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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4200621103

COMBINED SCIENCE **0653/42**

Paper 4 Theory (Extended) **February/March 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.

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1 **(a)** Fig. 1.1 shows a food web from land owned by one farmer.

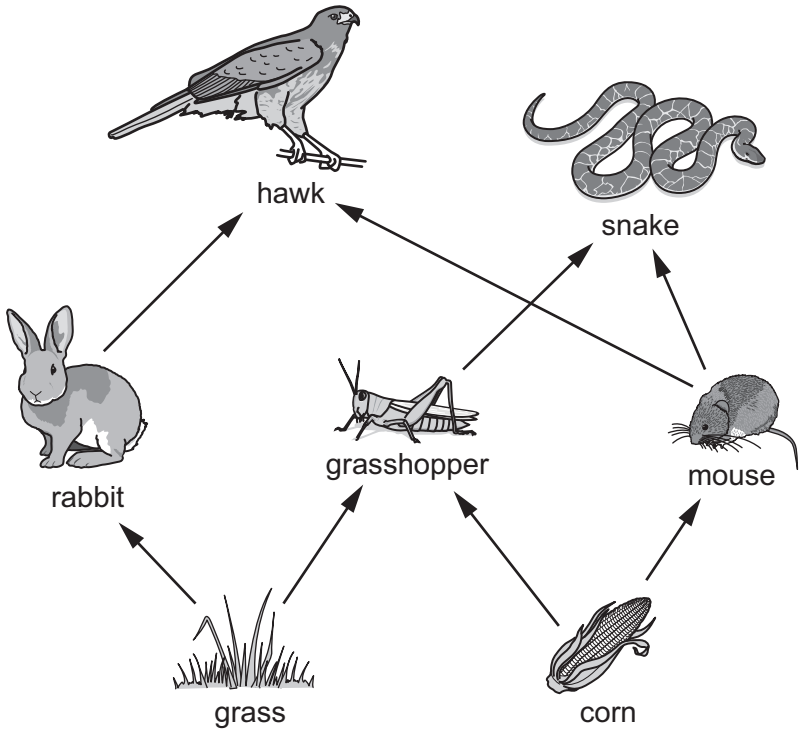


Fig. 1.1

(i) Identify **one** secondary consumer in Fig. 1.1.

..... [1]

(ii) One year, the farmer grows only corn on the land and **no** grass.

Use Fig. 1.1 to describe impacts on **two** different consumers in the food web.

1 .....

.....

2 .....

.....

[2]

(b) Hawks are an endangered species in some countries.

Describe **two** ways to conserve endangered species.

1 .....

.....

2 .....

.....

[2]

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(c) Corn is a principal dietary source of the carbohydrate starch.

(i) Complete these sentences about the chemical digestion of starch.

Starch is broken down by the enzyme ..... .

The products of starch digestion are simple ..... sugars.
[2]

(ii) Explain why starch needs to be digested before it is absorbed.

.....

..... [1]

[Total: 8]

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2 **(a)** Fig. 2.1 is a diagram of the structure of the human heart.

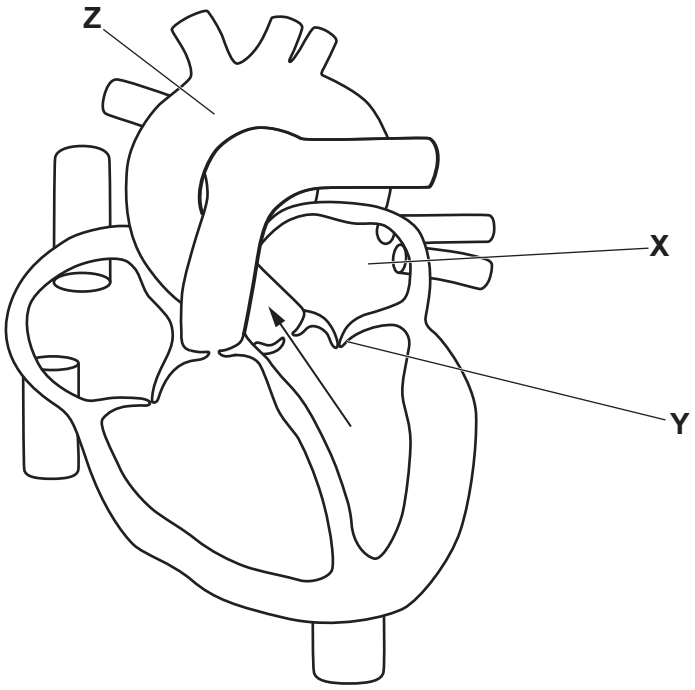


Fig. 2.1

(i) Identify the parts labelled **X** and **Y** on Fig. 2.1.

