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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

February/March 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 Figure 1.1 is a diagram of the human digestive system.

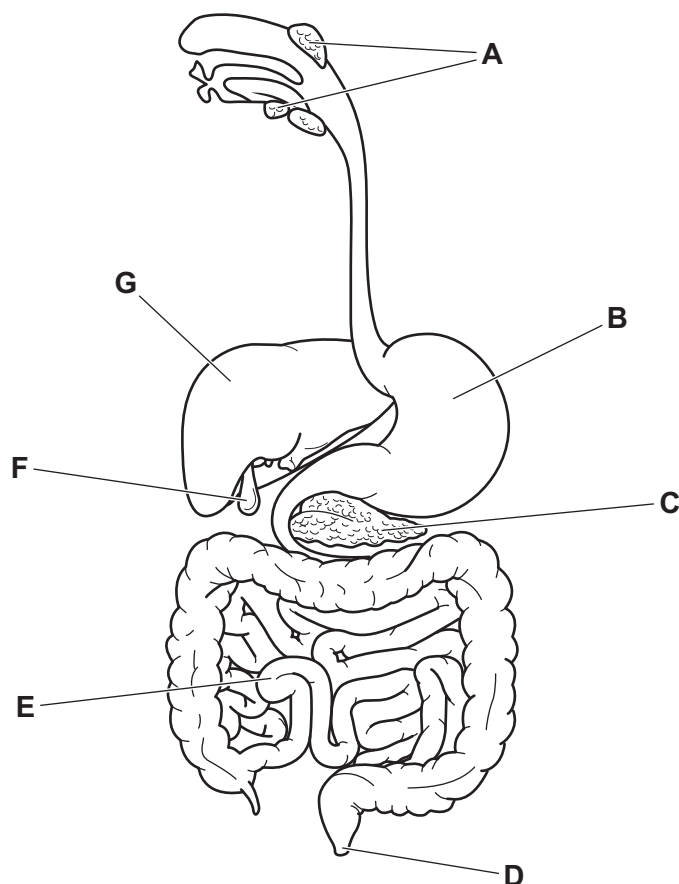


Figure 1.1

(a) State **one** letter from Figure 1.1 that identifies a part where:

absorption occurs

egestion occurs.

[2]

(b) State **all** the letters from Figure 1.1 that identify the parts of the digestive system that are part of the alimentary canal.

..... [1]

(c) The part labelled **B** in Figure 1.1 contains hydrochloric acid.

Hydrochloric acid provides the optimum pH for protease enzymes.

(i) Describe the **other** function of hydrochloric acid in the part labelled **B** in Figure 1.1.

.....

..... [1]



- (ii) Complete the sentences to explain why the enzyme amylase does **not** function in part **B** in Figure 1.1.

The acidic pH changes the shape of the of the enzyme.

Amylase is no longer complementary to its substrate, which is called

Enzyme–substrate can no longer form.

This process is called

[4]

- (iii) Describe **one** other environmental condition that causes the same process explained in **1(c)(ii)**.

..... [1]

[Total: 9]

- 2 (a) Figure 2.1 is a photograph of a wind-pollinated grass flower.



Figure 2.1

- (i) Describe **two visible** pieces of evidence in Figure 2.1 that show the stigma is adapted to wind-pollination.

1

.....

2

.....

[2]

- (ii) State the part of the flower where fertilisation occurs.

..... [1]

- (iii) Grass is part of a food chain. State the position of grass in a food chain.

..... [1]



(b) Deforestation causes species extinction and an increase of carbon dioxide in the atmosphere.

(i) State the balanced symbol equation for the process in plants that removes carbon dioxide from the atmosphere.

..... [2]

(ii) Describe ways to prevent the extinction of plant species.

.....
.....
.....
.....
..... [3]

[Total: 9]

- 3 (a) The aorta is the main artery from the heart and the vena cava is the main vein to the heart.

Table 3.1 shows some information about the features of the aorta and vena cava.

Table 3.1

name of blood vessel	type of blood vessel	cross-sectional area of the lumen/cm ²
aorta	artery	3.5
vena cava	vein	8.0

- (i) Calculate how many times greater the cross-sectional area of the vena cava lumen is compared to the cross-sectional area of the aorta lumen in Table 3.1.

..... [1]

- (ii) Explain the difference in size of the cross-sectional area of the aorta lumen and the vena cava lumen in Table 3.1.

.....

.....

.....

..... [2]



(b) Blood vessels transport red blood cells.

(i) State the name of the chemical that combines with oxygen in red blood cells.

