* 0019656636801 *

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 2957059438 *

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **May/June 2024**

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 **28** pages. Any blank pages are indicated.

DC (PB/CT) 331190/3

1 **(a)** Fig. 1.1 is a diagram of a wind-pollinated flower.

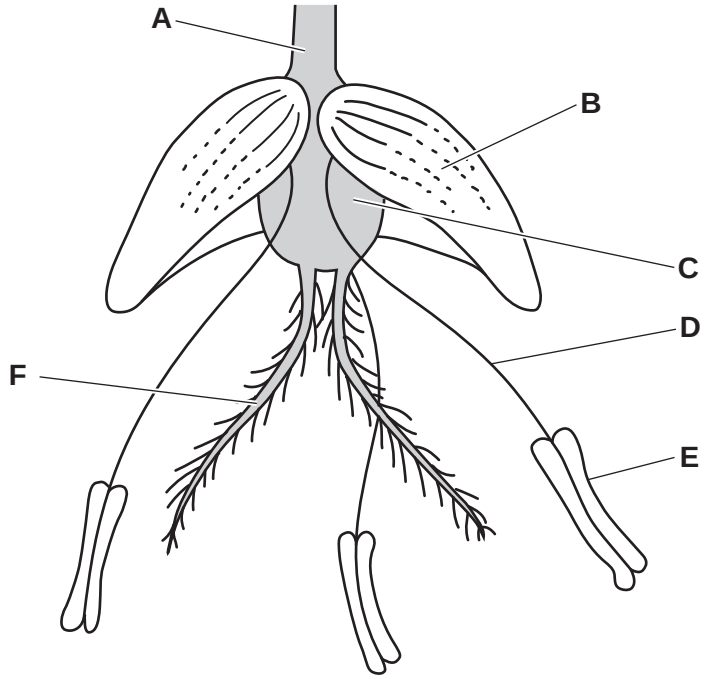

Fig. 1.1

(i) State which letter in Fig. 1.1 identifies the part where:

fertilisation occurs .....

pollen is produced. .....

[2]

(ii) Describe **two visible** pieces of evidence in Fig. 1.1 that show the flower is adapted for wind-pollination.

1 .....

.....

2 .....

.....

[2]

(b) Fig. 1.2 is a photomicrograph of pollen from an **insect**-pollinated flower.

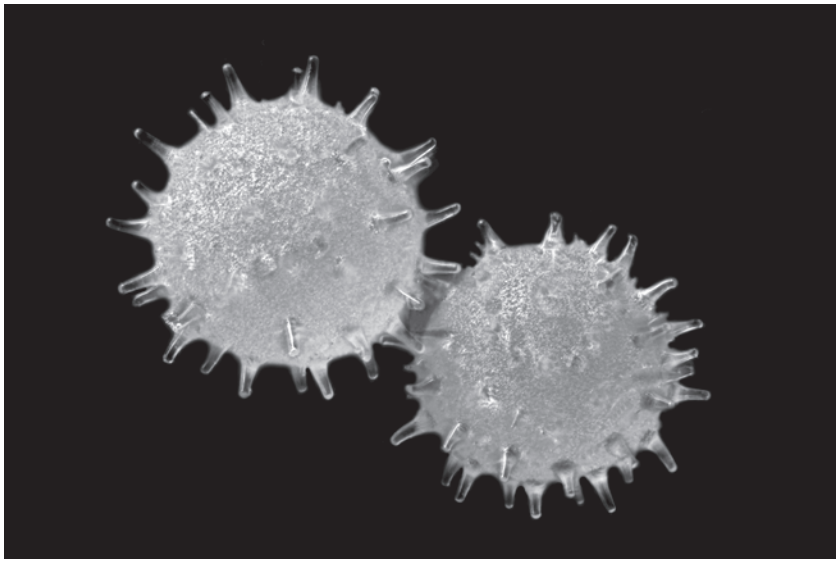

Fig. 1.2

Describe **two** ways the appearance of pollen from a wind-pollinated flower is different from the pollen from an insect-pollinated flower.

1 .....

.....

2 .....

.....

[2]

(c) Some plants can reproduce asexually and sexually.

(i) State **two** advantages of sexual reproduction compared to asexual reproduction in plants.

1 .....

.....

2 .....

.....

[2]

(ii) Suggest a situation where asexual reproduction is more useful to a plant in the wild than sexual reproduction.

.....

.....

..... [1]

(d) Reproduction is one of the characteristics of living organisms.

State **two** other characteristics of living organisms.

1 .....

2 .....