X .....

Y .....

[2]

(ii) The arrow in Fig. 2.1 shows the direction of blood flow out of the heart.

Explain how the part labelled **Z** is adapted to its function.

.....

.....

..... [2]

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(b) The heart rate of a person is measured before, during and after running a race.

Table 2.1 shows the results.

Table 2.1

time / minutes	heart rate / beats per minute (bpm)
0	65
1	65
2	64
3	83
4	116
5	125
6	129
7	132
8	133
9	115
10	89
11	75
12	68
13	65
14	65

(i) Describe how the data in Table 2.1 shows the race started after two minutes.

.....

..... [1]

(ii) Calculate the percentage increase from the lowest heart rate to the highest heart rate in Table 2.1.

percentage increase = ... [2]

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(iii) Explain the results between **10** and **14** minutes in Table 2.1.

.....

.....

.....

.....

..... [3]

(c) Blood produces antibodies in response to infections by pathogens.

State the component of blood that produces antibodies.

..... [1]

[Total: 11]

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3 **(a)** Fig. 3.1 shows a cross-section of a leaf.

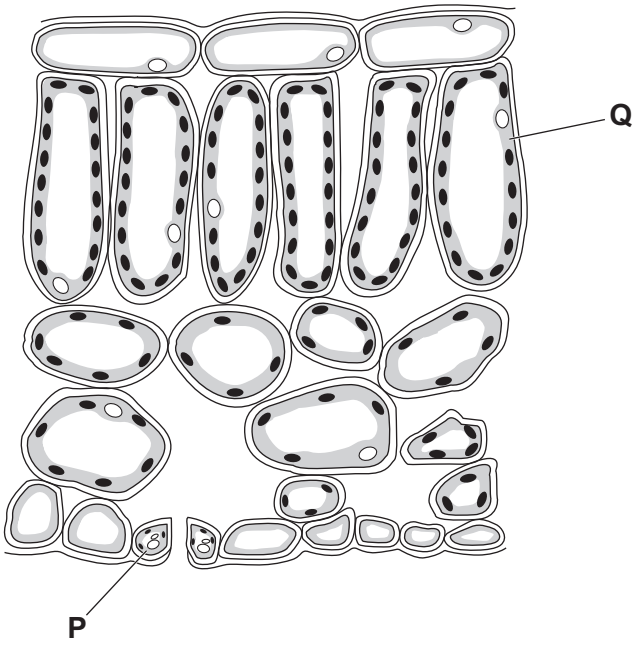


Fig. 3.1

(i) Name the type of cell labelled **P** in Fig. 3.1.

..... [1]

(ii) The cell labelled **Q** is specialised for a specific function.

State the function of the cell labelled **Q**.

..... [1]

(b) Root hair cells take in water and mineral ions from the soil.

Root hair cells are adapted for the uptake of mineral ions by having high numbers of mitochondria in their cytoplasm.

Explain why large numbers of mitochondria are important for the uptake of mineral ions.

.....

.....

.....

.....

..... [3]

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(c) Fig. 3.2 is a diagram of a plant cell that has been immersed in a sugar solution.

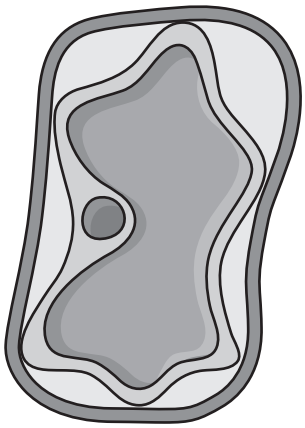


Fig. 3.2

Complete these sentences about the cell in Fig. 3.2.

Water has left the cell because the sugar solution has a lower

water ..... than that of the cell.

The loss of water reduces the ..... pressure inside the cell.

The cell membrane moves away from the cell wall and the cell becomes

..... .

[3]

[Total: 8]

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4 **(a)** Sodium is in Group I of the Periodic Table.

Copper is a transition element.

(i) Describe the observations when sodium and copper are added separately to cold water.

sodium .....

.....

copper .....

.....

[2]

(ii) State how the appearance of most copper compounds is different from the appearance of most sodium compounds.

.....

..... [1]

(iii) Table 4.1 shows information about some compounds of sodium and copper.

Table 4.1

name	metal ion in compound	formula
sodium oxide	Na^+	Na_2O
copper(II) oxide	Cu^{2+}	.....
sodium chloride	Na^+	.....
copper(II) chloride	Cu^{2+}	$CuCl_2$

Complete Table 4.1. [2]

(b) Most metals have high melting points and high boiling points.

