Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMBINED SCIENCE **5129/21**

Paper 2 Theory **October/November 2025**

1 hour 45 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.

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 **16** pages.

[Turn over

1 Draw straight lines from the box on the left to **three** of the boxes on the right to make three sentences that are correct for veins.

Veins ...	... carry blood at a higher pressure than arteries.
	... always carry deoxygenated blood.
	... have a narrow lumen.
	... have a thinner wall than arteries.
	... carry blood towards the heart.
	... have many valves to prevent the backflow of blood.

Fig. 1.1

[3]

2 **(a)** State the percentage of nitrogen gas, N_2, in clean, dry air.

.....% [1]

(b) State the type of bonding in a molecule of nitrogen gas.

..... [1]

(c) Nitrogen reacts with calcium, Ca, to form calcium nitride, Ca_3N_2.

(i) Calculate the relative formula mass, M_r, of calcium nitride, Ca_3N_2.

The relative atomic masses, A_r, of calcium and nitrogen are shown.

[A_r: Ca, 40; N, 14]

M_r = ... [1]

(ii) Calcium nitride melts at 1195 °C.

Deduce the type of bonding in calcium nitride.

..... [1]

(iii) Describe the separation and motion of the particles in melted calcium nitride.

separation .....

.....

motion .....

.....

[2]

[Total: 6]

3 An athlete throws a heavy shot put ball in a competition.

Fig. 3.1 shows how the height of the ball above the ground changes with time.

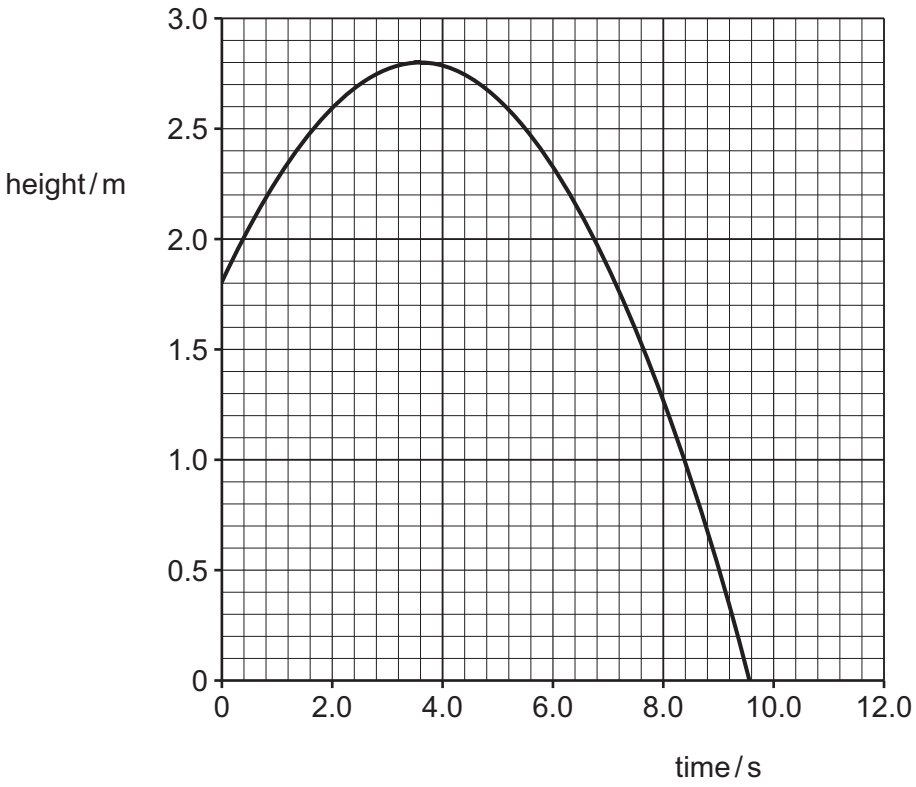

Fig. 3.1

(a) Use the information in Fig. 3.1 to determine:

(i) the height of the ball above the ground when it is released by the athlete.

height above the ground = ... m [1]

(ii) the time taken for the ball to land on the ground.

time taken = ... s [1]

(b) Explain how the graph shows that the speed of the ball is changing.

..... [1]

(c) The ball travels a horizontal distance of 19.3 m.

Calculate the average horizontal speed of the ball.

Use your answer to **(a)(ii)** in your calculation and give your answer to 2 significant figures.

average speed = ... m / s [3]

[Total: 6]

4 **(a)** Inspired air is air that is breathed in, and expired air is air that is breathed out.