[2]

[Total: 11]

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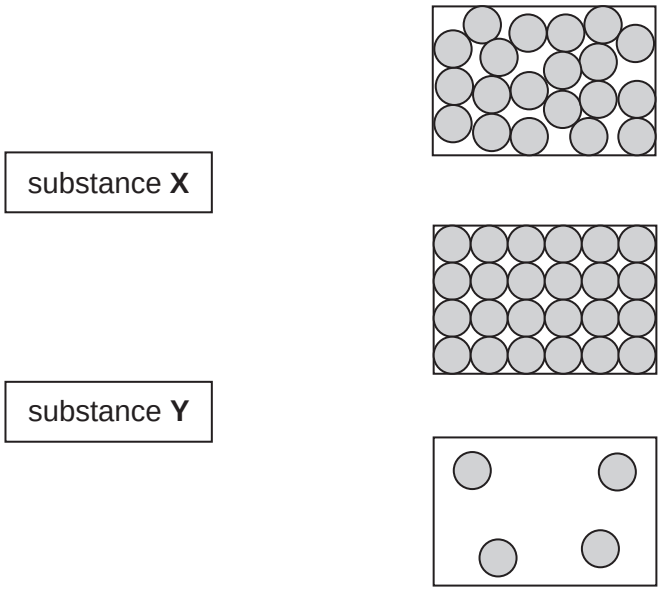
2 A student heats three substances **X**, **Y** and **Z** in a water-bath.

Table 2.1 shows the state of the three substances before heating, during heating and after cooling.

Table 2.1

substance	before heating	during heating	after cooling
X	solid	liquid	solid
Y	liquid	liquid	liquid
Z	solid	solid	solid

(a) Draw **one** line from substance **X** and **one** line from substance **Y** to show the arrangement of the particles before heating.



[2]

(b) Describe the difference in the **movement** of the particles in a solid and in a liquid.

solid .....

.....

liquid .....

.....

[2]

(c) Explain how we know that the change to substance **X** is a physical change and **not** a chemical change.

.....

.....

..... [2]

(d) Substance **Z** is the ionic compound sodium chloride, NaC*l*.

Draw a dot-and-cross diagram to show the ionic bonding in sodium chloride.

[2]

(e) Fig. 2.1 shows the electrolysis of concentrated aqueous sodium chloride.

Complete the **three** labels on Fig. 2.1 to show the products made.

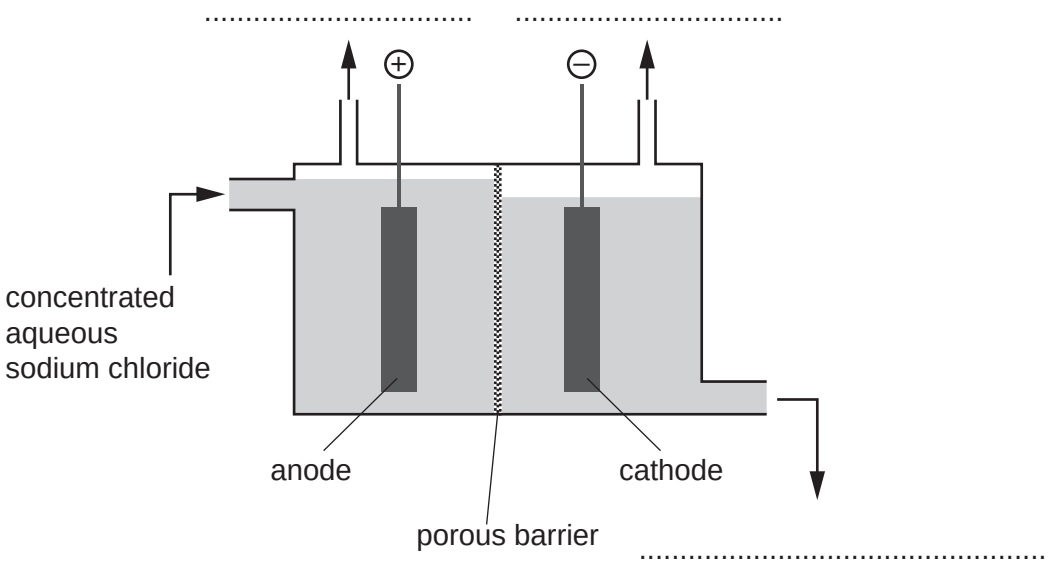


Fig. 2.1

[3]

[Total: 11]

