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COMBINED SCIENCE

0653/41

Paper 4 Theory (Extended)

May/June 2025

1 hour 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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- 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. Any blank pages are indicated.

1 (a) Fats are broken down in the small intestine by chemical digestion.

(i) State the name of the enzyme that breaks down fats.

..... [1]

(ii) **Circle** one product of fat digestion.

amino acid

cellulose

glycerol

glycogen

[1]

(b) One risk factor for coronary heart disease is a diet high in fats.

The graph in Fig. 1.1 shows the number of deaths from heart disease for one country between 1920 and 2020.

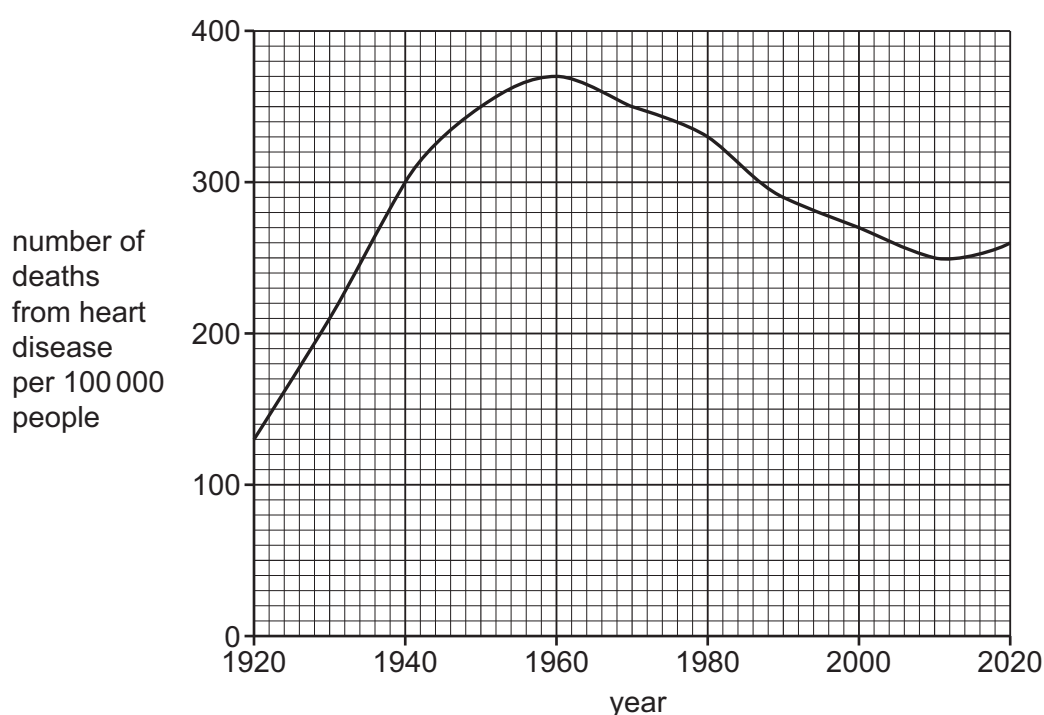


Fig. 1.1

(i) Describe the trend in the number of deaths from heart disease between 1920 and 1960 shown in Fig. 1.1.

..... [1]



- (ii) Calculate the percentage increase between the lowest number of deaths and the highest number of deaths shown in Fig. 1.1.

lowest number of deaths = ...

highest number of deaths = ...

percentage increase = ... [3]

- (c) Digested food molecules are absorbed into the blood from the small intestine by active transport and diffusion.

Compare active transport and diffusion of molecules.

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

[Total: 8]



- 2 (a) Fig. 2.1 is a photograph of a wind-pollinated flower.

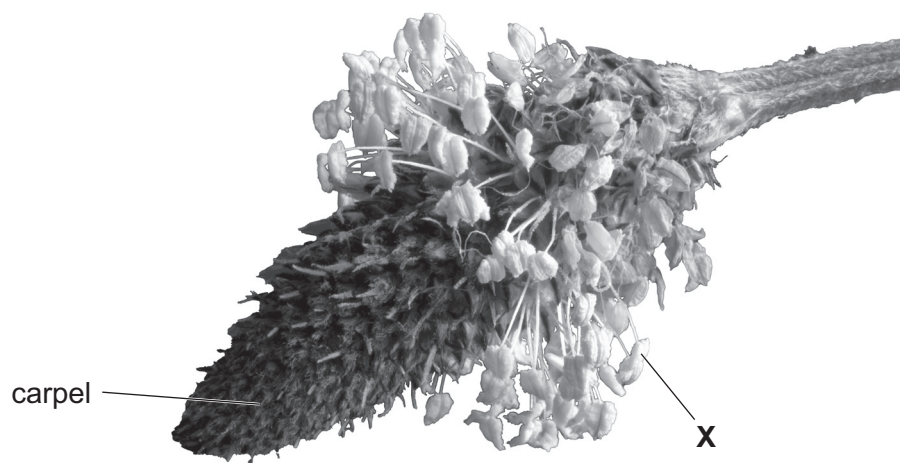


Fig. 2.1

- (i) Identify the part labelled X on Fig. 2.1.

..... [1]

- (ii) Describe how the flower in Fig. 2.1 is pollinated by the wind.

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



(b) Flowers produce seeds. Germination of seeds uses enzymes.

The graph in Fig. 2.2 shows the effect of pH on an enzyme.

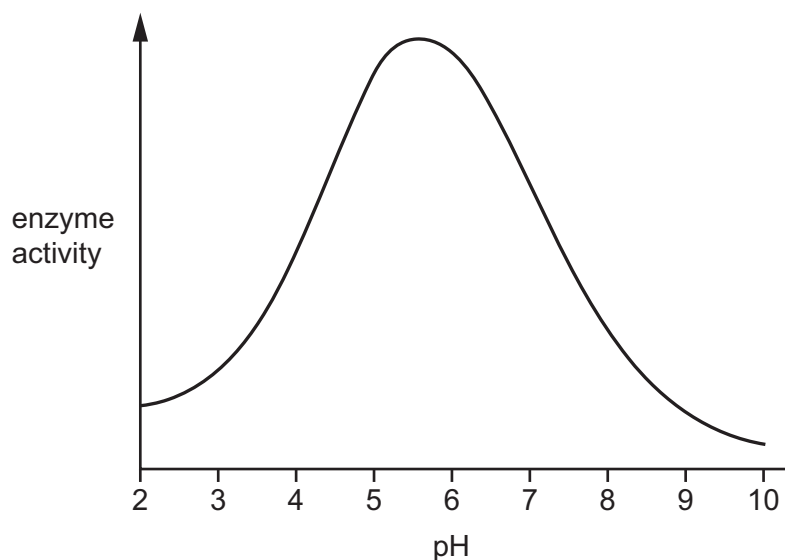


Fig. 2.2

Explain the effect of pH 10 on the enzyme in Fig. 2.2.

.....

.....

.....

.....

..... [3]



- (c) A student investigates the germination of seeds.
Seeds produce carbon dioxide when they germinate.

Hydrogencarbonate indicator is a red solution in atmospheric carbon dioxide concentrations.
In higher concentrations of carbon dioxide, the indicator turns yellow.

The student prepares the three test-tubes shown in Fig. 2.3.