..... [1]

(ii) Describe how oxygen moves through the membrane of a red blood cell.

.....
.....
.....
.....
..... [3]

(iii) Describe **two** factors that increase the rate of oxygen moving through the cell membrane.

1
2 [2]

[Total: 9]

- 4 (a) The electrolysis of molten magnesium chloride, MgCl_2 , is investigated.

The apparatus used is shown in Figure 4.1.

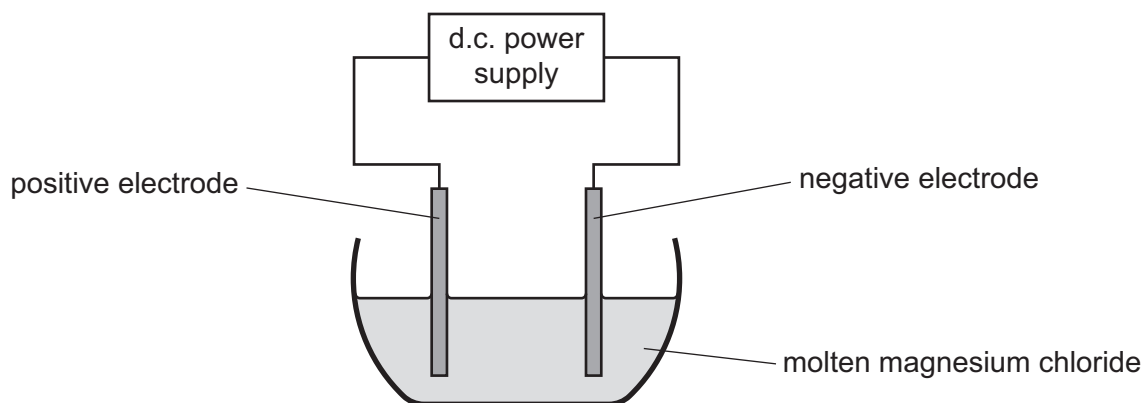


Figure 4.1

- (i) State the name of the negative electrode.

..... [1]

- (ii) Complete Table 4.1 to show information about the products formed at each electrode.

Table 4.1

	name of product	formula of product	appearance of product
negative electrode			
positive electrode			

[2]

- (iii) Solid magnesium chloride **cannot** be electrolysed.

The magnesium chloride shown in Figure 4.1 is molten.

State **one** other way that magnesium chloride can be electrolysed.

..... [1]



(b) Electrolysis is an endothermic process.

(i) Complete Figure 4.2 to show the reaction pathway diagram for an endothermic process.

Include:

- the products
- an arrow labelled E_a to show the activation energy
- an arrow labelled **X** to show the overall energy change of reaction.

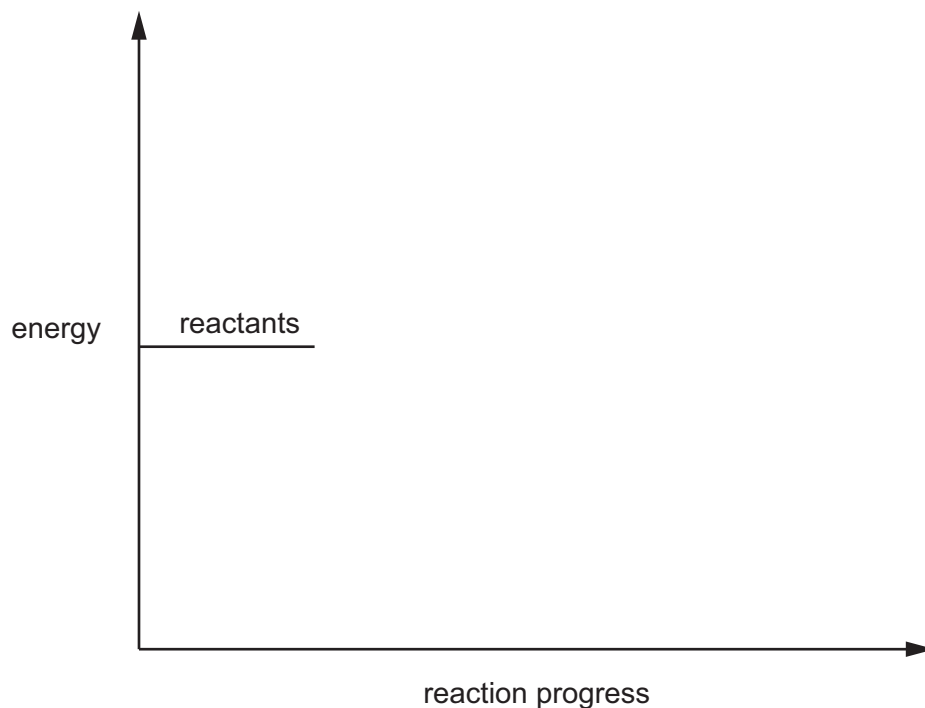


Figure 4.2

[3]

(ii) Define activation energy, E_a .

