Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

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COMBINED SCIENCE **0653/42**

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.

DC (DE/JG) 351868/2

[Turn over

1 **(a)** Fig. 1.1 is a diagram of a cross-section through a leaf.

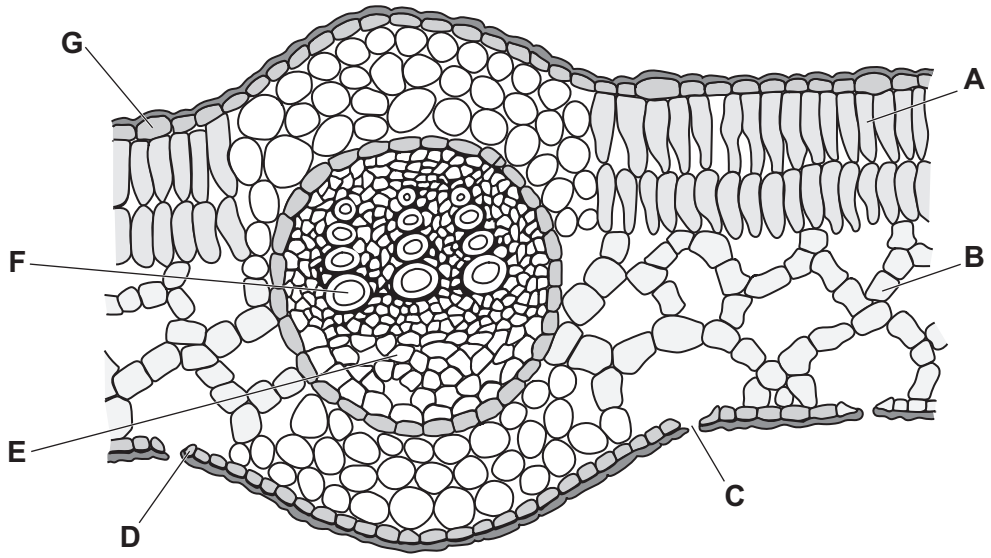


Fig. 1.1

State the letter on Fig. 1.1 that identifies one of the:

stomata .....

spongy mesophyll cells .....

cells that transport sucrose. .....

[3]

(b) Plants produce carbohydrates by the process of photosynthesis.

State the balanced symbol equation for photosynthesis.

..... [2]

(c) Fig. 1.2 is a graph showing the effect of temperature on the rate of photosynthesis in a plant.

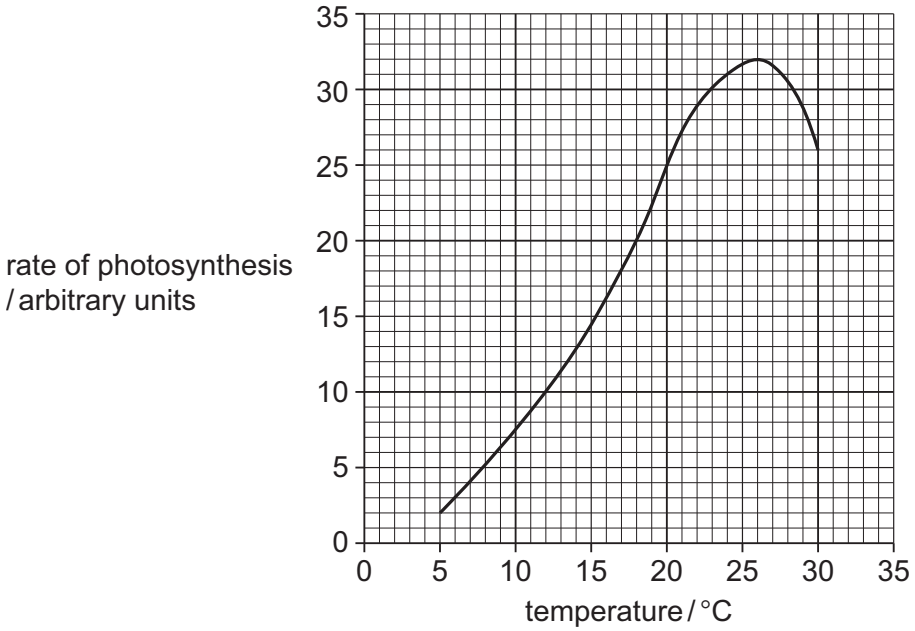


Fig. 1.2

(i) Calculate the difference in the maximum and minimum rates of photosynthesis shown in Fig. 1.2.

difference in rates of photosynthesis = ... arbitrary units [2]

(ii) Enzymes are involved in photosynthesis.

