* 0000800000001 * DFD

CAMBRIDGE
International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 2 9 9 5 0 3 3 9 7 0 *

CHEMISTRY **0620/31**

Paper 3 Theory (Core) **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.

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 **16** pages.

DC (WW/TC) 355349/4

[Turn over

1 The structures of six substances, **A** to **F**, are shown in Figure 1.1.

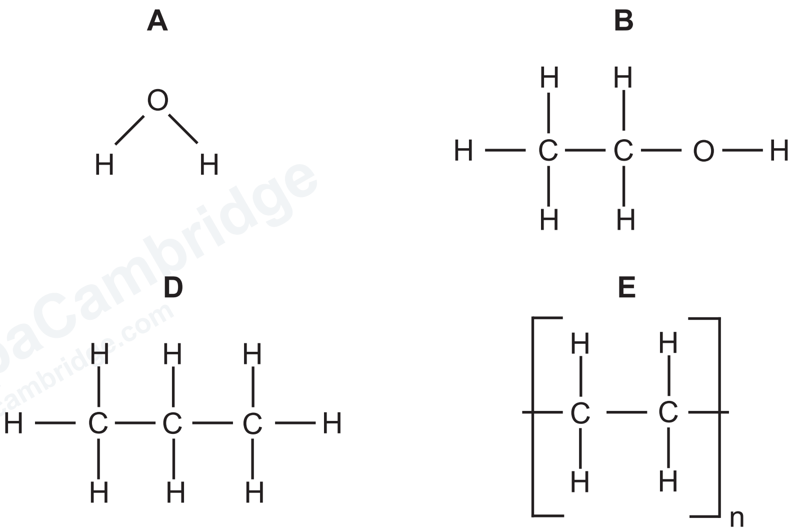

Figure 1.1

Answer the following questions about these substances.

Each substance may be used once, more than once or not at all.

(a) State which substance:

(i) is an alkane

.... [1]

(ii) is made by fermentation

.... [1]

(iii) is made in a fuel cell

.... [1]

(iv) has the general formula C_nH_{2n+2}

.... [1]

(v) is a polymer

.... [1]

(vi) is used in photosynthesis.

.... [1]

(b) **(i)** State which **two** substances are hydrocarbons.

.... and .... [2]

(ii) State which **two** substances are used as solvents.

.... and .... [2]

[Total: 10]

2 Table 2.1 shows some properties of the halogens.

Table 2.1

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g/cm^3
chlorine	–101	–35	0.0032
bromine	–7	+59	3.1
iodine		+184	
astatine	+302	+337	8.93

(a) Use the information in Table 2.1 to answer the following questions.

(i) Predict the melting point of iodine.

.... [1]

(ii) Predict the density of iodine at room temperature and pressure.

.... [1]

(iii) Deduce the physical state of bromine at –1 °C.

Give a reason for your answer.

physical state ....

reason ....

....
[2]

(iv) Predict the physical state of fluorine at room temperature and pressure.

.... [1]

(b) Chlorine, bromine and iodine are all non-metals.

(i) Aqueous chlorine reacts with aqueous sodium iodide to produce aqueous iodine and aqueous sodium chloride.

State the name of this type of reaction.

.... [1]

(ii) Complete the symbol equation for this reaction.

Cl_2 + ...NaI → .... + 2NaCl [2]

(iii) Explain why aqueous bromine does **not** react with aqueous sodium chloride.

....

.... [1]

(iv) On Figure 2.1, complete the dot-and-cross diagram for a molecule of bromine.

Show outer shell electrons only.

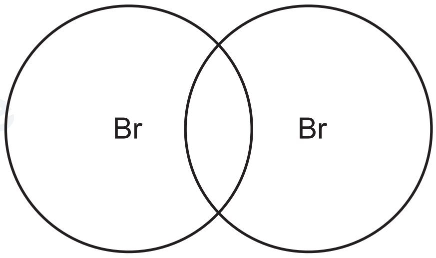

Figure 2.1

[2]

[Total: 11]

3 The equation for the reaction of magnesium with dilute hydrochloric acid is shown.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(a) State the meaning of the symbol (aq) in this equation.

.... [1]

(b) A student investigates the reaction of small pieces of magnesium with excess dilute hydrochloric acid.

Figure 3.1 shows the total volume of hydrogen gas released as the reaction proceeds.

