Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTER NUMBER	
CANDIDATE NUMBER	

7050183076

CHEMISTRY (US) **0439/43**

Paper 4 Theory (Extended) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Center number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

1 The following are the symbols and formulae of some elements and compounds.

Ar $Ca(OH)_2$ Cl_2 CO_2 Cu Fe SO_2 V_2O_5

Answer the following questions using only the elements or compounds in the list.
Each element or compound may be used once, more than once or not at all.

State which element or compound is used:

(a) to kill bacteria in drinking water ..... [1]

(b) as a food preservative ..... [1]

(c) as an electrical conductor in cables ..... [1]

(d) as an inert atmosphere in lamps ..... [1]

(e) to neutralize excess acidity in soil ..... [1]

(f) as a catalyst in the Contact process. ..... [1]

[Total: 6]

2 **(a)** ^{29}Al is a radioactive isotope of aluminum. The only non-radioactive isotope of aluminum is ^{27}Al.

(i) Describe, in terms of protons, neutrons and electrons, how the isotopes ^{29}Al and ^{27}Al are similar and how they are different.

how they are similar .....

how they are different .....
[2]

(ii) Complete the table to show the number of nucleons, neutrons and electrons in an $^{27}_{13}Al^{3+}$ ion.

	number in $^{27}_{13}Al^{3+}$
nucleons	
neutrons	
electrons	

[3]

(b) Aluminum is extracted from its ore by electrolysis.

(i) Name the main ore of aluminium.

..... [1]

(ii) Why is aluminum **not** extracted from its ore by reduction with carbon?

..... [1]

(iii) The main ore of aluminum contains aluminum oxide. Aluminum oxide is dissolved in molten cryolite before it is electrolyzed.

Give **two** reasons, other than cost, why cryolite is used.

1 .....

2 .....
[2]

[Turn over

(iv) The reaction at the anode during the extraction of aluminum by electrolysis is shown.

$$2O^{2-} \rightarrow O_2 + 4e^-$$

Is this process oxidation or reduction?
Give a reason for your answer.

..... [1]

(v) During the extraction of aluminum by electrolysis, carbon dioxide is formed at the anode.

Explain how carbon dioxide is formed at the anode.

.....

..... [2]

(c) When a piece of zinc metal is added to copper(II) sulfate solution there is an immediate reaction.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

When a piece of aluminum metal is added to copper(II) sulfate solution the initial reaction is very slow.

(i) Explain why zinc metal reacts with copper(II) sulfate.

..... [1]

(ii) What type of reaction is this?

..... [1]

(iii) Explain why the initial reaction between aluminum metal and copper(II) sulfate is very slow.

..... [1]

[Total: 15]

3 Cobalt is a transition element. Potassium is in Group I of the Periodic Table.

(a) State **one** physical property that is similar for cobalt and potassium.

..... [1]

(b) (i) State **one** physical property that is different for cobalt and potassium.

..... [1]

(ii) Describe how the physical property given in **(b)(i)** is different for cobalt compared to potassium.

..... [1]

(c) When a small piece of potassium is added to cold water, the potassium floats and disappears as it reacts.

Give **two** other observations that would be made when a small piece of potassium is added to cold water.

1 .....

2 .....
[2]

(d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.

(i) Describe a test for hydrogen.

test .....

result .....
[2]

(ii) The rate of reaction of cobalt with dilute hydrochloric acid can be made faster by heating the acid or by increasing its concentration.

State **one** other way to make the rate of reaction faster.

..... [1]

(iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

.....

.....

.....

.....

..... [3]

[Turn over

(e) When cobalt(II) chloride is added to water an equilibrium is established.

$$[CoCl_4]^{2-} + 6H_2O \rightleftharpoons [Co(H_2O)_6]^{2+} + 4Cl^-$$

blue pink

(i) A student adds water to a blue solution containing $[CoCl_4]^{2-}$ ions.

Describe what the student observes. Give a reason for your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

(ii) Another student cools a blue solution containing $[CoCl_4]^{2-}$. The blue solution turns pink.

What does this information indicate about the forward reaction?

.....

..... [1]

(f) Another compound of cobalt is $Co(OH)_3$.

Deduce the charge on the cobalt ion in $Co(OH)_3$.

