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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8317531983

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 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.

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. Any blank pages are indicated.

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[Turn over

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1 A list of symbols and formulae is shown.

Ba^{2+}
C
Cl_2
Cl^-
CO
CO_2
CuO
H_2
H_2O
K^+
Na^+
O^{2-}

Answer the following questions using only these symbols and formulae.
Each symbol or formula may be used once, more than once or not at all.

(a) State which symbol or formula represents:

(i) an element used as an inert electrode for electrolysis

..... [1]

(ii) an ion formed when an atom gains two electrons

..... [1]

(iii) a basic oxide

..... [1]

(iv) an ion that gives a yellow colour in a flame test

..... [1]

(v) a toxic gas formed during the incomplete combustion of methane

..... [1]

(vi) an element used as a reactant in a fuel cell.

..... [1]

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(b) Water, H_2O, is a simple covalent molecule.

Complete Fig. 1.1 to show the dot-and-cross diagram for a molecule of water.

Show outer shell electrons only.

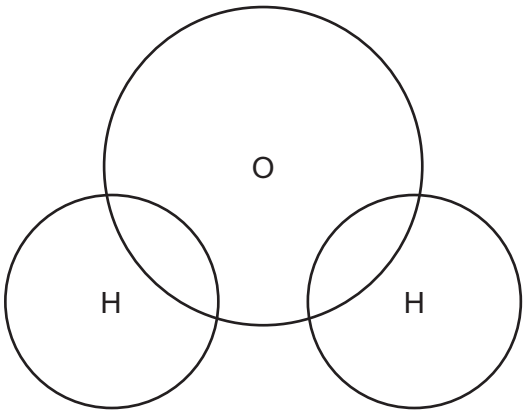

Fig. 1.1

[2]

[Total: 8]

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2 This question is about metals and alloys.

(a) Table 2.1 shows information about the reactions of four different metals with oxygen.

Table 2.1

metal	reaction with oxygen
calcium	burns rapidly to form an oxide
cobalt	burns slowly to form an oxide
platinum	no reaction
tin	forms an oxide but does not burn

Put the four metals in order of their reactivity.
Put the most reactive metal first.

most reactive ⟶ least reactive

[2]

(b) Cobalt is a transition element. Lithium is an element in Group I of the Periodic Table.

Describe **two** differences in the physical properties of cobalt compared to lithium.

1 .....

2 .....

[2]

(c) Brass and stainless steel are alloys.

(i) Describe what is meant by the term alloy.

.....

..... [1]

(ii) Name the **two** metals in brass.

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

(iii) Give **one** use for stainless steel.

..... [1]

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

$^{60}_{27}Co^{3+}$

number of protons .....

number of neutrons .....

number of electrons .....

[3]

(ii) State the charge on a neutron.

..... [1]

[Total: 12]

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3 A student investigates the reaction of magnesium with dilute sulfuric acid.

(a) Complete the word equation for the reaction of magnesium with dilute sulfuric acid.

magnesium	+	sulfuric acid	→	....	+	hydrogen

[1]

(b) The student sets up an experiment to investigate the rate of this chemical reaction.

The student:

- carries out the experiment at 25 °C using 2.00 g of magnesium ribbon and 25 cm^3 of dilute sulfuric acid
- measures the total volume of gas produced at regular time intervals
- plots a graph of the results.

Fig. 3.1 shows the graph of the student's results.