State **two** other physical properties of most metals.

1 .....

2 .....

[2]

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(c) Gold alloys are used to make jewellery.

Fig. 4.1 shows the arrangement of atoms in a gold alloy.

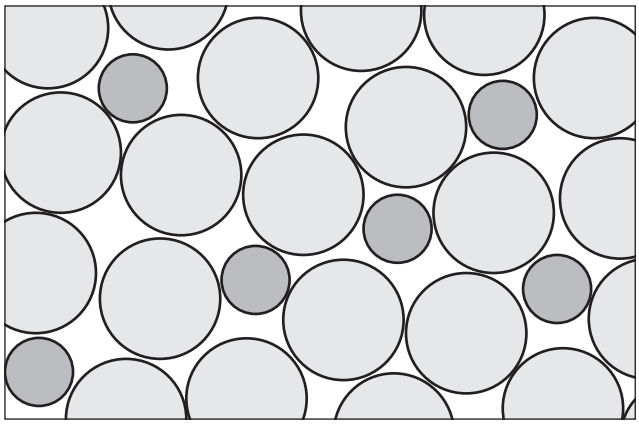


Fig. 4.1

(i) Explain why Fig. 4.1 represents an alloy.

.....

..... [1]

(ii) Gold alloys cost less than pure gold.

State **one** other reason why gold alloys are used to make jewellery.

.....

..... [1]

[Total: 9]

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5 The reaction between aluminium and iron(III) oxide is used to join iron railway lines together.

$$2Al(s) + Fe_2O_3(s) \rightarrow 2Fe(l) + Al_2O_3(s)$$

Molten iron is produced in the reaction. Molten iron becomes solid when it cools.

(a) (i) State how the equation shows that **molten** iron is produced.

..... [1]

(ii) Use the equation to explain why this reaction is a redox reaction.

.....

.....

..... [2]

(iii) Complete the ionic equation for this reaction.

$$Al + Fe^{3+} \rightarrow \text{.....} + \text{.....}$$ [2]

(b) Explain the meaning of the symbol (III) in iron(III) oxide.

.....

..... [1]

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(c) The reaction between aluminium and iron(III) oxide is exothermic.

A flame is used to provide the activation energy to start the reaction.

Fig. 5.1 shows the incomplete reaction pathway diagram for this 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.

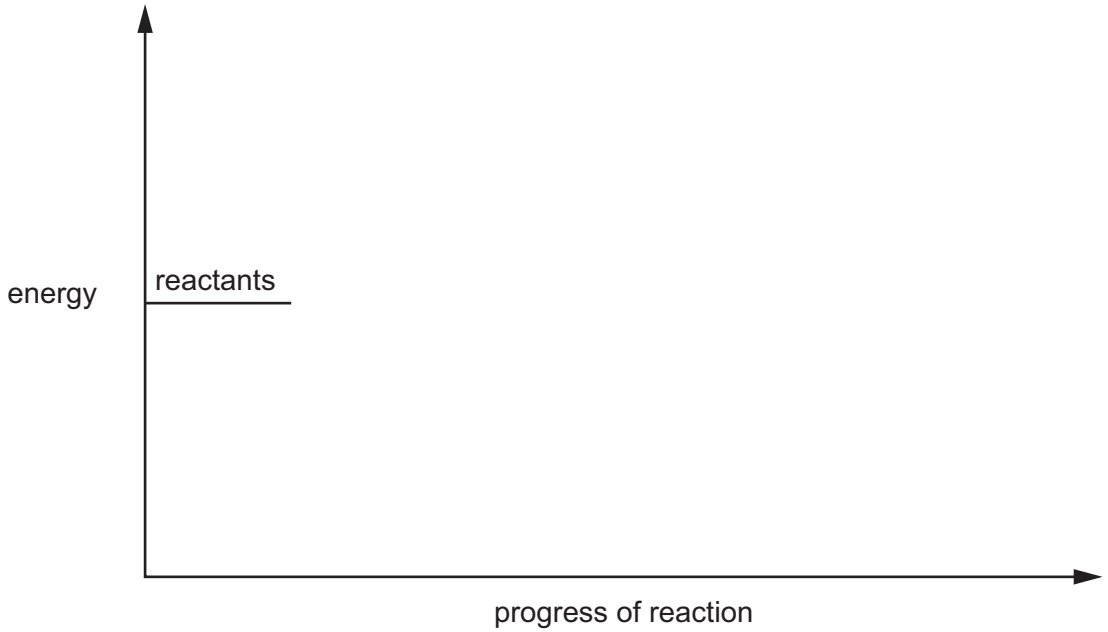


Fig. 5.1

[3]

[Total: 9]

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6 **(a)** Poly(ethene) is a polymer made from alkene monomers.

