Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1548165264

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2020**

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. 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 these questions.

aluminium sulfate
ammonia
calcium carbonate
carbon dioxide
chlorofluorocarbons
copper(II) sulfate
hydrogen chloride
potassium nitrate
sodium chloride

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

Which compound:

(a) is a gas which dissolves in water to form an alkaline solution

..... [1]

(b) is an anhydrous solid which is used to test for water

..... [1]

(c) contains ions with a 3+ charge

..... [1]

(d) is a solid used in flue gas desulfurisation

..... [1]

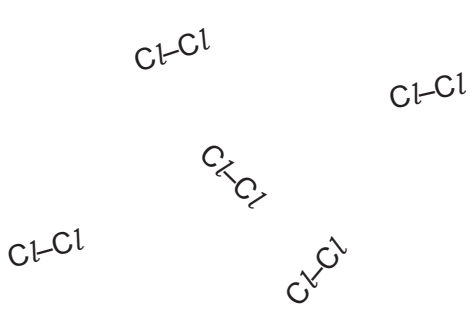
(e) causes eutrophication?

..... [1]

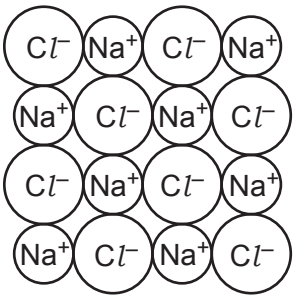
[Total: 5]

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2 Part of the structures of chlorine and sodium chloride are shown.



chlorine



sodium chloride

(a) Explain in terms of structure and bonding why chlorine has a low boiling point and sodium chloride has a high boiling point.

.....

.....

.....

.....

.....

..... [3]

(b) Write the electronic configuration of a chlorine atom.

..... [1]

(c) The electrolysis of molten sodium chloride is carried out using graphite electrodes.

(i) State the meaning of the term *electrolysis*.

.....

..... [1]

(ii) State the direction of movement of both the positive and negative ions when molten sodium chloride is electrolysed.

positive ions .....

negative ions .....
[1]

(iii) State one observation that can be made at the positive electrode when molten sodium chloride is electrolysed.

..... [1]

(iv) Give the formulae of the two negative ions present in aqueous sodium chloride.

..... [1]

(d) When aqueous sodium chloride is electrolysed, hydrogen is produced at the negative electrode.

Explain, in terms of transfer of electrons, why hydrogen and **not** sodium is produced at the negative electrode.

.....

..... [1]

(e) A 36.3 g sample of a compound contains 14.4 g carbon, 0.600 g hydrogen and 21.3 g chlorine.

(i) Calculate the empirical formula of this compound.

[2]

(ii) The relative molecular mass of this compound is 181.5.

Deduce the molecular formula of this compound.

[1]

[Total: 12]

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3 **(a)** A drop of black ink is placed at the bottom of a beaker of water.

After a time, the colour of the ink spreads throughout the water.

Explain this observation in terms of the kinetic particle theory.

.....

.....

.....

.....

..... [3]

(b) In the past, ink was made from a mixture containing iron(II) ions and tannic acid.

(i) Describe a test for iron(II) ions.

test .....

observations .....
[2]

(ii) The ink darkens when used on paper. This is because iron(II) ions are oxidised to iron(III) ions.

Write the ionic equation for this reaction.

..... [1]

(iii) After a time, the ink fades because of a hydrolysis reaction which is catalysed by acids.

State how a catalyst increases the rate of a chemical reaction.

.....

..... [1]

(c) Paper is made of cellulose.

Cellulose is a complex carbohydrate (polysaccharide).

(i) Name one other complex carbohydrate (polysaccharide).

..... [1]

(ii) Describe how complex carbohydrates can be hydrolysed to simple sugars.

.....

..... [2]

[Total: 10]

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4 Water from natural sources contains dissolved substances which are not pollutants, such as mineral salts.

(a) Name another substance found naturally in water which is **not** a mineral salt or a pollutant.