[Turn over

3 Fig. 3.1 shows a sea turtle.

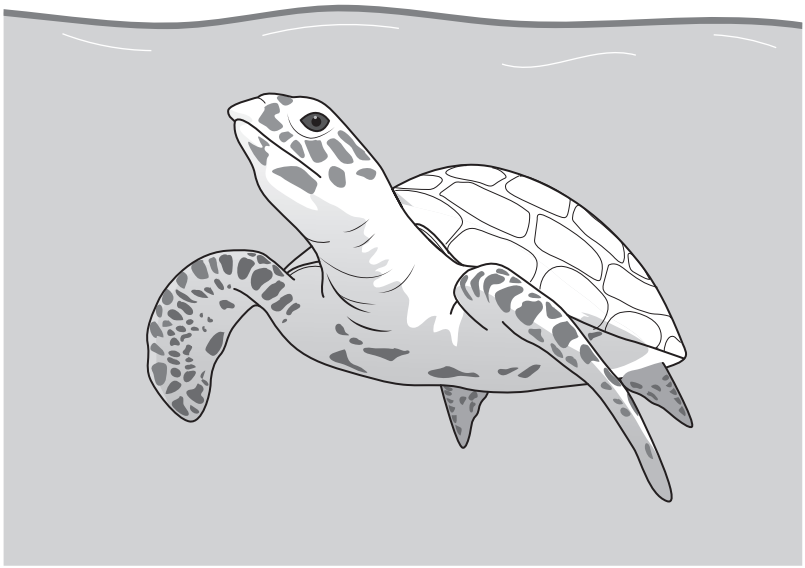


Fig. 3.1

(a) **(i)** On Fig. 3.1, draw an arrow to show the direction of the weight force acting on the sea turtle.

Label your arrow with the letter **W**. [1]

(ii) Complete the sentence to describe weight.

Weight is a force caused by the effect of a ..... field

on a ..... .

[1]

(b) The sea turtle travels a distance of 1200 km in 20 days.

Calculate the average speed of the sea turtle.

Give your answer in km / h.

average speed = ... km / h [3]

(c) A team of scientists fits a tracker unit to the sea turtle to monitor its location.

The tracker unit sends a signal using radio waves each time the sea turtle moves to the surface of the water.

(i) Radio waves are part of the electromagnetic spectrum.

Complete the sentences to compare radio waves to visible light.

Radio waves have a ..... frequency and

a ..... wavelength than visible light.

Radio waves and visible light both travel at ..... m/s in a vacuum. [2]

(ii) The radio waves emitted by the tracker unit have a frequency of 1.5×10^9 Hz.

Calculate the wavelength of the radio waves.

wavelength = ... m [2]

(iii) The tracker unit uses a battery with an electromotive force (e.m.f.) of 11 V that provides a power output of 22 mW.

The battery can transfer a total charge of 24 000 C before it needs replacing.

Calculate the time for which the battery operates before it needs replacing.

time = ... s [4]

[Total: 13]

[Turn over

4 **(a)** Blood glucose concentration is controlled so that it remains within set limits.

State the name given to this type of control.

..... [1]

(b) Fig. 4.1 shows the blood glucose concentration of a person after they have eaten a meal.

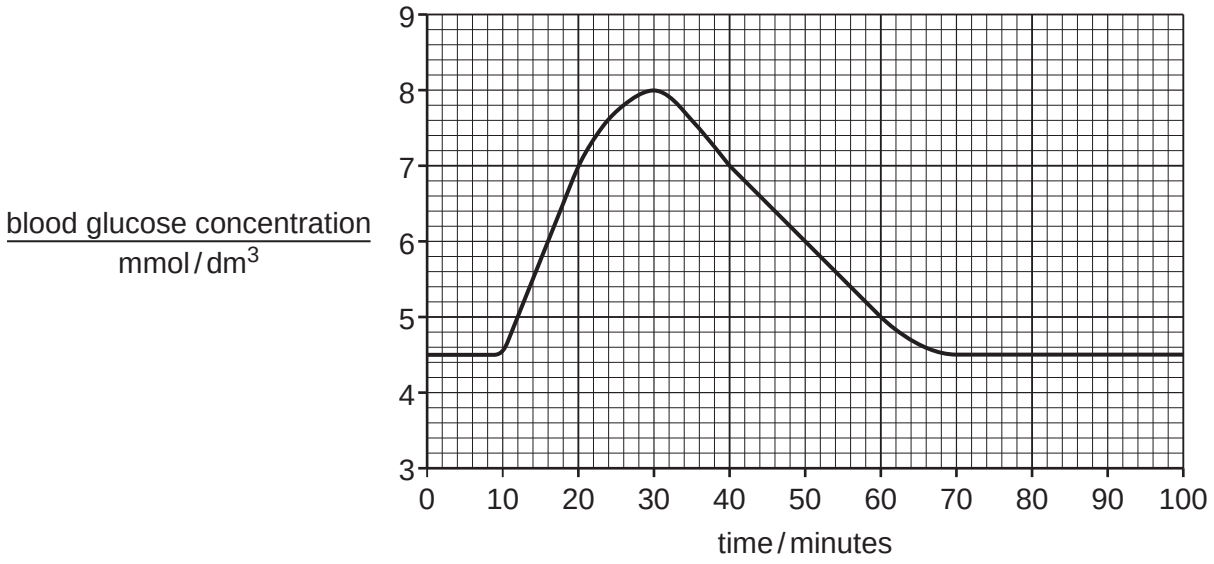


Fig. 4.1

Complete the sentences to describe and explain the changes seen in Fig. 4.1.

Carbohydrates such as starch are broken down by the enzyme

..... to form simpler sugars.