(i) State the type of polymerisation reaction that forms poly(ethene) from its monomers.

..... [1]

(ii) State the formula of the monomer used to make poly(ethene).

..... [1]

(b) Name the process that produces alkenes from larger alkanes.

..... [1]

(c) Table 6.1 shows statements about alkanes and alkenes.

Put a tick (✓) in **one** box in each row to show whether each statement is true for alkanes only, true for alkenes only, or true for both.

Table 6.1

	true for alkanes only	true for alkenes only	true for both
Four electrons are shared in a bond between two carbon atoms.			
The group of compounds have the same general formula.			
Complete combustion gives carbon dioxide and water.			
Adding aqueous bromine gives a colourless solution.			

[3]

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(d) Alkenes react with steam.

Alkenes also react with hydrogen.

Both reactions use a catalyst.

(i) State the type of catalyst used in the reaction of alkenes with steam.

..... [1]

(ii) Name the catalyst used in the reaction of alkenes with hydrogen.

..... [1]

[Total: 8]

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7 An electric motor is connected to a battery.

The motor lifts an object through a vertical distance of 0.36 m, as shown in Fig. 7.1.

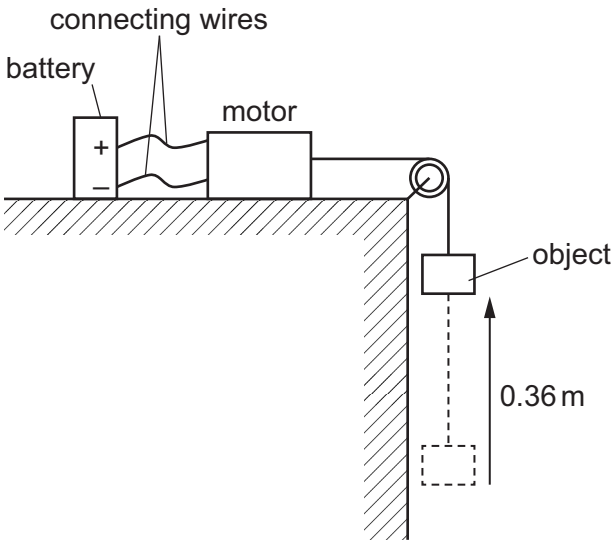


Fig. 7.1

(a) Fig. 7.2 shows a speed–time graph for the motion of the object.

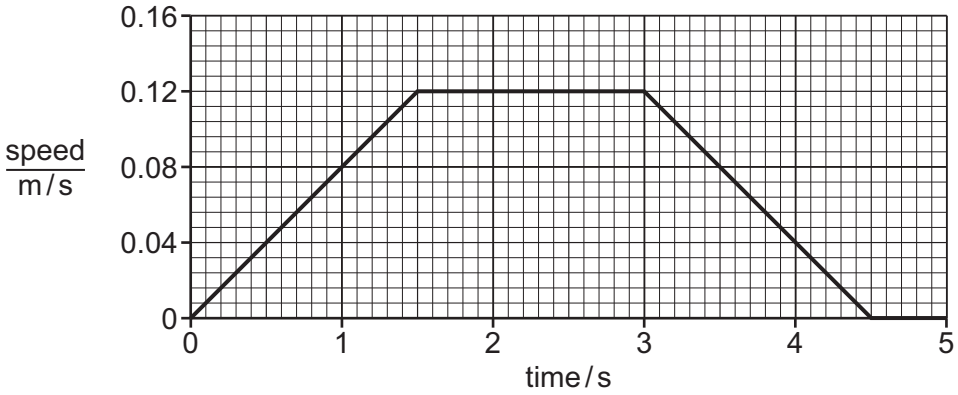


Fig. 7.2

(i) Describe the motion of the object between 1.5 s and 3.0 s.

..... [1]

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(ii) Determine the acceleration of the object between 3.0 s and 4.5 s.

acceleration = ... m/s^2 [3]

(iii) Use Fig. 7.2 to show that the object is lifted through a vertical distance of 0.36 m.

[2]

(b) The object has a mass of 130 g.

Calculate the change in gravitational potential energy ΔE_P of the object.

ΔE_P = ... J [3]

[Total: 9]

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8 Fig. 8.1 shows a helicopter hovering above the ground.

