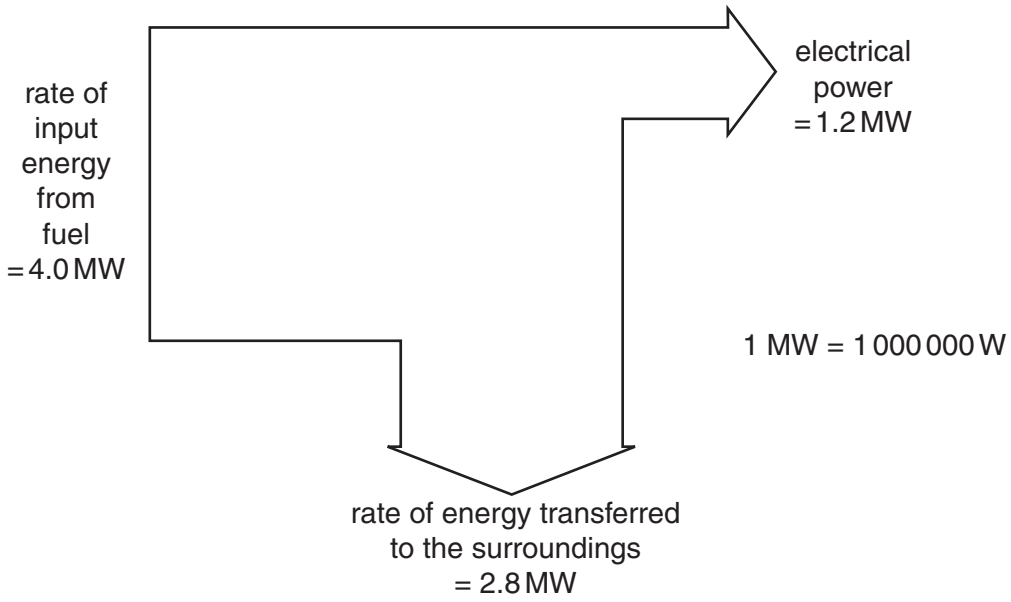


Fig. 9.1

(a) (i) State the original source of the energy stored in coal.

..... [1]

(ii) Calculate the efficiency of the power station. Give your answer as a percentage.

Show your working.

efficiency = ...% [2]

(iii) Use information from Fig. 9.1 to explain the meaning of conservation of energy.

.....

.....

..... [2]

(iv) Describe how the type of energy stored in coal changes as it is transferred through the power station to the generator.

.....

.....

.....

..... [3]

(b) When electricity has been generated in a power station, a step-up transformer increases the voltage before the electricity is transmitted through long-distance cables.

(i) Explain why the voltage of the electricity is increased before transmission.

.....

..... [2]

(ii) The power station generates electricity at 33 000 V. This voltage is stepped up by a transformer.

The number of turns on the primary coil of the transformer is 40 000. The number of turns on the secondary coil of the transformer is 500 000.

Calculate the output voltage from the transformer.

Show your working.

output voltage = ... V [2]

[Total: 12]

10 Alkanes and alkenes are hydrocarbons.

(a) **(i)** State the meaning of the term *hydrocarbon.*

.....

..... [1]

(ii) State the difference between the structures of alkanes and alkenes.

.....

.....

..... [2]

(b) Alkenes and smaller alkanes are made from longer chain alkanes by cracking.

Complete the equation for the cracking of the alkane $C_{20}H_{42}$.

$$C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + \text{.....} \quad [1]$$

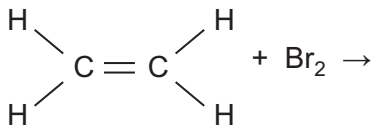
(c) Alkenes are more reactive that alkanes.

Alkenes are used in the petrochemical industry to make a range of products.

(i) Dibromoethane is used as a pesticide.

It is made by reacting ethene with bromine.

Complete the equation by drawing the molecular structure of dibromoethane.



[1]

(ii) Butene, $CH_3–CH_2–CH=CH_2$, is an alkene. Butene reacts with steam to form butanol.

Write the balanced symbol equation for this reaction.

..... [2]

(iii) Alkenes can be converted into alkanes.

Write the balanced symbol equation for the formation of ethane from ethene.

