Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0388144004

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2021**

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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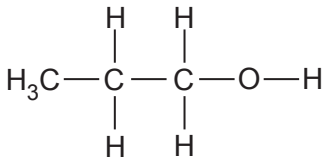
Section A

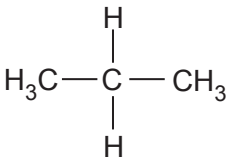
Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

1 Choose from the following compounds to answer the questions.



A



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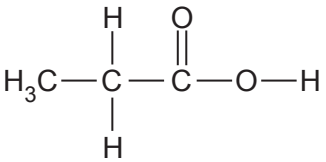

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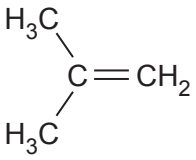

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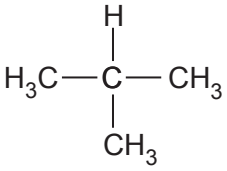

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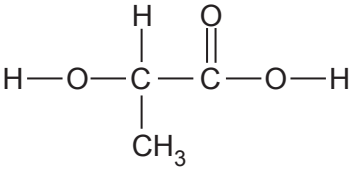

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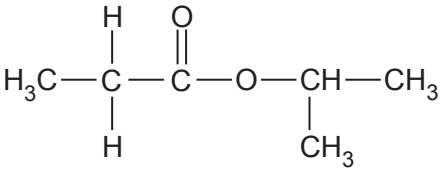


G

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

(a) State which compound:

(i) has a molecule with only 14 atoms

..... [1]

(ii) can be oxidised to form propanoic acid

..... [1]

(iii) is an isomer of butane

..... [1]

(iv) reacts with steam to make an alcohol

..... [1]

(v) can be polymerised to make a polyester.

..... [1]

(b) State which **two** compounds in aqueous solution turn blue litmus red.

..... [1]

[Total: 6]

2 Helium, neon, argon, krypton, xenon and radon are noble gases in Group VIII.

(a) Name the noble gas which has the greatest volume composition in air.

..... [1]

(b) State one use for helium.

..... [1]

(c) Radon is very unreactive.

Use the electronic structure of radon to explain why.

.....

..... [1]

(d) Two isotopes of radon are shown.

$^{220}_{86}Rn$ $^{222}_{86}Rn$

(i) Give one similarity in the atomic structure of these two isotopes.

..... [1]

(ii) Give one difference in the atomic structure of these two isotopes.

..... [1]

(e) Xenon forms a compound that contains only xenon, oxygen and fluorine.

The compound contains 22.1% oxygen by mass and 17.5% fluorine by mass.

Calculate the empirical formula of this compound.

empirical formula ..... [3]

(f) A sample of neon has a volume of 21 dm^3 at room temperature and pressure.

(i) The temperature of the sample is increased.

The pressure remains constant.

Describe and explain, using kinetic particle theory, what happens to the volume of the sample.

.....

..... [1]

(ii) The pressure of the sample is increased.

The temperature remains constant.

Describe and explain, using kinetic particle theory, what happens to the volume of the sample.

.....

..... [1]

(iii) Calculate the mass of neon in the 21 dm^3 sample.

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

mass ..... g [2]

[Total: 12]

3 Petroleum (crude oil) is a mixture of hydrocarbons.

(a) Petroleum (crude oil) is separated into fractions such as liquefied petroleum gas, petrol (gasoline) and naphtha.

(i) Name the process used to separate petroleum (crude oil) into fractions.

..... [1]

(ii) Name one **other** fraction separated from petroleum (crude oil).

Give a large-scale use for this fraction.

fraction .....

use .....
[1]

(iii) Petroleum (crude oil) does not contain enough of the fractions that contain smaller hydrocarbon molecules such as petrol (gasoline).

Petroleum contains a high proportion of larger hydrocarbon molecules such as naphtha.

Describe how the demand for smaller hydrocarbon molecules is satisfied.

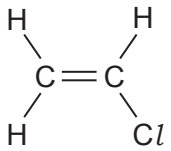
.....

.....

.....

..... [2]

(b) The structure of chloroethene is shown.



Chloroethene is the monomer used to make poly(chloroethene).

Poly(chloroethene) is non-biodegradable.

(i) Explain the meaning of the term *non-biodegradable*.

.....