Complete the sentences comparing inspired and expired air.

Inspired air has more ..... than expired air.

Expired air has more ..... than inspired air.

[2]

(b) The breathing rate of a student is measured for 10 minutes.

He stands still for most of the 10 minutes.

He exercises for a short period of time during the 10 minutes.

Fig. 4.1 shows how his breathing rate changes from the start of the 10 minutes to the beginning of minute 6.

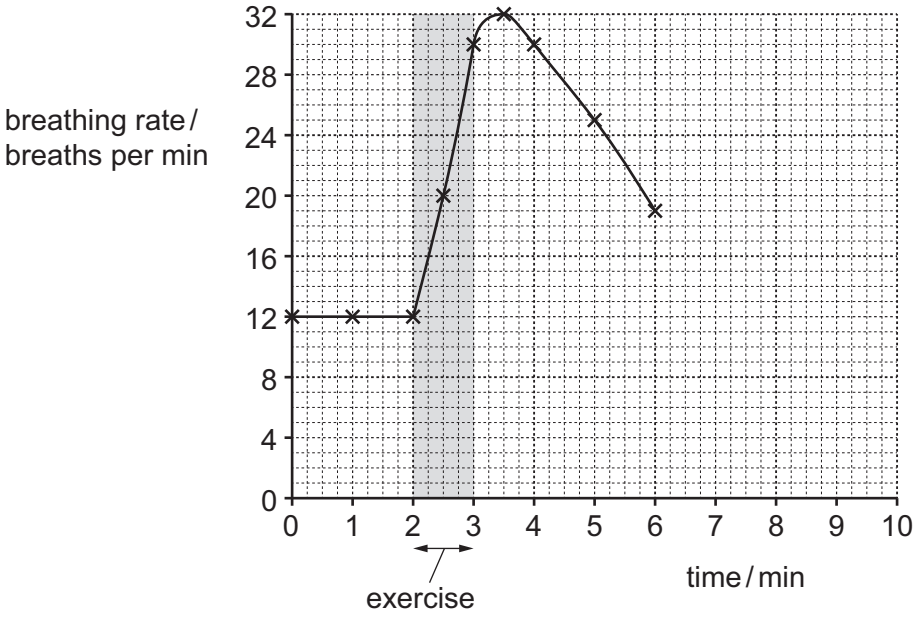

Fig. 4.1

(i) Use the graph to determine the student's breathing rate when the student is standing still before exercising.

..... breaths / min [1]

(ii) Use the graph to determine the duration of the exercise period.

..... min [1]

(iii) Calculate the **increase** in the student's breathing rate caused by the exercise.

..... breaths / min [1]

(iv) The line on the graph in Fig. 4.1 is incomplete.

Draw on the graph to continue the line from 6 to 10 minutes to show how the student's breathing rate changes. [2]

[Total: 7]

5 Table 5.1 shows the structural formulas of two hydrocarbons, **A** and **B**.

Table 5.1

A	B
$CH_2=CH_2$	$CH_3CH_2CH_3$

(a) State the name of hydrocarbon **A** and the name of hydrocarbon **B**.

A .....

B .....

[2]

(b) Describe **one** similarity and **one** difference in the structures of **A** and **B**.

similarity .....

.....

difference .....

.....

[2]

(c) State a use for hydrocarbon **A**.

..... [1]

(d) Explain the meaning of the term 'structural formula'.

.....

..... [1]

[Total: 6]

6 Fig. 6.1 shows a block of wood on a ramp. The ramp is tilted so that one end is at height *h* above the bench.

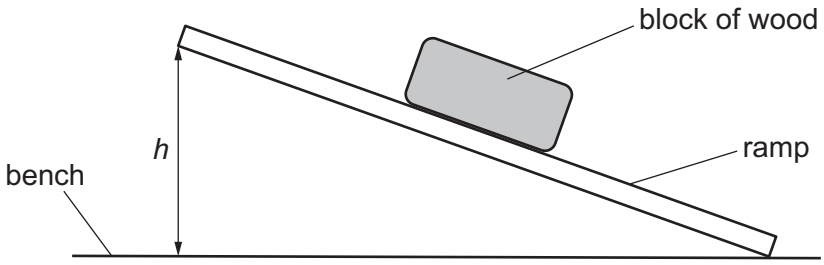

Fig. 6.1

(a) A force prevents the block sliding down the ramp.

(i) State the name of this force.