..... [2]

(d) A hydrocarbon is burnt in 175 cm^3 of oxygen.

The mixture is cooled. The volume of the remaining gases is 125 cm^3.

The carbon dioxide is removed. This leaves 25 cm^3 of unreacted oxygen.

(i) Determine the volume of oxygen used.

volume of oxygen used = ... cm^3 [1]

(ii) Determine the volume of carbon dioxide formed.

volume of carbon dioxide formed = ... cm^3 [1]

(iii) Deduce a possible formula for the hydrocarbon.

Write a balanced equation for the reaction of this hydrocarbon with oxygen.

.....
[2]

(e) Increased concentrations of carbon dioxide gas in the atmosphere contribute to climate change.

(i) State the general name of gases like carbon dioxide that contribute to climate change.

..... [1]

(ii) Give the name of **one** other gas that contributes to climate change.

..... [1]

[Total: 15]

11 Fig. 11.1 shows a river running next to agricultural land. Large amounts of artificial fertiliser have been sprayed onto the agricultural land.

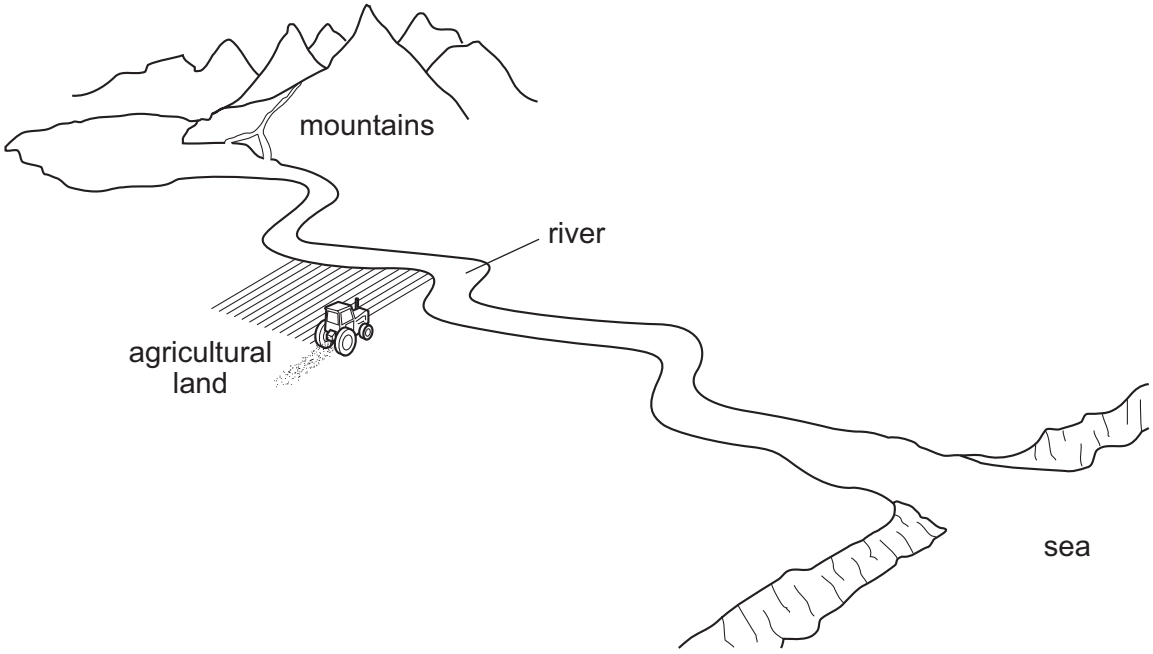


Fig. 11.1

The ecosystem in the river is affected when large amounts of mineral ions enter the water in the river.

(a) Name **one** mineral ion that would be present in the fertiliser.

..... [1]

(b) Describe how mineral ions in the fertiliser might reach the river.

.....

..... [1]

(c) Explain the effects of large amounts of mineral ions entering the river on

(i) algae (photosynthesising microorganisms),

.....

..... [1]

(ii) submerged aquatic plants,

.....

.....

..... [2]

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(iii) bacteria,

.....

.....

..... [2]

(iv) oxygen concentration,

.....

.....

..... [2]

(v) fish.

.....

.....

..... [2]

(d) If the farmer uses artificial fertiliser, suggest **one** way in which the effect of the fertiliser on the river could be reduced.

