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CAMBRIDGE
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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3791751645

COMBINED SCIENCE **0653/42**

Paper 4 Theory (Extended) **May/June 2026**

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. Do **not** use correction fluid or tape.
- 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.

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1 **(a)** Figure 1.1 is a diagram of the human breathing system.

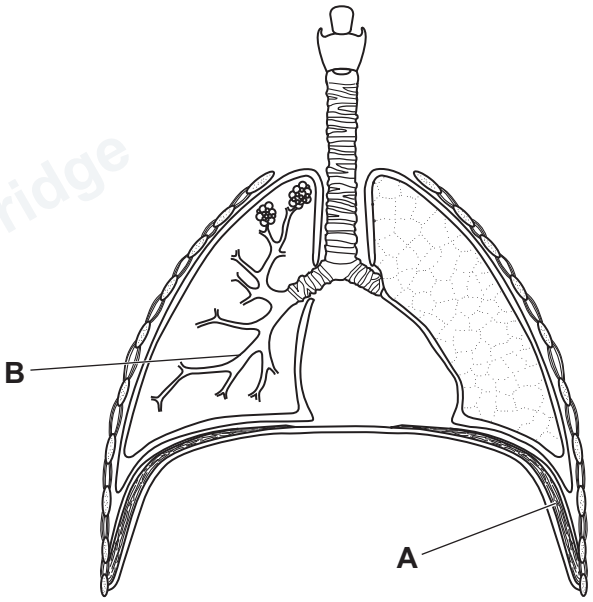


Figure 1.1

(i) Identify the parts labelled **A** and **B** on Figure 1.1.

A .....

B .....

[2]

(ii) Draw a label line and the letter **L** on Figure 1.1 to identify the larynx. [1]

(b) Oxygen diffuses into the blood across the gas exchange surface of the lungs.

(i) Gas exchange surfaces in humans have a large surface area.

State **two** other features of the gas exchange surface in humans.

1 .....

2 .....

[2]

(ii) Surface area and temperature influence the rate of diffusion.

Describe **two** other factors that influence the rate of diffusion.

1 .....

2 .....

[2]

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(c) Oxygen is transported in the blood.
Figure 1.2 is a photomicrograph showing two blood vessels.

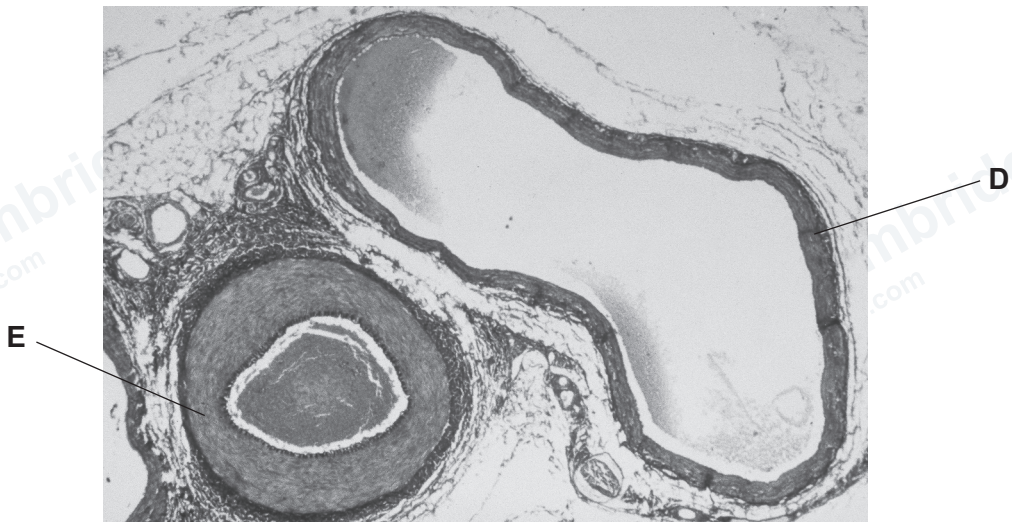


Figure 1.2

(i) State the letter in Figure 1.2 that identifies a vein.
Use Figure 1.2 to give reasons for your answer.

letter .....

reasons .....

.....

.....

.....
[2]

(ii) Describe the role of blood in defending the body from pathogens.

.....

.....

.....

..... [2]

[Total: 11]

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2 **(a)** The pancreas produces the enzyme lipase.

(i) State **one** other enzyme produced by the pancreas.

..... [1]

(ii) Name the large molecule lipase digests and the products of this digestion.

large molecule .....

products .....
[2]

(b) Figure 2.1 is a graph showing the effect of pH on lipase activity.