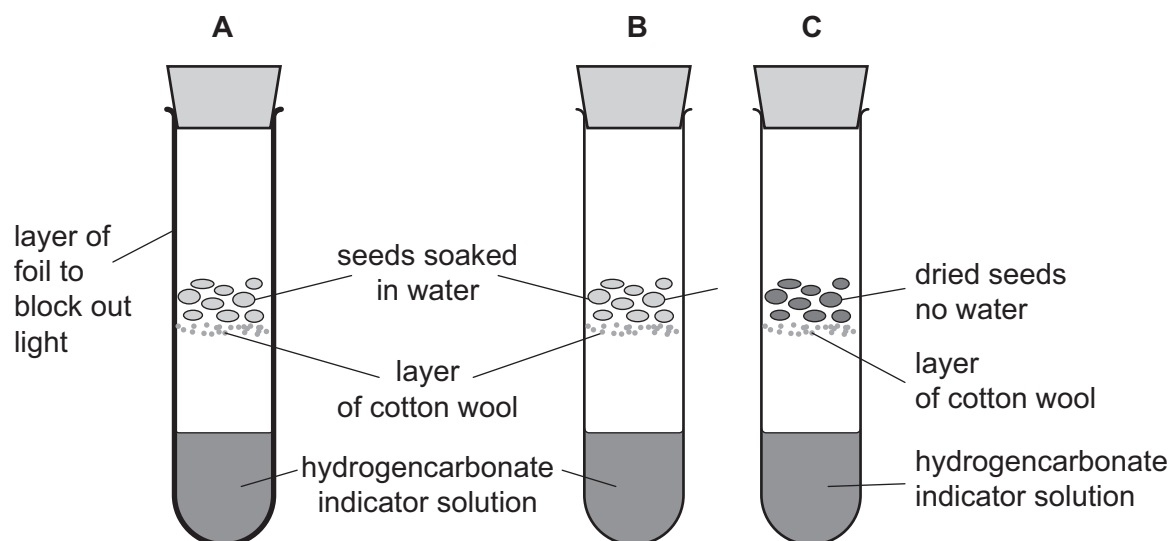


Fig. 2.3

After 24 hours, the student records the colour of the hydrogencarbonate indicator solution in each test-tube.

Table 2.1 shows the results.

Table 2.1

test-tube	conditions	colour of hydrogencarbonate indicator solution	
		at start	after 24 hours
A	dark and water	red	yellow
B	light and water	red	yellow
C	light and no water	red	red

- (i) Explain the results for test-tube **A** and test-tube **C**.

test-tube **A**

.....

test-tube **C**

.....

[2]



- (ii) During germination, energy is released from stored carbohydrates in the seeds.

Complete the sentences about this process.

Energy is released from the carbohydrates by the process of aerobic

.....

This is a chemical reaction in cells that uses gas to break down glucose.

The chemical formula for glucose is

[3]

[Total: 11]



- 3 (a) Fig. 3.1 is a diagram showing a cross-section of a bacterial cell.

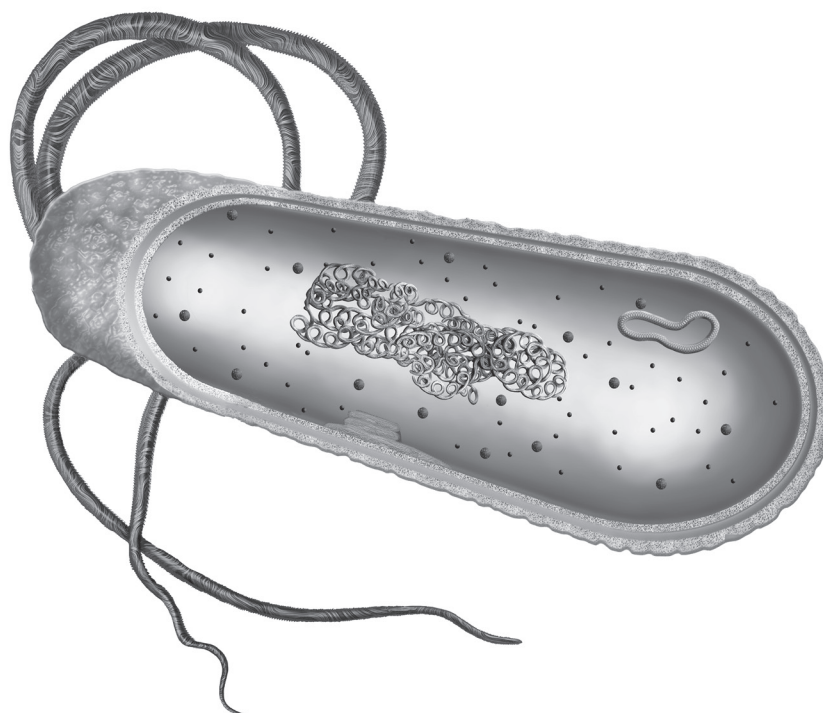


Fig. 3.1

- (i) Draw a label line and the letter **P** to identify a plasmid in Fig. 3.1. [1]

- (ii) Plasmids are one structure found in bacterial cells that are **not** found in plant cells.

Identify **two** structures visible in Fig. 3.1 that **are also** found in plant cells.

1

2 [2]

- (b) Some bacteria are pathogens that infect the human body.

- (i) Bacterial infections are treated with antibiotics.

Explain why antibiotics should only be used when essential.

.....

.....

..... [2]





- (ii) The body can develop active immunity after infection by some bacteria.

Describe what is meant by active immunity.

.....

.....

..... [1]

- (c) Some bacteria gain energy from waste organic material in sewage.

- (i) Name the type of organism that gains energy from waste organic material.

..... [1]

- (ii) Sewage treatment is one way to control the spread of disease.

State **one** other way to control the spread of disease.

.....

..... [1]

[Total: 8]



4 Iron is a metal.

(a) Fig. 4.1 shows the three physical states of iron.

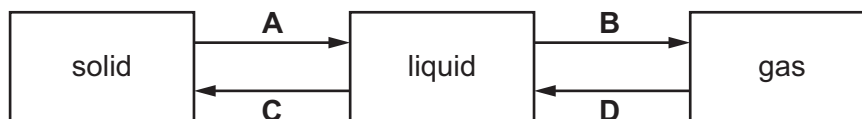


Fig. 4.1

Name the state changes shown by arrows **B** and **C**.

B

C

[2]

(b) Describe how the arrangement and movement of particles change when solid iron becomes a liquid.

Use ideas about kinetic particle theory in your answer.

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

(c) Stainless steel is an alloy of iron.

(i) Name **one** of the other elements in stainless steel.

..... [1]

(ii) Explain in terms of structure why stainless steel is harder and stronger than iron.

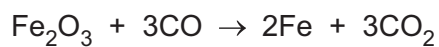
.....
.....
.....
..... [2]



(d) Iron is extracted from iron(III) oxide in the blast furnace.

Iron(III) oxide reacts with carbon monoxide to form iron.

The equation for the reaction is shown.



Explain how the equation shows the iron(III) oxide is reduced.

.....
..... [1]

[Total: 8]



- 5 (a) Table 5.1 shows properties of some halogens at room temperature (25 °C) and pressure.

Table 5.1

halogen	melting point / °C	state	colour
fluorine	−220	gas	pale yellow
chlorine	−101	gas	pale yellow-green
bromine		liquid	
iodine	+114	solid	grey-black
astatine	+302		black

- (i) State the colour of bromine at room temperature and pressure.

.....[1]

- (ii) Predict the:

- melting point of bromine
- physical state of astatine at room temperature and pressure.[2]

- (b) (i) State the type of chemical reaction when chlorine reacts with aqueous potassium bromide.

..... [1]

- (ii) Write the word equation for the reaction of chlorine with aqueous potassium bromide.

..... [1]

- (iii) Explain why chlorine does **not** react with aqueous potassium fluoride.

.....
 [1]



- (c) Iodine reacts with iron to form iron(III) iodide, FeI_3 .

Complete the balanced symbol equation for this reaction.



- (d) Aqueous bromine is used to distinguish between saturated and unsaturated hydrocarbons.

- (i) Circle the type of reaction when aqueous bromine reacts with an unsaturated hydrocarbon.

addition **combustion** **polymerisation** **sedimentation** [1]

- (ii) State the colour change when aqueous bromine is added to an **unsaturated** hydrocarbon.

..... to [1]

[Total: 9]



6 This question is about ionic compounds.

(a) Dilute nitric acid and solid copper oxide react to form copper nitrate.

Copper oxide is an insoluble base and copper nitrate is a soluble salt.

Describe how to produce pure, dry crystals of copper nitrate.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Sodium chloride is an ionic compound.

Complete the dot-and-cross diagram in Fig. 6.1 to show the outer-shell electrons for each ion in sodium chloride.

Include the charge on each ion.

