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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.

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

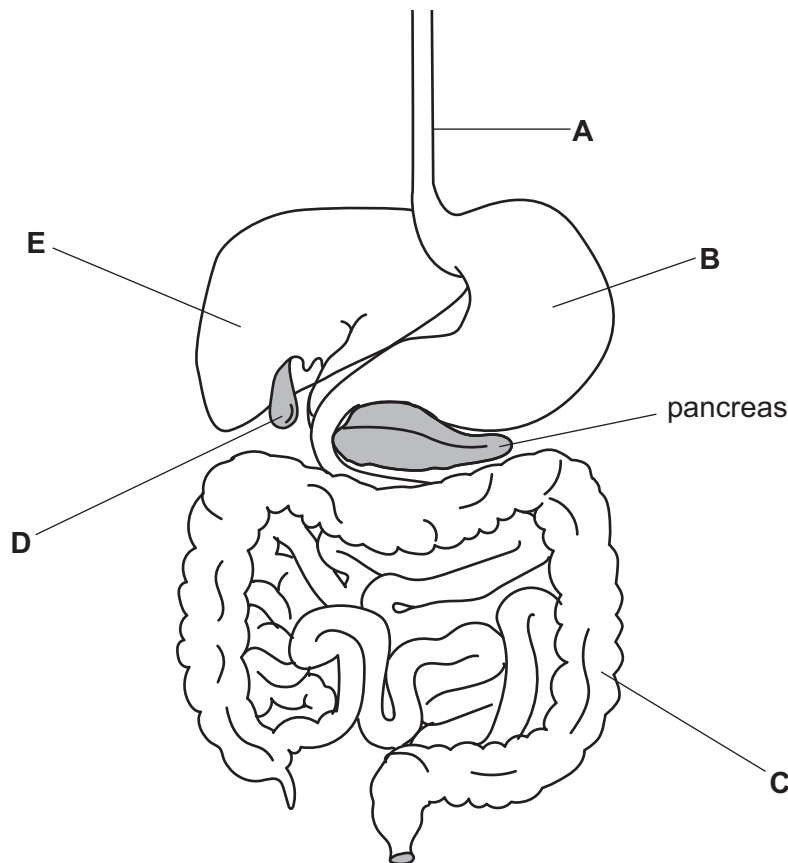


Figure 1.1

- (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]