These simpler sugars are absorbed into the blood. After 30 minutes, the blood glucose concentration reaches a maximum of ..... $mmol/dm^3$.

The increase in blood glucose concentration is detected and the hormone insulin is released from the ..... .

Insulin causes glucose to be converted to ..... .

This is then stored in the ..... reducing the blood glucose concentration to its previous level.

[5]

(c) State the names of **two** hormones that increase blood glucose concentration.

1 .....

2 .....

[2]

(d) State the name of the component of blood that transports hormones.

..... [1]

(e) Table 4.1 compares nervous and hormonal control.

Complete Table 4.1.

Table 4.1

	nervous control	hormonal control
form of transmission		chemical hormones
relative speed of action		
relative longevity of action		

[3]

[Total: 12]

[Turn over

5 Some students investigate the reaction between marble chips and dilute hydrochloric acid.

They react marble chips of three different sizes, **A**, **B** and **C**, with excess dilute hydrochloric acid.

They use the same mass of marble chips, the same concentration of acid and the same temperature for each experiment.

The students measure the volume of carbon dioxide gas every 30 seconds until the reaction finishes.

Fig. 5.1 shows a graph of their results.

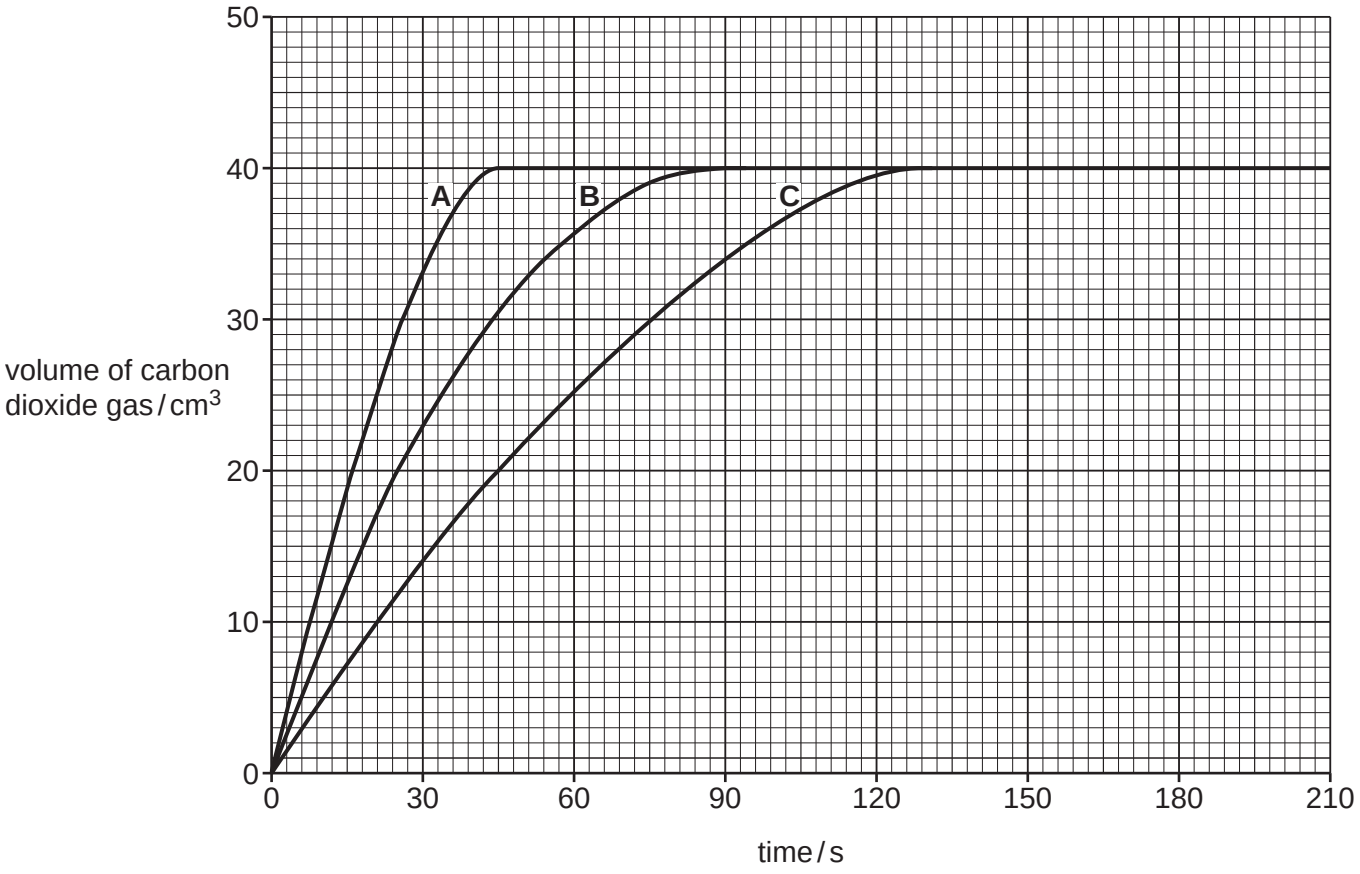


Fig. 5.1

(a) (i) State which marble chips, **A**, **B** or **C**, are the **smallest**.