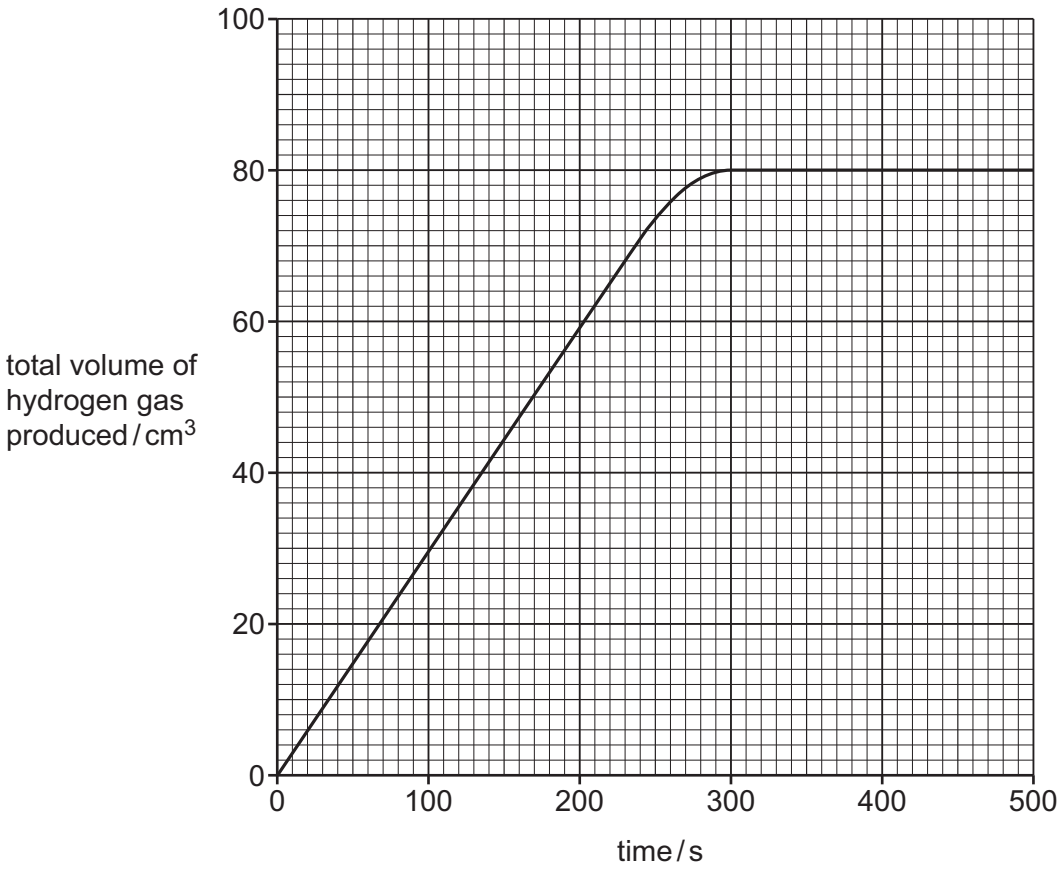

Fig. 3.1

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(i) Draw a labelled diagram of the apparatus the student should use to carry out this investigation.

[3]

(ii) Deduce the total volume of hydrogen gas produced in the first 100 s of this reaction.

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

(iii) Suggest why the reaction stops at 300 s.

.....

..... [1]

(iv) The experiment is repeated at a higher temperature.

All other conditions stay the same.

Draw a line **on the grid** in Fig. 3.1 to show how the volume of hydrogen gas produced changes at a higher temperature. [3]

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(v) The student repeats the experiment using sulfuric acid of a lower concentration.

All other conditions stay the same.

Describe how the rate of the reaction differs when sulfuric acid of a lower concentration is used.

..... [1]

(vi) The student repeats the experiment using a catalyst.

All other conditions stay the same.

Describe how the rate of the reaction differs when a catalyst is used.

..... [1]

(c) Describe a test for hydrogen.

test .....

observations .....
[1]

[Total: 12]

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Question 4 starts on the next page.

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4 **(a)** Fig. 4.1 shows the displayed formula of compound **B**.

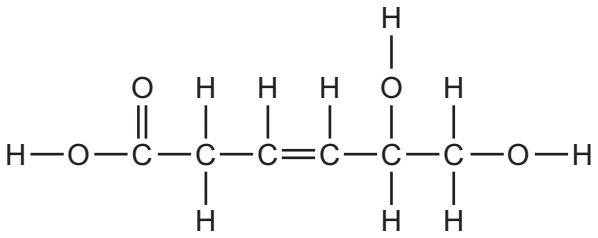

Fig. 4.1

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

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

..... [1]

(iii) Explain why compound **B** is unsaturated.

..... [1]

(iv) Describe a test for an unsaturated compound.

test .....

observations .....

.....
[2]

(b) Alkanes are hydrocarbons.

(i) State the type of bonding in an alkane molecule.

..... [1]

(ii) Ethane reacts with chlorine in a substitution reaction.

Draw the displayed formula of the organic product of this reaction.

[1]

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(iii) State the meaning of the term hydrocarbon.

.....

..... [1]

(c) Petroleum contains hydrocarbons.

Name the process used to separate petroleum into its useful components.

..... [1]

(d) Complete Table 4.1 to show the name and use for some of the components in petroleum.

Table 4.1

name	use
gasoline / petrol	.....
.....	jet fuel
bitumen	.....

[3]

[Total: 12]

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5 This question is about iron and its compounds.

(a) Fig. 5.1 shows the changes of the physical states of iron.

