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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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COMBINED SCIENCE **0653/41**

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.

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1 **(a)** Figure 1.1 shows part of the human digestive system.

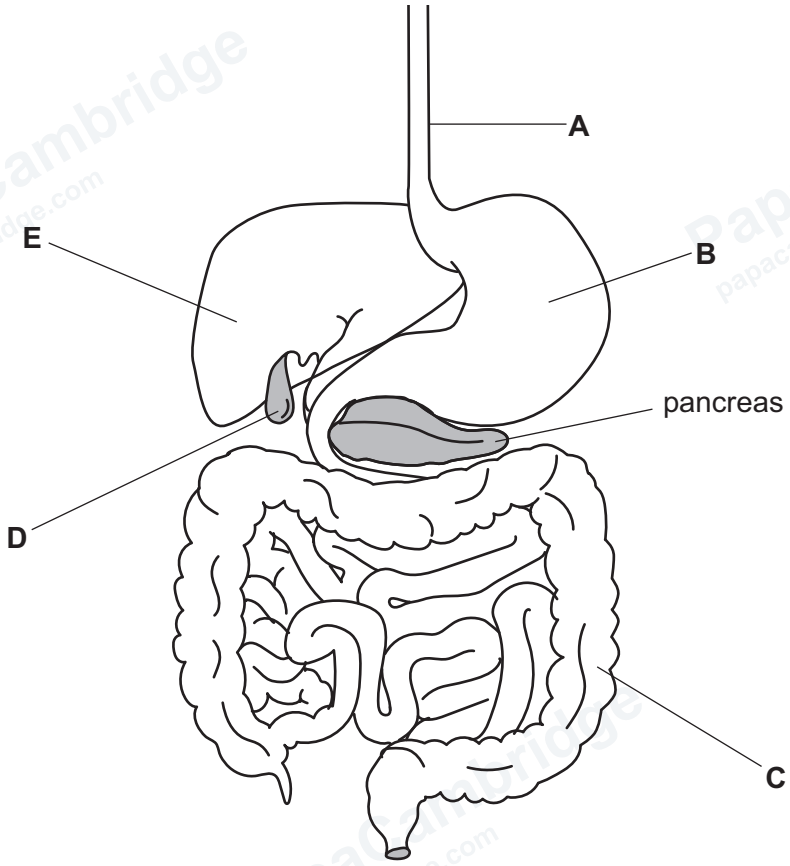


Figure 1.1

(i) State the letter on Figure 1.1 that identifies:

the liver .....

where water is absorbed from undigested food .....

where hydrochloric acid is used to kill harmful microorganisms. .....

[3]

(ii) The pancreas produces amylase.

Name the large molecule amylase digests and the product of this digestion.

large molecule .....

product .....

[2]

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(b) Figure 1.2 is a graph showing the effect of temperature on amylase activity.