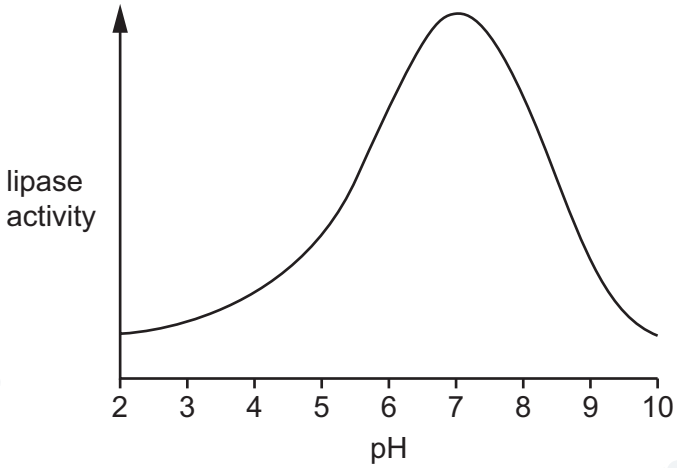


Figure 2.1

Explain the effect of pH 7 on the lipase activity shown in Figure 2.1.

.....

.....

.....

.....

.....

..... [3]

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(c) Enzymes are used in the process of photosynthesis in plants.

A student measures the rate of photosynthesis by counting the number of gas bubbles produced by an aquatic plant.

Figure 2.2 shows the apparatus the student uses.

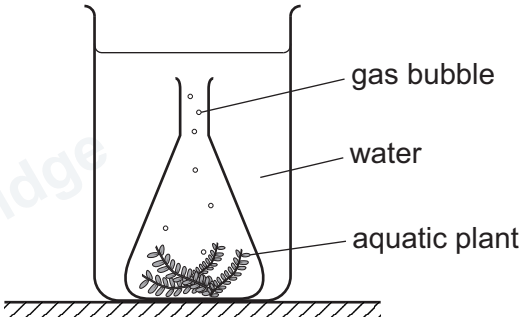


Figure 2.2

Table 2.1 shows the number of gas bubbles produced in 3 minutes for different concentrations of carbon dioxide in the water.

Table 2.1

percentage concentration of carbon dioxide	number of gas bubbles in 3 minutes	rate of photosynthesis / gas bubbles per minute
0.1	9	3
0.2	13	4
0.3	17	6
0.4	20	7
0.5	22	

(i) Calculate the rate of photosynthesis for the 0.5 percentage concentration of carbon dioxide shown in Table 2.1.

Give your answer to the nearest whole number.

rate of photosynthesis = ... gas bubbles per minute [2]

(ii) Describe the effect of changing the percentage concentration of carbon dioxide on the rate of photosynthesis shown in Table 2.1.

.....

..... [1]

[Total: 9]

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3 **(a)** Figure 3.1 shows a photograph of a flower.



Figure 3.1

(i) Identify the part labelled **G** in Figure 3.1.

..... [1]

(ii) Complete the sentences about the flower in Figure 3.1.

The flower is pollinated when pollen from another flower is carried by

..... to this flower.

The pollen lands on the ..... of the flower.

[2]

(b) After pollination, fertilisation occurs.

Compare fertilisation in humans and plants.

similarities .....

.....

.....

.....

differences .....

.....

.....

.....

[4]

[Total: 7]

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4 **(a)** Table 4.1 shows information about some ions of Group I and Group VII elements.

Table 4.1

formula of ion	number of protons	number of neutrons	number of electrons
Li^+			2
	9	10	10
	11		

Use the Periodic Table to complete Table 4.1. [4]

(b) Bromine, chlorine and iodine are elements in Group VII.

(i) Identify the least dense of these three elements.

..... [1]

(ii) Identify the least reactive of these three elements.

..... [1]

(c) A test-tube contains aqueous sodium bromide.

Aqueous chlorine is added to the test-tube and a reaction occurs.

(i) Identify this type of chemical reaction.

..... [1]

(ii) State the colour change of the solution in the test-tube.

from ..... to .....
[2]

[Total: 9]

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5 Methanol, CH_3OH, is an organic compound.

(a) Explain why methanol is **not** a hydrocarbon.

.....

..... [1]

(b) Complete the dot-and-cross diagram in Figure 5.1 to show the electronic configuration of a molecule of methanol, CH_3OH.

Show **only** the outer-shell electrons.

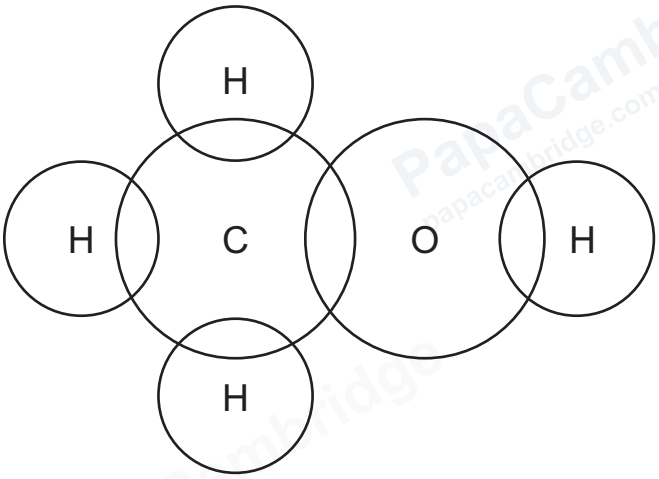


Figure 5.1

[3]

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(c) Methanol is used as a fuel for heating.