..... [1]

(ii) On Fig. 6.1, draw an arrow to show the direction of this force. Label this arrow with an **X**. [1]

(b) The height *h* is increased until the block begins to slide down the ramp.

Explain why the block begins to slide.

.....

..... [2]

(c) Energy is transferred between energy stores associated with the block as the block slides down the ramp.

(i) State the name of the energy store that decreases.

..... [1]

(ii) State the name of an energy store that increases.

..... [1]

[Total: 6]

7 Use words from the list to complete the sentences about sexual reproduction in humans.

Each word may be used once, more than once, or not at all.

abdomen **embryos** **gametes** **neurone**

ovary **scrotum** **sperm** **zygotes**

A testis is found inside the ..... .

A testis produces ..... cells which are the male ..... .

Egg cells are produced inside the ..... .

[4]

8 Table 8.1 shows the chemical equations for five different reactions **V**, **W**, **X**, **Y** and **Z**.

Table 8.1

label	chemical equation
V	$NaOH + HCl \rightarrow NaCl + H_2O$
W	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
X	$CaCl_2(aq) + 2KOH(aq) \rightarrow 2KCl(aq) + Ca(OH)_2(s)$
Y	$C_{20}H_{42} \rightarrow C_{10}H_{20} + C_3H_6 + C_7H_{16}$
Z	$CuO + Mg \rightarrow Cu + MgO$

State which equation, **V**, **W**, **X**, **Y** or **Z**, is an example of the type of reaction named in question parts **(a)** to **(e)**.

Each equation may be used once, more than once or not at all.

(a) precipitation

..... [1]

(b) neutralisation

..... [1]

(c) redox

..... [1]

(d) cracking

..... [1]

(e) complete combustion

..... [1]

[Total: 5]

9 **(a)** Describe how useful electrical power may be obtained from nuclear fuel.

.....

.....

.....

.....

.....

..... [4]

(b) Describe **one** advantage of using nuclear fuel to produce electrical power.

.....

..... [1]

[Total: 5]

10 Human activity has impacts on ecosystems.

(a) Describe **two** effects of pollution by untreated sewage on freshwater ecosystems.

1 .....

.....

2 .....

.....

[2]

(b) Describe **two** effects of introducing non-native species into ecosystems.

1 .....

.....

2 .....

.....

[2]

[Total: 4]

11 **(a)** Copper is a metal.

The melting point of copper is 1083 °C.

The boiling point of copper is 2595 °C.

Use this data to deduce the physical state of copper at 2000 °C. Explain your reasoning.

physical state .....

explanation .....

.....

[2]

(b) State a use for copper metal and the property that makes it suitable for that use.

use .....

property .....

.....

[2]

[Total: 4]

12 Fig. 12.1 shows apparatus used to demonstrate convection.

A piece of smoking paper is placed above a glass tube attached to a box. A lit candle is placed inside the box, below another glass tube.

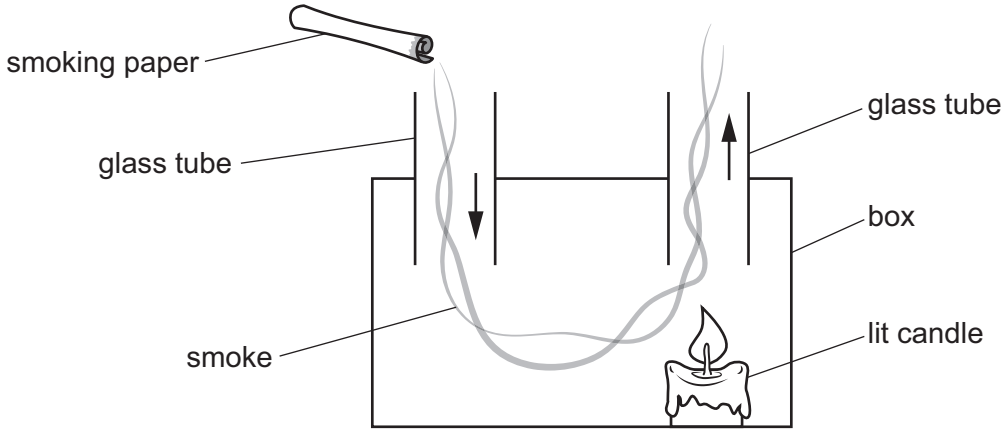

Fig. 12.1

Each arrow shows the direction of the smoke as it moves through that part of the box.

(a) Explain why the smoke moves in the directions shown in Fig. 12.1.

