Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5508182648

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **May/June 2020**

2 hours

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 120.
- 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 **32** pages. Blank pages are indicated.

DC (JC/CB) 183535/4

1 **(a)** Fig. 1.1 is a photomicrograph of pollen from an insect-pollinated plant.

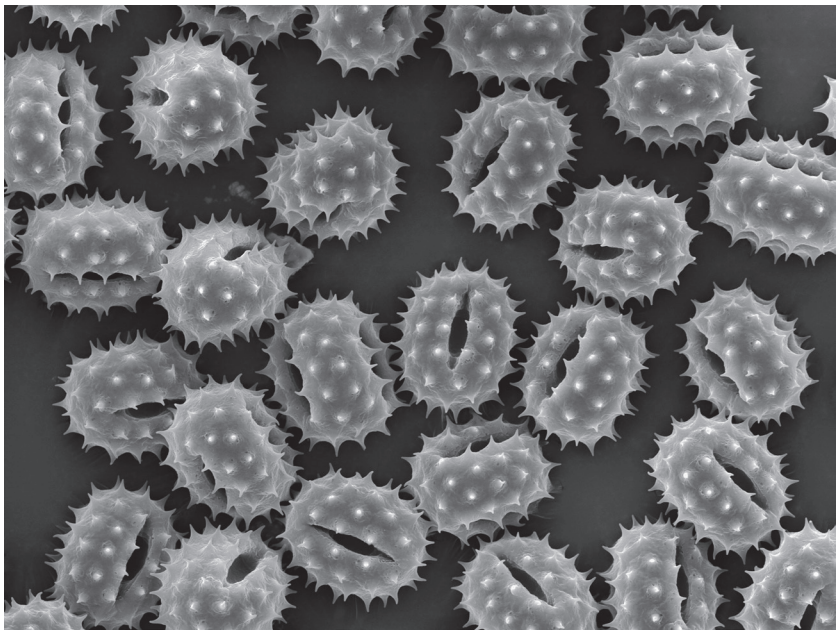

Fig. 1.1

Describe **one visible** piece of evidence that shows this pollen is from an insect-pollinated plant.

.....

..... [1]

(b) Fig. 1.2 is a diagram of a flower from a wind-pollinated plant.

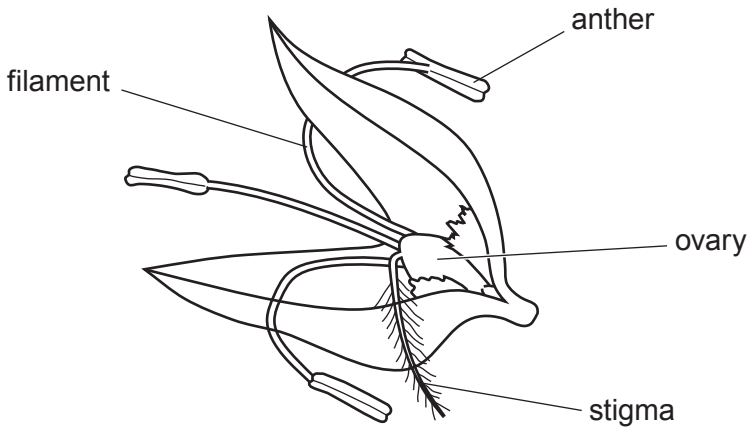

Fig. 1.2

Describe two ways the stigma shown in Fig. 1.2 is specialised for wind-pollination.

1 .....

.....

2 .....

.....

[2]

(c) Pollination is the transfer of pollen. This can lead to fertilisation.

Describe the process of fertilisation in plants.

.....

.....

.....

..... [2]

(d) A species of flowering plant has 18 chromosomes in its mesophyll cells.

Deduce the number of chromosomes in its:

male gametes in its pollen .....

root hair cells. .....

[2]

(e) Plants can reproduce asexually or sexually.