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

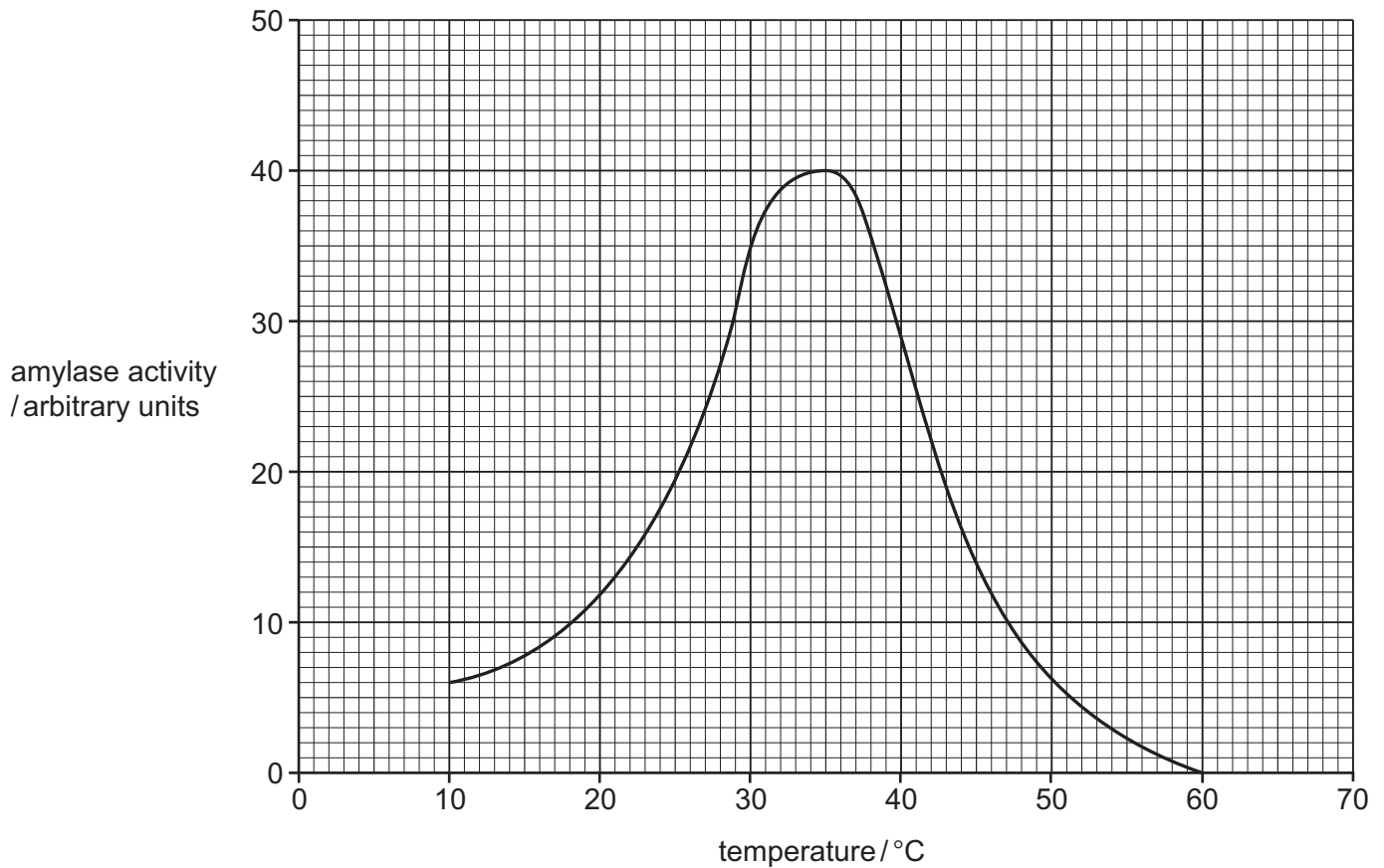


Figure 1.2

(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]

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

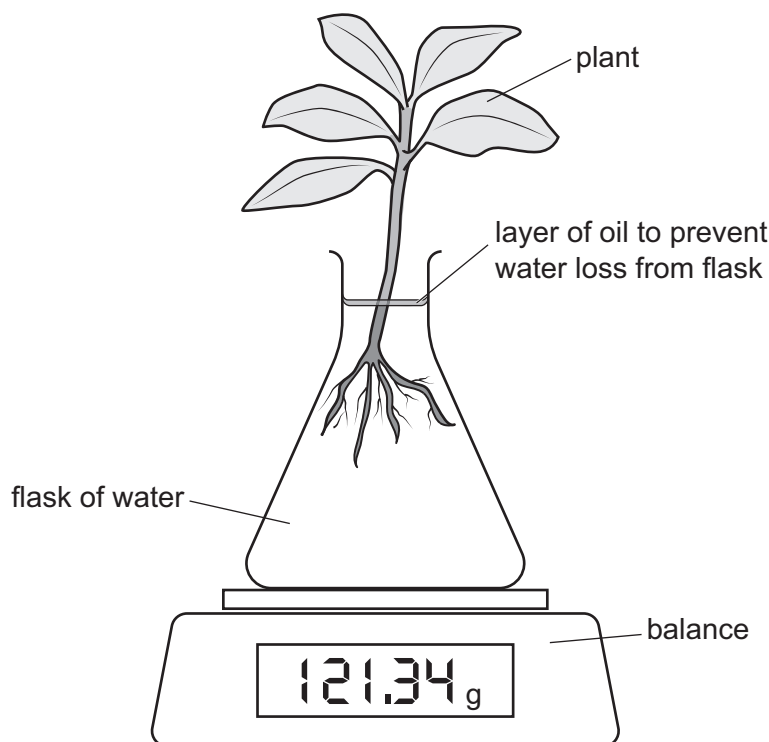


Figure 2.1

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]



- (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]

- 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.