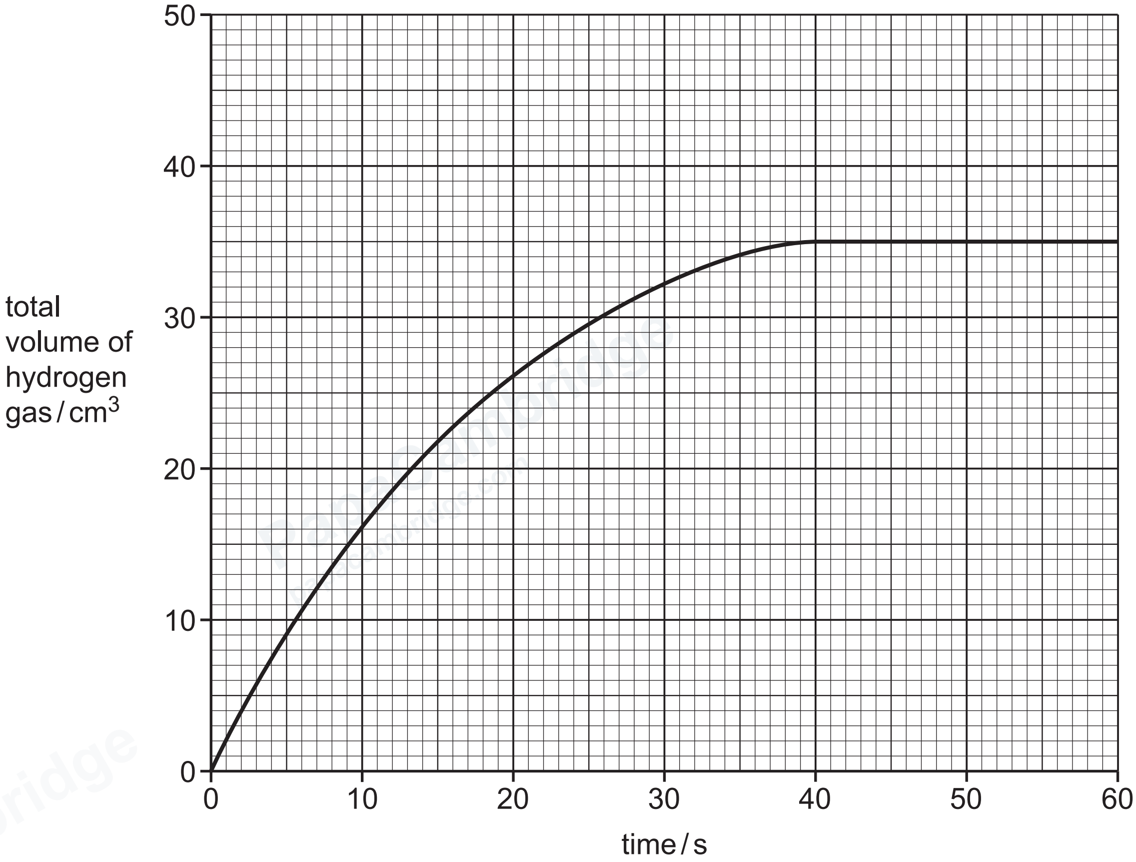

Figure 3.1

(i) Name the piece of apparatus used to collect and measure the volume of hydrogen gas produced in this reaction.

.... [1]

(ii) Use the graph in Figure 3.1 to determine the total volume of hydrogen gas released in 10 s.

total volume of hydrogen gas = ... cm^3 [1]

(iii) Use the graph in Figure 3.1 to deduce the time taken for the reaction to finish.

time = ... s [1]

(iv) Explain why the reaction finishes.

....

.... [1]

(v) The student repeats the experiment using the same volume of dilute hydrochloric acid at a higher temperature.

Draw a line on the grid in Figure 3.1 to show how the total volume of hydrogen gas released changes over time in this second experiment. [2]

(vi) State how the rate of reaction differs, if at all, when larger pieces of magnesium are used.

.... [1]

(c) The student repeats the experiment and adds 1 g of a solid, insoluble catalyst.

(i) State how the rate of reaction differs, if at all, when a catalyst is added.

.... [1]

(ii) Describe how the student can show the catalyst is unchanged at the end of the reaction.

In your answer, include how the catalyst is separated from the reaction mixture.

....

....

....

....

.... [3]

[Total: 12]

4 This question is about organic compounds and their reactions.

(a) Compound **M** is unsaturated.

Figure 4.1 shows the displayed formula of compound **M**.

M

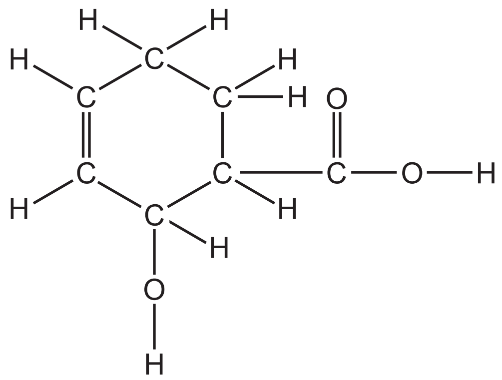

Figure 4.1

(i) On Figure 4.1, draw a circle around the carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of compound **M**.