Explain the shape of the graph between 10 °C and 15 °C shown in Fig. 1.2.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

2 **(a)** Fig. 2.1 is a diagram of a bacterial cell.

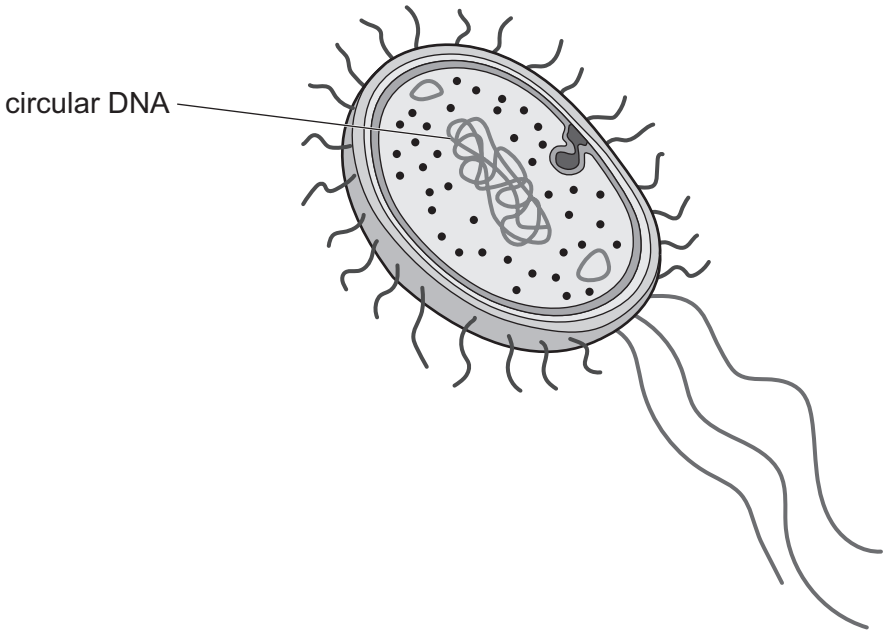


Fig. 2.1

(i) Circular DNA provides the code for the production of proteins in protein synthesis.

On Fig. 2.1:

- draw a label line to identify a structure that is the **site** of protein synthesis
- label the line with the name of this structure.

[2]

(ii) Respiration and protein synthesis are linked.

Complete the sentences.

Protein synthesis requires ..... from respiration.

Respiration is a chemical reaction in cells that breaks down

..... molecules.

[2]

(iii) The list shows some cell structures that are **not** found in bacterial cells.

chloroplasts **mitochondria** **nuclei** **vacuoles**

Use **one** word from the list to complete the sentence.

In animal and plant cells, aerobic respiration takes place in structures called

..... .

[1]

(b) Some bacteria cause diseases.

(i) Describe how platelets in the blood help prevent bacterial infection.

.....

.....

.....

..... [2]

(ii) Explain why some treatments of bacterial infections have become less effective.

.....

.....

.....

..... [2]

(c) Providing a clean water supply helps reduce the spread of diseases.

State **two** other ways to reduce the spread of diseases.

1 .....

.....

2 .....

.....

