Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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0118995405

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2022**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **three** 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 75.
- 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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Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

1 Choose from the following compounds to answer the questions.

$AgCl$

$Ba(NO_3)_2$

KI

$KMnO_4$

K_2SO_3

$Mg(NO_3)_2$

Na_2CO_3

Na_3N

NH_4Cl

$ZnSO_4$

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

State which compound:

(a) is purple in colour

..... [1]

(b) reacts with aqueous sodium sulfate to form a white precipitate

..... [1]

(c) reacts with aqueous chlorine to give a brown solution

..... [1]

(d) is prepared using a precipitation reaction

..... [1]

(e) contains an anion with a charge of –3

..... [1]

(f) is used to test for a reducing agent.

..... [1]

[Total: 6]

2 The table shows some information about elements in Group VI.

element	electronic configuration	melting point / °C	density in g / cm^3
oxygen	2, 6	–218	0.0013
sulfur		113	2.1
selenium	2, 8, 18, 6	217	4.8
tellurium	2, 8, 18, 18, 6	450	6.3
polonium	2, 8, 18, 32, 18, 6	254	

(a) State the electronic configuration for sulfur.

..... [1]

(b) Predict the density of polonium.

..... g / cm^3 [1]

(c) Sulfur has a boiling point of 445 °C.

Predict the physical state of sulfur at 200 °C.

Explain your answer.

physical state .....

explanation .....

.....
[1]

(d) Oxygen exists as a diatomic molecule, O_2.

(i) Draw the dot-and-cross diagram for a molecule of oxygen.

Show only the outer shell electrons.

[1]

(ii) Explain, in terms of structure and bonding, why oxygen has a low melting point.

.....

..... [1]

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(e) Selenium, Se, is a non-metal.

(i) Deduce the formula of selenium(IV) oxide.

..... [1]

(ii) A small sample of selenium(IV) oxide is dissolved in water.

Two drops of universal indicator are added to this aqueous solution.

Predict the colour of the universal indicator in this solution.

Explain your answer.

colour .....

explanation .....

.....
[1]

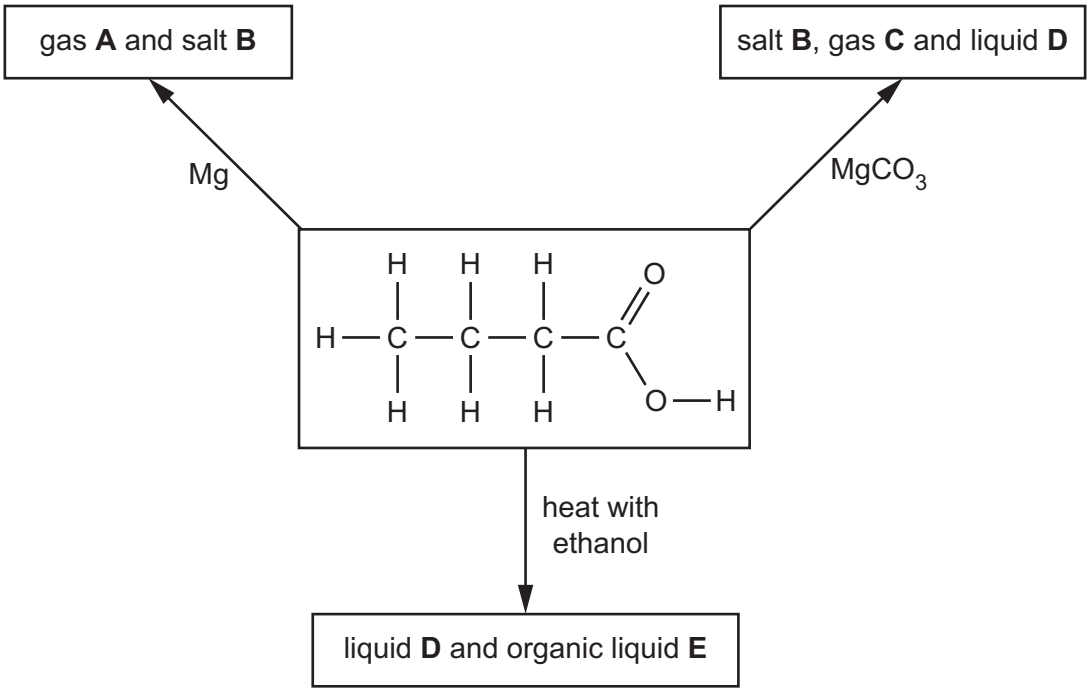
(f) Calculate the volume, in dm^3, of 30.2 g of oxygen at room temperature and pressure.