(i) A flame is needed to light the methanol so that it starts to burn.
The flame provides activation energy, E_a, for the reaction.

Define activation energy.

.....

.....

..... [2]

(ii) The combustion of methanol produces carbon dioxide and water.

Complete the word equation and the symbol equation for this reaction.

methanol + [ ] → carbon dioxide + water

$2CH_3OH$ + [ ] → [ ] + $4H_2O$

[3]

(iii) State the test for carbon dioxide and the observation for a positive result.

test .....

observation .....

[1]

[Total: 10]

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6 **(a)** Table 6.1 shows the average mass of pollutants in 1 m^3 of air in three cities, **J**, **K** and **L**.

Table 6.1

pollutant	mass of pollutant in 1 m^3 of air / μg		
	city **J**	city **K**	city **L**
particulates	65	51	46
oxides of nitrogen	221	231	211
sulfur dioxide	50	45	55
carbon monoxide	5	4	5

(1 million μg = 1 g)

(i) State **two** pollutants in Table 6.1 which are formed due to incomplete combustion of hydrocarbons.

1 .....

2 .....

[2]

(ii) Identify which city, **J**, **K** or **L**, has air with the highest mass in 1 m^3 of gaseous pollutants that cause acid rain.

Explain your answer.

city .....

explanation .....

.....

[2]

(iii) Use Table 6.1 to calculate the total mass of **gaseous** pollutants in 1 m^3 of the air of city **L**.

total mass of **gaseous** pollutants =..... μg [1]

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(b) Two strategies for reducing the effects of climate change are planting trees and reducing livestock farming.

Explain how each strategy reduces the effects of climate change.

planting trees .....

.....

reducing livestock farming .....

.....

[2]

[Total: 7]

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7 **(a)** A student assembles the electrical circuit shown in Figure 7.1.

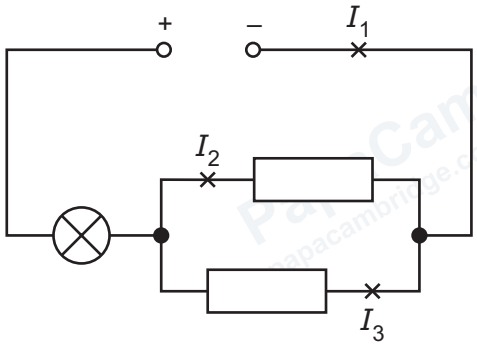


Figure 7.1

(i) The current in the lamp is 0.26 A.

The potential difference (p.d.) across the lamp is 2.5 V.

Calculate the power of the lamp.

power = ... W [2]

(ii) Draw an arrow above the lamp in Figure 7.1 to show the direction of the flow of **electrons** through the lamp.

Give a reason for your answer.

.....

..... [1]

(iii) The currents at other positions in the circuit are labelled I_1, I_2 and I_3.

Write an equation to show the relationship between I_1, I_2 and I_3.

..... [1]

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(b) Describe the difference between a direct current (d.c.) and an alternating current (a.c.).

.....

..... [1]

(c) An electric bell is connected to a battery.

The bell is switched on for 5.0 s.

During this time, 4.7×10^{19} electrons pass through the bell. The charge on each electron is 1.6×10^{-19} C.

Calculate the current in the bell.

current = ... A [3]

[Total: 8]

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8 **(a)** A sound wave is an example of a longitudinal wave.

(i) Give an example of a transverse wave.

..... [1]

(ii) A sound wave travels through a gas as a series of compressions and rarefactions.

Describe the difference between a compression and a rarefaction in terms of pressure and distance between gas particles.

pressure .....

.....

distance .....

.....

[2]

(b) Solids expand less than gases when heated.

Solids contract less than gases when cooled.

Give **two** reasons why.

1 .....

.....

2 .....

.....

[2]

(c) Describe how thermal energy is transferred through a solid metal.

.....

.....

.....

..... [3]

[Total: 8]

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9 The Sun is the main source of energy for most of our energy resources.

(a) State **two** energy resources that do **not** have the Sun as their main source of energy.

1 .....

2 .....

[2]

(b) Describe how energy is released by reactions in stable stars like the Sun.

.....

.....

..... [2]

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(c) A solar cell uses light from the Sun to power the toy car shown in Figure 9.1.

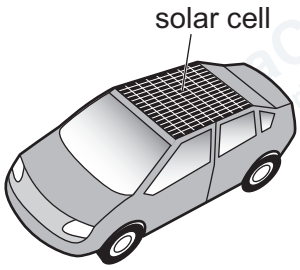


Figure 9.1

The car moves with an initial constant speed of 0.25 m / s.

The car then accelerates with a constant acceleration of 0.40 m / s^2.

The final constant speed of the car is 1.25 m / s.

(i) The kinetic energy of the car at its initial speed is 1.25×10^{-3} J.

Show that the kinetic energy of the car at its final speed is 0.031 J.

[3]

(ii) Calculate the distance the car moves while it is accelerating.

distance = ... m [4]

[Total: 11]

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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.).

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