Describe **one** advantage and **one** disadvantage of plants reproducing **asexually** in the wild.

advantage .....

.....

disadvantage .....

.....

[2]

[Total: 9]

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2 **(a)** **(i)** Fig. 2.1 shows the three states of matter.

Complete the labels on Fig. 2.1. [2]

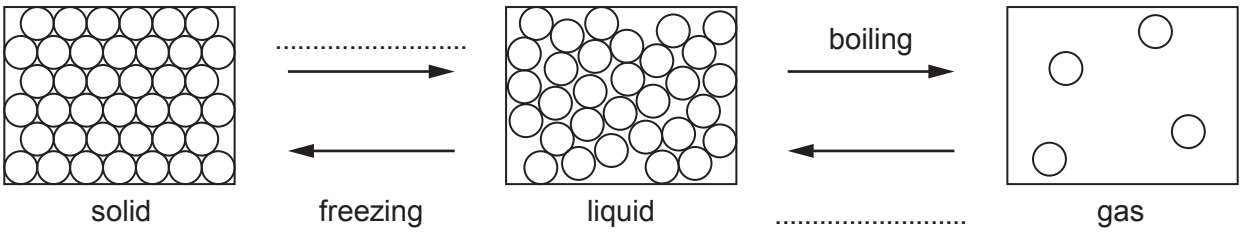

Fig. 2.1

(ii) Describe what happens to the total kinetic energy of the particles as the gas changes to a liquid and then to a solid.

..... [1]

(b) A scientist analyses an unknown ink sample and four dyes, **A**, **B**, **C** and **D**.

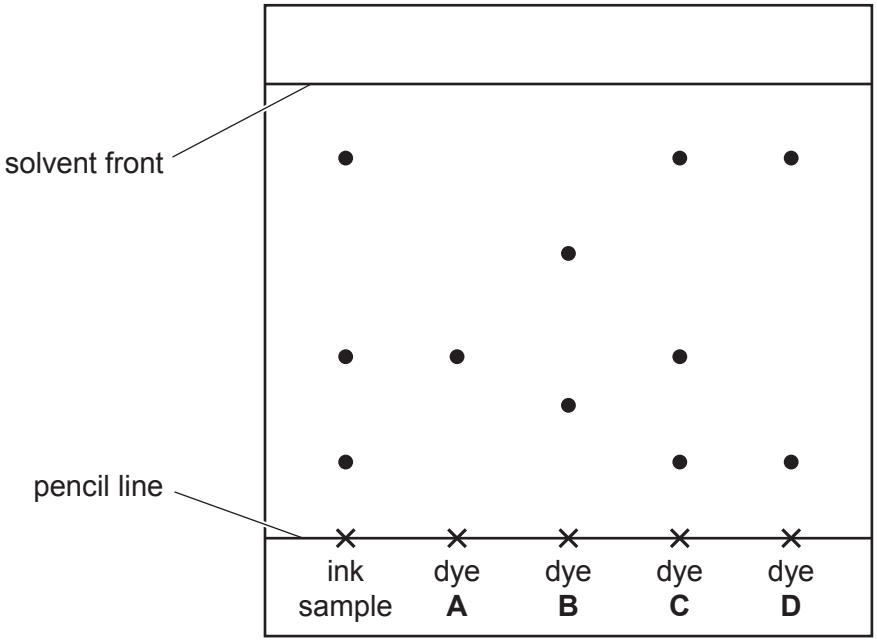

Fig. 2.2

Fig. 2.2 shows the chromatogram produced.

(i) Calculate the R_f value for dye **A**.

R_f value = ... [2]

(ii) State which dye **cannot** be in the ink sample.

Explain your answer.

dye .....

explanation .....

.....

.....

[2]

(iii) A solvent is used during chromatography.

Define the term *solvent*.

.....

..... [1]

(c) Table 2.1 shows the melting point of two substances, **X** and **Y**.