Give your answer to **two** significant figures.

volume ..... dm^3 [3]

[Total: 10]

3 The diagram shows some reactions of butanoic acid.



(a) **A**, **B**, **C** and **D** are different substances.

Identify by name **A**, **B**, **C** and **D**.

A .....

B .....

C .....

D .....

[4]

(b) Name and draw the structure of **E**.

name .....

structure

[2]

(c) Butanoic acid is a weak acid.

State what is meant by the term *weak* in weak acid.

.....

..... [1]

[Total: 7]

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4 The table shows information about some particles.

particle	number of		
	protons	neutrons	electrons
$^{79}_{35}Br$	35	44	35
$^{79}_{35}Br^-$	35	44	
$^{40}_{20}Ca$	20	20	20
$^{40}_{20}Ca^{2+}$	20	20	18

(a) State the nucleon number for $^{79}_{35}Br$.

..... [1]

(b) State the number of electrons in $^{79}_{35}Br^-$.

..... [1]

(c) $^{40}_{20}Ca$ is the full symbol for one isotope of calcium.

Write the full symbol for one **other** isotope of calcium.

..... [1]

(d) Describe how a calcium ion, Ca^{2+}, is formed from a calcium atom, Ca.

.....

..... [1]

(e) Calcium bromide is an ionic compound.

Calcium bromide conducts electricity when molten but not when solid.

(i) Explain why calcium bromide conducts electricity when molten but **not** when solid.

.....

.....

..... [2]

(ii) Predict two **other** physical properties of calcium bromide.

1. .....

2. .....

[2]

[Total: 8]

5 Ethanol is manufactured by the reaction between ethene and steam.

The conditions used are 300 °C, a high pressure and a phosphoric acid catalyst.

(a) The reaction between ethene and steam is reversible.

The forward reaction is exothermic.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

An equilibrium mixture is formed when the reversible reaction happens in a closed system.

(i) Predict what happens to the amount of ethanol in the equilibrium mixture if the temperature is decreased and the pressure remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

[2]

(ii) Predict what happens to the amount of ethanol in the equilibrium mixture if the pressure is decreased and the temperature remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

[2]

(b) Describe the manufacture of aqueous ethanol by the fermentation of glucose.

Include the equation and the essential conditions needed for this fermentation.

.....

.....

.....

..... [3]

[Total: 7]

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6 A sample of an alloy containing aluminium and copper is added to hot dilute sulfuric acid.

Only the aluminium reacts with the dilute sulfuric acid. The products of the reaction are hydrogen and aqueous aluminium sulfate.

(a) Construct the ionic equation, with state symbols, for the reaction of aluminium with dilute sulfuric acid.

..... [2]

(b) Describe a chemical test for aluminium ions.

.....

.....

.....

..... [2]

(c) The aqueous aluminium sulfate formed is crystallised to make hydrated aluminium sulfate, $Al_2(SO_4)_3 \cdot xH_2O$.

The relative formula mass of hydrated aluminium sulfate is 666.

Calculate the value of x in the formula $Al_2(SO_4)_3 \cdot xH_2O$.

x = ... [2]

(d) State what is meant by the term *alloy*.

.....

..... [1]

[Total: 7]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

7 Carbon dioxide and sulfur dioxide are pollutants formed at power stations that burn fossil fuels such as coal.

(a) State one environmental problem caused by producing carbon dioxide as an atmospheric pollutant.

..... [1]

(b) State one environmental problem caused by producing sulfur dioxide as an atmospheric pollutant.