..... [1]

(ii) Look at the line for marble chips **B**.

State when the rate of reaction is the **greatest**.

Choose your answer from the list.

0 – 30 s

30 – 60 s

60 – 90 s

90 – 120 s

answer = ... s [1]

(b) The students did the experiments at 20 °C.

State how the rate of reaction will change if they do the experiments again at 40 °C.

Explain your answer using ideas about collisions between particles.

.....

.....

.....

.....

.....

..... [3]

(c) Calculate the volume occupied by 1.1 g of carbon dioxide gas at room temperature and pressure.

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

[A_r: C, 12; O, 16]

volume of carbon dioxide gas = ... dm^3 [3]

(d) Carbon dioxide is a greenhouse gas.

State **two** problems caused by increased concentrations of greenhouse gases.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

6 Fig. 6.1 shows an electric pressure-washer being used to wash a car.

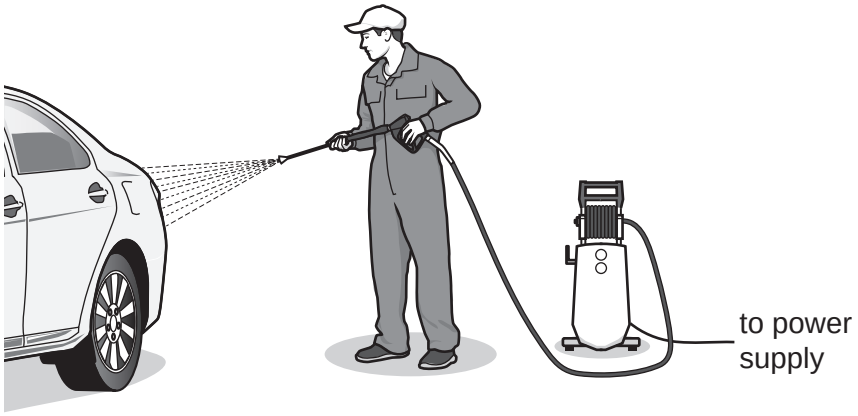


Fig. 6.1

(a) The pressure-washer pumps water at a high pressure through a small nozzle.

The cross-sectional area of the nozzle is $5.0 \times 10^{-6}\,m^2$.

The water leaves the nozzle with a pressure of $9.0 \times 10^{6}\,Pa$.

Calculate the force exerted by the water as it leaves the nozzle.

force = ... N [2]

(b) The pressure-washer uses a d.c. motor to pump the water out of the nozzle.

Fig. 6.2 shows a diagram of a simple d.c. motor.

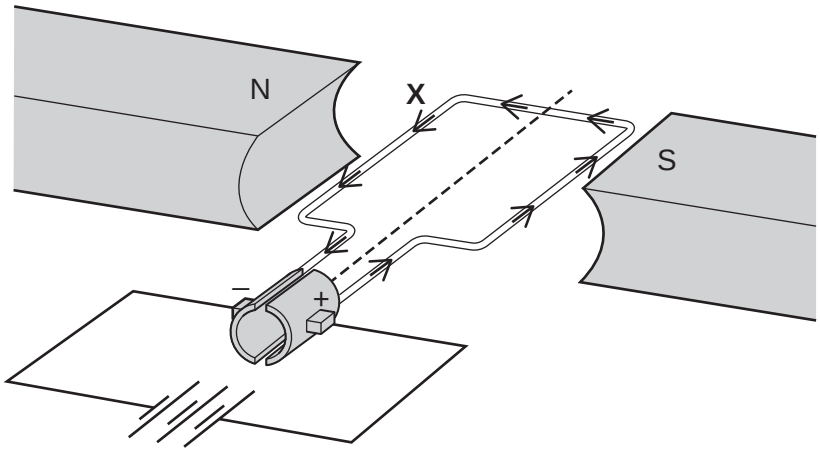


Fig. 6.2

(i) The arrows on Fig. 6.2 show the direction of the current.

Draw an arrow to show the direction of the force acting on the coil at the point labelled **X**. [1]

(ii) Describe the function of the split-ring commutator in a simple d.c. motor.

.....

.....

.....

..... [2]

(c) After the car has been washed, droplets of cold water remain on the roof of the car.

After a few minutes, the droplets of water have disappeared.

(i) State the name of the process which causes the droplets of water to disappear.

..... [1]

(ii) Describe the process which causes the droplets of water to disappear in terms of molecules.

.....

.....

..... [2]

[Total: 8]

7 **(a)** A student investigates antibiotic resistance in one strain of bacteria.

They use five different antibiotics on paper discs.

