

CANDIDATE
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CHEMISTRY

0620/43

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 Centre 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.

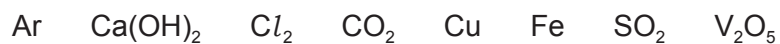
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

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



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 neutralise 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 aluminium. The only non-radioactive isotope of aluminium 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 $^{27}_{13}\text{Al}^{3+}$ ion.

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

[3]

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

(i) Name the main ore of aluminium.

..... [1]

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

..... [1]

(iii) The main ore of aluminium contains aluminium oxide. Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

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

1

2

[2]

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



Is this process oxidation or reduction?

Give a reason for your answer.

..... [1]

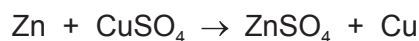
- (v) During the extraction of aluminium by electrolysis, carbon dioxide is formed at the anode.

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.



When a piece of aluminium 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 aluminium 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.

.....

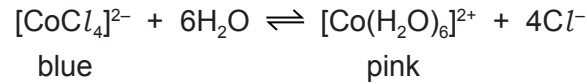
.....

.....

.....

..... [3]

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



(i) A student adds water to a blue solution containing $[\text{CoCl}_4]^{2-}$ 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 $[\text{CoCl}_4]^{2-}$. The blue solution turns pink.

What does this information indicate about the forward reaction?

.....
 [1]

(f) Another compound of cobalt is $\text{Co}(\text{OH})_3$.

Deduce the charge on the cobalt ion in $\text{Co}(\text{OH})_3$.

..... [1]

[Total: 15]

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

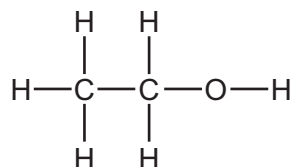
(a) Give **two** characteristics of members of a homologous series.

1

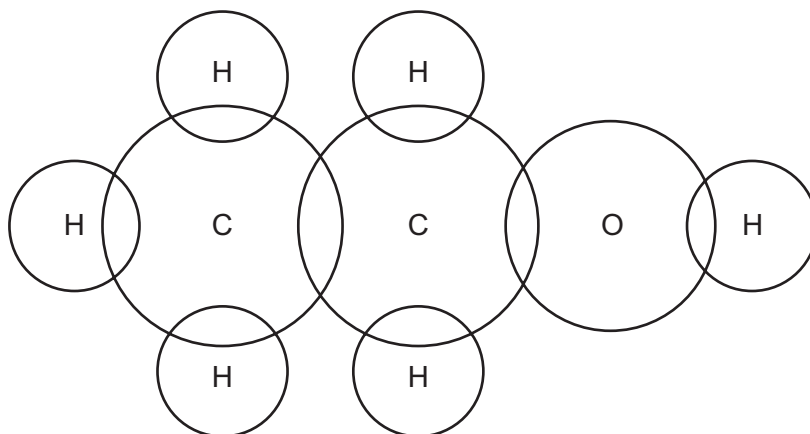
2

[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, $\text{C}_6\text{H}_{12}\text{O}_6$.

..... [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]

- (d) Ethanol can be oxidised to ethanoic acid.

State the chemical reagent needed to oxidise 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, $\text{Cu}(\text{CH}_3\text{COO})_2$.

- (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]

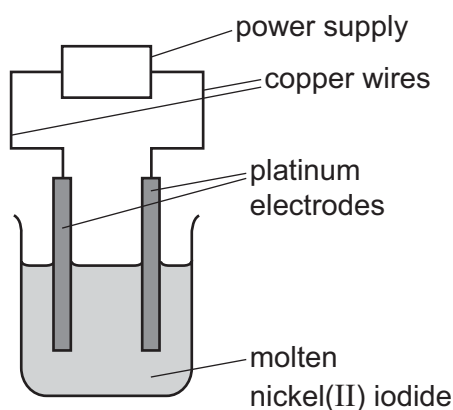
[Total: 18]

- 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 electrolysed 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]

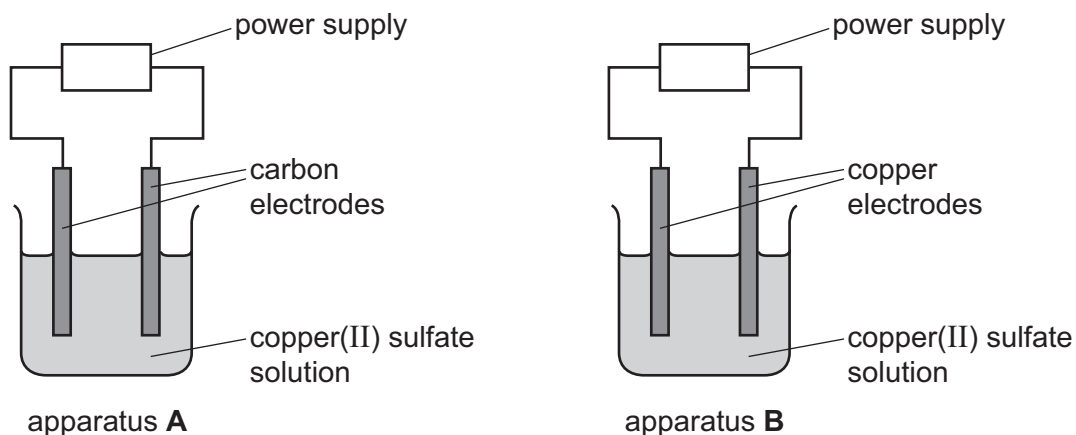
- (iii) Predict the products of the electrolysis of molten nickel(II) iodide. Write an ionic half-equation for the formation of **one** of these products.

products

ionic half-equation

[3]

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



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 colour of the solution in apparatus **A** and apparatus **B** as the electrolysis progresses.
Explain your answer.

colour of the solution in apparatus **A**

colour of the solution in apparatus **B**

explanation

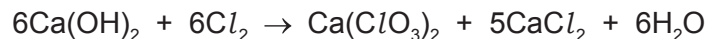
.....

.....

[3]

[Total: 13]

- 6 Calcium chlorate(V), $\text{Ca}(\text{ClO}_3)_2$, is made by reacting calcium hydroxide with chlorine gas.



- (a) 8.88 g of calcium hydroxide and 7200 cm³ 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 cm³?

..... 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 cm³ 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 cm³ 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 colourless 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 colour 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.



[1]

[Total: 13]

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The Periodic Table of Elements

		Group																																				
I	II	III	IV	V	VI	VII	VIII																															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																					
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36											
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86			
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222			
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	
Fr francium	Ra radium	Ac actinium	Rf rutherfordium	Db dubnium	Sg seaborgium	Bh bohrium	Hs hassium	Mt meitnerium	Ds darmstadtium	Rg roentgenium	Cn copernicium	Fl flerovium	Lv livermorium	Uu ununoctium	Uub unubium	Uuc unucium	Uud unudium	Uue unuectium	Uuq unquadium	Uur unrutherfordium	Uus unseptium	Uuh unhassium	Uuo unoscium	Uuq unquadium	Uur unrutherfordium	Uus unseptium	Uuh unhassium	Uuo unoscium	Uuq unquadium	Uur unrutherfordium	Uus unseptium	Uuh unhassium	Uuo unoscium	Uuq unquadium	Uur unrutherfordium	Uus unseptium	Uuh unhassium	Uuo unoscium

Key

atomic number
atomic symbol
name
relative atomic mass

1
H
hydrogen
1

lanthanoids

actinoids

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac actinium	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).