..... [1]

(c) Sulfur dioxide produced at power stations can be removed by a process called flue gas desulfurisation.

In flue gas desulfurisation, sulfur dioxide reacts with calcium carbonate.

$$CaCO_3(s) + SO_2(g) \longrightarrow CaSO_3(s) + CO_2(g)$$

The reaction needs to be fast to remove as much sulfur dioxide as possible.

(i) Explain, using ideas about particles, why the calcium carbonate needs to be a powder instead of a single solid lump.

.....

.....

..... [2]

(ii) Explain, using ideas about particles, why decreasing the temperature decreases the rate of the reaction between calcium carbonate and sulfur dioxide.

.....

.....

.....

..... [2]

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(d) Sulfur dioxide reacts with oxygen as shown.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

(i) Explain why sulfur dioxide is oxidised in this reaction.

.....

..... [1]

(ii) Explain, using ideas about bond breaking and bond forming, why the reaction is exothermic.

.....

.....

.....

..... [2]

(iii) Explain why the addition of a catalyst increases the rate of this reaction.

.....

..... [1]

[Total: 10]

8 Zinc is a metal.

(a) Coating iron with zinc prevents iron from rusting.

Explain how a coating of zinc prevents iron from rusting when the coating is scratched.

.....

.....

.....

..... [2]

(b) Zinc has metallic bonding.

(i) Describe, with the aid of a labelled diagram, the metallic bonding in solid zinc.

.....

.....

.....

[2]

(ii) Explain why zinc is a good conductor of electricity.

.....

..... [1]

(c) One of the stages in the extraction of zinc involves electrolysis.

At the cathode, zinc ions, Zn^{2+}, are changed into zinc atoms.

At the anode, hydroxide ions, OH^-, are changed into oxygen molecules and water molecules.

Write the ionic equations for the reactions at the cathode and at the anode.

cathode .....

anode .....

[2]

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(d) A sample of 2.34 g of zinc is reacted with 50.0 cm^3 of 2.00 mol / dm^3 hydrochloric acid.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Show by calculation that the hydrochloric acid is in excess in this reaction.

[3]

[Total: 10]

9 Alkanes are a homologous series of saturated hydrocarbons.

(a) Draw the structures of two different alkanes with the molecular formula C_4H_{10}.

Show all of the atoms and all of the bonds in each structure.

[2]

(b) State, using the general formula of alkanes, the molecular formula of an alkane which has only 12 carbon atoms in its molecule.

..... [1]

(c) Many alkanes are separated from petroleum (crude oil) by fractional distillation.

Describe the fractional distillation of petroleum (crude oil).

.....

.....

.....

.....

.....

.....

..... [3]

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(d) Butane, C_4H_{10}, reacts with chlorine to give several products.

(i) State the condition needed for this substitution reaction.

..... [1]

(ii) One of these products contains 37.8% carbon by mass, 6.30% hydrogen by mass and 55.9% chlorine by mass.

Calculate the empirical formula of the product.

Deduce the molecular formula of the product.

empirical formula .....

molecular formula .....
[3]

[Total: 10]

10 Nitric acid, HNO_3, is used to make fertilisers.

(a) Nitric acid is manufactured from ammonia.

In the first step, ammonia reacts with oxygen.

Balance this equation.

..... NH_3 + ... O_2 $\rightarrow$ ..... NO + ... H_2O [1]

(b) Nitric acid is used to make the soluble salt potassium nitrate, KNO_3.

(i) Name the alkali that reacts with dilute nitric acid to make potassium nitrate.

..... [1]

(ii) Describe the experimental procedure used to make colourless aqueous potassium nitrate from the alkali and dilute nitric acid.

.....

.....

.....

.....

..... [2]

(iii) Calculate the percentage by mass of nitrogen in potassium nitrate.

percentage = ... [2]

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(c) Fertilisers leach into rivers and cause water pollution problems.

(i) Name one **other** pollutant found in river water.

..... [1]

(ii) State **three** processes used in the purification of river water to produce drinking water.

.....

.....

..... [3]

[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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).