The antibiotic discs are placed in a Petri dish with the bacteria and left for three days.

Fig. 7.1 shows the results.

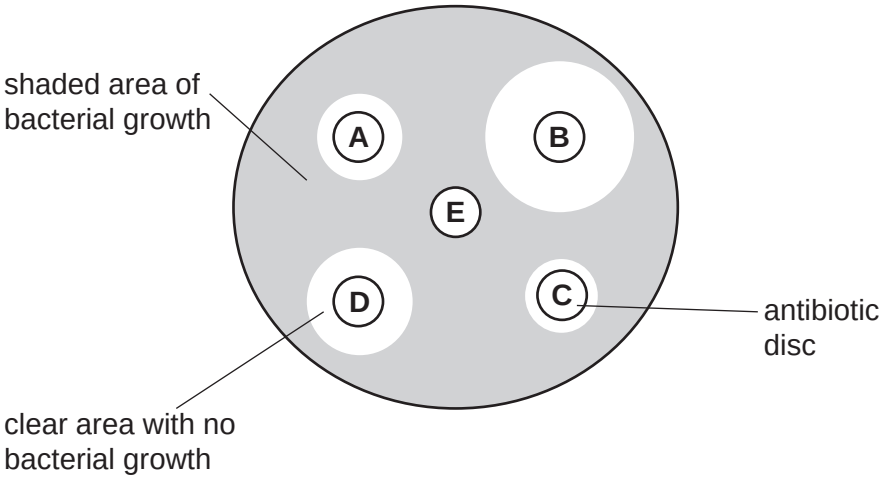


Fig. 7.1

Identify the antibiotic in Fig. 7.1 that is **most** effective against this strain of bacteria.

Give **one** reason for your answer.

antibiotic .....

reason .....

.....

[2]

(b) The differences in antibiotic resistance in bacteria are caused by random mutation.

(i) State the structure in a cell where mutation occurs.

..... [1]

(ii) State the type of radiation that increases the rate of mutation.

..... [1]

(c) Explain why the development of antibiotic resistance in bacteria is an example of evolution.

.....

.....

.....

.....

..... [2]

[Total: 6]

8 Fig. 8.1 shows the structures of three carbon compounds.

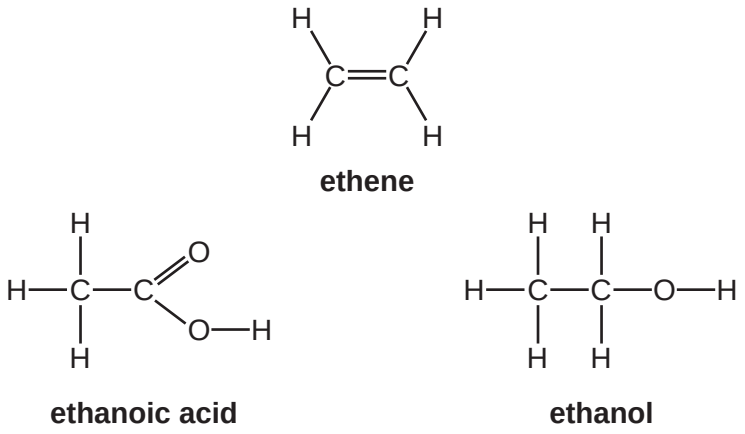


Fig. 8.1

(a) Ethene is an **unsaturated hydrocarbon**.

Explain how the structure of ethene shows that ethene is an unsaturated hydrocarbon.

unsaturated .....

.....

hydrocarbon .....

.....

[2]

(b) Ethene, C_2H_4, reacts with hydrogen to make an alkane.

Write the balanced symbol equation for this reaction.

..... [2]

(c) Complete the dot-and-cross diagram in Fig. 8.2 to show the bonding in ethene.

Only show the outer-shell electrons.

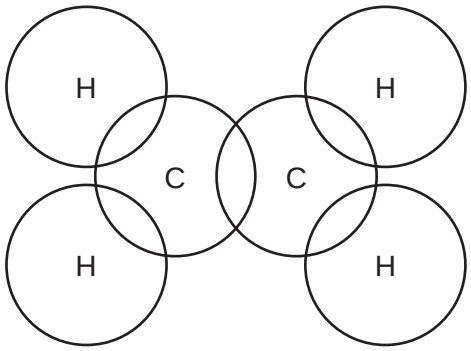


Fig. 8.2

[2]

(d) Ethanol is made by fermentation.

State **one** condition for making ethanol by fermentation.

..... [1]

(e) Ethanol can also be made from ethene in an addition reaction.

Complete the symbol equation for this reaction.

$$C_2H_4 + \ldots\ldots\ldots \rightarrow C_2H_5OH$$

[1]

(f) A scientist makes a solution of ethanol.

250 cm^3 of the solution contains 5.75 g of ethanol.

Calculate the concentration of the ethanol solution in **mol / dm^3**.