.....
 [2]

(iii) Give **one** conclusion about the energy involved in bond breaking compared with bond making in endothermic reactions.

.....
 [1]

[Total: 10]

- 5 (a) A student adds drops of aqueous chlorine to three separate test-tubes containing aqueous halide compounds as shown in Figure 5.1.

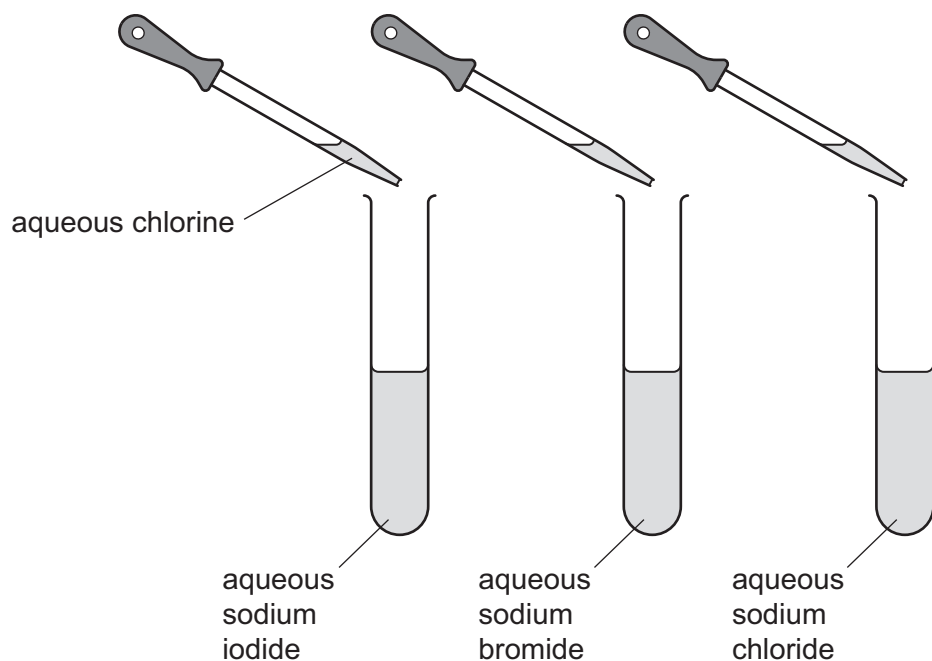


Figure 5.1

- (i) Complete Table 5.1 to show the observations in each test-tube.

Table 5.1

	aqueous sodium iodide	aqueous sodium bromide	aqueous sodium chloride
aqueous chlorine			

[3]

- (ii) Each aqueous halide compound contains a different halide ion. State the type of chemical reaction that occurs between halogens and other halide ions.

..... [1]



(b) Aqueous bromine reacts with aqueous sodium iodide.

Give the balanced symbol equation for this reaction.

..... [2]

(c) Fluorine is a Group VII halogen.

Figure 5.2 shows the electronic configuration for an atom of sodium and an atom of fluorine.

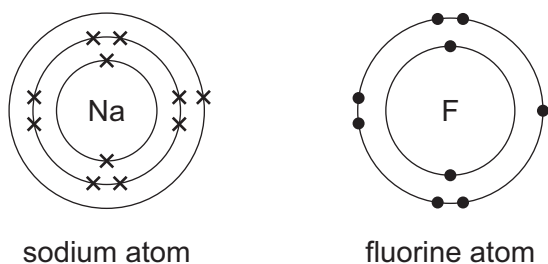


Figure 5.2

Complete the dot-and-cross diagram in Figure 5.3 to show the ionic bonding in sodium fluoride, NaF.

Show **only** the outer-shell electrons and include the charges on the ions.



Figure 5.3

[3]

[Total: 9]

- 6 (a) Figure 6.1 shows the structure of pentane.

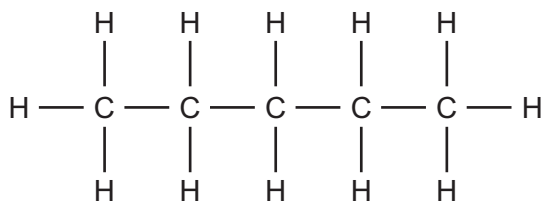


Figure 6.1

- (i) Deduce the molecular formula for pentane.