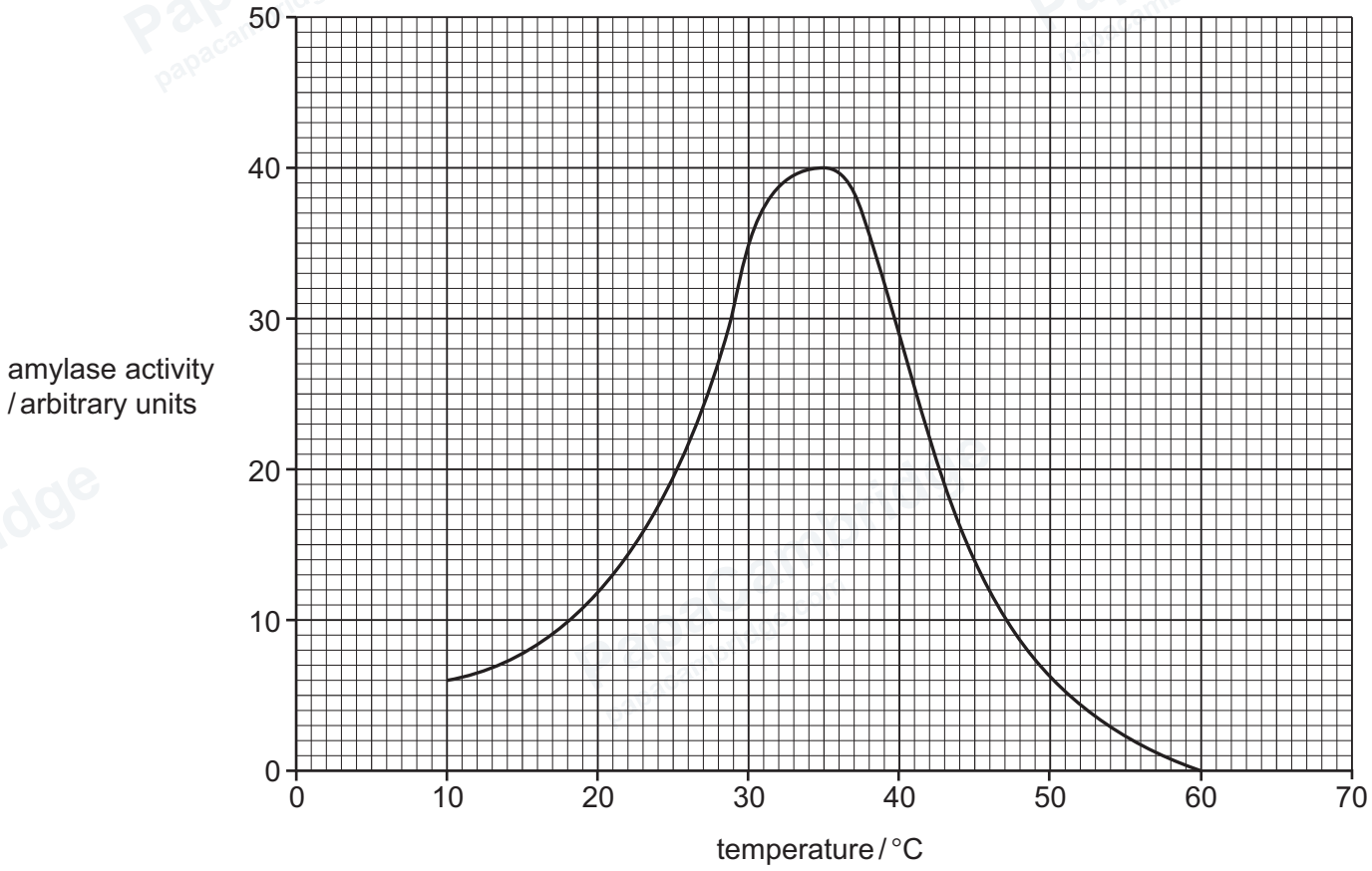


Figure 1.2

(i) Identify the optimum temperature for amylase shown in Figure 1.2.

..... [1]

(ii) Explain the effect of increasing the temperature from **10 °C** to **30 °C** on the amylase activity shown in Figure 1.2.

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

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2 **(a)** Figure 2.1 shows apparatus used to measure water loss from a plant.