.....

..... [1]

[Total: 12]

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[Turn over

12 **(a)** Fig. 12.1 shows the electrical circuit for a torch (flashlight).

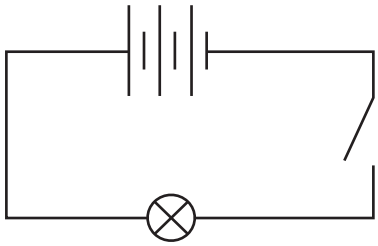

Fig. 12.1

(i) The potential difference across each cell is 1.5 V.

State the total potential difference across the lamp when the switch is closed.

..... V [1]

(ii) There is a current of 0.9 A in the lamp for 60 s.

Calculate the charge that passes through the lamp.

Show your working and state the unit of your answer.

charge = ... unit ..... [3]

(b) The lamp from the torch has a resistance of 5.0 Ω when lit.

Two lamps, identical to the torch lamp, are connected together in a parallel circuit as shown in Fig. 12.2.

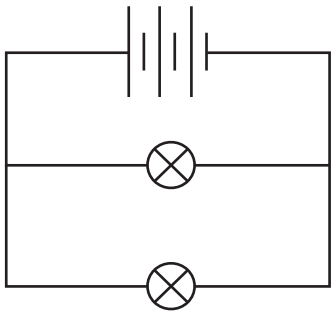

Fig. 12.2

Calculate the combined resistance of the two lamps.

Show your working.

resistance = ...Ω [2]

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(c) Fig. 12.3 shows the circuit controlling a cooling fan in a greenhouse. The circuit includes a motor, a thermistor and a 6.0 V battery.

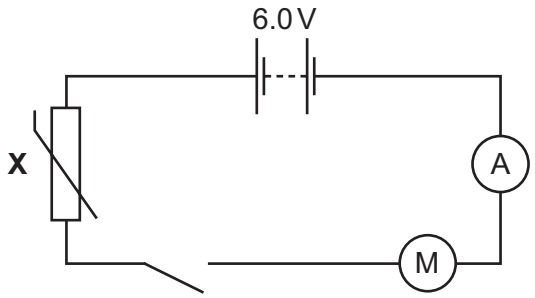

Fig. 12.3

Explain the purpose of the thermistor in this circuit.

.....

.....

.....

.....

..... [3]

[Total: 9]

13 The plates in Fig. 13.1 produce a uniform electric field.

The line labelled **A** shows the path of an α–particle as it travels through the field.

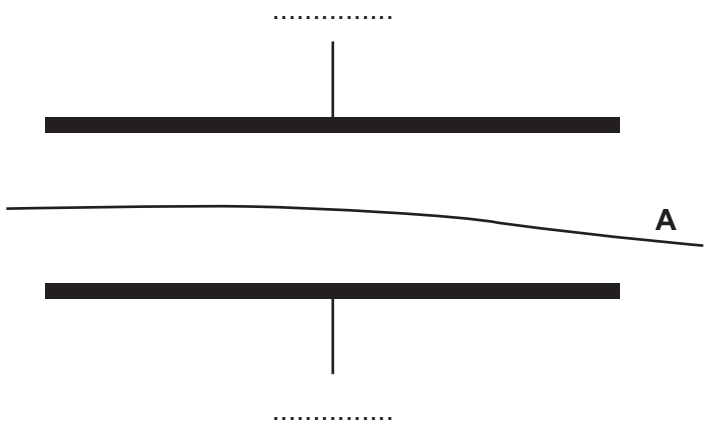

Fig. 13.1

(a) **(i)** On Fig. 13.1 use symbols + and – to show the polarity of the plates. [1]

(ii) On Fig. 13.1 draw the path of a β-particle of similar energy as it travels through the field. [2]

(b) An α-particle has 2 protons and 2 neutrons.
Plutonium-238 (Pu-238) decays to form an isotope of Uranium (U) by emitting an α-particle.

Complete the equation for this type of nuclear decay.

$$^{238}_{94}\text{Pu} \rightarrow {}^{.....}_{.....}\alpha + {}^{.....}_{.....}\text{U}$$

[3]

[Total: 6]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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											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											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 dm^3 at room temperature and pressure (r.t.p.).

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