..... [1]

(b) When lithium reacts with water, aqueous lithium hydroxide, LiOH, and hydrogen are formed.

Construct the equation for this reaction.

..... [1]

(c) Sodium and potassium react with water in a similar way to lithium.

(i) Explain, in terms of their electronic configuration, why lithium, sodium and potassium all react in a similar way.

.....

..... [1]

(ii) Describe the trend in reactivity of the Group I elements lithium, sodium and potassium.

..... [1]

(d) Water and oxygen are formed when aqueous hydrogen peroxide decomposes.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Calculate the maximum volume of oxygen, at room temperature and pressure, which is produced by the complete decomposition of a solution containing 16.0 g of hydrogen peroxide.

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

volume of oxygen ..... dm^3 [3]

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(e) A fuel cell generates electricity when hydrogen and oxygen react on platinum electrodes.

(i) Name a process used in industry to produce hydrogen.

..... [1]

(ii) Some cars use a hydrogen–oxygen fuel cell instead of a petrol (gasoline) engine as a source of energy.

Describe two advantages of a hydrogen–oxygen fuel cell compared with a petrol (gasoline) engine.

1. .....

2. .....
[2]

[Total: 10]

5 Alkenes are made in an oil refinery by cracking hydrocarbons.

(a) (i) Give one **other** reason why petroleum companies carry out cracking.

.....

..... [1]

(ii) Complete the equation for the cracking of tridecane, $C_{13}H_{28}$, to form propene, C_3H_6, and one other hydrocarbon.

$$C_{13}H_{28} \rightarrow C_3H_6 + \text{.....} \quad [1]$$

(b) Propene is an alkene.

(i) Write the general formula for an alkene.

..... [1]

(ii) Propene reacts with steam by an addition reaction.

Predict the molecular formula of the product of this reaction.

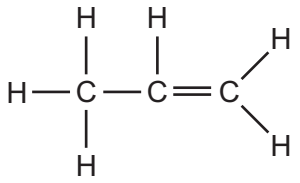
..... [1]

(iii) When propene undergoes incomplete combustion, a small amount of carbon dioxide is formed.

Name two **other** substances formed when propene undergoes incomplete combustion.

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

(c) The structure of propene is shown.



Deduce the partial structure of poly(propene) to show three repeat units.

[2]

[Total: 8]

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Section B

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

The total mark for this section is 30.

6 Methanoic acid and ethanoic acid are weak acids.

(a) What does the term *weak* mean, when applied to acids?

.....

..... [1]

(b) Methanoic acid, HCO_2H, reacts with magnesium powder.

(i) Construct the equation for this reaction.

..... [1]

(ii) State and explain how the rate of this reaction changes when the experiment is repeated using a piece of magnesium ribbon with the same mass as the powder.

All other conditions stay the same.

Include in your answer ideas about collisions between particles.

.....

.....

..... [2]

(c) Methanoic acid reacts with propanol, C_3H_7OH, to form an ester.

Name and draw the structure of this ester, showing all of the atoms and all of the bonds.

name .....

structure

[2]

(d) Ethanoic acid is present in vinegar.

(i) Name the organic compound which is converted to ethanoic acid when vinegar is made.

..... [1]

(ii) What type of chemical reaction is this?

..... [1]

(e) The table shows some properties of four carboxylic acids.

carboxylic acid	formula	density in g/cm^3	boiling point in °C
methanoic acid	HCO_2H	1.22	101
ethanoic acid	CH_3CO_2H		118
propanoic acid	$C_2H_5CO_2H$	0.99	141
butanoic acid	$C_3H_7CO_2H$	0.96	164

(i) Predict the density of ethanoic acid.

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

(ii) Describe and explain the change in the boiling point as the number of carbon atoms in a molecule increases.

.....

..... [1]

[Total: 10]

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7 Iron is extracted from iron ore in a blast furnace using limestone and coke (carbon).

(a) Name a common ore of iron.