Table 2.1

substance	melting point / °C
X	84
Y	78–82

State which substance is pure.

Explain your answer.

pure substance .....

explanation .....

.....

[1]

[Total: 9]

3 **(a)** A car has two identical headlamps $\mathbf{L}_1$ and $\mathbf{L}_2$.

The lamps are connected in parallel across a 12 V battery as shown in Fig. 3.1.

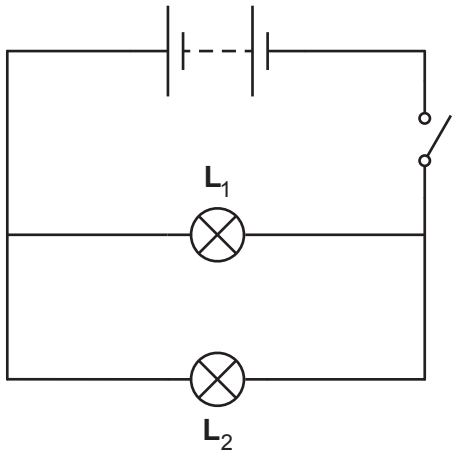

Fig. 3.1

(i) The current passing through $\mathbf{L}_1$ is 5.0 A.

Show that the resistance of $\mathbf{L}_1$ is 2.4 Ω.

[2]

(ii) Calculate the combined resistance of the two lamps connected in parallel.

resistance = ... Ω [2]

(iii) State one reason why the lamps are connected in parallel rather than in series.

.....

.....

..... [1]

(b) The headlamps emit visible light. The frequency of some of this light is 6.0×10^{14} Hz.

Calculate the wavelength of this light.

wavelength = ... m [3]

(c) The car engine is noisy and emits sound waves that pass through the air as a series of compressions and rarefactions.

Fig. 3.2 shows the positions of the compressions and rarefactions as the sound wave passes through the air.

Fig. 3.2

(i) On Fig. 3.2 label the centre of a rarefaction with the letter **R**. [1]

(ii) Explain in terms of compressions what is meant by the frequency of a sound wave.

.....

..... [1]

(d) The steel radiator on the car transfers thermal energy through the radiator wall by conduction.

Describe how thermal energy passes through a metal by conduction.

.....

.....

.....

.....

..... [2]

[Total: 12]

4 **(a)** A student measures his breathing rate at rest and during exercise.

The results are shown in Table 4.1.

Table 4.1

average breathing rate / number of breaths per minute	
at rest	during exercise
14	62

(i) The student exercises for 30 minutes.

Calculate the average number of breaths taken during 30 minutes of exercise.

..... [1]

(ii) Explain the reasons for the difference in breathing rate shown in Table 4.1.

.....

.....

.....

.....

.....

..... [3]

(iii) Describe two ways that the composition of inspired air differs from expired air.

1 .....

2 .....

[2]

(b) Alveoli are the site of gas exchange.

One of the features of gas exchange surfaces is that they are surrounded by capillaries providing a good blood supply.

(i) List two other features of gas exchange surfaces in humans.

1 .....

2 .....
[2]

(ii) Describe how capillaries are adapted for their function.

.....

.....

.....

..... [2]

[Total: 10]

5 Aluminium is used to make aircraft parts.

(a) State how aluminium is extracted from aluminium oxide.

..... [1]

(b) Explain why aluminium is used to make aircraft parts.

.....

.....

..... [2]

(c) Table 5.1 shows information about the reactions of some metals.

Table 5.1

metal	reaction with dilute hydrochloric acid
gold	no reaction
magnesium	reacts quickly to make hydrogen gas
sodium	reacts explosively to make hydrogen gas
tin	reacts very slowly to make hydrogen gas
zinc	reacts slowly to make hydrogen gas

(i) Use the information in Table 5.1 to complete the order of reactivity of the metals.

..... most reactive

.....

.....

.....