..... [1]

- (ii) Name the homologous series to which pentane belongs.

..... [1]

- (iii) Tick (✓) **all** the statements in Table 6.1 that are true for pentane.

Table 6.1

statement	true
It forms air pollutants during combustion.	
It contains covalent bonds.	
It is generally unreactive.	
It is a saturated hydrocarbon.	
It reacts with hydrogen in the presence of a nickel catalyst.	

[3]

- (b) Pentane is used to make smaller hydrocarbons.

Name this process and describe **two** conditions required.

process

condition 1

condition 2

[2]

[Total: 7]





Turn over

7 The Sun is a stable star.

(a) Figure 7.1 shows two planets, **J** and **K**, orbiting a stable star.

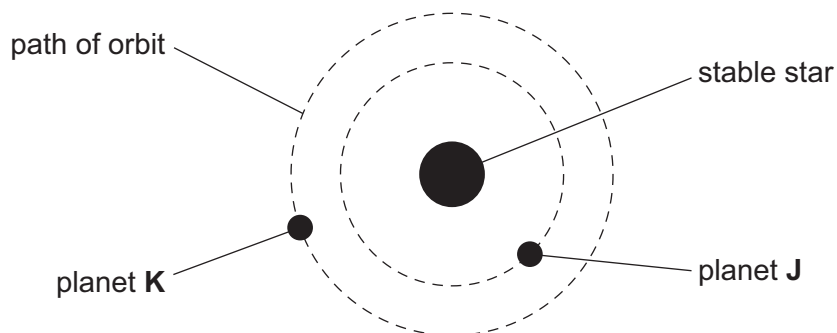


Figure 7.1

State which planet has the greater orbital speed.

Explain your answer in terms of forces.

planet

explanation

.....

[2]

(b) The Sun is a small mass star.

Complete Figure 7.2 to show the next stages in the lifecycle of the Sun.

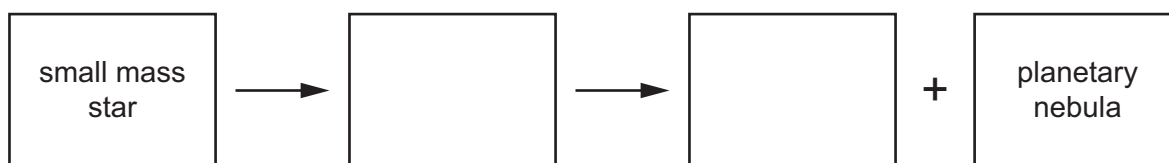


Figure 7.2

[2]



- (c) There is a region of gases in the Sun called the convection zone.

Thermal energy is transferred from the hotter interior to the cooler exterior of the Sun by convection.

Describe the process of convection in a gas.

.....

.....

..... [2]

- (d) Table 7.1 shows data for two of the planets in the Solar System.

Table 7.1

planet	<u>gravitational field strength</u> N/kg
Mercury	3.7
Mars	3.7

Student **A** says: 'I will have a smaller mass and a smaller weight on Mercury than on Mars.'

Student **B** says: 'I will have the same mass and weight on Mercury as on Mars.'

Explain which student is correct.

student

explanation

.....

..... [2]

[Total: 8]



- 8 (a) Figure 8.1 shows a distance–time graph for a car on a journey.

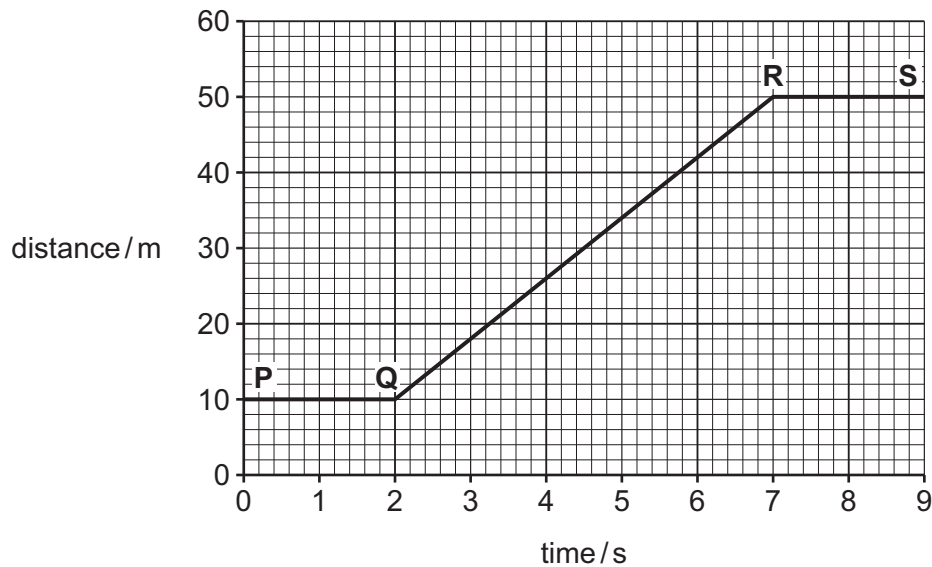


Figure 8.1

Calculate the speed of the car between point **Q** and point **R**.