[2]

[Total: 11]

3 Fig. 3.1 shows a food web from a grassland habitat.

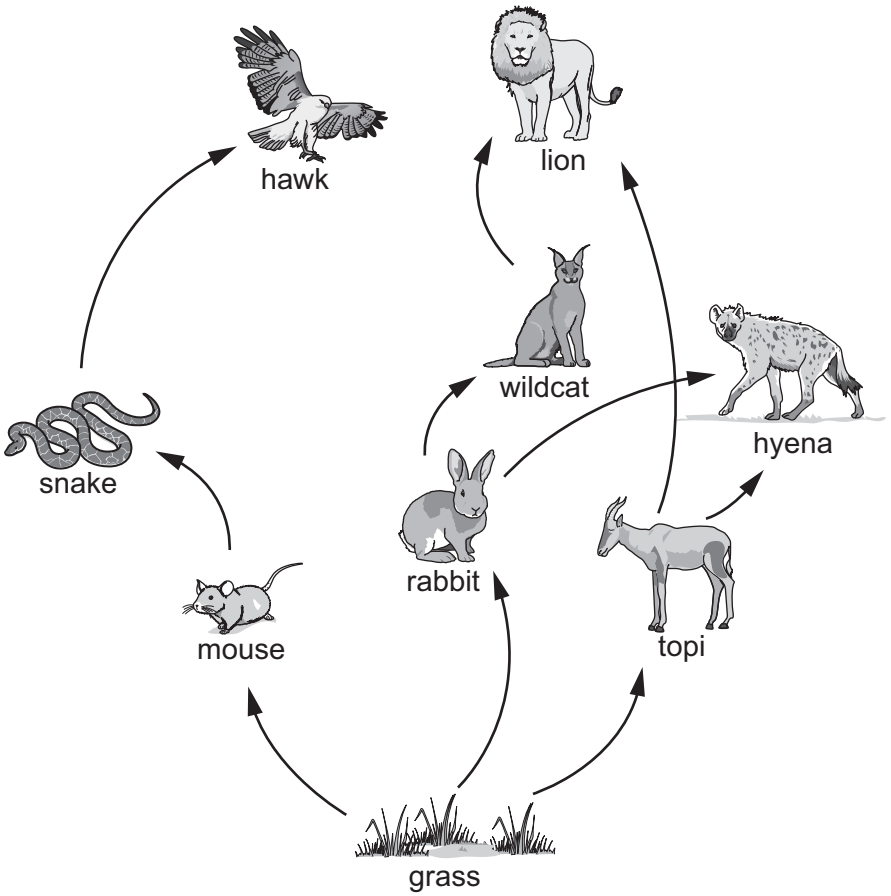


Fig. 3.1

(a) The food web in Fig. 3.1 is **not** complete.

The hawk also eats the mouse and the rabbit.

(i) Complete the food web in Fig. 3.1. [1]

(ii) Identify **one** herbivore in Fig. 3.1.

..... [1]

(b) People living near the grassland habitat burn areas of grassland to clear the ground for growing crops.

Replacing grassland with crops is causing the lions in the area to become endangered.

(i) Use information from Fig. 3.1 to explain why the lions are becoming endangered.

.....

.....

.....

..... [2]

(ii) Captive breeding programmes are one method of conserving endangered species.

State what is meant by a captive breeding programme.

.....

.....

.....

..... [2]

[Total: 6]

4 **(a)** A student investigates the reaction between aqueous sodium hydroxide, NaOH, and dilute hydrochloric acid, HC*l*.

The apparatus is shown in Fig. 4.1.