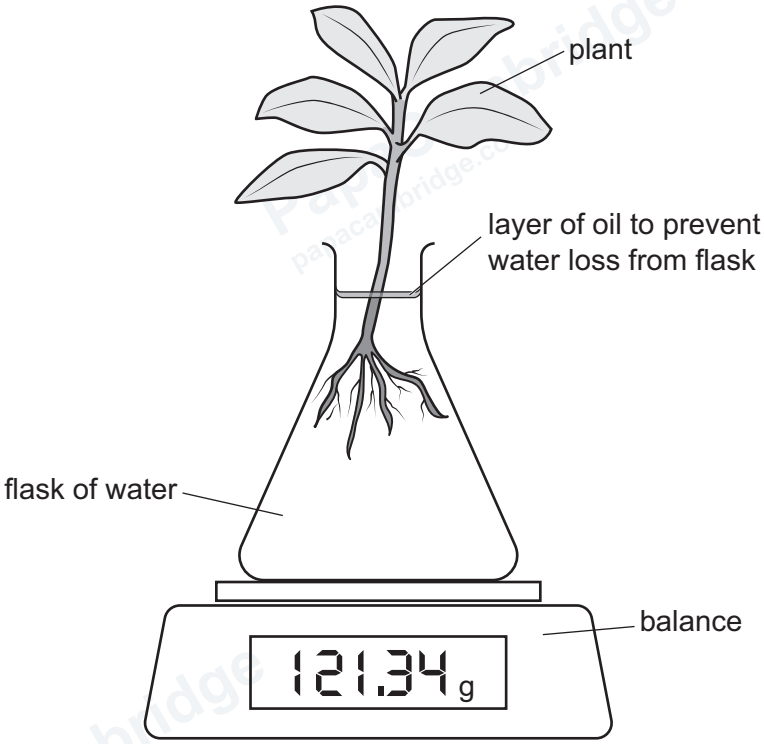


Figure 2.1

The plant is left in a warm room for 20 minutes and the change in mass is calculated.
The procedure is repeated in the same room with an electric fan turned on next to the plant to increase the wind speed.

Table 2.1 shows the results.

Table 2.1

conditions	mass at start / g	mass at end of 20 minutes / g	change in mass / g	rate of water loss / g per minute
no electric fan	121.34	119.56	1.78	0.09
electric fan turned on	119.56	115.23		

(i) Use Table 2.1 to calculate the rate of water loss with the electric fan turned on.

rate of water loss = ... g per minute [2]

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(ii) Increasing wind speed affects the rate of water loss from a plant.

State **one** other environmental condition that has the same effect as increasing wind speed.

..... [1]

(b) Complete these sentences about water movement through a plant.

Water moves from the soil into root ..... cells.

The water then moves through root cortex cells to ..... vessels.

These vessels transport the water to the leaves.

In the leaves, water moves from the vessels into ..... cells.

[3]

(c) Water is used in the process of photosynthesis.

(i) State the balanced symbol equation for photosynthesis.

..... [2]

(ii) Name the specialised leaf cells adapted for photosynthesis.

..... [1]

[Total: 9]

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3 **(a)** A person is given a vaccination for a disease.
A few weeks later the person is infected by the pathogen that causes this disease.

Figure 3.1 shows how the concentration of antibodies in the person's blood changes in response to the vaccination and in response to infection by the pathogen.

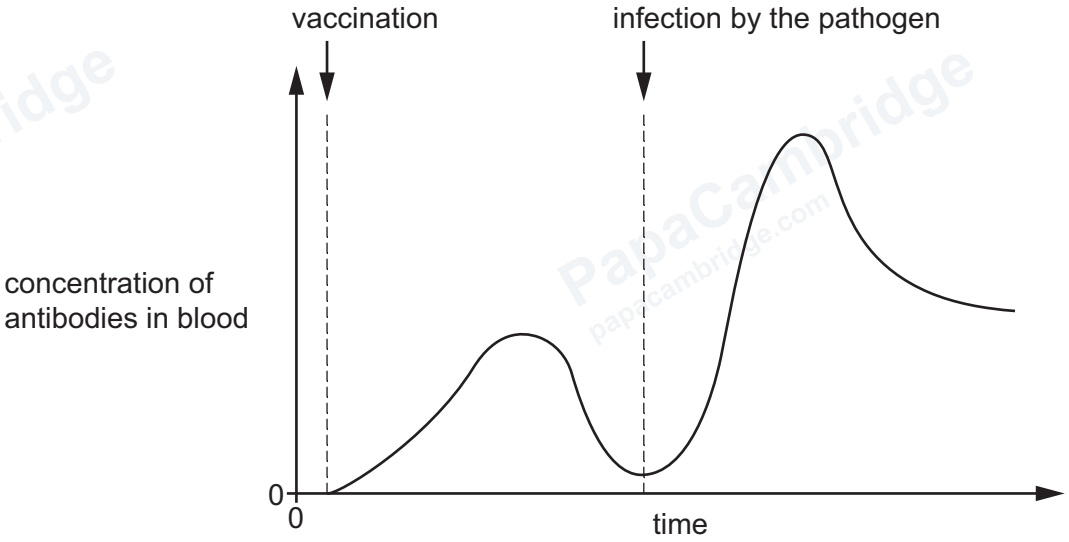


Figure 3.1

Compare these changes in response shown in Figure 3.1.

.....

.....

.....

.....

.....