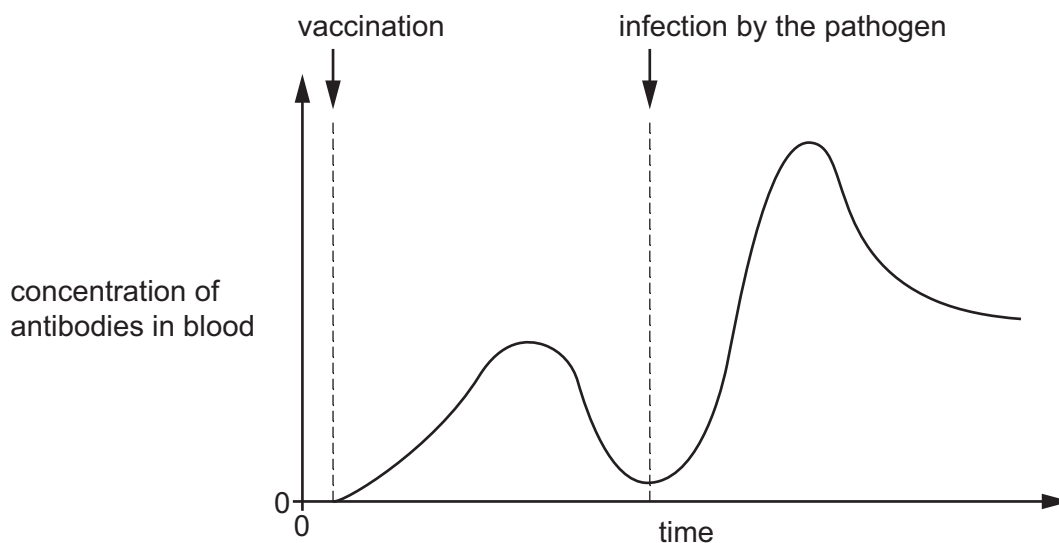


Figure 3.1

Compare these changes in response shown in Figure 3.1.

.....

.....

.....

.....

.....

..... [3]



(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]



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

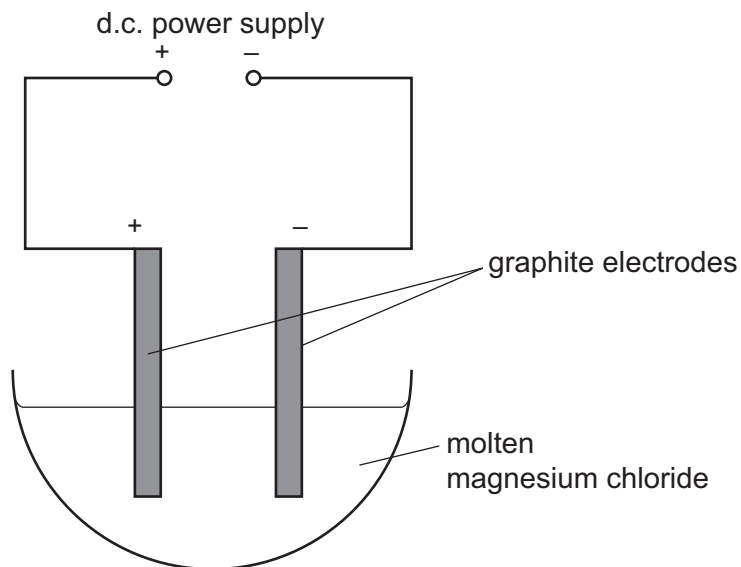


Figure 4.1

- (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]



- (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.

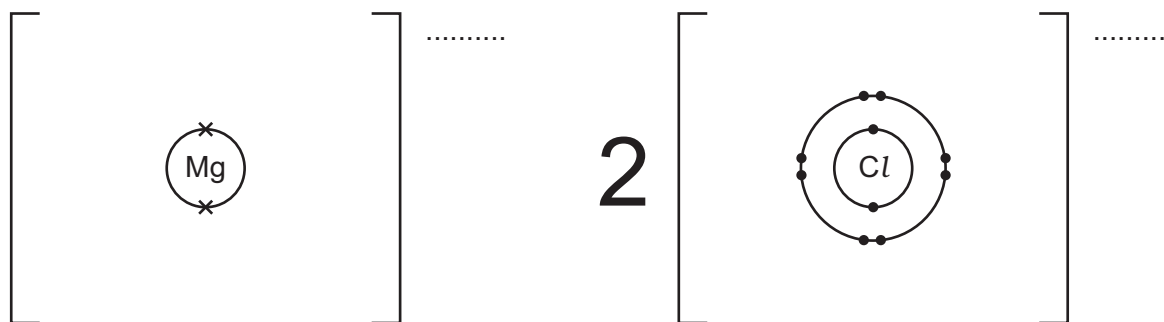


Figure 4.2

[3]

[Total: 9]

- 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]



(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 ΔH
- an arrow that represents the activation energy, labelled E_a .