..... least reactive [2]

(ii) Write a balanced symbol equation for the reaction of magnesium with hydrochloric acid, HC*l*.

..... [2]

(iii) Aluminium is more reactive than zinc.

When aluminium is added to cold dilute hydrochloric acid there appears to be no reaction.

Explain this apparent unreactivity.

.....

.....

..... [2]

[Total: 9]

6 The nuclear fuel used in some power stations is plutonium-239.

(a) (i) Plutonium-239 decays by α-particle emission.

Use nuclide notation to complete the symbol equation for this decay process.

$$^{239}_{94}\text{Pu} \longrightarrow$$

[3]

(ii) Plutonium-239 has a half-life of 24 000 years.

2 kg of plutonium-239 is sealed in a lead container.

Calculate the mass of plutonium-239 remaining after 120 000 years.

mass = ... kg [2]

(b) The nuclear fuel releases 8.6×10^{13} J of energy.

From this, only 3.2×10^{13} J of electrical energy is generated.

Calculate the efficiency of this generation process.

efficiency = ...% [2]

(c) The power station generates electricity at 25 000 V.

A transformer increases this voltage to 400 000 V before the electricity is transmitted over large distances through transmission cables.

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

Calculate the number of turns on the primary coil of the transformer.

number of turns = ... [2]

(d) When electricity has been generated at the power station the voltage is increased by a transformer to reduce power losses in the transmission cables.

Explain why power losses in cables are lower when the voltage is high.

.....

.....

.....

..... [2]

[Total: 11]

7 **(a)** A lake is an example of an ecosystem.

Fig. 7.1 shows a food chain from a lake.

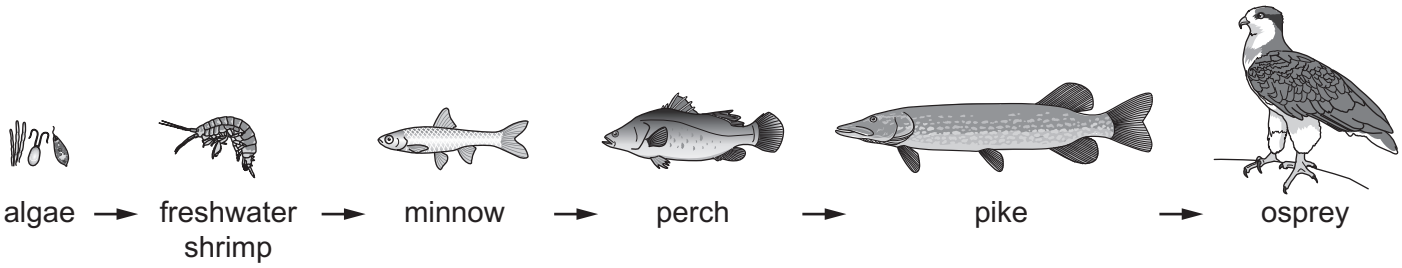

Fig. 7.1

(i) Identify the quaternary consumer in this food chain.

..... [1]

(ii) State the number of trophic levels in this food chain.

..... [1]

(iii) Explain why the number of trophic levels in this food chain is unusual.

.....

.....

.....

.....

.....

..... [3]

(b) Table 7.1 shows definitions for three terms related to the environment.

Complete Table 7.1 by adding the term that matches each definition.

Table 7.1

definition	term
a network of interconnected food chains	
an organism that makes its own organic nutrients	
an organism that gets its energy from dead or waste organic matter	

[3]

(c) A forest is also an ecosystem.

Deforestation has negative impacts on the environment.

Landslides are one example.

Fig. 7.2 is a photograph of a landslide.

Fig. 7.2

(i) Explain why deforestation can increase the chance of a landslide.

.....

.....

.....

..... [2]

(ii) Describe how deforestation can lead to a decrease in the concentration of oxygen in the atmosphere.

.....

.....