..... [3]

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(b) Bacterial infections are treated with a type of drug.

Explain why it is important to only use this type of drug when essential.

.....

.....

.....

.....

.....

..... [3]

(c) A balanced diet helps reduce the risk of coronary heart disease.

(i) State **one** other way of reducing the risk of coronary heart disease.

..... [1]

(ii) Explain why eating plenty of fruit and vegetables as part of a balanced diet is important.

.....

.....

..... [2]

[Total: 9]

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4 **(a)** Figure 4.1 shows apparatus used for the electrolysis of molten magnesium chloride.

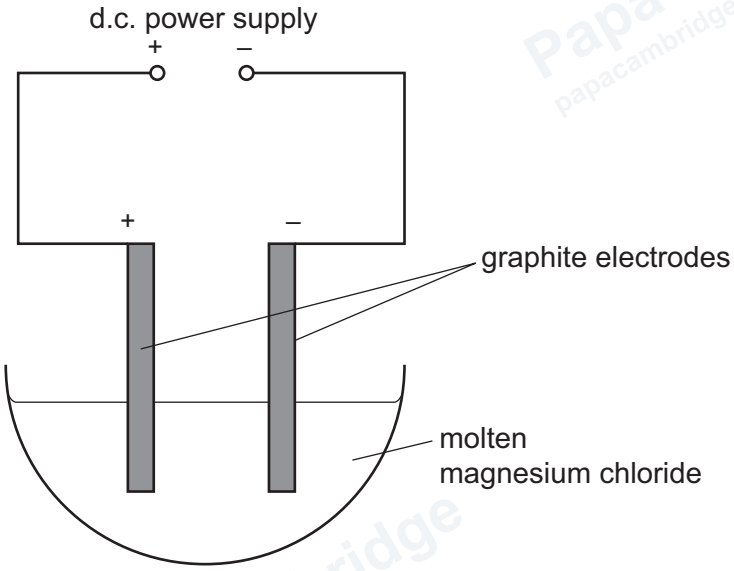


Figure 4.1

(i) Suggest **two** properties of graphite that make it suitable for use as an electrode.

1 .....

2 .....
[2]

(ii) For electrolysis to take place, the magnesium chloride must be molten.

Predict the product at the negative electrode.

..... [1]

(iii) Explain why magnesium chloride does **not** conduct electricity when it is a solid.

.....

..... [1]

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(b) When solid magnesium chloride melts, the particles have a more random arrangement.

Explain why energy is needed to melt solid magnesium chloride.

.....

.....

.....

..... [2]

(c) Magnesium chloride, $MgCl_2$, contains magnesium ions and chloride ions.

Complete the dot-and-cross diagram in Figure 4.2 to show the outer-shell electrons for the ions in magnesium chloride.

Include the charge on each ion.

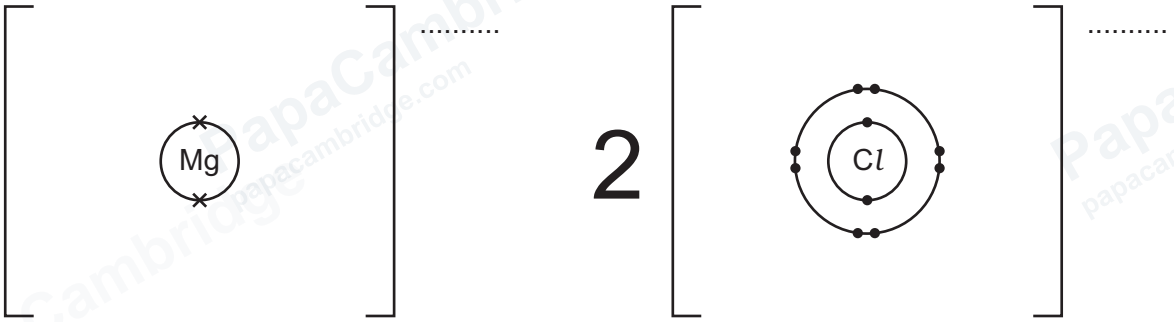


Figure 4.2

[3]

[Total: 9]

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5 A beaker contains dilute hydrochloric acid, HCl, and a few drops of methyl orange indicator.