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

concentration of ethanol solution = ... mol / dm^3 [4]

[Total: 12]

9 The element strontium has many naturally occurring isotopes, some of which are unstable.

(a) Table 9.1 shows the half-lives of four unstable isotopes of strontium.

Table 9.1

isotope	half-life
strontium-82	25.4 days
strontium-83	1.35 days
strontium-85	64.8 days
strontium-90	28.9 years

(i) Fig. 9.1 shows a decay curve for one of the isotopes given in Table 9.1.

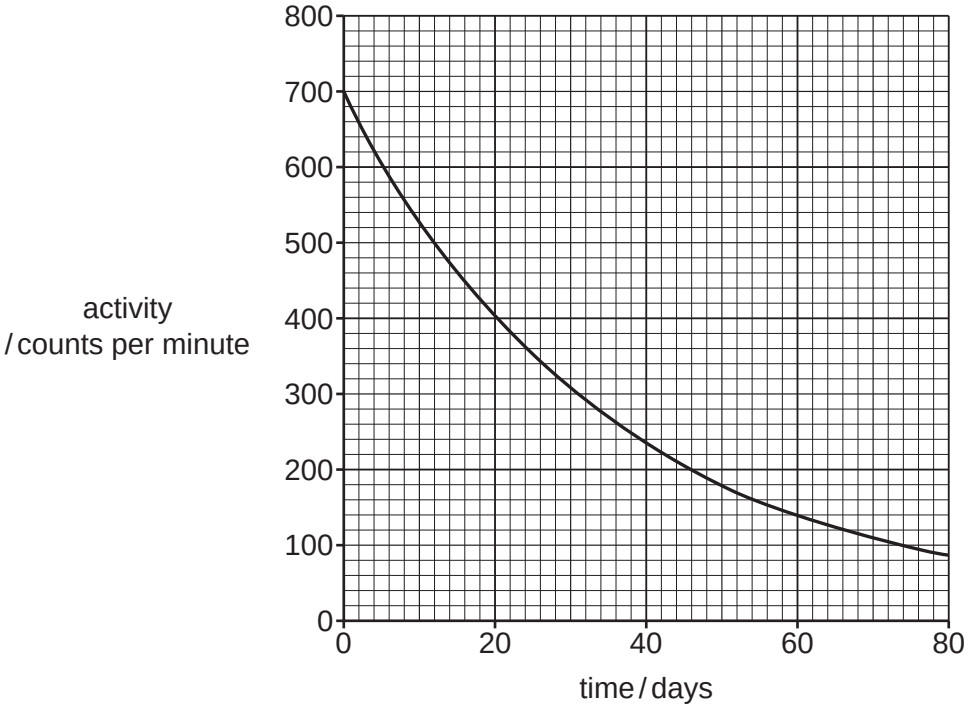


Fig. 9.1

Determine which isotope of strontium from Table 9.1 would give the data shown in Fig. 9.1.

isotope ..... [2]

(ii) A scientist purchases a sample of a strontium isotope to use as a radioactive source in a series of experiments.

The scientist estimates that the experiments will take three months to complete.

Suggest which of the isotopes in Table 9.1 would be best for the scientist to purchase.

Explain your suggestion.

isotope .....

explanation .....

.....

.....

[1]

(b) Place ticks (✓) in Table 9.2 to show the nature of a beta particle.

Table 9.2

has a positive charge	
has a negative charge	
has no charge	
is affected by electric fields	
is affected by magnetic fields	
is not affected by electric or magnetic fields	

[2]

(c) The density of strontium is 2.6 g / cm^3.

A sample of strontium has a mass of 7.8 g.

Calculate the volume of the sample of strontium.

volume = ... cm^3 [2]

[Total: 7]

10 (a) Red blood cells are specialised to transport oxygen.

Describe **two** ways that red blood cells are adapted for their function.

1 .....

.....

2 .....

.....

[2]

(b) A student investigates the effect of different concentrations of salt solution on red blood cells.

The student immerses the red blood cells in different concentrations of salt solution and observes the cells after immersion.

Table 10.1 shows the results.

Table 10.1

concentration of salt solution / g/dm^3	observation
10.0	cells shrink
8.0	no change
6.0	cells burst
4.0	cells burst
2.0	cells burst

(i) Identify the salt solution with the same water potential as red blood cells.

..... g/dm^3 [1]

(ii) Explain the observation seen at 10.0 g/dm^3 in Table 10.1.

.....

.....

.....

.....

.....

.....

..... [3]

(c) The investigation is repeated with plant cells.

(i) Plants cells do **not** burst when immersed in 2.0 g / dm^3 salt solution.

Explain why.

.....

.....

.....

.....

..... [2]

(ii) State **two** uses of water in plant cells.

1 .....

2 .....

[2]

(iii) State the name of the type of plant cell specialised for absorption of water.

..... [1]

[Total: 11]

11 Sulfuric acid is made by the Contact process.

Fig. 11.1 shows part of the Contact process.

