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COMBINED SCIENCE

0653/42

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 diagram of the digestive system and associated organs.

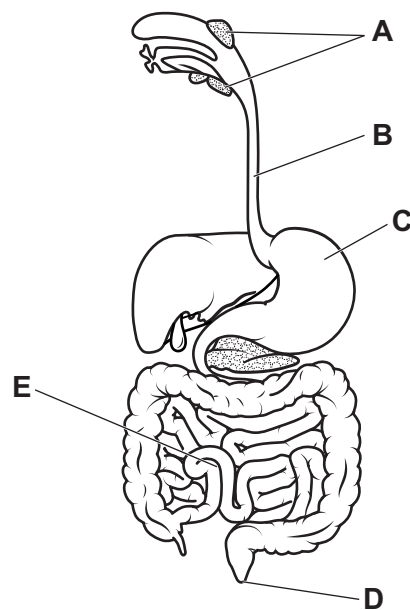


Fig. 1.1

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.

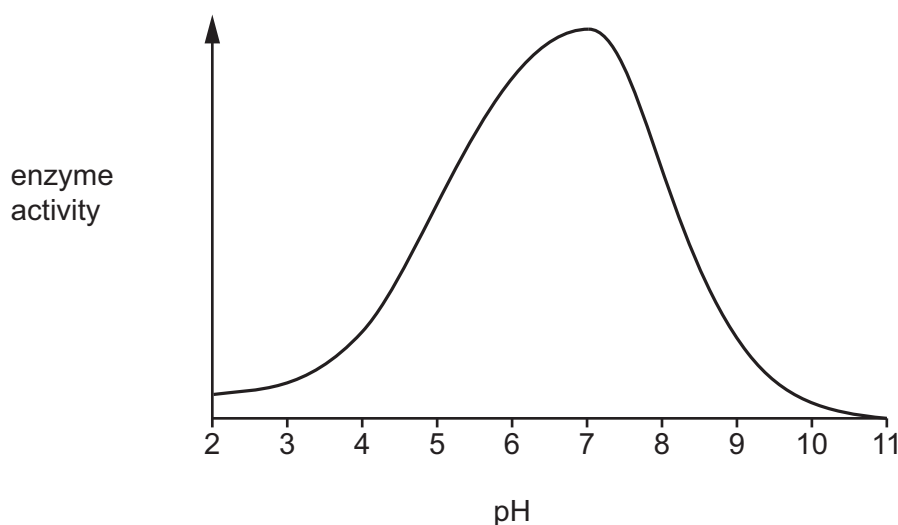


Fig. 1.2

Explain why this enzyme stops working at pH 11.

.....

.....

.....

.....

.....

[3]

[Total: 9]



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

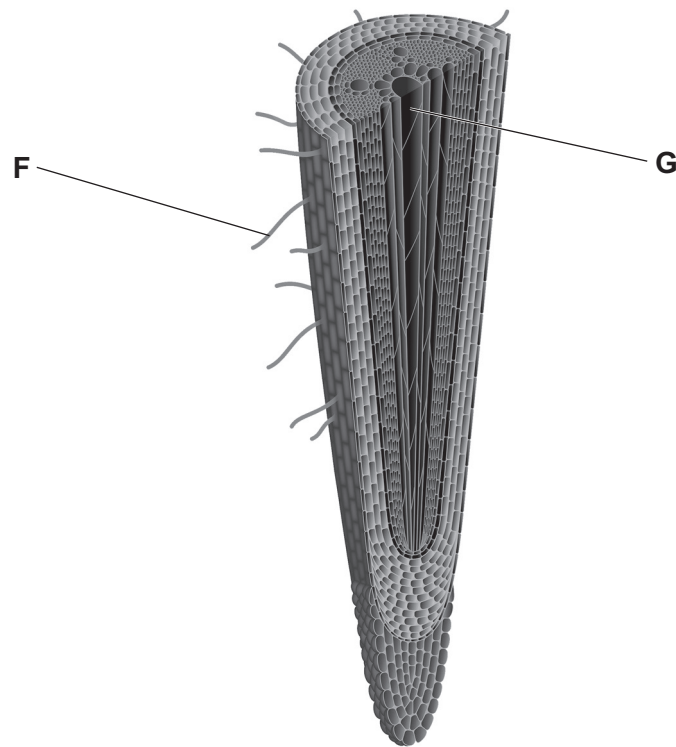


Fig. 2.1

(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.