Excess solid calcium oxide, CaO, is added to the beaker. A reaction occurs.

(a) Describe the colour change observed.

from ..... to ..... [1]

(b) The products of the reaction are calcium chloride, CaCl_2, and water.

Write the balanced symbol equation for this reaction.

..... [2]

(c) The experiment is repeated using a higher concentration of acid.

Explain why the rate of reaction increases.

.....

.....

.....

..... [2]

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(d) The reaction is exothermic.

Complete the reaction pathway diagram in Figure 5.1 for this reaction.

Include:

- labels for reactants and products
- an arrow that represents the overall energy change, labelled **Y**
- an arrow that represents the activation energy, labelled E_a.



Figure 5.1

[3]

[Total: 8]

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6 Alkenes are members of a homologous series.

(a) State **two** general characteristics of a homologous series.

1 .....

2 .....

[2]

(b) Ethene is an alkene.

Name the type of chemical reaction that takes place when ethene reacts with aqueous bromine.

..... [1]

(c) Ethene reacts with hydrogen.

(i) Name the catalyst used in this reaction.

..... [1]

(ii) Name the product formed in this reaction.

..... [1]

(d) Diesel oil is obtained from petroleum.

Diesel oil contains a mixture of alkanes, alkenes and sulfur compounds.

Combustion of diesel oil produces air pollutants.

Name **two** of these air pollutants and state **one** adverse effect for each.

pollutant .....

effect .....

pollutant .....

effect .....

[4]

[Total: 9]

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7 **(a)** Figure 7.1 shows the speed–time graph for part of the journey of a train along a straight level track.

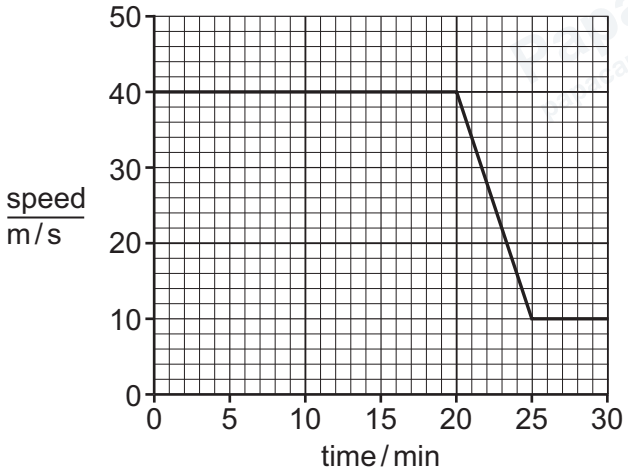


Figure 7.1

(i) Describe the motion of the train between 0 min and 20 min.

..... [1]

(ii) At time t = 20 min, the train decelerates uniformly at 0.10 m / s^2 for 5 min.

Use the equation for acceleration to show that the change in speed of the train is 30 m / s.

[2]

(iii) Determine the distance the train travels when it is decelerating.

distance = ... m [3]

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(b) (i) A rocket is launched vertically upwards from a launch tower.

Figure 7.2 shows the forces acting on the rocket.

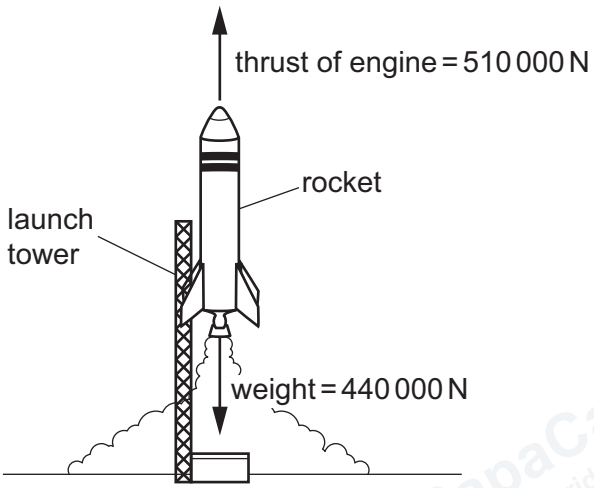


Figure 7.2

The acceleration of the rocket is 1.25 m / s^2.