.....

..... [2]

[Total: 12]

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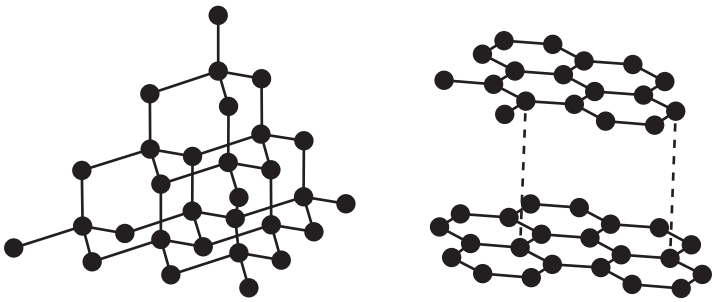
8 Diamond and graphite are different forms of the element carbon.

Fig. 8.1 shows the structures of diamond and graphite.



diamond graphite

Fig. 8.1

(a) (i) Diamond is used in cutting tools.

Explain why.

Use ideas about the structure and bonding in diamond.

.....

.....

..... [2]

(ii) Graphite is used to make electrodes because it conducts electricity.

Explain why graphite conducts electricity.

Use ideas about the structure and bonding in graphite.

.....

.....

..... [2]

(b) Carbon can bond with hydrogen to form hydrocarbons.

Ethene, C_2H_4, is a hydrocarbon.

Draw a dot-and-cross diagram to show the bonding in ethene.

Show all of the outer shell electrons. Do **not** show the inner electrons.

[2]

(c) Ethene burns in oxygen to form carbon dioxide.

Carbon dioxide is a greenhouse gas.

State an effect of increased concentrations of greenhouse gases in the atmosphere.

..... [1]

(d) Carbon monoxide is made in a car engine.

The carbon monoxide is removed by a catalytic converter.

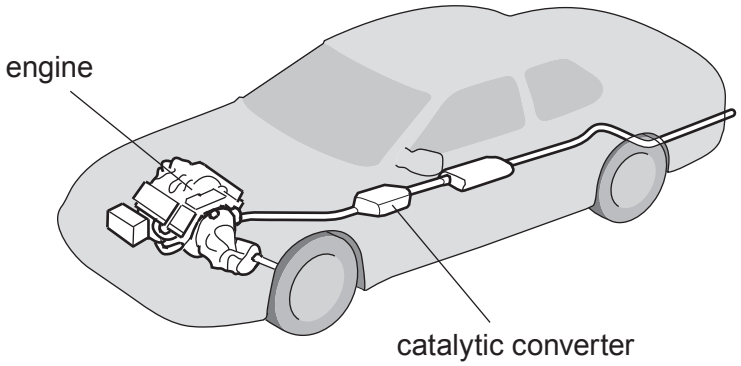


Fig. 8.2

Describe how a catalytic converter removes carbon monoxide.

Include a **balanced symbol** equation in your answer.

.....

.....

.....

..... [3]

[Total: 10]

9 A mountaineer climbs a mountain.

(a) At the top of the mountain there is some ice that is melting in the sunshine.

(i) State the melting point of water. ..... °C [1]

(ii) Describe, in terms of molecular motion and arrangement, how liquid water is different from ice.

motion .....

.....

arrangement .....

.....

[2]

(b) On the mountain, the mountaineer is exposed to ultraviolet radiation.

Ultraviolet radiation is an electromagnetic wave.

On Fig. 9.1 write ultraviolet in the correct place in the incomplete electromagnetic spectrum.

	X-rays		visible light			radio waves

[1]

Fig. 9.1

(c) The mountaineer observes lightning striking a nearby mountain.

(i) There is an electric field between the negative charge on a cloud and the positive charge on the mountain.

State what is meant by an *electric field*.

.....

..... [1]

(ii) The lightning occurs when the cloud loses some of its charge to the mountain.