.....

.....

..... [2]

(b) The lighted candle emits radiation with a wavelength of 12×10^{-6} m.

The speed of light in air is approximately 3.0×10^{8} m/s.

Calculate the frequency of this radiation.

The wavelength and the speed are given in standard form.

Give your answer in standard form.

frequency = ... Hz [4]

[Total: 6]

13 Some of the organs of the human digestive system are labelled with the numbers 1–7 on Fig. 13.1.

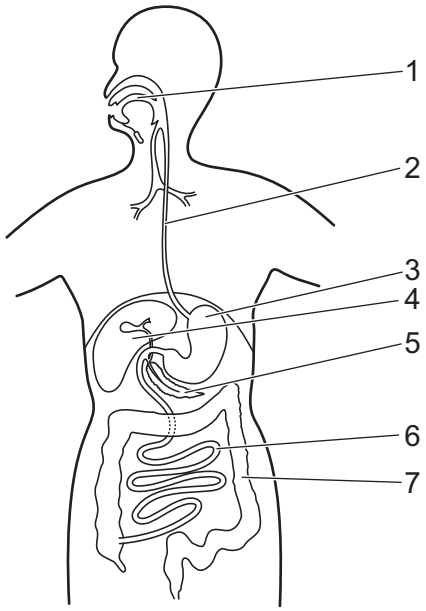

Fig. 13.1

Complete Table 13.1 by inserting the number from Fig. 13.1 that identifies the organ where the function occurs.

Each number may be used once, more than once or not at all.

Table 13.1

function	number of organ
produces urea	.....
bacteria are killed	.....
absorbs water	.....
stores glycogen	.....
produces amylase, lipase and protease	.....

[5]

14 A reaction between zinc metal and nitric acid produces a salt and hydrogen gas.

(a) State the name of the salt produced in the reaction.

..... [1]

(b) Describe the test and the result of the test that confirms that hydrogen gas is produced.

test .....

result .....

.....

[2]

(c) The rate of this chemical reaction is increased by using a catalyst and by increasing the temperature of the reactants.

State **two** other ways to increase the rate of this chemical reaction.

1 .....

2 .....

[2]

[Total: 5]

15 Fig. 15.1 shows apparatus used to demonstrate electrical charge. The metal dome is given a charge that results in a very high potential difference between it and the ground.

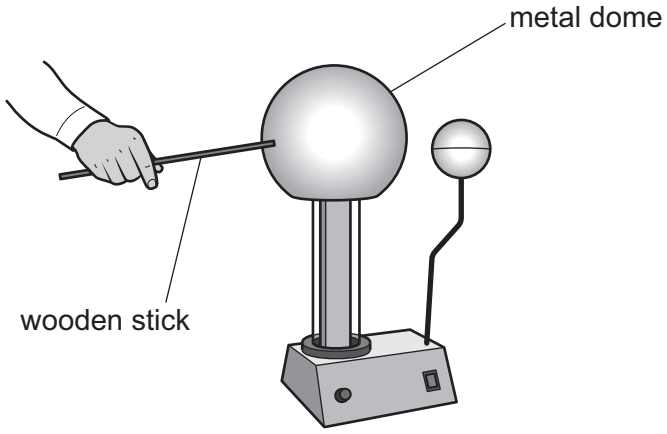

Fig. 15.1

A teacher uses a wooden stick to discharge the metal dome.

(a) The charge Q on the dome is initially 1.6×10^{-6} C.

When the teacher touches the dome with the wooden stick, the current I in the stick is initially 7.2×10^{-7} A.

Assume that these values of Q and I stay constant.

Calculate the time to discharge the dome.

time = ... s [2]

(b) The potential difference of the charged dome is initially 110 000 V.

(i) Suggest **one** electrical property of the wooden stick that is constant.

..... [1]

(ii) In reality, the potential difference of the charged dome decreases as it discharges.

This means that the actual time taken to discharge the dome is more than the time calculated in **(a)**.

Explain why the decreasing potential difference causes the time to discharge the dome to increase.

.....

..... [1]

[Total: 4]

16 The boxes on the left contain the names of structures found in plants.

The boxes on the right contain functions performed by plant structures.

Draw **one** straight line from each structure to its function.

You must draw a total of **five** lines.

structure	function
chloroplasts	translocation of sucrose
mitochondria	aerobic respiration
phloem	photosynthesis
stomata	transport of mineral ions
xylem	gas exchange

Fig. 16.1

[4]

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.).