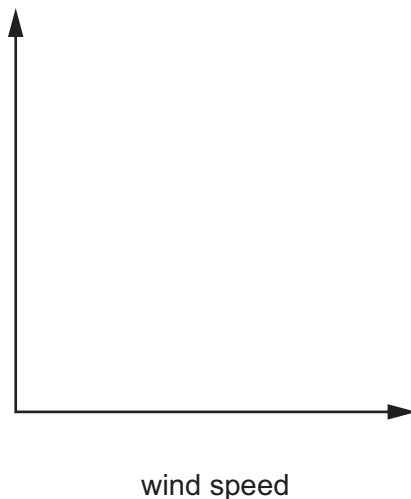


Fig. 2.2

[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.

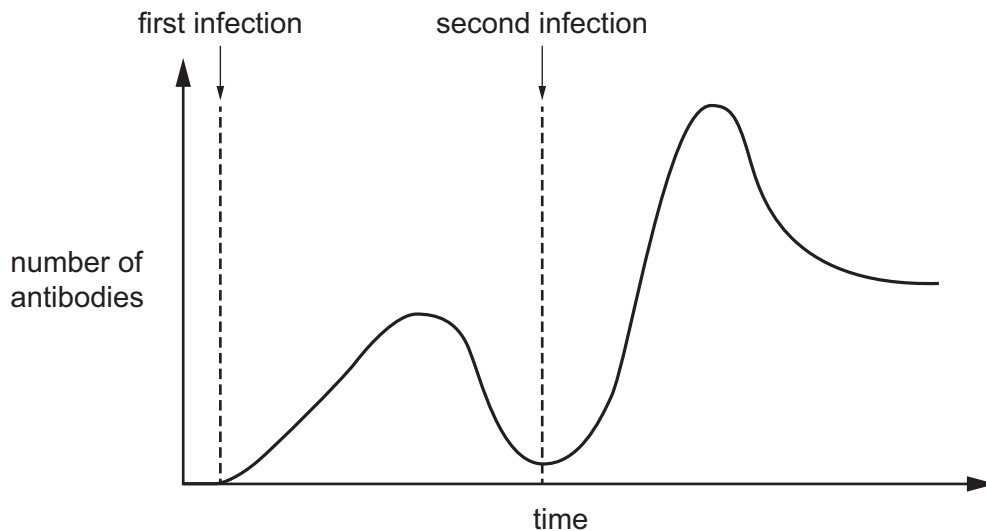


Fig. 3.1

- (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.

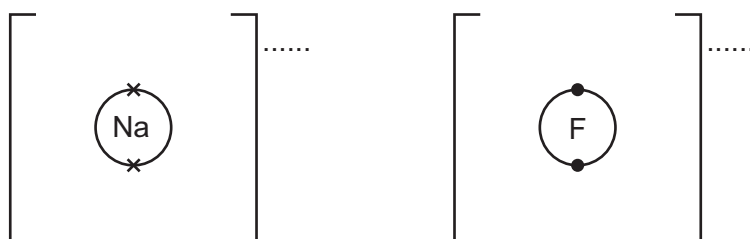


Fig. 4.1

[3]



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

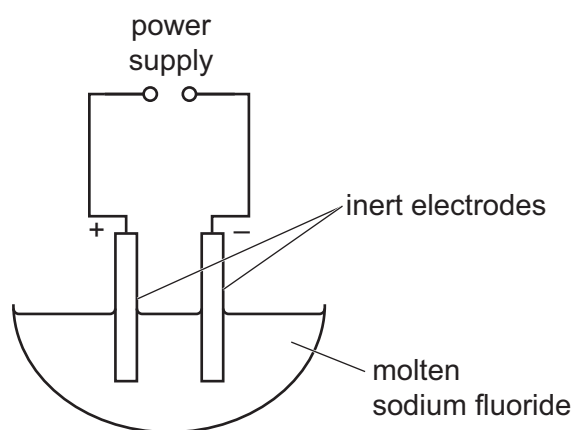


Fig. 4.2

(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.

