Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMBINED SCIENCE **0653/41**

Paper 4 Theory (Extended) **October/November 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.

DC (KS/CT) 351867/3

1 **(a)** Fig. 1.1 is a diagram of the male reproductive system in humans.

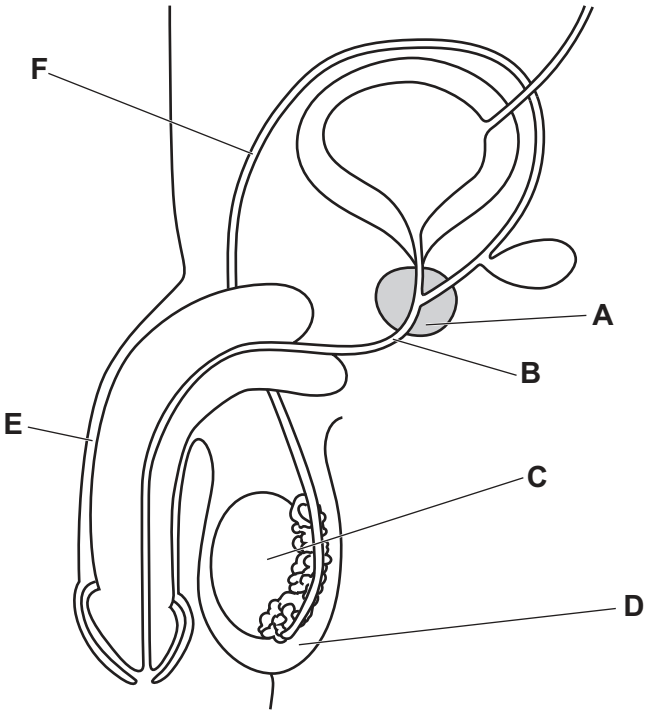


Fig. 1.1

State the letter on Fig. 1.1 that identifies:

the penis .....

where sperm is produced .....

where fluid for sperm to swim in is produced. .....

[3]

(b) Fig. 1.2 is a drawing of a human sperm cell.

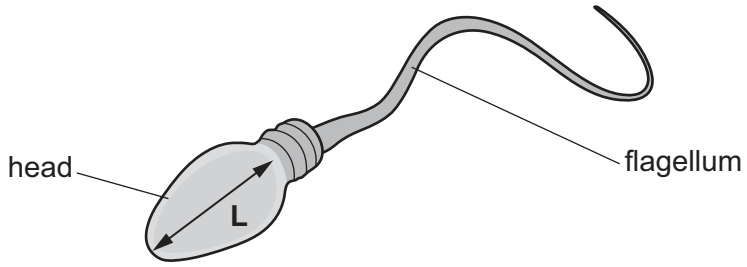


Fig. 1.2

(i) Arrow **L** in Fig. 1.2 shows the length of the head of the sperm cell in the drawing.

Arrow **L** is 20 mm in length.

The magnification of the drawing is ×4000.

Calculate the actual length of the head of the sperm cell in micrometers (μm).

actual length = ... μm [3]

(ii) A sperm cell moves its flagellum to swim.

A sperm cell contains a large number of mitochondria.

Describe how a large number of mitochondria helps a sperm cell to move.

.....

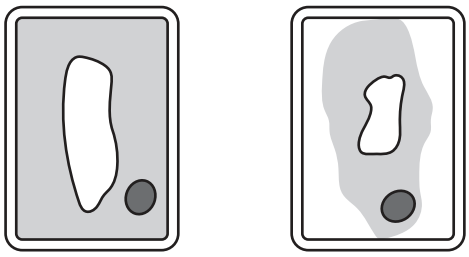
.....

.....

..... [2]

[Total: 8]

2 **(a)** Fig. 2.1 shows a plant cell before and after being immersed in a concentrated salt solution.



before **after**

Fig. 2.1

(i) State the name of the effect shown in Fig. 2.1.

..... [1]

(ii) The plant cell in Fig. 2.1 is now removed from the salt solution and immersed in pure water for 60 minutes.

Explain the effect of being immersed in pure water on the plant cell.

.....

.....

.....

.....

.....

..... [3]

(b) Plants photosynthesise to produce the carbohydrate glucose.

(i) Glucose is used to make other carbohydrates.

Circle **all** the carbohydrates made from glucose.

amino acids **amylase** **cellulose** **fatty acids**

glycerol **lipase** **starch**

[2]

(ii) Complete these sentences about photosynthesis in plants.

Photosynthesis requires the raw materials ..... and

..... .

Photosynthesis also requires ..... from light and the

green pigment ..... .

[3]

(c) The information in Fig. 2.2 is about organisms in a food chain.