The lightning flash discharges 3.0 C in 0.00012 s.

Calculate the current that passes.

current = ... A [2]

[Total: 7]

10 (a) Fig. 10.1 is a sketch graph showing the effect of temperature on the rate of transpiration (loss of water from leaves).

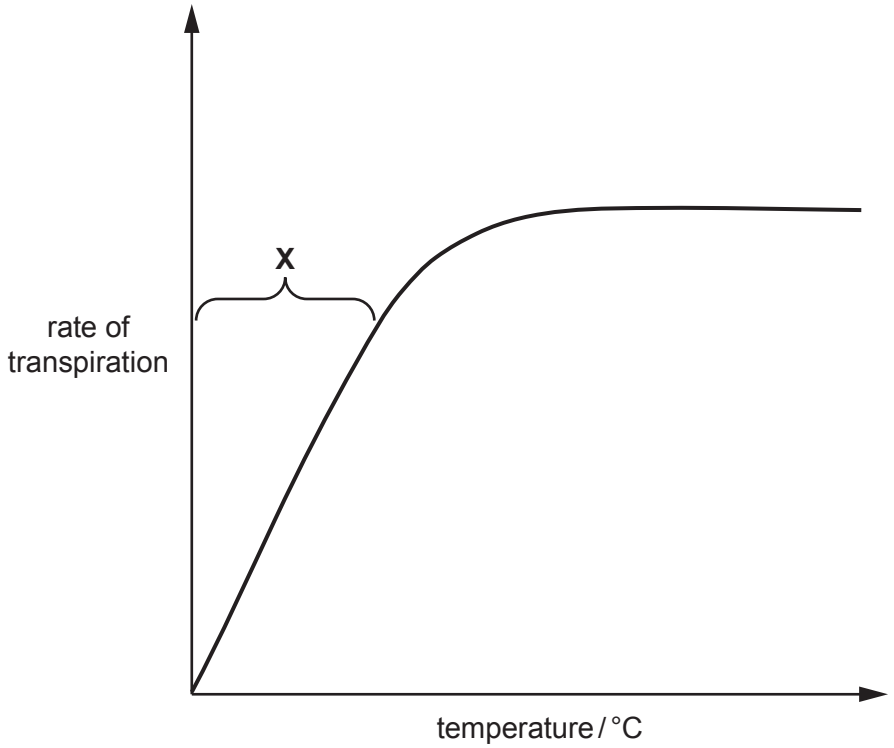


Fig. 10.1

(i) Explain the trend seen in the part of the graph labelled **X**.

Include in your answer a reference to water molecules and the name of the part of the leaf where transpiration occurs.

.....

.....

.....

.....

.....

..... [3]

(ii) State one other factor that affects the rate of transpiration.

..... [1]

(b) Table 10.1 compares transpiration with translocation.

Table 10.1

	transpiration	translocation
substances moved	water	1 ..... 2 .....
direction of movement	from roots to leaves	
name of tissue used for transport		

Complete Table 10.1. [3]

(c) State the balanced symbol equation for photosynthesis.

..... [2]

[Total: 9]

11 Ammonium sulfate is used as a fertiliser.

(a) Ammonium sulfate contains the ions NH_4^+ and SO_4^{2-}.

Determine the formula of ammonium sulfate.

..... [1]

(b) Describe why it is important that farmers use fertilisers containing nitrogen, phosphorus and potassium.

.....

.....

..... [2]

(c) Ammonium sulfate is made by reacting dilute sulfuric acid with ammonia.

Ammonia is made in the Haber process.

Nitrogen gas reacts with hydrogen gas as shown in the equation.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) Explain why a temperature of 450 °C is used rather than a temperature of 800 °C. Do **not** include cost in your answer.

.....

..... [1]

(ii) Explain why a temperature of 450 °C is used rather than a temperature of 200 °C. Do **not** include cost in your answer.

.....