..... [1]

(b) The coke burns to form carbon dioxide.

This reaction is exothermic.

Explain, in terms of bond making and bond breaking, why this reaction is exothermic.

.....

.....

..... [2]

(c) Carbon dioxide reacts with hot coke to form carbon monoxide.

The carbon monoxide reduces the iron(III) oxide in the iron ore.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) Use this equation to explain why the Fe_2O_3 is reduced.

.....

..... [1]

(ii) Calculate the maximum mass of iron formed when 12.5 g of iron(III) oxide react with excess carbon monoxide.

mass of iron ..... g
[2]

(d) Silicon dioxide is an impurity in the iron ore.

Explain how the addition of limestone helps remove silicon dioxide from the blast furnace.

.....

.....

.....

..... [2]

(e) Iron is a metal.

Describe metallic bonding.

.....

.....

..... [2]

[Total: 10]

8 This question is about some compounds of sulfur.

(a) Dilute sulfuric acid reacts with aqueous sodium hydroxide as shown.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(i) A student titrates 25.0 cm^3 of dilute sulfuric acid with sodium hydroxide of concentration 0.0150 mol/dm^3, using litmus as an indicator.

A volume of 24.0 cm^3 of aqueous sodium hydroxide reacts exactly with the dilute sulfuric acid.

Calculate the concentration of the dilute sulfuric acid.

concentration of dilute sulfuric acid ..... mol/dm^3
[3]

(ii) Describe how to prepare pure dry crystals of sodium sulfate from aqueous sodium sulfate.

.....

.....

.....

.....

..... [3]

(b) Concentrated sulfuric acid oxidises arsenic to arsenic(III) oxide.

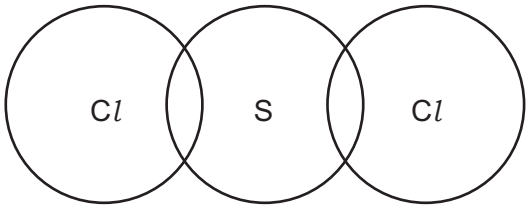
Complete the equation for this reaction.

$$.....As + ...H_2SO_4 \rightarrow As_4O_6 + ...H_2O + 6SO_2$$ [1]

(c) Sulfur dichloride, C*l* — S — C*l*, has a simple molecular structure.

Complete the dot-and-cross diagram for a molecule of sulfur dichloride.

Include only the outer shell electrons.



[1]

(d) The melting point of sulfur dichloride is –121 °C.
The boiling point of sulfur dichloride is 59 °C.

Deduce the state of sulfur dichloride at room temperature.

Give a reason for your answer.

.....

..... [2]

[Total: 10]

Question 9 starts on the next page.

9 Lead is a metal in Group IV of the Periodic Table.

(a) An ion of lead has the symbol

$$^{207}_{82}Pb^{2+}$$

Deduce the number of electrons and neutrons in this ion.

number of electrons .....

number of neutrons .....
[2]

(b) Lead(IV) oxide, PbO_2, is an oxidising agent.

(i) Describe a test for oxidising agents.

test .....

observations .....
[2]

(ii) Lead(IV) oxide reacts with concentrated hydrochloric acid to form lead(IV) chloride, $PbCl_4$, and water.

Construct the equation for this reaction.

..... [1]

(c) When lead(IV) chloride is warmed in a closed container an equilibrium mixture is formed.

The forward reaction is exothermic.

$$PbCl_4(l) \rightleftharpoons PbCl_2(s) + Cl_2(g)$$

lead(IV) chloride lead(II) chloride

(i) Describe and explain the effect, if any, on the position of equilibrium when the concentration of chlorine is increased.

.....

.....

..... [2]

(ii) Describe and explain the effect, if any, on the position of equilibrium when the temperature is increased.

.....

.....

..... [2]

(d) Name a lead salt which is soluble in water.

..... [1]

[Total: 10]

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The Periodic Table of Elements

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 –		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.).