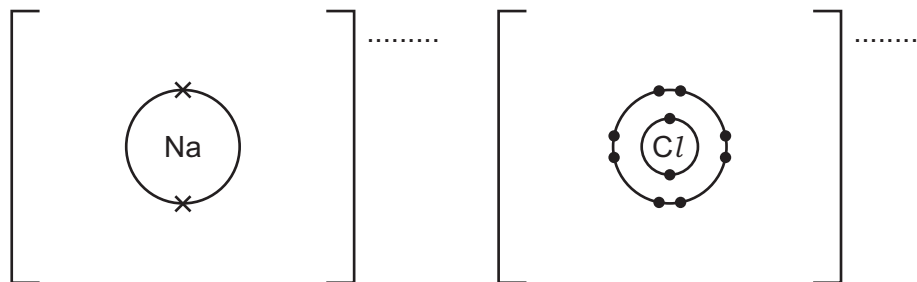


Fig. 6.1

[3]





(c) Describe the arrangement of ions in solid sodium chloride.

.....

.....

.....

..... [2]

[Total: 9]



7 Fig. 7.1 shows an electric car.

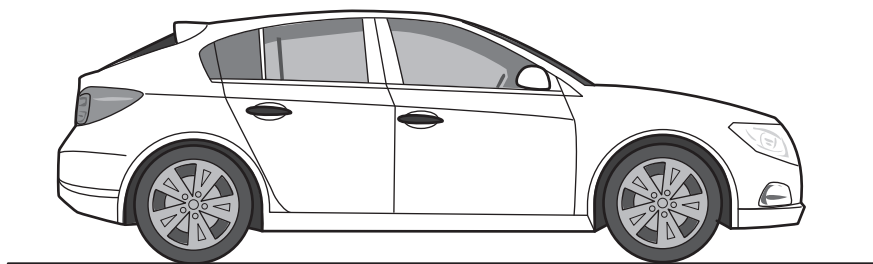


Fig. 7.1

The mass of the car is 2000 kg.

The speed of the car increases from 5.0 m/s to 23 m/s in a time of 4.0 s.

(a) (i) Complete Fig. 7.2 to show one energy transfer that occurs.

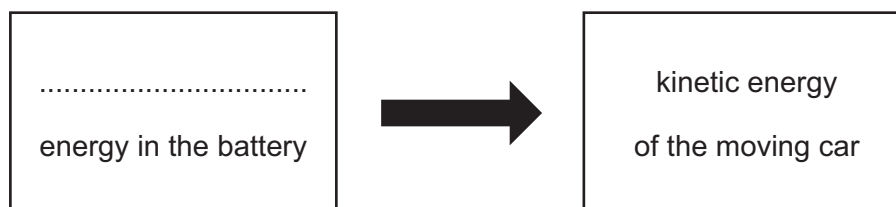


Fig. 7.2

[1]

(ii) State the equation used for calculating the efficiency of energy transfers.

..... [1]

(b) Show that the acceleration of the car is approximately 5 m/s^2 .

[2]





(c) Calculate the resultant force acting on the car.

Include the unit in your answer.

force = ... unit [3]

(d) Calculate the increase in the kinetic energy of the car.

increase in kinetic energy = ... J [2]

[Total: 9]



8 Fig. 8.1 shows the two tyres of a motorcycle.

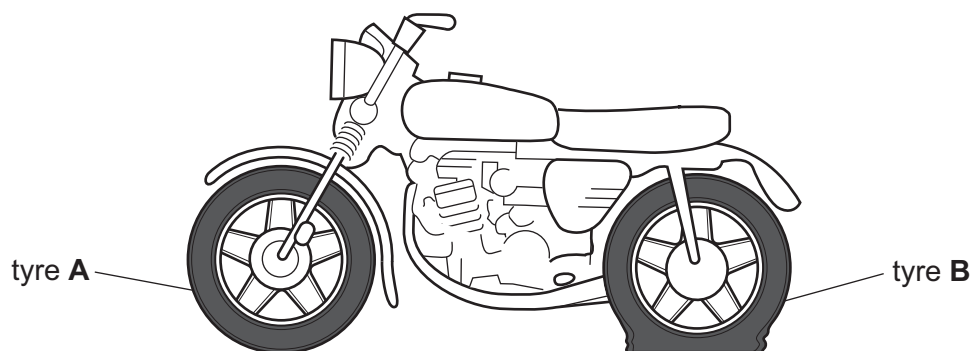


Fig. 8.1

Tyre **A** is full of air and is at the correct pressure.

Tyre **B** is flat and does **not** have enough air in it.

(a) The weight of the motorcycle is shared equally between the two tyres.

(i) Identify which tyre, **A** or **B**, exerts the greater pressure on the road.

Give a reason for your answer.

tyre

reason

[2]

(ii) Describe how the pressure inside tyre **A** is caused by the air particles inside the tyre.

.....

.....

..... [2]



- (b) Each tyre has a pressure sensor that transmits an electromagnetic wave as a signal when the pressure is low.

Table 8.1 shows the approximate frequency ranges of the different regions of the electromagnetic spectrum.

Table 8.1

gamma radiation	X-rays	ultraviolet	visible light	infrared	micro-waves	radio waves
more than 1×10^{19} Hz	1×10^{16} Hz to 1×10^{19} Hz	8×10^{14} Hz to 1×10^{16} Hz	4×10^{14} Hz to 8×10^{14} Hz	1×10^{11} Hz to 4×10^{14} Hz	1×10^9 Hz to 1×10^{11} Hz	less than 1×10^9 Hz

The frequency of the transmitted wave is 3.5×10^8 Hz.

- (i) Use Table 8.1 to identify the region of the electromagnetic spectrum of this transmitted wave.

..... [1]

- (ii) State the speed of electromagnetic waves in a vacuum.

speed = ... m/s [1]

- (iii) Use your answer to (b)(ii) to calculate the wavelength of the transmitted wave.

wavelength = ... m [2]

[Total: 8]



- 9 Fig. 9.1 shows a circuit that contains an electric motor and a light-emitting diode (LED) connected to a direct current (d.c.) power supply.

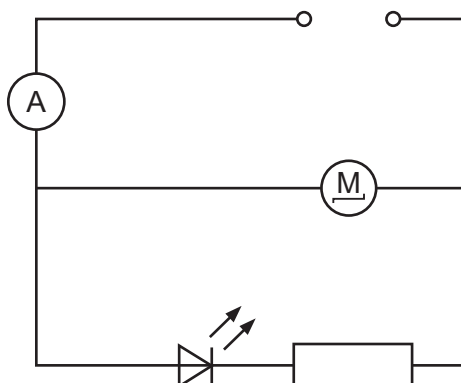


Fig. 9.1

- (a) When the motor is switched on, the LED lights up.

- (i) On Fig. 9.1, show the polarity of the terminals of the power supply using + and – signs.

Give a reason why the + and – signs must be the way you have shown.

.....
 [1]

- (ii) The power supply is 9.0V.

The reading on the ammeter is 6.6A.

The current in the LED is 0.30A.

Calculate the resistance of the motor.

resistance = ... Ω [3]



- (b) (i) State the name of the component with the electrical symbol shown.



..... [1]

- (ii) Complete the sentence to define electromotive force (e.m.f.).

Electromotive force is the electrical done by a source in
moving a unit around a complete circuit.

[2]

- (c) The circuit in Fig. 9.1 is used in a satellite.

- (i) The satellite orbits the Earth at a distance of 15 000 km from the centre of the Earth.

The orbital speed of the satellite is 17 km/s.

Calculate the orbital period T of the satellite.

$T =$ s [2]

- (ii) The satellite is used to study the Universe.
State the approximate age of the Universe.

..... [1]

[Total: 10]







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The Periodic Table of Elements

Group																			
I	II											III	IV	V	VI	VII	VIII		
												1 H hydrogen 1							

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
	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.).



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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

May/June 2025

1 hour 15 minutes

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- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- 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 **20** pages. Any blank pages are indicated.

- 1 (a) Fig. 1.1 is a diagram of the digestive system and associated organs.

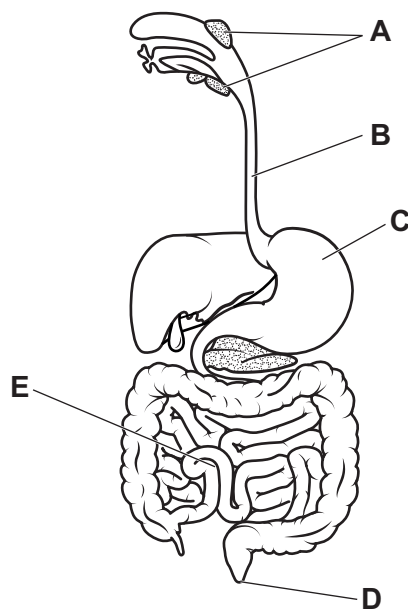


Fig. 1.1

Table 1.1 shows some information about the parts labelled in Fig. 1.1.