- crabs eat starfish
- limpets eat algae
- sharks eat crabs
- starfish eat limpets

Fig. 2.2

(i) Construct a food chain using **all** the organisms in Fig. 2.2.

..... [2]

(ii) Identify the primary consumer in Fig. 2.2.

..... [1]

[Total: 12]

3 **(a)** Fig. 3.1 is a diagram of a human heart.

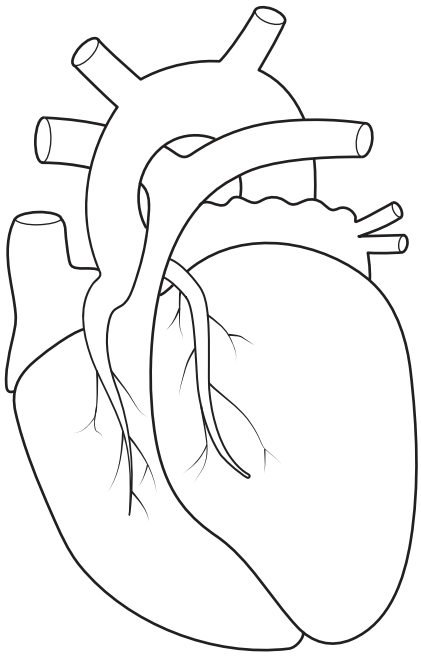


Fig. 3.1

(i) Draw a label line and the letter **C** to identify a coronary artery in Fig. 3.1. [1]

(ii) Describe what happens to the coronary artery when a person has coronary heart disease.

.....

..... [1]

(iii) Diet is one risk factor for coronary heart disease.

State **two** other risk factors for coronary heart disease.

1 .....

2 .....

[2]

(b) Arteries transport blood away from the heart.

Explain how the structure of an artery is adapted to its function.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

4 Copper metal reacts with oxygen to form copper oxide, CuO.

(a) Write the balanced symbol equation for this reaction.

..... [2]

(b) A student investigates the reaction between excess copper metal and oxygen in air.

The student uses the apparatus shown in Fig. 4.1.

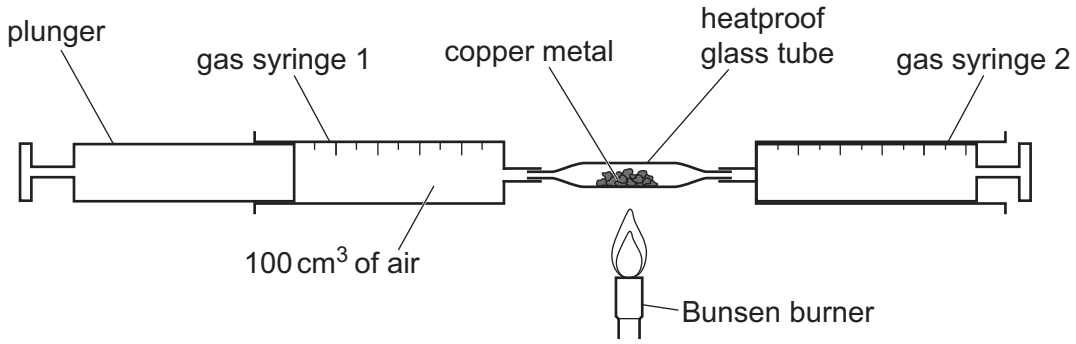


Fig. 4.1

There is initially 100 cm^3 of clean dry air inside gas syringe 1.

The student pushes the plunger on gas syringe 1 all the way in. Air moves over the hot copper metal into gas syringe 2. The plunger in gas syringe 2 moves outwards.

The student then pushes the plunger on gas syringe 2 all the way in. Air moves over the hot copper metal into gas syringe 1. The plunger in gas syringe 1 moves outwards.

The process is repeated until all the oxygen in the air has reacted with the copper.

Predict the total volume of air remaining in the gas syringes at the end of the reaction.

Give a reason for your answer.

volume of air = ... cm^3

reason .....

.....

[2]

(c) Fig. 4.2 is a reaction pathway diagram for a reaction catalysed by copper.

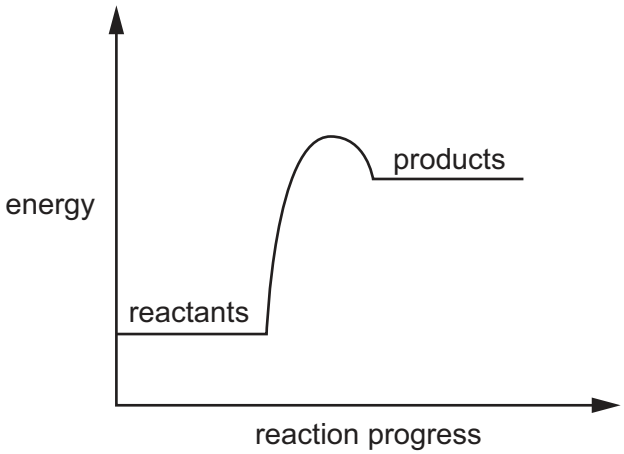


Fig. 4.2

(i) Identify the type of chemical reaction shown in Fig. 4.2.