..... [1]

[Total: 15]

4 Ethanol is a member of the homologous series of alcohols.

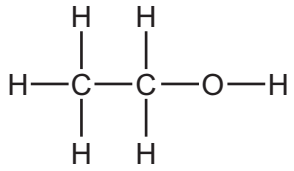
(a) Give **two** characteristics of members of a homologous series.

1 .....

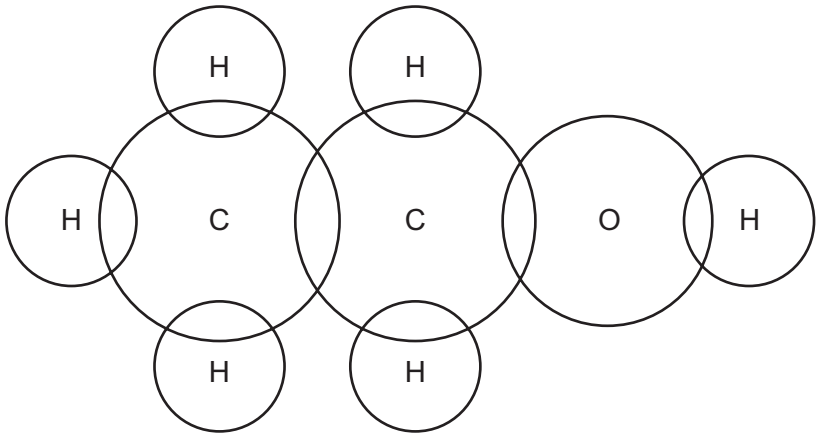
2 .....

[2]

(b) The structure of ethanol is shown.



Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanol. Show outer shell electrons only.



[2]

(c) Ethanol can be produced by the catalytic addition of steam to ethene or by the fermentation of glucose.

(i) Write a chemical equation for the production of ethanol by the catalytic addition of steam to ethene.

..... [1]

(ii) Write a chemical equation for the production of ethanol by the fermentation of glucose, $C_6H_{12}O_6$.

..... [1]

(iii) State **one** advantage of producing ethanol by the catalytic addition of steam to ethene. Your answer must **not** refer to cost.

..... [1]

(iv) State **one** advantage of producing ethanol by the fermentation of glucose. Your answer must **not** refer to cost.

..... [1]

[Turn over

(d) Ethanol can be oxidized to ethanoic acid.

State the chemical reagent needed to oxidize ethanol to ethanoic acid.

..... [1]

(e) Ethanoic acid reacts with ethanol in the presence of an acid catalyst. The products are an organic compound and water.

(i) Draw the structure of the organic compound formed. Show all of the atoms and all of the bonds.

[2]

(ii) State the name of the organic compound formed.

..... [1]

(iii) Which homologous series does the organic compound formed belong to?

..... [1]

(f) Ethanoic acid, CH_3COOH, is a weak acid. It reacts with copper(II) carbonate to form the salt copper(II) ethanoate, $Cu(CH_3COO)_2$.

(i) What is meant by the term *weak* when applied to acids?

..... [1]

(ii) Describe how a crystalline sample of copper(II) ethanoate can be prepared starting with ethanoic acid and copper(II) carbonate.

.....

.....

.....

.....

.....

..... [3]

(iii) Write the word equation for the reaction between ethanoic acid and copper(II) carbonate.

..... [1]

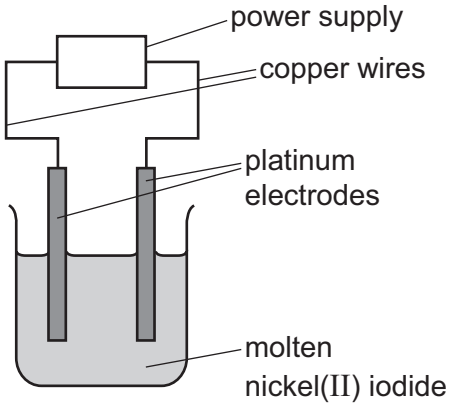
[Total: 18]

5 **(a)** Nickel(II) iodide crystals are hydrated. A sample of hydrated nickel(II) iodide crystals has the following composition by mass: Ni, 14.01%; I, 60.33%; H, 2.85%; O, 22.81%.

Calculate the empirical formula of the hydrated nickel(II) iodide crystals.

empirical formula = ... [2]

(b) Molten nickel(II) iodide can be electrolyzed using the apparatus shown.



During electrolysis, charge is transferred through the copper wires and through the molten nickel(II) iodide.