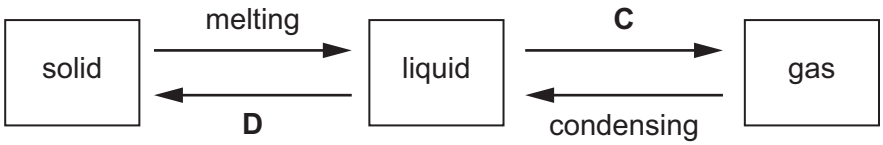

Fig. 5.1

Name the changes of physical states **C** and **D**.

C .....

D .....

[2]

(b) Use the kinetic particle model to describe the arrangement and motion of the particles in liquid iron.

arrangement .....

.....

motion .....

.....

[2]

(c) Complete the symbol equation for the reaction of iron with oxygen.

$$.....Fe + ...O_2 \rightarrow Fe_3O_4$$ [2]

(d) Iron can be obtained from iron ore in the blast furnace.

(i) Name the main ore of iron used in the blast furnace.

..... [1]

(ii) State **one** reason why carbon is burned in the blast furnace.

.....

..... [1]

(iii) Name the **solid** compound that forms when limestone undergoes thermal decomposition.

..... [1]

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(e) Iron is used as a catalyst in the reaction shown.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

State the meaning of the symbol $\rightleftharpoons$.

..... [1]

(f) Iron rusts when in contact with air and water.

Name **one** barrier method used to prevent iron from rusting.

..... [1]

[Total: 11]

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6 This question is about acids and bases.

(a) Dilute hydrochloric acid reacts with calcium carbonate powder.

Name the **three** products formed in this reaction.

1 .....

2 .....

3 .....

[3]

(b) State the colour of methyl orange when it is added to dilute hydrochloric acid.

..... [1]

(c) For the test for halide ions, a dilute acid and aqueous silver nitrate are required.

(i) Explain why the acid used must **not** be hydrochloric acid.

.....

..... [1]

(ii) Suggest a suitable dilute acid that can be used for the test for halide ions.

..... [1]

(d) Barium carbonate is insoluble in water.

Choose from the list one **other** compound that is insoluble in water.

Tick (✓) **one** box.

ammonium carbonate	☐
lead(II) sulfate	☐
potassium hydroxide	☐
sodium nitrate	☐

[1]

(e) Write the formula of the carbonate ion.

..... [1]

[Total: 8]

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7 **(a)** A list of common air and water pollutants is shown.

methane
nitrates
oxides of nitrogen
particulates
plastics
sewage

Answer the following questions using **only** these pollutants.
Each pollutant may be used once, more than once or not at all.

State which pollutant:

(i) contains harmful microbes that can cause disease

..... [1]

(ii) can be produced by the incomplete combustion of carbon-containing fuels

..... [1]

(iii) is a gas formed from the decomposition of vegetation.

..... [1]

(b) A 250 cm^3 sample of polluted water contains 3.5 mg of particulates.

Calculate the mass of particulates present in 100 cm^3 of this polluted water.

mass of particulates = ... mg [1]

(c) Sulfur dioxide in the atmosphere causes acid rain.

State **one** method of reducing the emissions of sulfur dioxide to the atmosphere.

.....

..... [1]

(d) Sulfur dioxide is a simple molecular compound.

State **two** physical properties of simple molecular compounds.

1 .....

2 .....
[2]

[Total: 7]

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8 **(a)** Molten potassium chloride is electrolysed using inert electrodes.

(i) Name the product formed at each electrode.

product at positive electrode .....

product at negative electrode .....

[2]

(ii) State the general name of the negative electrode used in electrolysis.

..... [1]

(b) Potassium forms a salt when added to ethanoic acid.

Name the salt formed.

..... [1]

(c) Dilute ethanoic acid gives a yellow colour when tested with universal indicator.

Choose from the list the pH value for dilute ethanoic acid.

Draw a circle around your chosen answer.

pH 1 **pH 5** **pH 7** **pH 13** [1]

(d) Ethanoic acid has the formula CH_3COOH.

Complete Table 8.1 to calculate the relative molecular mass of CH_3COOH.

Table 8.1

type of atom	number of atoms	relative atomic mass	
carbon	2	12	2 × 12 = 24
hydrogen		1	
oxygen		16	

relative molecular mass = ... [2]

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(e) A molecule of ethanol also contains two carbon atoms.

(i) Ethanol can be manufactured by the addition of steam to ethene.

In this process, a pressure of 60 atm is used.

State **two other** conditions used in this process.

1 .....

2 .....

[2]

(ii) State **one** use of ethanol.

..... [1]

[Total: 10]

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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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