..... [1]

(ii) Describe one environmental problem caused by the disposal of non-biodegradable plastics.

.....

..... [1]

(iii) Draw the partial structure of poly(chloroethene).

Show at least **two** repeat units.

[2]

(iv) A factory uses 100 tonnes of chloroethene to make poly(chloroethene).

Deduce the mass of poly(chloroethene) made. Assume the percentage yield is 100%.

Explain your answer.

.....

..... [1]

(v) Chloroethene reacts with hydrogen in the presence of a catalyst.

Suggest the structure of the product of this reaction.

[1]

[Total: 10]

4 Copper(II) chloride, copper(II) iodide and copper(II) carbonate are ionic compounds.

(a) Predict two physical properties, other than electrical conductivity, of copper(II) chloride.

1. .....

2. .....
[2]

(b) Copper is a transition element.

Suggest **one** property of copper(II) chloride that is characteristic of a compound of a transition element.

..... [1]

(c) Copper reacts with chlorine to make copper(II) chloride.

$$Cu + Cl_2 \longrightarrow CuCl_2$$

Copper(II) chloride contains Cu^{2+} and Cl^- ions.

Explain, in terms of the movement of electrons, how $CuCl_2$ is formed from copper atoms and chlorine molecules.

.....

.....

..... [2]

(d) Copper(II) iodide decomposes to make iodine and copper(I) iodide.

The ionic equation for this reaction is shown.

$$2Cu^{2+} + 4I^- \longrightarrow 2CuI + I_2$$

(i) Use the information to explain that oxidation takes place.

.....

..... [1]

(ii) Use the information to explain that reduction takes place.

.....

..... [1]

(e) A sample of copper(II) carbonate is heated strongly.

Name the products of this reaction.

..... [1]

[Total: 8]

5 Iron pyrite, FeS_2, is an ore of iron.

When heated in air, FeS_2 produces both iron(III) oxide and sulfur dioxide.

(a) Balance the equation shown.

……. FeS_2 + ……. O_2 → ……. Fe_2O_3 + ……. SO_2 [1]

(b) Describe one environmental problem caused by sulfur dioxide in the air.

..... [1]

(c) Describe how sulfur dioxide is converted into sulfuric acid in the contact process.

.....

.....

.....

.....

..... [3]

(d) State one **other** use of sulfur dioxide.

..... [1]

(e) Iron(III) oxide, coke, limestone and hot air are heated together in a blast furnace to make molten iron.

Describe the function in the blast furnace of:

(i) coke

.....

..... [1]

(ii) limestone

.....

..... [1]

(iii) hot air.

.....

..... [1]

[Total: 9]

Section B

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

The total mark for this section is 30.

6 Carbon dioxide and water vapour are greenhouse gases found in air.

(a) (i) Name one **other** greenhouse gas.

..... [1]

(ii) State **one** environmental problem that may be caused by an increase in the percentage of carbon dioxide in the air.

..... [1]

(b) Draw the dot-and-cross diagram to show the bonding in a molecule of carbon dioxide.

Only show the outer shell electrons.

[1]

(c) Some power stations burn methane, CH_4.

Construct the equation to show the complete combustion of methane.

..... [1]

(d) The carbon dioxide made in power stations can be removed by a reversible reaction with water.

$$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$$

The forward reaction is exothermic.

(i) The concentration of carbon dioxide is increased.

The temperature is kept constant.

Predict and explain how the position of equilibrium changes.

.....

.....

..... [2]

(ii) The temperature of the water is increased.

All other conditions are kept constant.

Predict and explain how the position of equilibrium changes.

.....

.....

..... [2]

(e) Carbonic acid, $H_2CO_3(aq)$, is a weak acid.

(i) What is the meaning of the term *weak* in weak acid?

.....

..... [1]

(ii) Carbonic acid contains a small concentration of carbonate ions, $CO_3^{2-}(aq)$.

If carbonic acid is pumped deep underground, the $CO_3^{2-}(aq)$ will react with metal ions to form insoluble carbonates.

Write the ionic equation for the reaction of magnesium ions with $CO_3^{2-}(aq)$.

..... [1]

[Total: 10]

[Turn over

7 Aqueous ammonium nitrite, $NH_4NO_2(aq)$, decomposes when heated, as shown.

$$NH_4NO_2(aq) \longrightarrow N_2(g) + 2H_2O(l)$$

(a) A 25.0 cm^3 sample of 0.150 mol / dm^3 $NH_4NO_2(aq)$ is heated.