Complete Table 1.1.

Table 1.1

name of part	letter	function of part
stomach		digestion
small intestine	E	digestion and of digested food
.....	A	

[3]



(b) The stomach contains protease and hydrochloric acid.

State the function of protease and hydrochloric acid in the stomach.

protease

.....

hydrochloric acid

.....

.....

[3]

(c) Fig. 1.2 is a graph of the effect of pH on the activity of an enzyme found in the mouth.

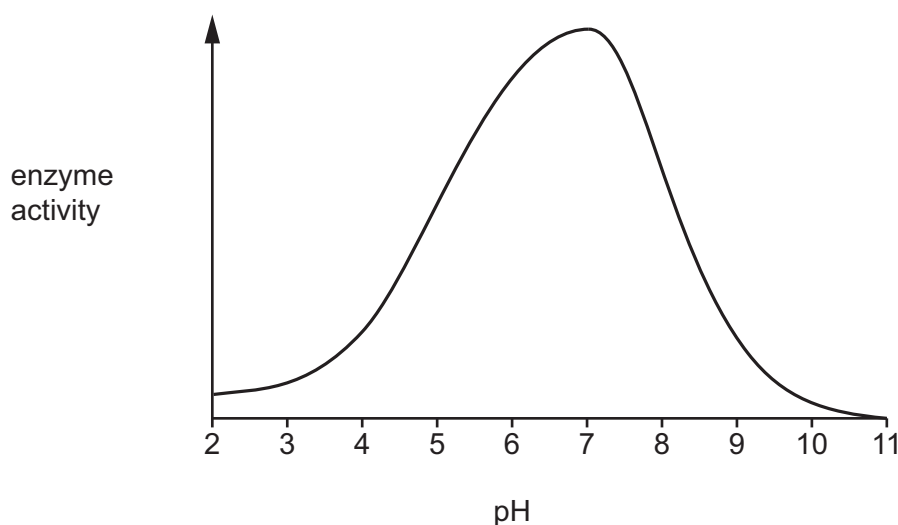


Fig. 1.2

Explain why this enzyme stops working at pH 11.

.....

.....

.....

.....

..... [3]

[Total: 9]



2 (a) Fig. 2.1 shows the structure of a plant root.

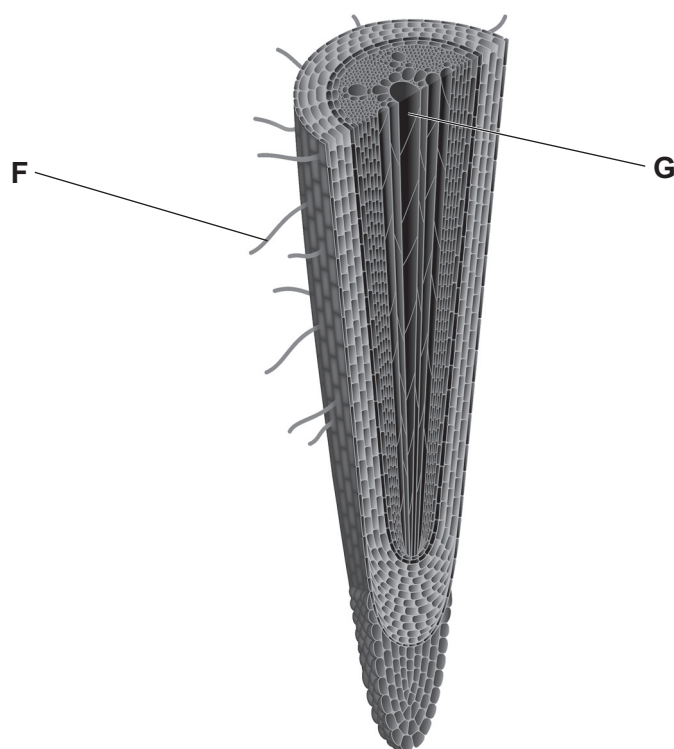


Fig. 2.1

(i) Identify the parts labelled **F** and **G** in Fig. 2.1.

F

G

[2]

(ii) Complete the sentences about cell **F** in Fig. 2.1, to describe how the cell is adapted to its function.

Cell **F** is adapted to its function by having a large

This adaptation increases the uptake of water and

[2]



(b) Water is lost from the leaves of a plant by the process of transpiration.

A student investigates the effect of wind speed on the rate of transpiration.

Complete Fig. 2.2 by:

- labelling the y-axis
- drawing a line to predict the expected results of this investigation.

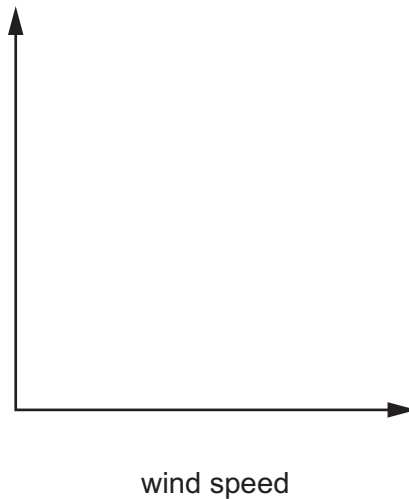


Fig. 2.2

[2]

(c) Plants use water in the process of photosynthesis.

Describe the process of photosynthesis.

.....

.....

.....

.....

..... [3]

[Total: 9]



- 3 (a) A person is infected by a pathogen. A few months later they are infected again by the same pathogen.

Fig. 3.1 shows how the number of antibodies in the body of the person changes after each infection.

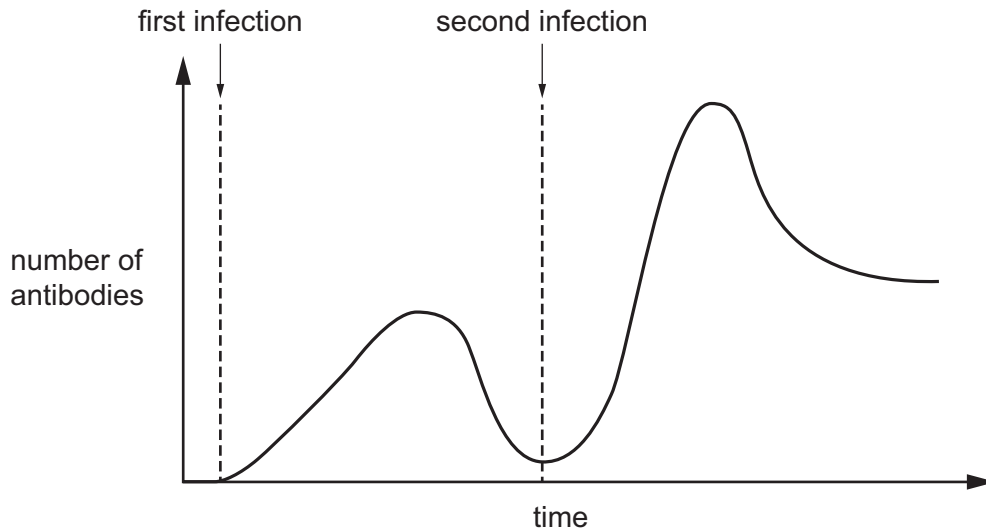


Fig. 3.1

- (i) Describe how Fig. 3.1 shows evidence that the body of the person has gained active immunity to the pathogen.

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

- (ii) State **one** other way the body gains active immunity to a pathogen.

..... [1]

- (b) Explain why a clean water supply is important in controlling the spread of diseases.

.....
..... [1]



- (c) Some bacteria and viruses are pathogens.

A virus has a diameter of $0.4\text{ }\mu\text{m}$.

A bacterial cell has a diameter of 0.001 mm .

- (i) Calculate how many times larger the diameter of the bacterial cell is compared to the virus.

..... $\times$ [2]

- (ii) Give **two** reasons why someone infected with a virus should **not** be given antibiotics.

1

.....

2

.....

[2]

- (iii) One structural feature of a virus is that it contains genetic material.