Explain your answer.

type of chemical reaction .....

explanation .....

.....

.....

[2]

(ii) Draw an arrow on Fig. 4.2 to show the activation energy for this reaction. [1]

(iii) Define activation energy.

.....

.....

.....

..... [2]

(iv) Describe what is meant by a catalyst.

.....

.....

.....

..... [2]

[Total: 11]

5 **(a)** Fig. 5.1 shows the electrolysis of molten zinc chloride, $ZnCl_2$, using inert electrodes.

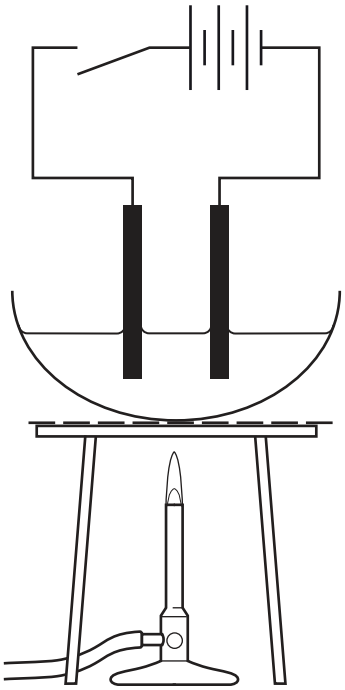


Fig. 5.1

(i) The switch is closed.

Describe the observation at the positive electrode.

.....

..... [1]

(ii) Write the ionic equation for the formation of zinc.

Include state symbols in your equation.

..... [2]

(b) A metal alloy contains metal **A** and metal **B**.

Fig. 5.2 shows an atom of metal **A** and an atom of metal **B**.

Fig. 5.2

(i) The alloy contains 80% of metal **A** and 20% of metal **B**.

Sketch a possible structure for this alloy in Fig. 5.3.

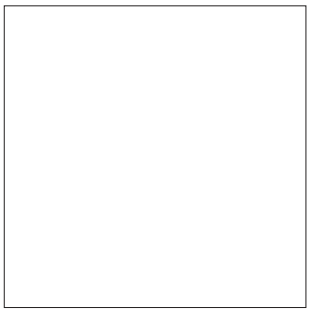


Fig. 5.3

[2]

(ii) This alloy is harder and stronger than pure metal **A** and pure metal **B**.

Explain in terms of structure why this alloy is harder and stronger.

.....

.....

.....

..... [2]

[Total: 7]

6 Fig. 6.1 shows the structure of ethene.

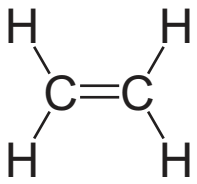


Fig. 6.1

(a) Tick (✓) **all** the statements that are true for ethene.

It is part of the alkane homologous series. ☐

It is formed by cracking large alkanes. ☐

It reacts with hydrogen to form ethane. ☐

It is a polymer. ☐

It decolourises aqueous bromine. ☐

[3]

(b) Complete the dot-and-cross diagram in Fig. 6.2 to show the bonding in an ethene molecule.

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

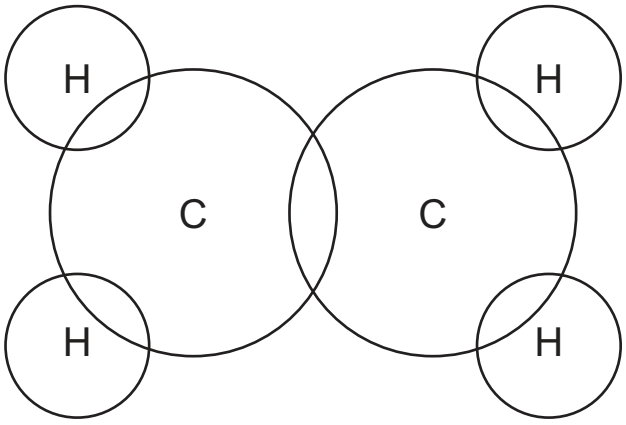


Fig. 6.2

[2]

(c) Complete the sentences about a reaction of ethene.

Ethene reacts with ..... to form ethanol.

This is an ..... reaction.

The reaction happens in the presence of an ..... catalyst.

[3]

[Total: 8]

7 A student rides a bicycle along a straight, level road.

(a) Fig. 7.1 shows the speed–time graph for part of the student's journey.