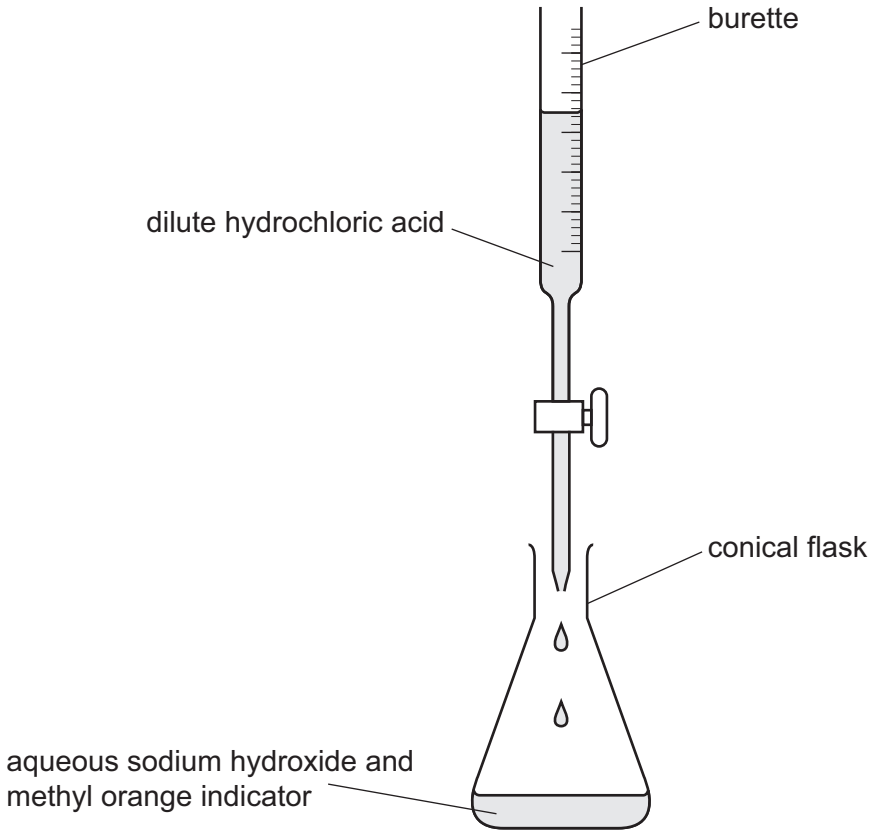


Fig. 4.1

(i) Write the balanced symbol equation for the reaction shown in Fig. 4.1.

Include state symbols.

..... [2]

(ii) State the colour change of the methyl orange indicator during this reaction.

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

(iii) Tick (✓) **all** the statements that are true for aqueous sodium hydroxide.

It is a covalent substance. ☐

It turns universal indicator purple. ☐

It reacts with dilute sulfuric acid to form sodium sulfate. ☐

It is a base but **not** an alkali. ☐

[2]

(b) The reaction between aqueous sodium hydroxide and dilute hydrochloric acid transfers thermal energy to the surroundings.

(i) Give **one** conclusion about the energy involved in bond breaking and bond making in this reaction.

.....

..... [1]

(ii) Complete Fig. 4.2 to show the reaction pathway diagram for this reaction.

Label:

- the reactants and products
- the overall energy change using an arrow.

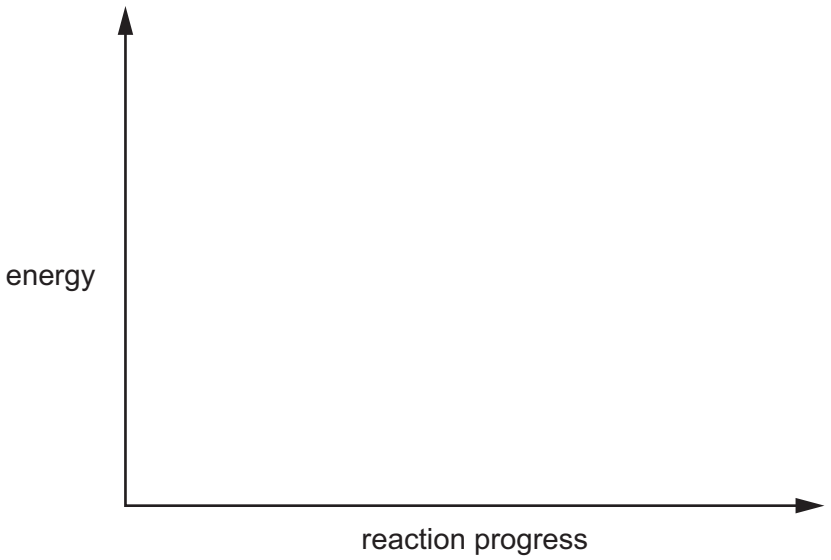


Fig. 4.2

[3]

[Total: 10]

5 **(a)** Iron is extracted from hematite in the blast furnace.