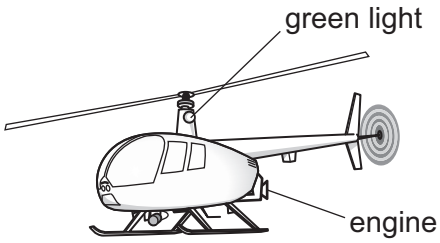


Fig. 8.1

(a) The helicopter has a green light.

State a colour in the visible spectrum that has a shorter wavelength than green light.

..... [1]

(b) The helicopter transmits a radio signal vertically down to the ground below.

The signal is reflected vertically upwards from the ground.

The signal is received by the helicopter 3.3×10^{-6} s after it is transmitted.

Calculate the height of the helicopter above the ground.

height = ... m [4]

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(c) The engine of the helicopter contains pistons and cylinders.

Fig. 8.2 shows a piston moving down a cylinder containing gas.

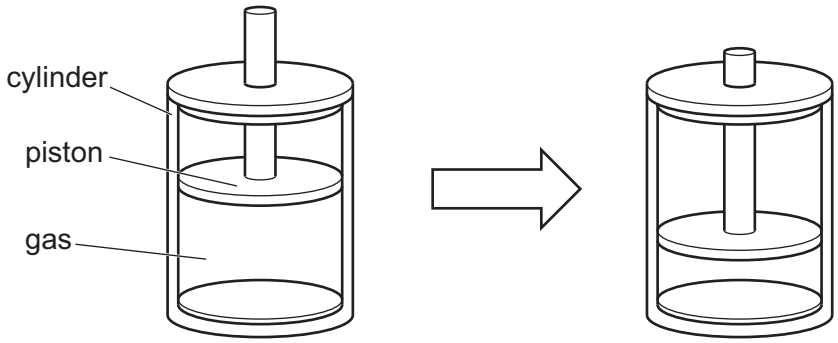


Fig. 8.2

(i) Complete the sentences about the process shown in Fig. 8.2.

The piston is pushed down. This causes the ..... of the gas to decrease. The gas remains at constant temperature. The pressure of the gas increases.

[1]

(ii) Explain why the force exerted by the gas on the bottom of the cylinder increases.

Use ideas about particles in your answer.

.....

.....

.....

.....

..... [3]

[Total: 9]

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9 Fig. 9.1 shows a satellite.

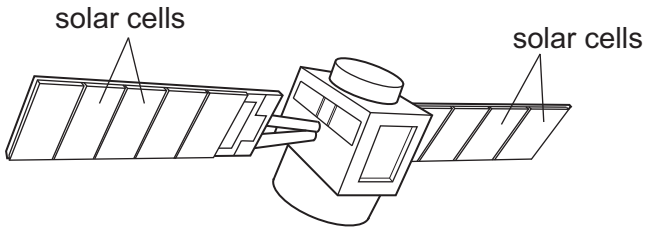


Fig. 9.1

(a) The satellite contains batteries that are charged using energy from the Sun.

(i) Complete the following sentences about energy.

Energy is released in the Sun by the process of ....

Energy from the Sun is transferred through space by electromagnetic radiation to the solar cells of the satellite.

The energy provided by the solar cells is in the .....

energy store in the batteries of the satellite.

[2]

(ii) The power input per square metre to the solar cells is 1800 W / m^2.

The total area of the solar cells on the satellite is 12 m^2.

The useful power output from the solar cells is 3900 W.

Calculate the efficiency of the solar cells.

efficiency = ...% [3]

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(b) Fig. 9.2 shows a circuit diagram for an electrical circuit on the satellite.

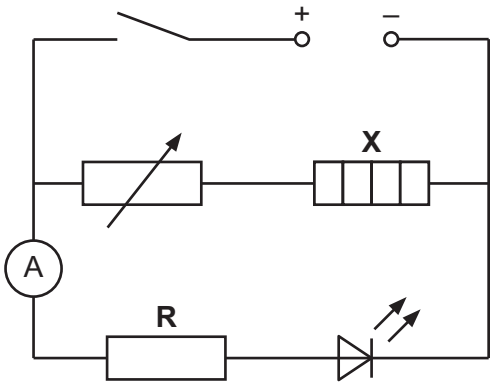


Fig. 9.2

The circuit uses a 6.0 V direct current (d.c.) power supply.

When the circuit is switched on, both the light-emitting diode (LED) and component **X** work.

(i) State the name of component **X**.

..... [1]

(ii) The potential difference (p.d.) across the LED is 1.2 V.

Determine the p.d. across fixed resistor **R**.

p.d. = ... V [1]

(iii) The reading on the ammeter is 15 mA.

Use your answer to **(b)(ii)** to calculate the resistance of fixed resistor **R**.

resistance = ... Ω [2]

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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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