Calculate the total mass of the rocket.

mass = ... kg [3]

(ii) The rocket goes into orbit around the Moon.

State the equation for calculating orbital speed.

..... [1]

[Total: 10]

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8 **(a)** A teacher has a fixed mass of gas in a sealed container.

The teacher measures the initial pressure of the gas.

The teacher increases the temperature of the gas at constant volume.

State what happens to the pressure of the gas.

Explain your answer in terms of particles.

pressure .....

explanation .....

.....

.....

..... [3]

(b) **(i)** Figure 8.1 represents a sound wave travelling in a gas.

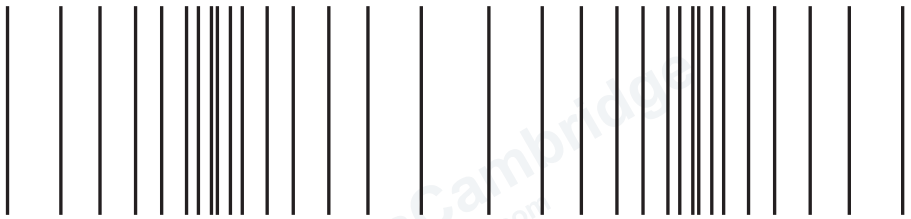


Figure 8.1

On Figure 8.1, label one compression with **C** and one rarefaction with **R**. [1]

(ii) Complete the sentences about sound waves.

In a sound wave, the direction of vibration is parallel to the direction of propagation.

Sound waves are an example of a ..... wave. [1]

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(c) Table 8.1 shows the speeds of sound waves in different materials. The sound waves all have a frequency of 9000 Hz.

Table 8.1

material	state of matter	speed of sound waves m/s
W	liquid	1209
X	liquid	1496
Y		
Z	liquid	1450

Material **Y** is **not** a liquid. The wavelength of the sound waves in material **Y** is 0.11 m.

State and explain which state of matter material **Y** is most likely to be.

Use a calculation in your answer.

state of matter .....

explanation .....

.....

[3]

[Total: 8]

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9 **(a)** Complete the definition of electromotive force (e.m.f.).

Electromotive force (e.m.f.) is the electrical work done by a source in moving a unit ..... around a circuit.

[1]

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

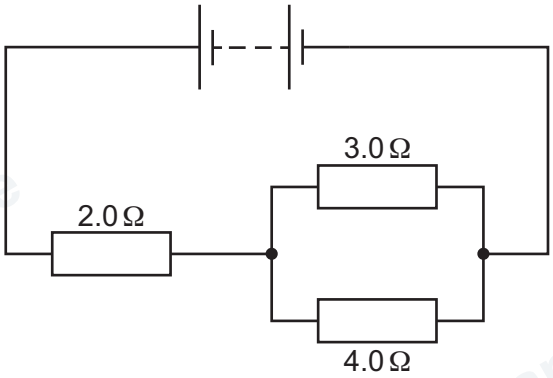


Figure 9.1

The current in the 4.0 Ω resistor is 1.2 A.

(i) Show that the potential difference (p.d.) across the 4.0 Ω resistor is 4.8 V.

[1]

(ii) State the p.d. across the 3.0 Ω resistor.

p.d. across 3.0 Ω resistor = ... V [1]

(iii) Determine the e.m.f. of the source.

e.m.f. = ... V [4]

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(c) In another circuit, resistors $\mathbf{R_A}$ and $\mathbf{R_B}$ are connected in parallel, as shown in Figure 9.2.

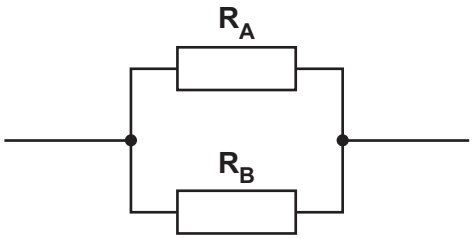


Figure 9.2

The resistance of resistor $\mathbf{R_A}$ is 20 Ω.

The combined resistance of resistors $\mathbf{R_A}$ and $\mathbf{R_B}$ is 15 Ω.

Determine the resistance of resistor $\mathbf{R_B}$.

resistance = ... Ω [2]

[Total: 9]

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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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