speed = m/s [2]

- (b) A different car is moving at a constant speed with a kinetic energy of 61 000 J.

The mass of the car is 850 kg.

Calculate the speed of the car.

speed = m/s [2]



(c) The rear lamps of the car contain light emitting diodes (LEDs) that emit red light.

(i) Draw the circuit symbol for a light emitting diode (LED).

[1]

(ii) The red light has a frequency of 4.0×10^{14} Hz.

Calculate the wavelength of the red light.

wavelength = m [3]

(iii) Light is a transverse wave.

Describe the difference between a transverse wave and a longitudinal wave.

Use ideas about direction of vibrations in your answer.

.....

 [2]

[Total: 10]

- 9 (a) A car battery is charged using a 120 V, 30 kW charger.

The battery is charged for 1.5 hours.

- (i) Calculate the energy, in kWh, transferred to the battery.

energy transferred = kWh [2]

- (ii) Calculate the charge that flows while the battery is charging.

charge = C [5]





(b) Table 9.1 shows data for three wires, **W**, **X** and **Y**.

The wires are all made of the same metal.

The wires all have the same length.

Table 9.1

wire	cross-sectional area /cm ²	resistance /Ω
W	1.0	12
X	2.0	6
Y	3.0	4

Wire **Z** is made from the same metal and has the same length as wires **W**, **X** and **Y**.

Wire **Z** has a resistance of 5 Ω.

Determine the cross-sectional area of wire **Z**.

Show your working.

cross-sectional area of wire **Z** = cm² [2]

[Total: 9]

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The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
3 Li lithium 7 11 Na sodium 23 19 K potassium 39 37 Rb rubidium 85 55 Cs caesium 133 87 Fr francium —		1 H hydrogen 1 atomic number atomic symbol name relative atomic mass																
4 Be beryllium 9	12 Mg magnesium 24	21 Sc scandium 45 39 Y yttrium 89 57–71 lanthanoids 89–103 actinoids	22 Ti titanium 48 40 Zr zirconium 91 72 Hf hafnium 178 104 Rf rutherfordium —	23 V vanadium 51 41 Nb niobium 93 73 Ta tantalum 181 105 Db dubnium —	24 Cr chromium 52 42 Mo molybdenum 96 74 W tungsten 184 106 Sg seaborgium —	25 Mn manganese 55 43 Tc technetium — 75 Re rhenium 186 107 Bh bohrium —	26 Fe iron 56 44 Ru ruthenium 101 76 Os osmium 190 108 Hs hassium —	27 Co cobalt 59 45 Rh rhodium 103 77 Ir iridium 192 109 Mt meitnerium —	28 Ni nickel 59 46 Pd palladium 106 78 Pt platinum 195 110 Ds darmstadtium —	29 Cu copper 64 47 Ag silver 108 79 Au gold 197 111 Rg roentgenium —	30 Zn zinc 65 48 Cd cadmium 112 80 Hg mercury 201 112 Cn copernicium —							
5 B boron 11 13 Al aluminium 27 31 Ga gallium 70 49 In indium 115 81 Tl thallium 204 113 Nh nihonium —				6 C carbon 12 14 Si silicon 28 32 Ge germanium 73 50 Sn tin 119 82 Pb lead 207 114 Fl flerovium —	7 N nitrogen 14 15 P phosphorus 31 33 As arsenic 75 51 Sb antimony 122 83 Bi bismuth 209 115 Mc moscovium —	8 O oxygen 16 16 S sulfur 32 34 Se selenium 79 52 Te tellurium 128 84 Po polonium — 116 Lv livermorium —	9 F fluorine 19 17 Cl chlorine 35.5 35 Br bromine 80 53 I iodine 127 85 At astatine — 117 Ts tennessine —	10 Ne neon 20 18 Ar argon 40 36 Kr krypton 84 54 Xe xenon 131 86 Rn radon — 118 Og oganesson —										

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).