.... [1]

(iii) State why compound **M** is unsaturated.

.... [1]

(b) **(i)** Outline how petroleum is separated by fractional distillation.

In your answer, include:

- the property of the fractions which allows them to be separated
- a description of how fractional distillation separates the petroleum into fractions.

....

....

....

....

....

.... [4]

(ii) Two of the fractions obtained from petroleum are bitumen and fuel oil.

State **one** use of each of these fractions.

bitumen ....

fuel oil ....
[2]

(c) Pentane is a member of the alkane homologous series. Pentane reacts in the same way as ethane.

(i) Name the **two** products of the complete combustion of pentane.

.... and .... [2]

(ii) Identify the type of reaction that takes place when pentane reacts with chlorine.

Draw a circle around your chosen answer.

addition **neutralisation** **redox** **substitution** [1]

[Total: 12]

5 Three states of matter are solid, liquid and gas.

(a) State **two** general properties of a solid.

1 ....

2 ....
[2]

(b) Complete Table 5.1 to show the separation and arrangement of particles in a solid and a gas.

Table 5.1

physical state	separation of particles	arrangement of particles
solid		
gas		

[4]

(c) Draw a line from each statement to the correct change of state.

statement	change of state
carbon dioxide gas turns into liquid carbon dioxide	melting
ice turns into water	boiling
liquid nitrogen changes into nitrogen gas	condensing

[2]

(d) A sealed gas syringe contains 60 cm^3 of oxygen gas.

State how the pressure inside the syringe changes when the plunger of the syringe is pushed in and the temperature remains constant.

.... [1]

[Total: 9]

6 Cobalt is a metal.

(a) (i) State the period number of cobalt in the Periodic Table.

.... [1]

(ii) Deduce the number of electrons, neutrons and protons in the cobalt ion shown.

$^{59}_{27}Co^{2+}$

number of electrons ....

number of neutrons ....

number of protons ....
[3]

(b) Cobalt is a transition metal that forms coloured compounds.

State **two** other properties of transition metals.

1 ....

2 ....
[2]

(c) (i) Cobalt reacts with oxygen to form cobalt(III) oxide.

Complete the symbol equation for this reaction.

$$.....Co + ...O_2 \rightarrow 2Co_2O_3$$ [1]

(ii) State if cobalt(III) oxide is an acidic oxide or a basic oxide.

Give a reason for your answer.

....

.... [1]

(d) Another compound of cobalt is cobalt(II) chloride.

Molten cobalt(II) chloride is electrolysed using inert graphite electrodes.

(i) Define the term electrolysis.

....

....

....

.... [2]

(ii) Name a metal that is used as an inert electrode.

.... [1]

(iii) Name the products formed at each electrode during the electrolysis of molten cobalt(II) chloride, and give the observations at the positive electrode.

product at the negative electrode ....

product at the positive electrode ....

observations at the positive electrode ....

....
[3]

(e) Cobalt forms a compound with the nitrate ion. The formula of the compound is $Co(NO_3)_2$.

Complete Table 6.1 to calculate the relative formula mass of $Co(NO_3)_2$.

Table 6.1

type of atom	number of atoms	relative atomic mass	
cobalt	1	59	1 × 59 = 59
nitrogen		14	
oxygen		16	

relative formula mass = ... [2]

[Total: 16]

7 **(a)** State the percentage of clean, dry air that is nitrogen.

.... [1]

(b) Sulfur dioxide is an air pollutant.

(i) State **one** source of sulfur dioxide in the air.

.... [1]

(ii) State **one** adverse effect of sulfur dioxide in the air.

.... [1]

(iii) Oxides of nitrogen are also air pollutants. They form acids when they dissolve in water.

Choose the pH value that is acidic.

Draw a circle around your chosen answer.

pH 3 **pH 7** **pH 10** **pH 14** [1]

(c) Water from natural sources can be polluted with harmful substances.

State why sewage and phosphates in river water are harmful.

sewage ....

....

phosphates ....

....

[2]

(d) **(i)** Name the **three** elements present in an NPK fertiliser.

.... [1]

(ii) Explain why fertilisers are used.

....

.... [1]

(e) Some fertilisers contain chloride ions.

Describe the test to identify aqueous chloride ions.

test ....

....

observations ....

[2]

[Total: 10]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	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 –

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.).