State **one** other structural feature of a virus.

..... [1]

[Total: 9]



4 Sodium fluoride, NaF, is an ionic compound.

(a) Tick (✓) **all** the boxes that are properties of sodium fluoride.

high boiling point

☐

insoluble in water

☐

conducts electricity when solid

☐

[1]

(b) Complete the dot-and-cross diagram in Fig. 4.1 to show the outer-shell electrons for each ion in sodium fluoride.

Include the charge on each ion.

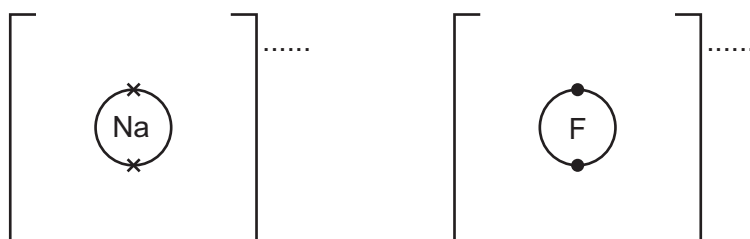


Fig. 4.1

[3]



(c) Fig. 4.2 shows equipment used in the electrolysis of molten sodium fluoride.

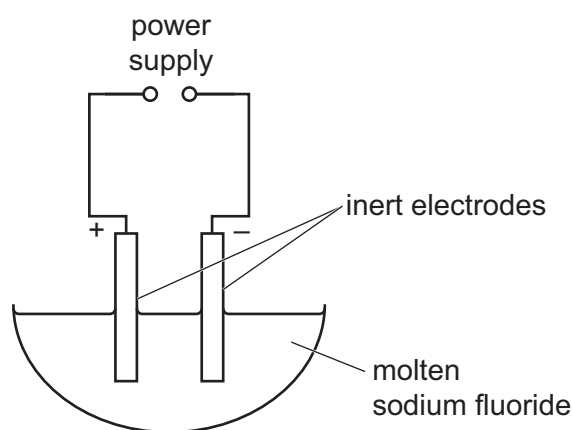


Fig. 4.2

(i) Define electrolysis.

.....

 [2]

(ii) Predict the product formed at the:

- positive electrode
- negative electrode. [2]

(d) Aqueous sodium fluoride reacts with aqueous silver nitrate, AgNO_3 , to form aqueous sodium nitrate, NaNO_3 , and one other product.

Write the balanced symbol equation for this reaction.

..... [1]

[Total: 9]



- 5 (a) Calcium oxide, CaO, is used to make cement.

Calcium oxide is formed by the decomposition of calcium carbonate, CaCO₃, at a very high temperature.

The equation for the reaction is shown.



- (i) Suggest why making cement contributes to global warming.

.....

.....

.....

..... [2]

- (ii) The reaction is endothermic.

Explain what is meant by an endothermic reaction.

Use ideas about making bonds and breaking bonds in your answer.

.....

.....

.....

.....

..... [3]



(iii) Fig. 5.1 shows the incomplete reaction pathway diagram for an endothermic reaction.

Complete Fig. 5.1.

Include:

- the energy level of the products
- a labelled arrow to show the activation energy, E_a
- a labelled arrow to show the overall energy change of the reaction.

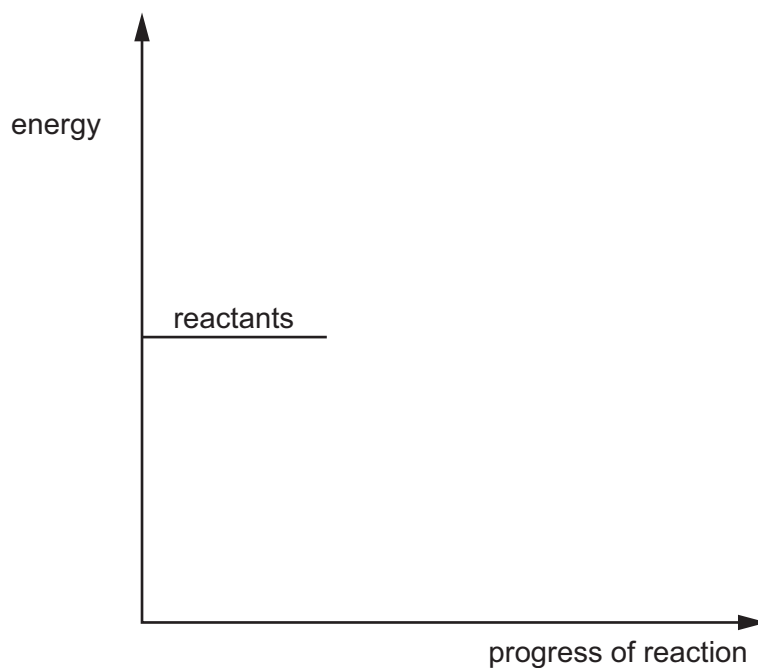


Fig. 5.1

[3]

(b) Calcium oxide reacts with water to form calcium hydroxide.

(i) The ions in calcium hydroxide are Ca^{2+} and OH^- .

Deduce the formula for calcium hydroxide.

..... [1]

(ii) Aqueous calcium hydroxide is an alkali.

State the colour of methyl orange indicator in aqueous calcium hydroxide.

..... [1]

[Total: 10]



6 Alkanes and alkenes are two different homologous series.

(a) State **two** general characteristics of a homologous series.

- 1
- 2 [2]

(b) Alkenes are unsaturated compounds.

State what is meant by unsaturated compound.

..... [1]

(c) Name the process used to manufacture alkenes from alkanes.

..... [1]

(d) Ethene is an alkene.

Poly(ethene) is a polymer made from ethene molecules.

State the general name for the small molecules that join together to form a polymer.

..... [1]

(e) Ethene reacts with steam to form ethanol.

(i) State the type of catalyst used in this reaction.

..... [1]

(ii) The structure of ethanol is shown in Fig. 6.1.

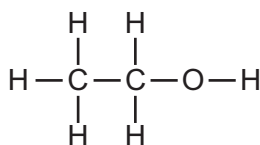


Fig. 6.1

Explain why ethanol is **not** a hydrocarbon.

..... [1]

[Total: 7]





7 Fig. 7.1 shows a tram powered by electricity supplied through overhead cables.

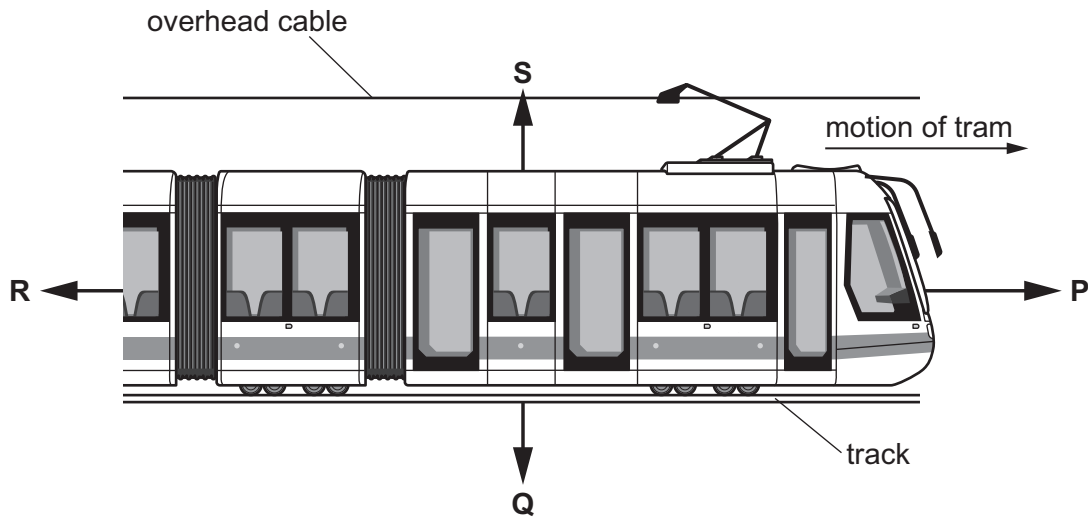


Fig. 7.1

The tram accelerates horizontally along a level track.

(a) Forces **P**, **Q**, **R** and **S** act on the tram as it accelerates, as shown in Fig. 7.1.