..... [1]

(iii) State why iron is needed in the Haber process.

.....

..... [1]

[Total: 6]

12 (a) A cyclist accelerates along a straight road from a speed of 4 m / s to maximum speed.

The combined mass of the cyclist and bicycle is 80 kg.

Fig. 12.1 is the speed-time graph for the bicycle and cyclist.

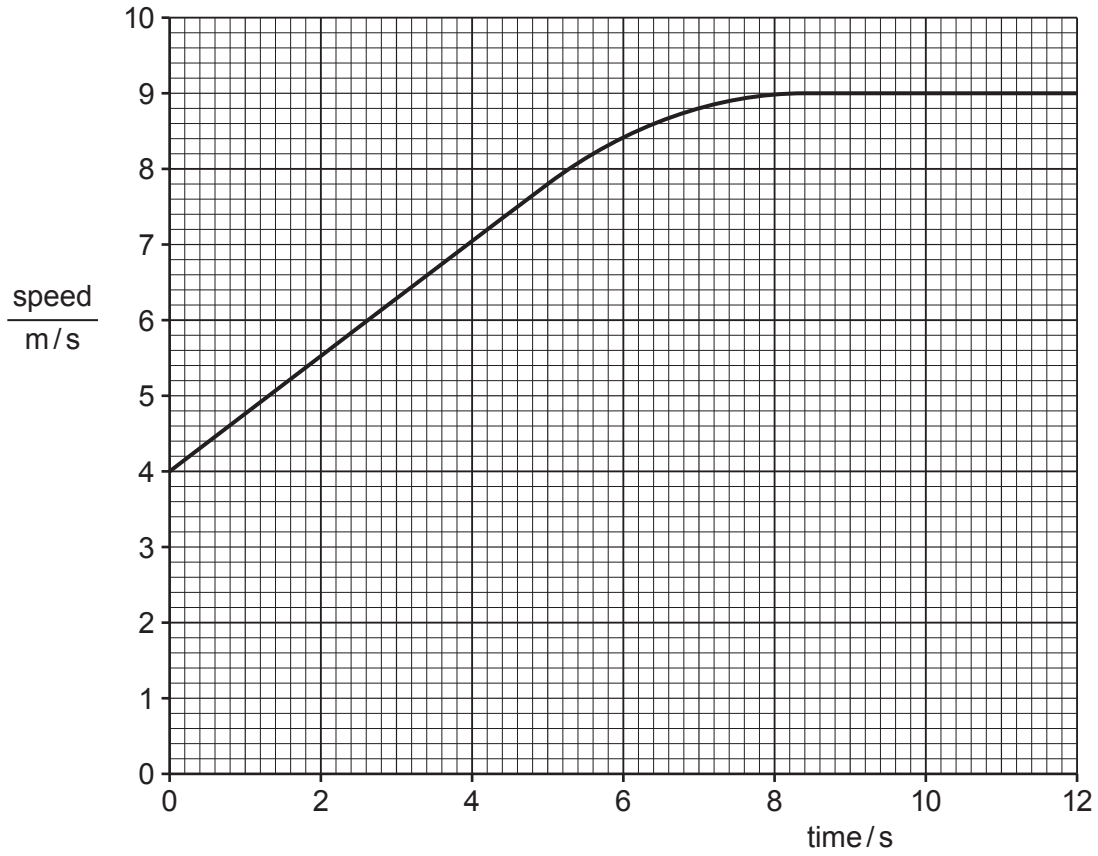


Fig. 12.1

(i) Use Fig. 12.1 to calculate the acceleration at 2 s.

Show your working.

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

(ii) Calculate the resultant force acting on the cyclist and bicycle during this acceleration.

force = ... N [2]

(iii) Calculate the maximum kinetic energy of the cyclist and bicycle during the 12 second period in Fig. 12.1.

kinetic energy = ... J [3]

(b) Fig. 12.2 shows a section through a plastic reflector on the bicycle. A ray of light from a car is incident on the flat surface of the reflector.