During the extraction, carbon monoxide is formed.

(i) Describe how carbon monoxide is formed in the blast furnace.

.....

.....

.....

.....

.....

..... [3]

(ii) The carbon monoxide reacts with iron(III) oxide to form iron and carbon dioxide.

Write the balanced symbol equation for this reaction.

..... [2]

(b) **(i)** Complete the dot-and-cross diagram in Fig. 5.1 to show the bonding in a carbon dioxide molecule.

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

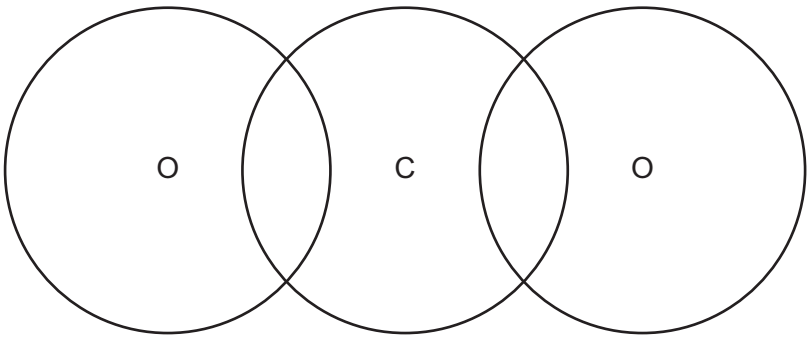


Fig. 5.1

[2]

(ii) Carbon dioxide is a greenhouse gas that contributes to climate change.

State **two** strategies to reduce the effects of climate change.

1 .....

2 .....

[2]

[Total: 9]

6 **(a)** Fig. 6.1 shows the structures of ethene and ethane.

ethene **ethane**

Fig. 6.1

(i) Organic compounds in the same homologous series as ethene have the general formula C_nH_{2n}.

Deduce the general formula for the homologous series to which **ethane** belongs.

..... [1]

(ii) Name the homologous series to which ethene belongs and to which ethane belongs.

ethene .....

ethane .....

[1]

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

Ethene reacts with ..... to form ethane.

This reaction is an ..... reaction.

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

[3]

(c) Fig. 6.2 shows the structure of butane.

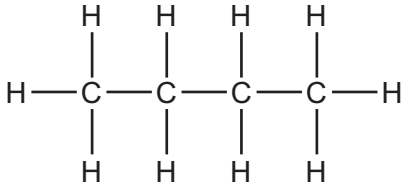


Fig. 6.2

Butane and ethane are in the same homologous series.

The boiling point of ethane is –88 °C.

Predict the boiling point of butane.

Give a reason for your answer.

boiling point ..... °C

reason .....

.....

[2]

[Total: 7]

7 A toy car contains a battery and an electric motor.

(a) Fig. 7.1 shows the speed–time graph for the toy car moving along a level surface.

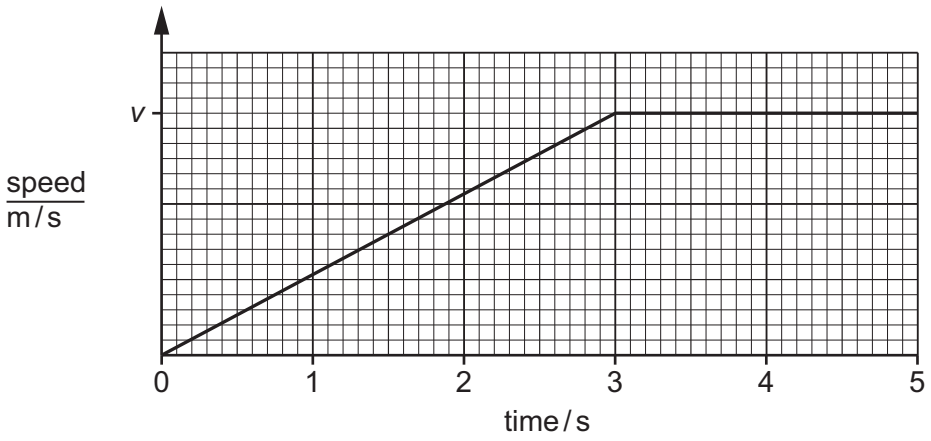


Fig. 7.1

(i) Identify **one** energy store of the toy car that decreases between 0 and 3 s.