(i) State which force, **P**, **Q**, **R** or **S**, is the driving force.

..... [1]

(ii) Explain why forces **Q** and **S** must be balanced.

.....
..... [1]





- (b) The mass of the tram is 32 000 kg.

The tram accelerates horizontally at 0.75 m/s^2 for 8.0 s.

The speed of the tram increases.

- (i) Calculate the resultant force acting on the tram.

Include the unit in your answer.

force = ... unit [3]

- (ii) Calculate the increase in speed of the tram.

increase in speed = ... m/s [2]

- (iii) Calculate the power required for this increase in speed.

power = ... W [3]

[Total: 10]



- 8 A student constructs an electrical circuit containing a metal heating element.

Fig. 8.1 shows the circuit diagram.

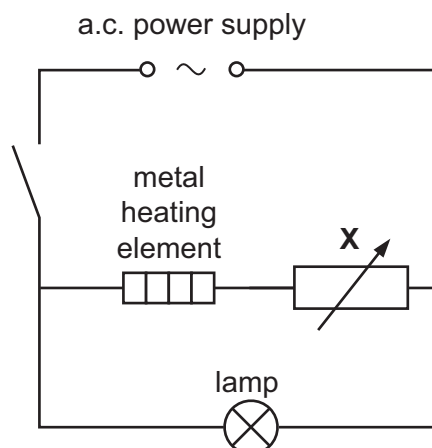


Fig. 8.1

- (a) State the name of component **X**.

..... [1]

- (b) Metal is a good thermal conductor.

- (i) An insulator is a bad thermal conductor.

Give **one** example of an insulator.

..... [1]

- (ii) Describe thermal conduction in a metal.

.....

 [2]

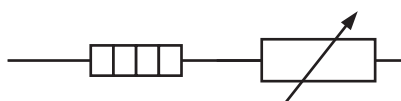


(c) The student changes the lamp in Fig. 8.1 to a light-emitting diode (LED).

This change means that the student **must** also change the power supply.

The rest of the circuit is **not** changed.

Complete the circuit diagram for this new circuit.



[3]

[Total: 7]



- 9 (a) (i) Complete the sentence about the Solar System.

The Sun contains most of the of the Solar System and this explains why the planets orbit the Sun.

[1]

- (ii) The radius of the orbit of the Earth around the Sun is 1.5×10^8 km.

The orbital period of the Earth is 365 days.

Calculate the orbital speed, in km/s, of the Earth around the Sun.

orbital speed = ... km/s [3]

- (iii) The orbital speed of Mars around the Sun is 24 km/s.

The orbital speed of Venus around the Sun is 35 km/s.

Explain why the orbital speed of Mars around the Sun is less than the orbital speed of Venus.

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



(b) Betelgeuse is a red supergiant star in the Milky Way.

(i) Betelgeuse is a large mass star.

State the next **two** stages in the life cycle of Betelgeuse.

red supergiant → → [2]

(ii) Betelgeuse is a stable star.

Describe the process that releases energy in stable stars.

.....

..... [2]

[Total: 10]

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The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass																
1 H hydrogen 1																		
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	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 —

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
	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.).



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COMBINED SCIENCE

0653/43

Paper 4 Theory (Extended)

May/June 2025

1 hour 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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- 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 **20** pages. Any blank pages are indicated.

1 (a) Fig. 1.1 is a photomicrograph of human blood.

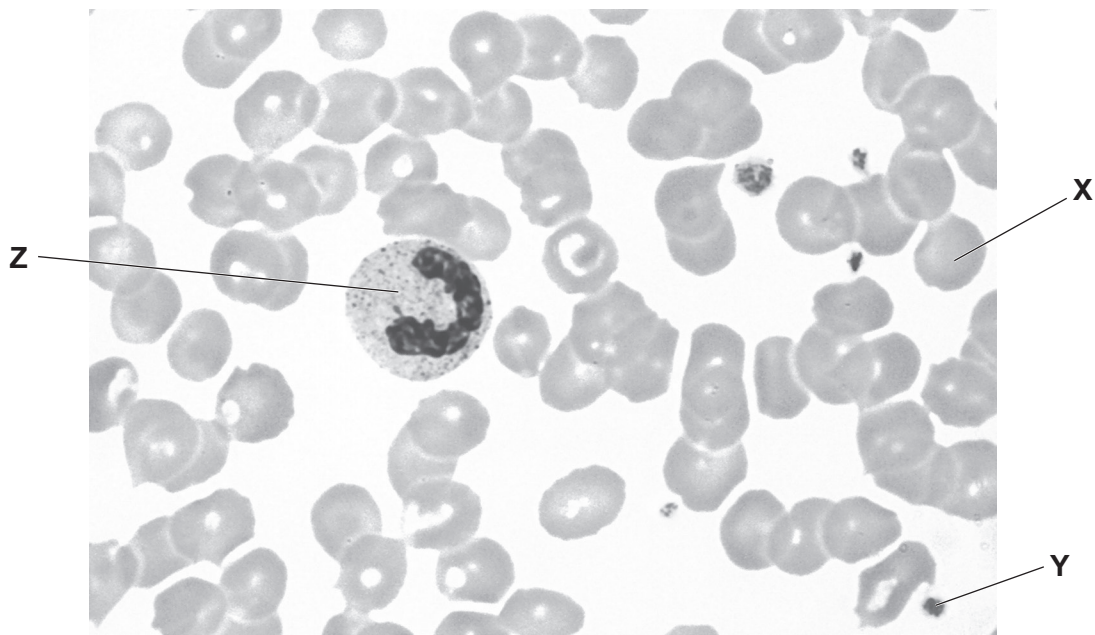


Fig. 1.1

(i) Name the blood component labelled **X** on Fig. 1.1.

..... [1]

(ii) State **one** function of the blood component labelled **Z** on Fig. 1.1.

..... [1]

(iii) The blood component labelled **Y** on Fig. 1.1 helps blood clot.

State **two** reasons why blood clots when skin is damaged.

1

.....

2

.....

[2]



(b) Blood is transported in blood vessels.

Fig. 1.2 is a photomicrograph of an artery and a vein.

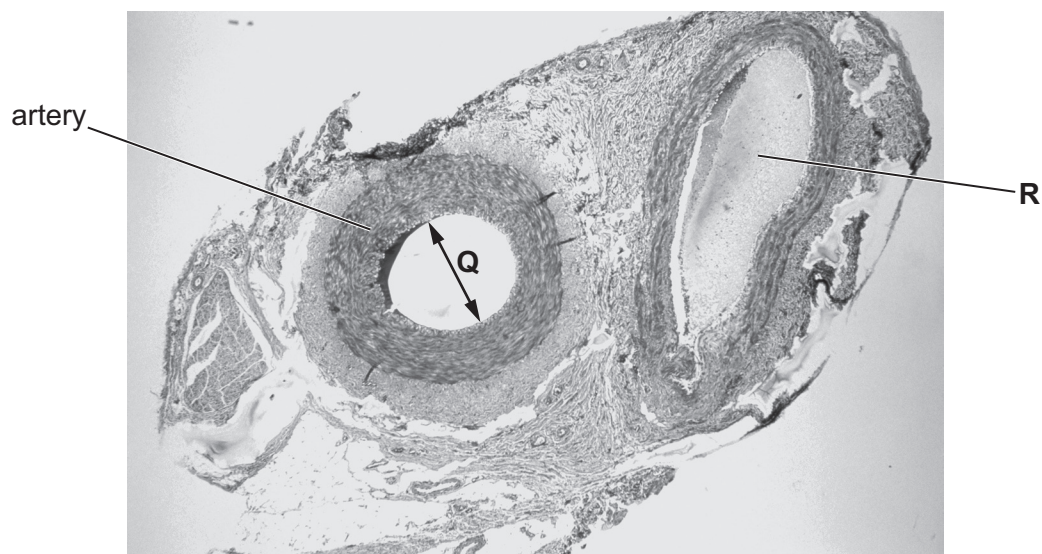


Fig. 1.2

(i) Describe evidence from Fig. 1.2 that the blood vessel labelled **R** is a vein.

.....

.....

.....

..... [2]

(ii) The diameter of the inside of the artery is indicated by line **Q** in Fig. 1.2.