Calculate the maximum volume, in dm^3, of nitrogen formed, measured at room temperature and pressure.

volume of nitrogen ..... dm^3 [2]

(b) The concentration of $NH_4NO_2(aq)$ is decreased.

The temperature of the reaction remains constant.

State and explain how the rate of reaction changes.

.....

.....

.....

.....

..... [3]

(c) NH_4NO_2 contains the ammonium ion, NH_4^+, and the nitrite ion.

A mixture of aqueous calcium hydroxide and $NH_4NO_2(s)$ is warmed.

Calcium nitrite, water and a gas are formed. The gas turns damp red litmus paper blue.

Construct the equation for this reaction.

..... [3]

(d) $NH_4NO_2(aq)$ is added to a sample of aqueous potassium iodide.

A brown solution is formed.

(i) Name the brown solution.

..... [1]

(ii) Name the type of reaction that causes this brown solution to form.

..... [1]

[Total: 10]

8 Silver is a transition element with proton number 47.

(a) Use the Periodic Table to state the number of occupied electron shells in an atom of silver.

..... [1]

(b) Describe, with the aid of a diagram, the metallic bonding in silver.

.....

.....

.....

..... [3]

(c) Give two physical properties of silver that are **only** characteristic of transition elements but **not** of all metals.

1. .....

2. .....
[1]

(d) Silver nitrate is a white crystalline soluble salt.

Name a suitable combination of an acid and an insoluble base which is used to prepare silver nitrate.

acid .....

base .....
[1]

(e) Aqueous silver nitrate, $AgNO_3(aq)$, is electrolysed using inert electrodes.

The products of the electrolysis are silver and oxygen.

(i) Silver ions are reduced at the cathode to make silver atoms.

Construct the ionic equation for this reduction.

..... [1]

(ii) Hydroxide ions are oxidised at the anode to make both oxygen molecules and water molecules.

Construct the ionic equation for this oxidation.

..... [1]

(iii) Explain why solid silver nitrate cannot be electrolysed.

.....

..... [1]

(f) Acidified aqueous silver nitrate reacts with aqueous sodium iodide.

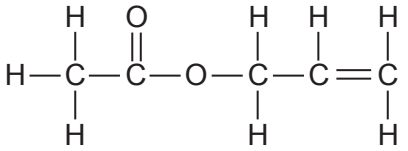
State the observations for this reaction.

..... [1]

[Total: 10]

[Turn over

9 The structure of propenyl ethanoate is shown.



(a) Use the structure to explain why propenyl ethanoate is unsaturated.

.....

..... [1]

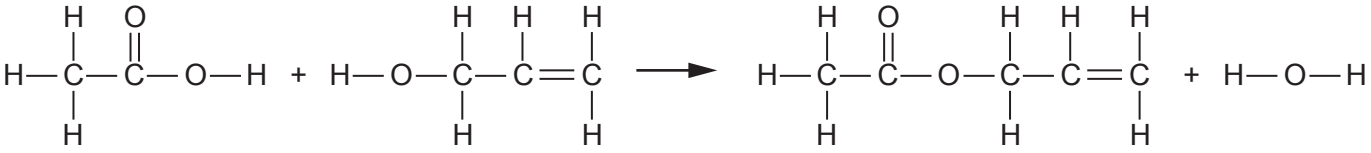
(b) Describe a chemical test to show that propenyl ethanoate is unsaturated.

test .....

observation .....

.....
[2]

(c) Propenyl ethanoate is prepared by the reaction between a carboxylic acid and an alcohol, as shown.



(i) Name the carboxylic acid used.

..... [1]

(ii) The reaction uses concentrated sulfuric acid as a catalyst.

Describe how a catalyst speeds up a chemical reaction.

.....

.....

..... [2]

(d) In an experiment 11.6 g of the alcohol is reacted with an excess of the carboxylic acid. The experimental yield of propenyl ethanoate is 6.72 g.

[The relative formula mass of propenyl ethanoate is 100.]

(i) Show that the maximum possible yield of propenyl ethanoate is 20.0 g.

[3]

(ii) Calculate the percentage yield of propenyl ethanoate in this experiment.

% yield ..... [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 –		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.).