..... [1]

(ii) Use Fig. 7.1 to identify **one** energy store of the toy car that increases between 0 and 3 s.

..... [1]

(iii) State which feature of the speed–time graph represents the acceleration of the toy car.

Explain your answer.

feature .....

explanation .....

.....

[2]

(iv) The toy car travels a total distance of 5.6 m in a time of 5.0 s.

Determine the maximum speed v of the toy car.

v = ... m / s [2]

(b) The toy car now moves from the top to the bottom of the slope shown in Fig. 7.2.

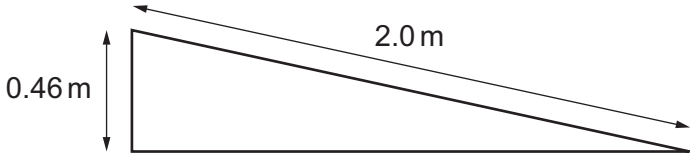


Fig. 7.2

The slope has a length of 2.0 m and a vertical height of 0.46 m.

The mass of the toy car is 72 g.

Calculate the change in the gravitational potential energy of the toy car.

change in gravitational potential energy = ... J [3]

[Total: 9]

8 **(a)** A student uses the apparatus shown in Fig. 8.1 to investigate the transfer of thermal energy by radiation.

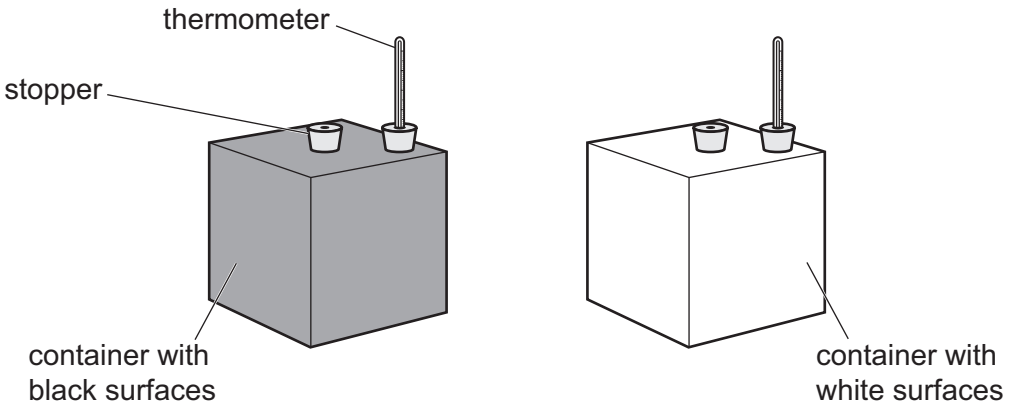


Fig. 8.1

The two containers are identical in size and made from the same material.

One container has only black surfaces, and the other container has only white surfaces.

The student has access to hot water.

Describe how the student uses this apparatus to determine whether a black surface or a white surface is a better emitter of thermal radiation.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) (i) Explain why energy is transferred through space from the Sun to the Earth by radiation but **not** by conduction or convection.

.....

.....

..... [2]

(ii) Complete Fig. 8.2 to show the stages in the life cycle of a small mass star like the Sun.