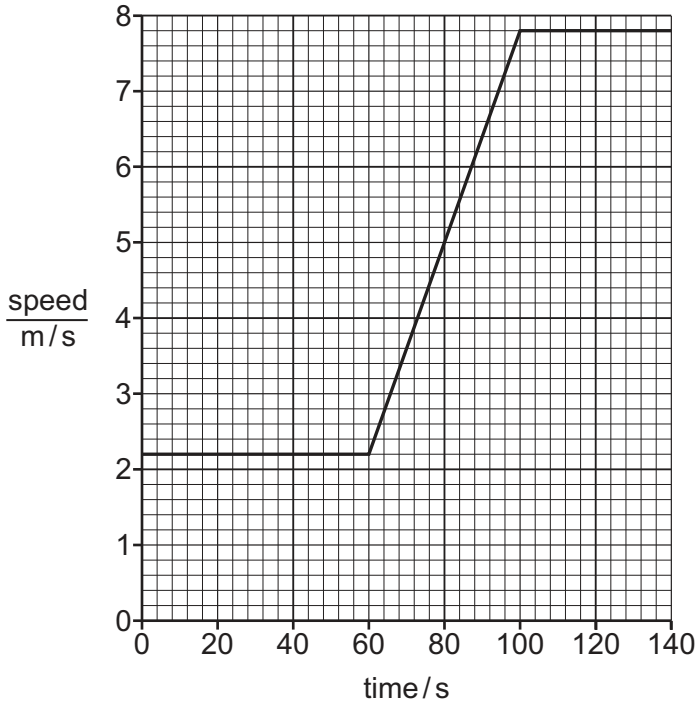


Fig. 7.1

(i) Define the acceleration of an object moving in a straight line.

.....

..... [1]

(ii) Determine the acceleration of the student between 60 s and 100 s.

Include the unit in your answer.

acceleration = ... unit ..... [3]

(b) The student throws a ball of mass 0.060 kg vertically upwards.

The kinetic energy of the ball as it leaves the student's hand is 0.15 J.

(i) Calculate the speed of the ball as it leaves the student's hand.

speed = ... m/s [2]

(ii) Calculate the maximum change in height Δh of the ball.

Ignore any air resistance acting on the ball.

Δh = ... m [3]

[Total: 9]

8 This question is about the transfer of thermal energy.

(a) An example of a material which is a good thermal conductor is copper.

(i) Complete the sentences about a **bad** thermal conductor.

An example of a material which is a bad thermal conductor is

..... .

A bad thermal conductor is called a thermal ..... .

[2]

(ii) Copper is a metal.

Describe **two** ways that thermal energy is transferred in a metal.

1 .....

.....

2 .....

.....

[3]

(b) Thermal energy is transferred from the Sun to the Earth by infrared radiation with a frequency of 410 GHz.

The speed of infrared radiation in space is 3.0×10^8 m/s.

Calculate the wavelength of the infrared radiation.

wavelength = ... m [3]

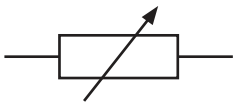
[Total: 8]

9 **(a)** Complete the definition of potential difference (p.d.).

Potential difference (p.d.) is the work done by a unit ..... moving between two points in a circuit.

[1]

(b) State the names of the electrical components with the symbols shown.



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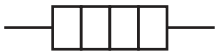

.....

[2]

(c) A student assembles the circuit shown in Fig. 9.1.

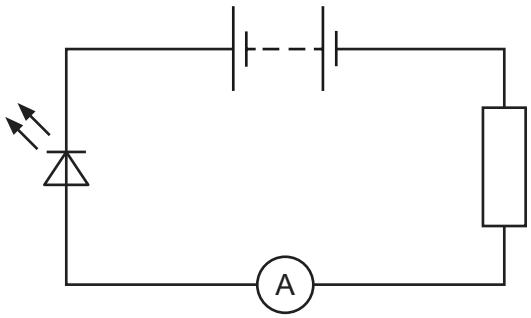

Fig. 9.1

The student makes an error in the assembly of the circuit.

The light-emitting diode (LED) does not emit light and the ammeter shows there is no current in the circuit.

Identify the error in the assembly of the circuit.

.....

..... [1]

(d) Two wires, **A** and **B**, are made of the same metal.

Wire **A** has length 2.5 m, diameter 0.75 mm and resistance 0.16 Ω.

Wire **B** has length 7.5 m and diameter 1.5 mm.

Calculate the resistance of wire **B**.

resistance = ... Ω [3]

(e) A satellite orbits the Earth with an orbital speed of 7800 m / s and an orbital period of 5400 s.

The radius of the Earth is 6.38×10^6 m.

Calculate the distance of the satellite above the Earth's surface.

distance = ... m [3]

[Total: 10]

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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.).