Line **Q** is 15 mm in length.

The magnification of the image is $\times 75$.

Calculate the actual diameter of the inside of the artery in micrometres (μm).

actual diameter = ... μm [3]

[Total: 9]



2 (a) Fig. 2.1 is a diagram of a cross-section through a leaf.

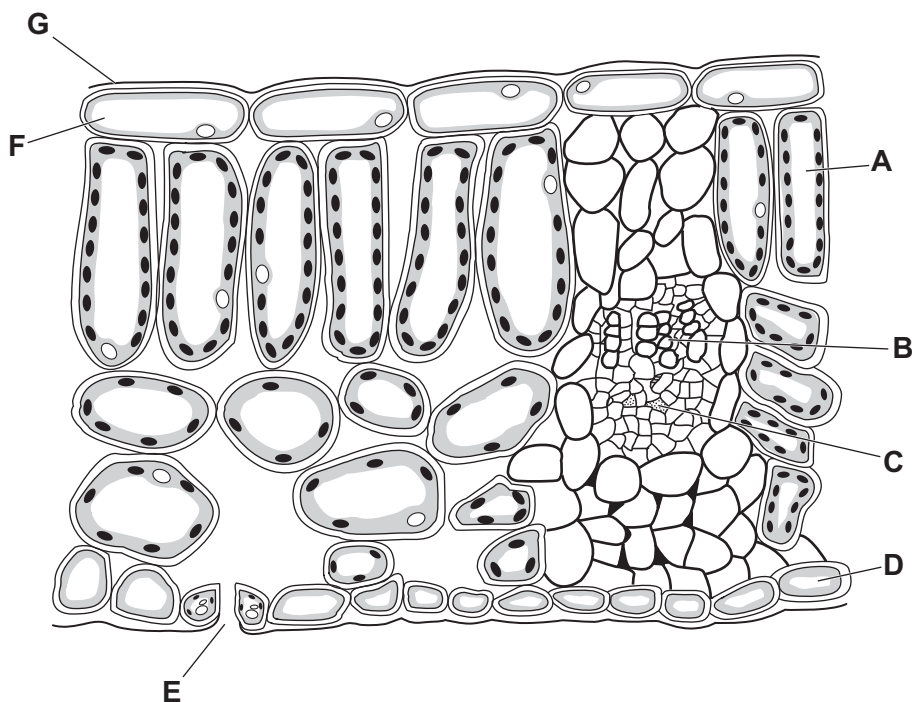


Fig. 2.1

State the letter on Fig. 2.1 that identifies:

cuticle

a cell specialised for photosynthesis

a cell that transports mineral ions to the leaf.

[3]

(b) A green pigment is needed for photosynthesis.

State the name of this pigment and its role in photosynthesis.

name

role

.....

.....

.....

[3]



(c) The graph in Fig. 2.2 shows the effect of temperature on the rate of photosynthesis in a plant.

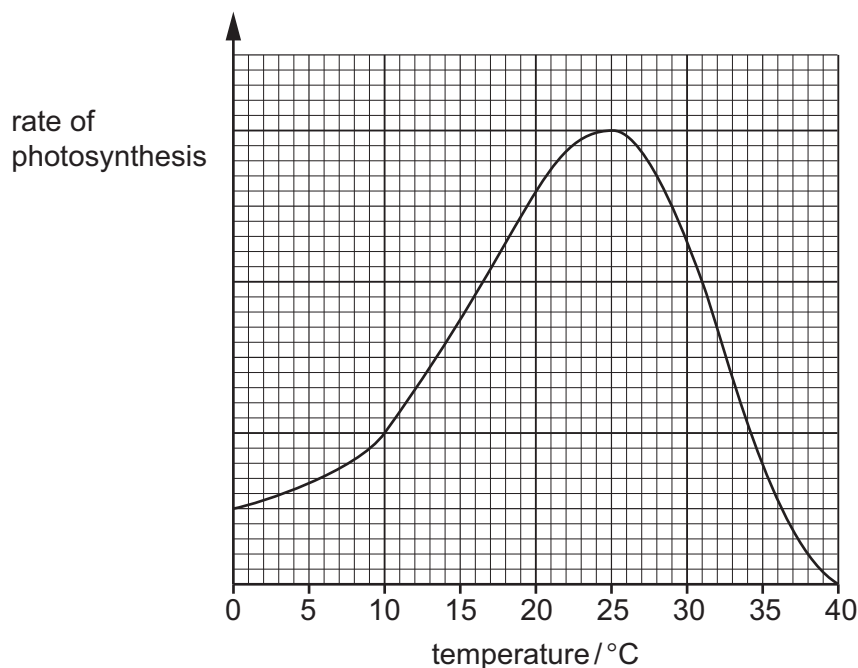


Fig. 2.2

- (i) Identify the optimum temperature for photosynthesis shown in Fig. 2.2.

..... °C

[1]

- (ii) Enzymes are involved in photosynthesis.

Explain the result at 40 °C shown in Fig. 2.2.

.....

.....

.....

.....

..... [3]

[Total: 10]



- 3 (a) Fig. 3.1 shows part of the breathing system in humans.

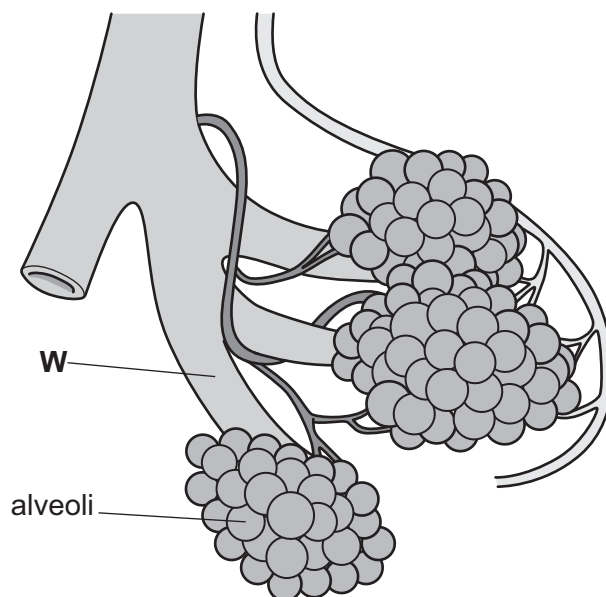


Fig. 3.1

- (i) Identify the part labelled **W** in Fig. 3.1.

..... [1]

- (ii) Alveoli are the gas exchange surface in humans.

Describe **two** features of the gas exchange surface in humans.

1

2

[2]

- (b) The breathing system excretes carbon dioxide produced in aerobic respiration.

State the balanced symbol equation for aerobic respiration.

..... [2]



(c) Respiration is part of the carbon cycle. Human activities have an impact on the carbon cycle.

(i) Explain why deforestation impacts the carbon cycle.

.....

.....

.....

..... [2]

(ii) The impact on the carbon cycle is one undesirable effect of deforestation.

State **one other** undesirable effect of deforestation.

..... [1]

[Total: 8]



4 Table 4.1 shows information about three compounds, **A**, **B** and **C**.

Table 4.1

compound	melting point /°C	boiling point /°C	electrical conductivity
A	801	1465	conducts only when molten or in aqueous solution
B	1713	2950	does not conduct
C	–210	–196	does not conduct

(a) (i) Identify the compound in Table 4.1 that is a solid at 25°C **and** has only covalent bonding.

Explain your choice.

compound

explanation

.....

.....

[2]

(ii) Identify the compound in Table 4.1 that is a simple molecular compound.

Explain your choice.

compound

explanation

.....

.....

[1]



- (b) The temperature of compound **A** is increased from 800 °C to 802 °C.

Describe how the arrangement, energy and motion of the particles in compound **A** change with this increase in temperature.

arrangement

.....

energy

.....

motion

.....

[3]

- (c) An electric current is passed through an aqueous solution of compound **A**.

A chemical change occurs.

Explain why this is a chemical change.

.....

.....

..... [2]

[Total: 8]



5 Chlorine is in Group VII of the Periodic Table.

(a) Chlorine gas is bubbled through aqueous bromide ions.

A reaction occurs and an orange-brown solution forms.

(i) Name the substance that causes the orange-brown colour.