(i) Name the type of particles which transfer charge through the copper wires.

..... [1]

(ii) Name the type of particles which transfer charge through the molten nickel(II) iodide.

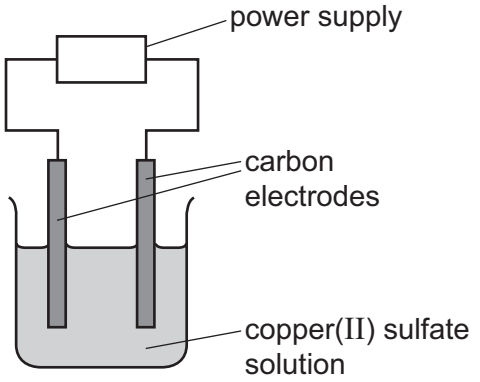
..... [1]

(iii) Predict the products of the electrolysis of molten nickel(II) iodide. Write an ionic half-equation for the formation of **one** of these products.

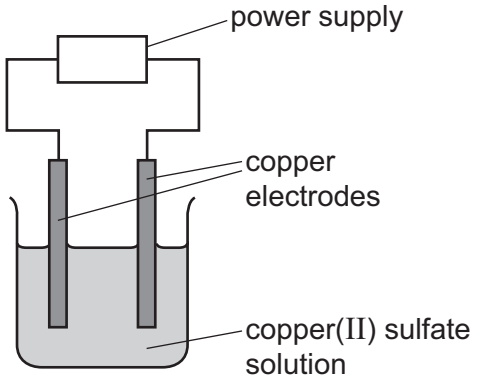
products .....

ionic half-equation .....
[3]

(c) A student electrolyzed copper(II) sulfate solution using the two sets of apparatus shown.



apparatus **A**



apparatus **B**

In apparatus **A** the student used carbon electrodes.
In apparatus **B** the student used copper electrodes.

The student made the following observations.

apparatus **A**	apparatus **B**
The mass of the negative electrode increased.	The mass of the negative electrode increased.
The mass of the positive electrode stayed the same.	The mass of the positive electrode decreased.
Bubbles were seen at the positive electrode.	No bubbles were seen at the positive electrode.

(i) Explain why the mass of the negative electrode increased in **both** sets of apparatus.

.....

..... [1]

(ii) Name the gas that formed the bubbles seen in apparatus **A**.

..... [1]

(iii) Explain why the mass of the positive electrode decreased in apparatus **B**.

.....

..... [1]

(iv) Suggest what happens to the color of the solution in apparatus **A** and apparatus **B** as the electrolysis progresses.
Explain your answer.

color of the solution in apparatus **A** .....

color of the solution in apparatus **B** .....

explanation .....

.....

.....

[3]

[Total: 13]

6 Calcium chlorate(V), $Ca(ClO_3)_2$, is made by reacting calcium hydroxide with chlorine gas.

$$6Ca(OH)_2 + 6Cl_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$$

(a) 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas are mixed together.

(i) How many moles is 8.88 g of calcium hydroxide?

..... mol [2]

(ii) How many moles of chlorine gas is 7200 cm^3?

..... mol [1]

(iii) What is the maximum **number of moles** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... mol [1]

(iv) What is the maximum **mass** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... g [2]

The experiment is repeated using different amounts of calcium hydroxide and chlorine gas. The maximum mass of calcium chlorate(V) that can be made in the experiment is 4.84 g.

(v) The actual mass of calcium chlorate(V) made in the experiment is 3.63 g.

Calculate the percentage yield.

percentage yield = ... % [1]

(b) Calcium chlorate(V) undergoes thermal decomposition.

The only products are calcium chloride and a colorless gas.

(i) What must be done to calcium chlorate(V) to make it thermally decompose?

..... [1]

(ii) Write a chemical equation for the thermal decomposition of calcium chlorate(V).

..... [2]

(c) Chloric(V) acid, $HClO_3$, is a strong acid. It can be made from calcium chlorate(V).

(i) What color is methyl orange indicator in chloric(V) acid?

..... [1]

(ii) Define the term *acid* in terms of proton transfer.

..... [1]

(iii) Complete the chemical equation to show $HClO_3$ behaving as an acid in water.

$$HClO_3 + H_2O \rightarrow \text{.....} + \text{.....}$$

[1]

[Total: 13]

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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 aluminum 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 cesium 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.).