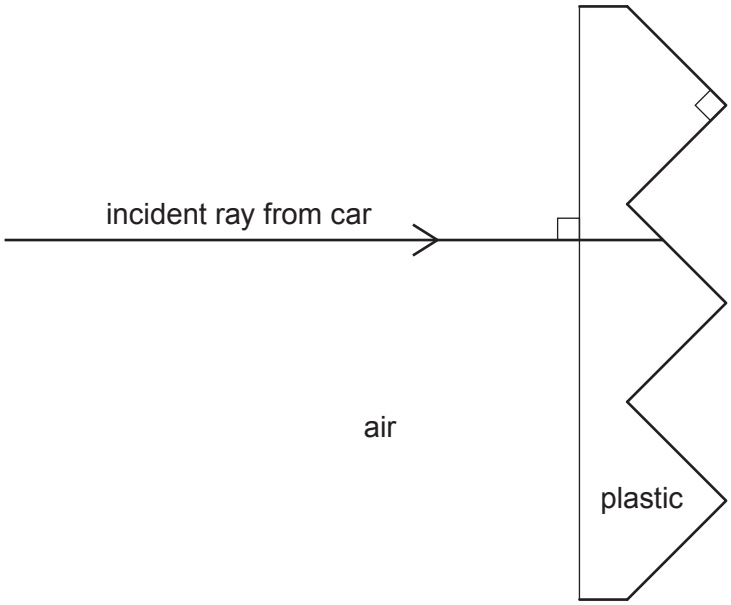


Fig. 12.2

The incident ray is totally internally reflected.

Continue the incident ray on Fig. 12.2 to show the path of the ray of light until it leaves the reflector. [2]

(c) Fig. 12.3 shows a metal nut on the bicycle wheel.

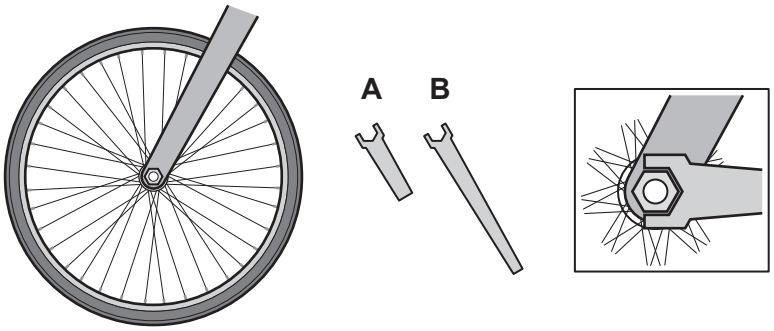


Fig. 12.3

The nut must be turned by either spanner **A** or spanner **B**.

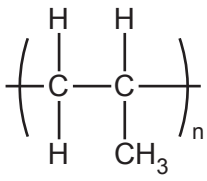
State why spanner **B** will turn the nut more easily than spanner **A**.

..... [1]

[Total: 10]

13 Polymers are made from small molecules called monomers.

(a) The structure of a polymer is shown.



Draw the structure of the monomer.

[1]

(b) Poly(ethene) is an **addition** polymer.

Nylon is a **condensation** polymer.

Describe the differences between addition polymerisation and condensation polymerisation.

.....

.....

.....

..... [2]

(c) A mixture containing 3.9 g of ethene and 4.0 g of steam is allowed to react.

Ethanol, C_2H_6O, is made.

$$C_2H_4 + H_2O \rightarrow C_2H_6O$$

Determine the **limiting reactant** in this reaction.

Show your working and explain your answer.

[A_r: C, 12; H, 1; O, 16]

limiting reactant .....

explanation .....

.....

[3]

[Total: 6]

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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											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 –		

Key

atomic number
atomic symbol
name
relative atomic mass

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.).