..... [1]

(ii) Explain why this reaction happens.

..... [1]

(iii) Bonds break in this reaction.

State the type of energy change that occurs when bonds break.

..... [1]

(b) Chlorine reacts with sodium to form sodium chloride.

(i) Complete the dot-and-cross diagram in Fig. 5.1 to show the outer-shell electrons in sodium ions and in chloride ions.

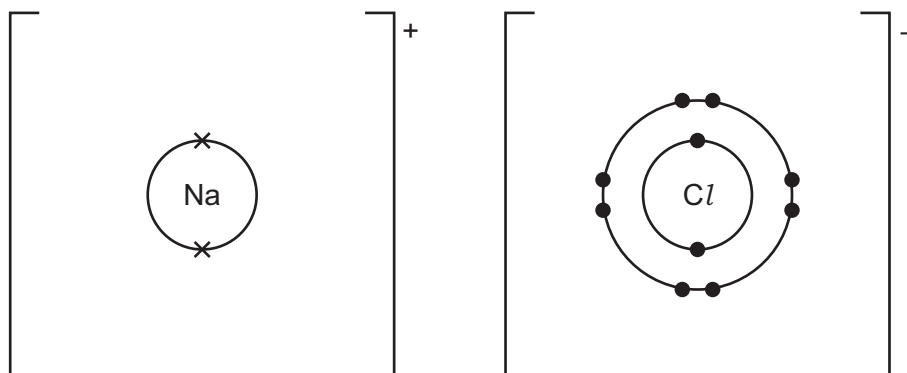


Fig. 5.1

[2]



- (ii) Solid sodium chloride has a giant lattice structure of positive sodium ions and negative chloride ions.

Complete Fig. 5.2 to show the arrangement of ions in solid sodium chloride.

Show at least eight ions. Two have been drawn for you.

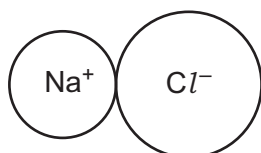


Fig. 5.2

[2]

- (c) Aqueous sodium chloride reacts with aqueous lead(II) nitrate to make lead(II) chloride.

Lead(II) chloride is an insoluble salt.

- (i) State the type of chemical reaction that forms an insoluble salt from two aqueous solutions.

..... [1]

- (ii) Name the other salt that forms in this reaction.

..... [1]

[Total: 9]



- 6 (a) Ethene is an alkene.

The structure of ethene, C_2H_4 , is shown in Fig. 6.1.

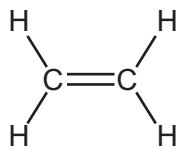


Fig. 6.1

Table 6.1 shows the formula of each product and the reaction conditions when ethene undergoes addition reactions with different molecules.

- (i) Complete Table 6.1.

Table 6.1

molecule	formula of product	reaction conditions
$Br_2(aq)$		room temperature
$H_2O(g)$	C_2H_5OH	
	C_2H_6	

[4]



- (ii) The symbol (g) is used in Table 6.1.

State the meaning of this symbol.

..... [1]

- (b) Table 6.2 shows the formulas and boiling points of some alkenes.

Table 6.2

formula	boiling point / °C
C_3H_6	-47
C_4H_8	-7
C_5H_{10}	30

- (i) Deduce the formula of the alkene that contains 7 carbon atoms.

..... [1]

- (ii) The alkenes in Table 6.2 are members of the same homologous series.

State **two** ways the information in Table 6.2 supports this statement.

1

.....

2

.....

[2]

- (iii) State how the information in Table 6.2 shows that alkenes are hydrocarbons.

.....

..... [1]

[Total: 9]



7 Fig. 7.1 shows a toy car, powered by a battery.

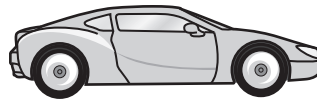


Fig. 7.1

The mass of the car is 0.64 kg.

(a) (i) Complete the sentences about mass and weight.

Mass is a measure of the quantity of in an object.

Weight is the force on an object that has mass.

[2]

(ii) Calculate the weight of the car.

weight = ... N [2]

(b) The car accelerates from rest with a constant acceleration of 0.25 m/s^2 for a time of 5.2 s.

(i) Calculate the resultant force acting on the car.

force = ... N [2]

(ii) Calculate the speed of the car at 5.2 s.

speed = ... m/s [2]





(c) The total power input to the car is 3.00 W.

The useful power output of the car is 0.75 W.

(i) Calculate the efficiency of the car.

efficiency = ... % [2]

(ii) Explain why the efficiency of the car is **not** 100%.

.....

..... [1]

[Total: 11]



8 Fig. 8.1 shows a pan of water being heated on an electric hotplate.

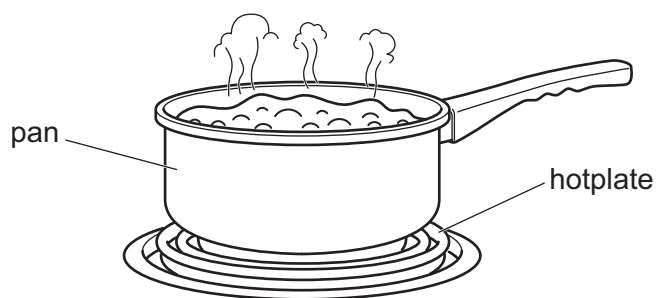


Fig. 8.1

(a) Convection occurs in the water in the pan.

Explain convection in the water in terms of density changes.

.....

.....

.....

..... [2]

(b) Some of the liquid water changes to steam.

(i) State the term that describes the change in state from liquid water to steam.

..... [1]

(ii) Describe how the forces between particles change when liquid water becomes steam.

.....

..... [1]



(c) Fig. 8.2 shows a circuit diagram for the electric hotplate.

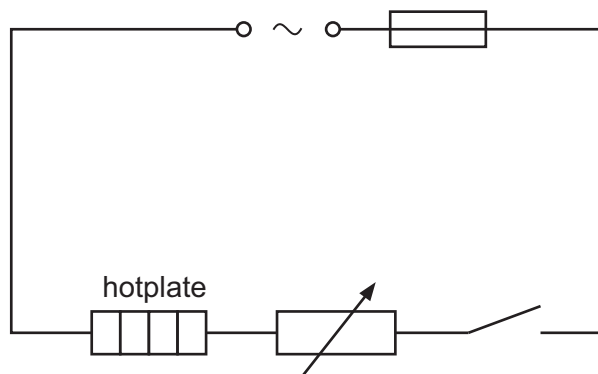


Fig. 8.2

- (i) State the type of power supply used in this circuit.

..... [1]

- (ii) The supply voltage is 240 V.

The hotplate has a maximum power of 2000 W.

Use a calculation to determine whether a fuse rated at 30 A is appropriate for this circuit.

Explain your answer.

explanation

..... [3]

[Total: 8]



- 9 (a) State the approximate age of the Universe.

..... [1]

- (b) Describe how a stable star is formed.

.....

 [3]

- (c) A telescope is used to observe a stable star in space.

The telescope can detect electromagnetic waves with wavelengths in the range 300 nm to 3000 nm.

- (i) State the speed of electromagnetic waves in a vacuum.

..... [1]

- (ii) Fig. 9.1 shows wavelengths for the different regions of the electromagnetic spectrum.

0.001 nm	1.0 nm	400 nm	700 nm	1.0 mm	1.0 m	
gamma radiation	X-rays	ultraviolet	visible light	infrared	microwaves	radio waves

Fig. 9.1

Use Fig. 9.1 to identify **all** the regions of the electromagnetic spectrum that the telescope can detect.

.....
 [2]

- (iii) The speed of sound waves in air is much slower than the speed of electromagnetic waves in air.

State **one** other difference between sound waves and electromagnetic waves.

.....
 [1]

[Total: 8]



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The Periodic Table of Elements

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19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	20 Ca calcium 40	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	83 Bi bismuth 209	84 Po polonium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	38 Sr strontium 88	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	155 Db dubnium —	156 Lr lawrencium —	293 Ux unbinilium —	294 Og oganeson —	295 Ts tennessine —
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	56 Ba barium 137	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	155 Db dubnium —	156 Lr lawrencium —	293 Ux unbinilium —	294 Og oganeson —	295 Ts tennessine —
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