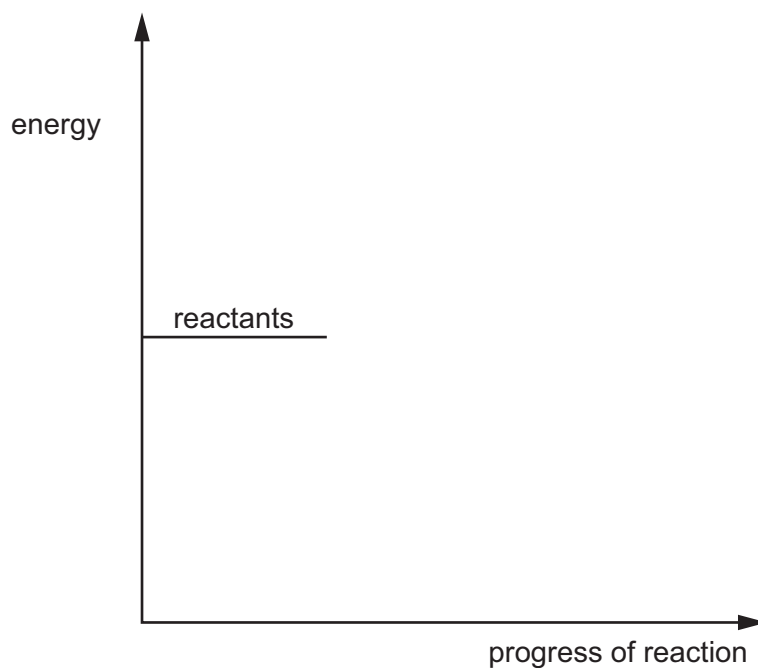


Fig. 5.1

[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.

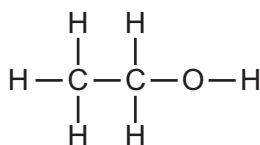


Fig. 6.1

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

..... [1]

[Total: 7]





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

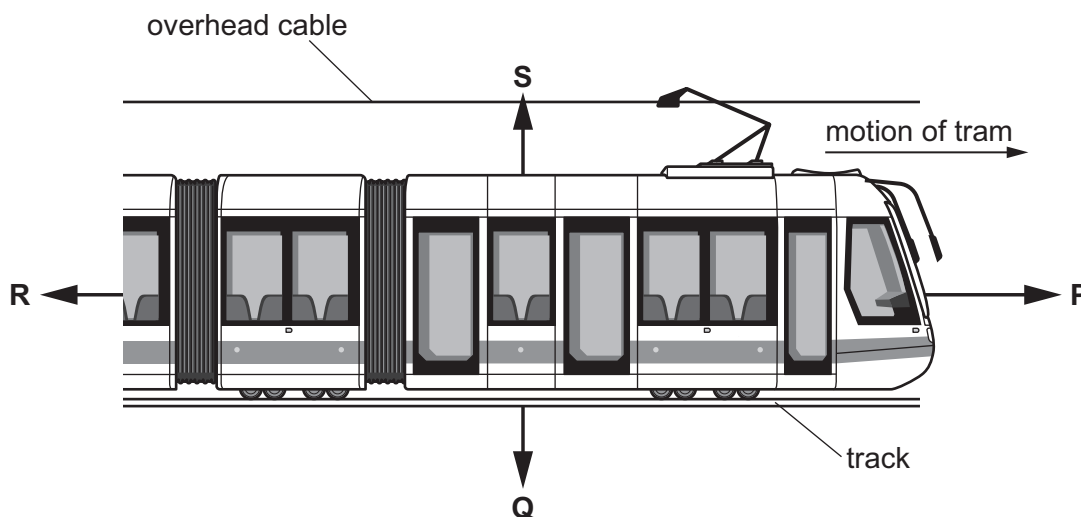


Fig. 7.1

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.

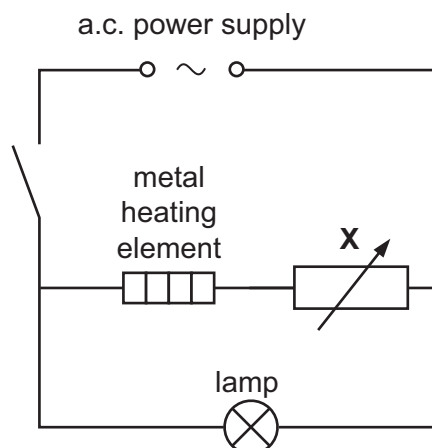


Fig. 8.1

- (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]

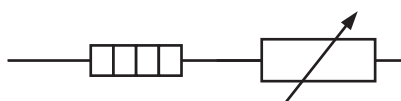


(c) The student changes the lamp in Fig. 8.1 to a light-emitting diode (LED).

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											III	IV	V	VI	VII	VIII	
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										1 H hydrogen 1						2 He helium 4
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 57–71		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 —	actinoids 89–103		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.).