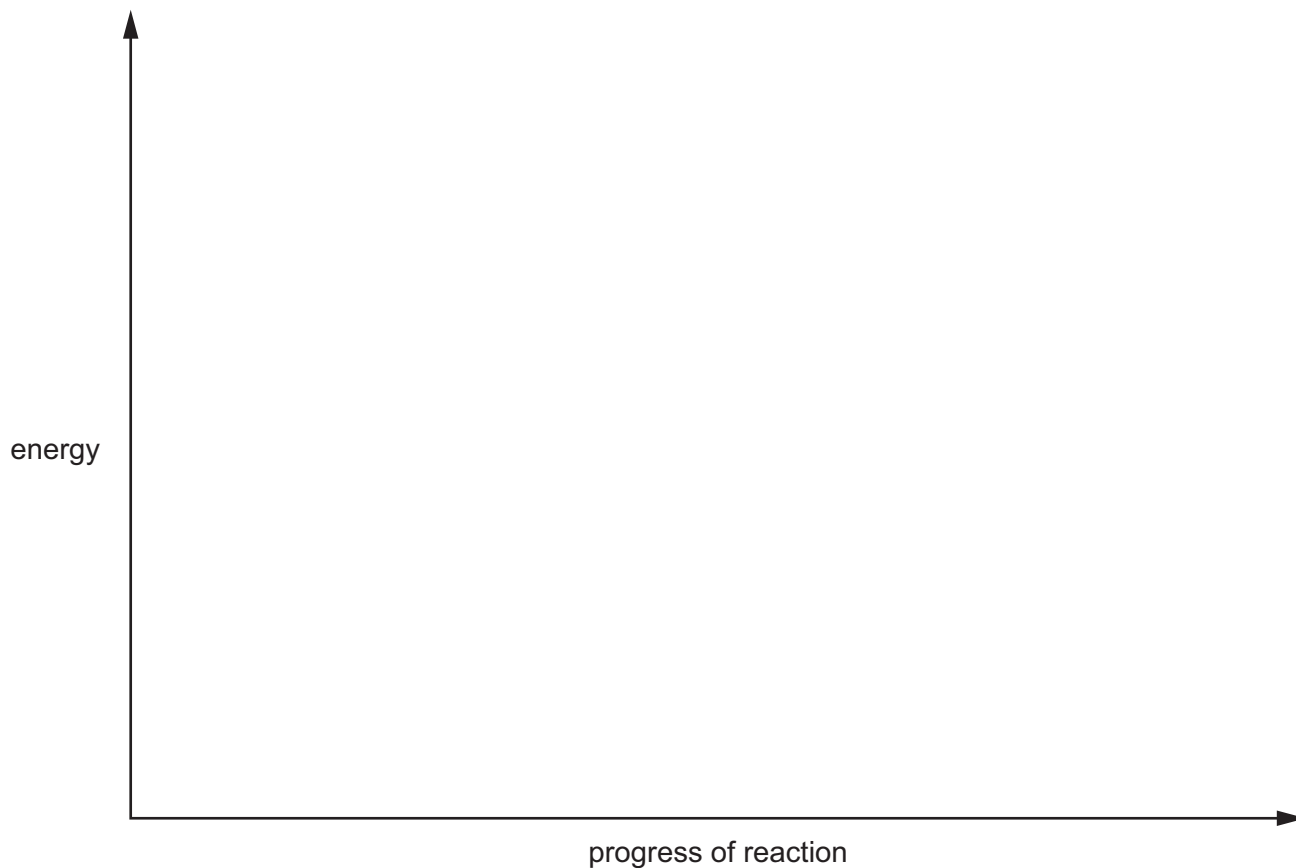


Figure 5.1

[3]

[Total: 8]

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]