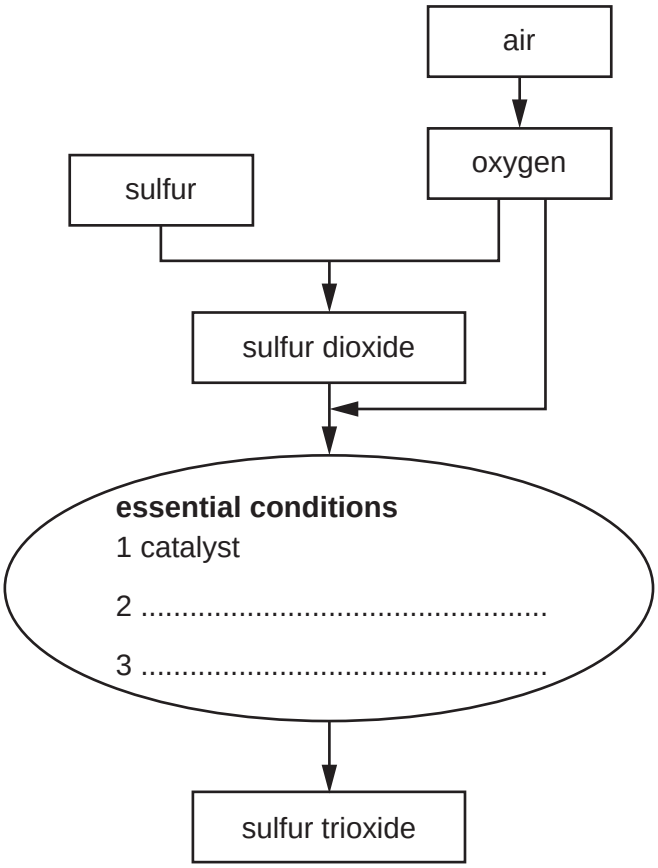


Fig. 11.1

(a) A catalyst is used in the Contact process.

Complete Fig. 11.1 to show the **two** other essential conditions used. [2]

(b) In the Contact process, sulfur dioxide, SO_2, reacts with oxygen, O_2, to make sulfur trioxide, SO_3.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

(i) Calculate the maximum mass of sulfur trioxide that is made from 1.6 kg of sulfur dioxide.

[A_r: O, 16; S, 32]

mass of sulfur trioxide = ... kg [3]

(ii) Fig. 11.2 shows the energy level diagram for the reaction to make sulfur trioxide.

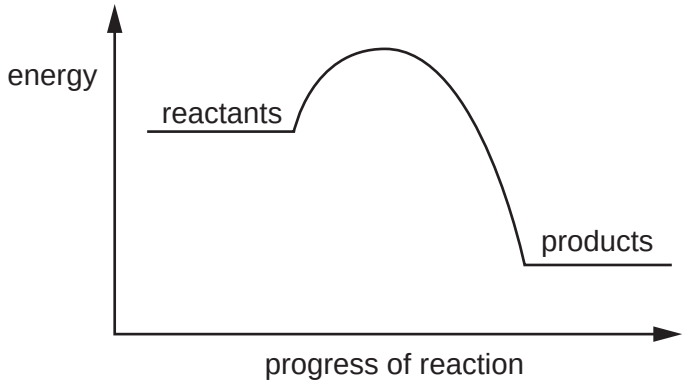


Fig. 11.2

Draw and label on Fig. 11.2:

- the energy change in the reaction
- the activation energy of the reaction.

[2]

[Total: 7]

12 Electricity can be generated in different types of power stations.

(a) Table 12.1 gives some information about six types of power station.

Table 12.1

type of power station	energy per kg of fuel / MJ	efficiency of transfer to electrical energy / %	percentage of world electricity production
coal	29	32	37
hydroelectric (HEP)	–	90	15
natural gas	45	49	24
nuclear	5.0×10^5	93	10
solar	–	21	9
wind	–	40	5

(i) Use data from Table 12.1 to explain why electricity generation is negatively impacting the environment.

.....

.....

.....

.....

..... [3]

(ii) Nuclear power stations are very expensive to build.

Apart from cost, state **one** advantage and **one** disadvantage of generating electricity using wind compared to nuclear.

advantage .....

.....

disadvantage .....

.....

[2]

(iii) Use data from Table 12.1 to calculate the mass of natural gas needed to generate the same electrical energy output as 1 kg of nuclear fuel.

mass = ... kg [3]

(b) A coal power station generates electricity at a voltage of 25 000 V.

A transformer is used to step the voltage up to 132 000 V for transmission.

(i) The step-up transformer contains 3000 turns on the primary coil.

Calculate the number of turns on the secondary coil.

number of turns = ... [2]

(ii) Explain why electricity is transmitted at a voltage of 132 000 V and **not** 25 000 V.

.....

.....

.....

..... [2]

[Total: 12]

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).