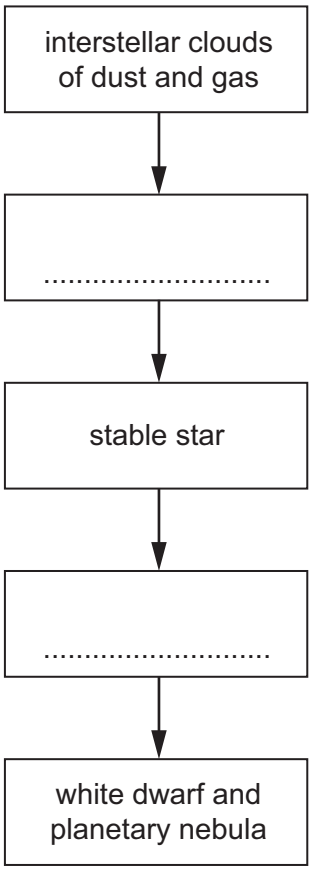


Fig. 8.2

[2]

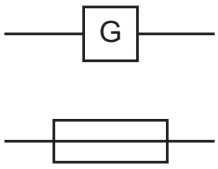
(iii) A supernova is part of the life cycle of a large mass star.

State what may form from the nebula after a supernova.

..... [1]

[Total: 8]

9 **(a)** State the names of the electrical components with the symbols shown.



.....

.....

[2]

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

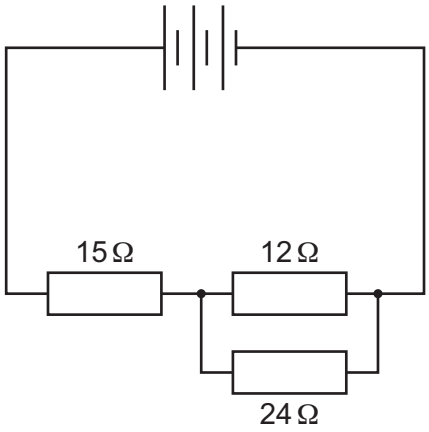


Fig. 9.1

The battery has an electromotive force (e.m.f.) of 9.0 V.

(i) Define e.m.f.

.....

.....

..... [2]

(ii) Calculate the combined resistance of the three resistors in the circuit.

resistance = ... Ω [3]

(c) A student stands in front of a vertical plane mirror of length 40 cm, as shown in Fig. 9.2.

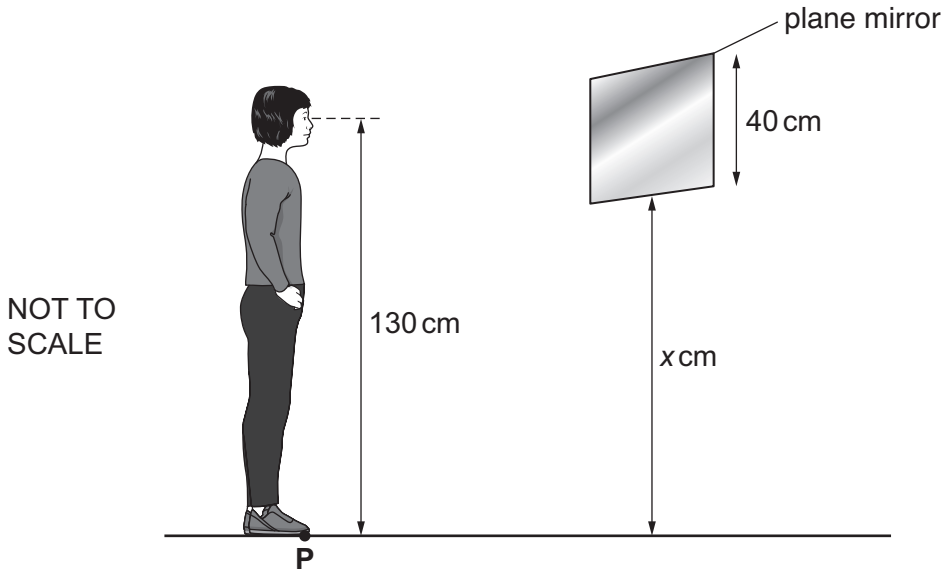


Fig. 9.2

The vertical position of the mirror can be adjusted.

- **P** is a point on the ground that is vertically below the student's eyes.
- The vertical distance between the student's eyes and point **P** is 130 cm.
- The vertical distance between the bottom of the mirror and the ground is *x* cm.

Determine the **smallest** value of *x* at which it is possible for the student to see point **P** in the mirror.

x = ... cm [3]

[Total: 10]

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.).