Turn over

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

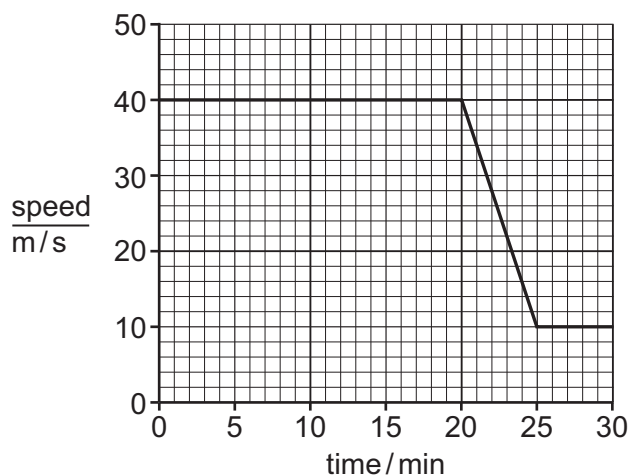


Figure 7.1

- (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]



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

Figure 7.2 shows the forces acting on the rocket.

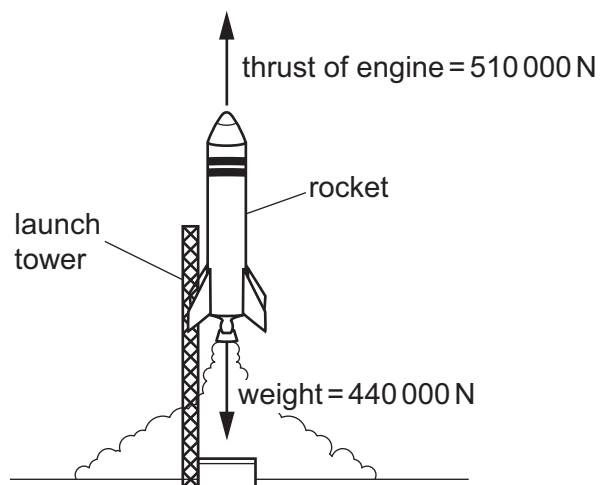


Figure 7.2

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]

- 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.

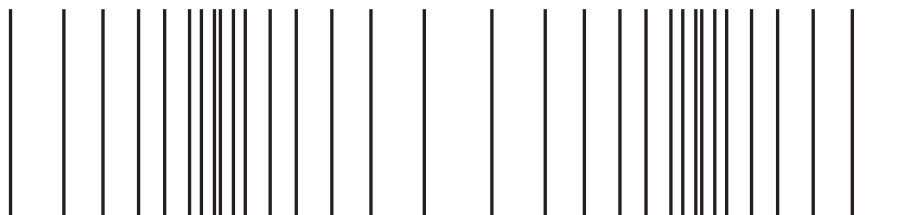


Figure 8.1

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]



- (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	<u>speed of sound waves</u> 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]

- 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.

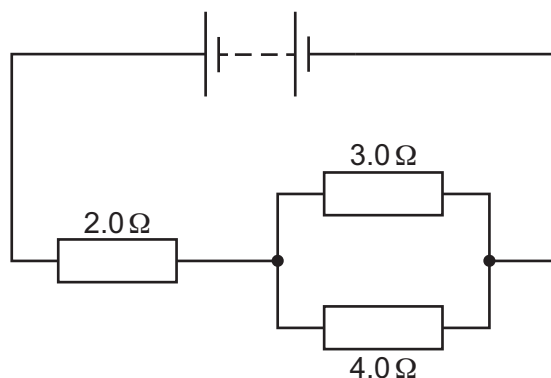


Figure 9.1

The current in the $4.0\ \Omega$ resistor is 1.2 A .

- (i) Show that the potential difference (p.d.) across the $4.0\ \Omega$ resistor is 4.8 V .

[1]

- (ii) State the p.d. across the $3.0\ \Omega$ resistor.

p.d. across $3.0\ \Omega$ resistor = V [1]

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

e.m.f. = V [4]



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

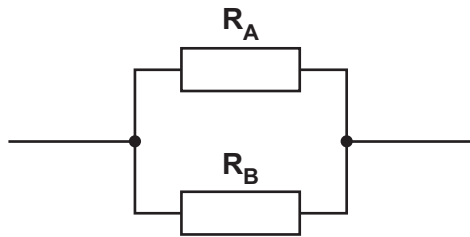


Figure 9.2

The resistance of resistor R_A is $20\ \Omega$.

The combined resistance of resistors R_A and R_B is $15\ \Omega$.

Determine the resistance of resistor R_B .

resistance = Ω [2]

[Total: 9]

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The Periodic Table of Elements

Group																		
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII	
		Key atomic number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
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 oganeson —

lanthanoids

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).