



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTER
NUMBER

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CHEMISTRY (US)

0439/21

Paper 2

October/November 2013

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 in the spaces at the top of this page.

Write in dark blue or black pen.

You may need to use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, 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.



1 (a) Choose from the list of elements below to answer the following questions.

- calcium
- helium
- iodine
- nickel
- nitrogen
- sodium
- sulfur

Each element can be used once, more than once or not at all.

Which element:

- (i) is an element present in most fertilizers, [1]
- (ii) is in Group VI of the Periodic Table, [1]
- (iii) is in Period 5 of the Periodic Table, [1]
- (iv) has a single electron shell containing two electrons, [1]
- (v) is a transition element, [1]
- (vi) forms ions with a single negative charge? [1]

(b) What is the meaning of the term *element*?

.....

..... [1]

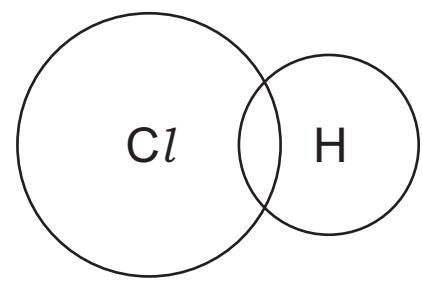
(c) Many of the elements in the Periodic Table have metallic properties. Describe **three** physical properties which are typical of most metals.

- 1.
- 2.
- 3. [3]

[Total: 10]

2 Hydrogen chloride is an acidic gas.

(a) (i) Complete the dot and cross diagram to show the electronic structure of hydrogen chloride.



[2]

(ii) Is hydrogen chloride a covalent or an ionic compound? Give a reason for your answer.

..... [1]

(b) Hydrogen chloride reacts with water to form hydrochloric acid. Which one of the following is the most likely pH of hydrochloric acid? Put a ring around the correct answer.

- pH 2
- pH 7
- pH 9
- pH 14

[1]

(c) Hydrochloric acid reacts with both metal oxides and carbonates.

(i) Complete the word equation for the reaction of hydrochloric acid with calcium carbonate.

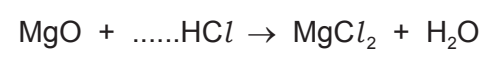
hydrochloric + calcium → + +

acid carbonate

.....

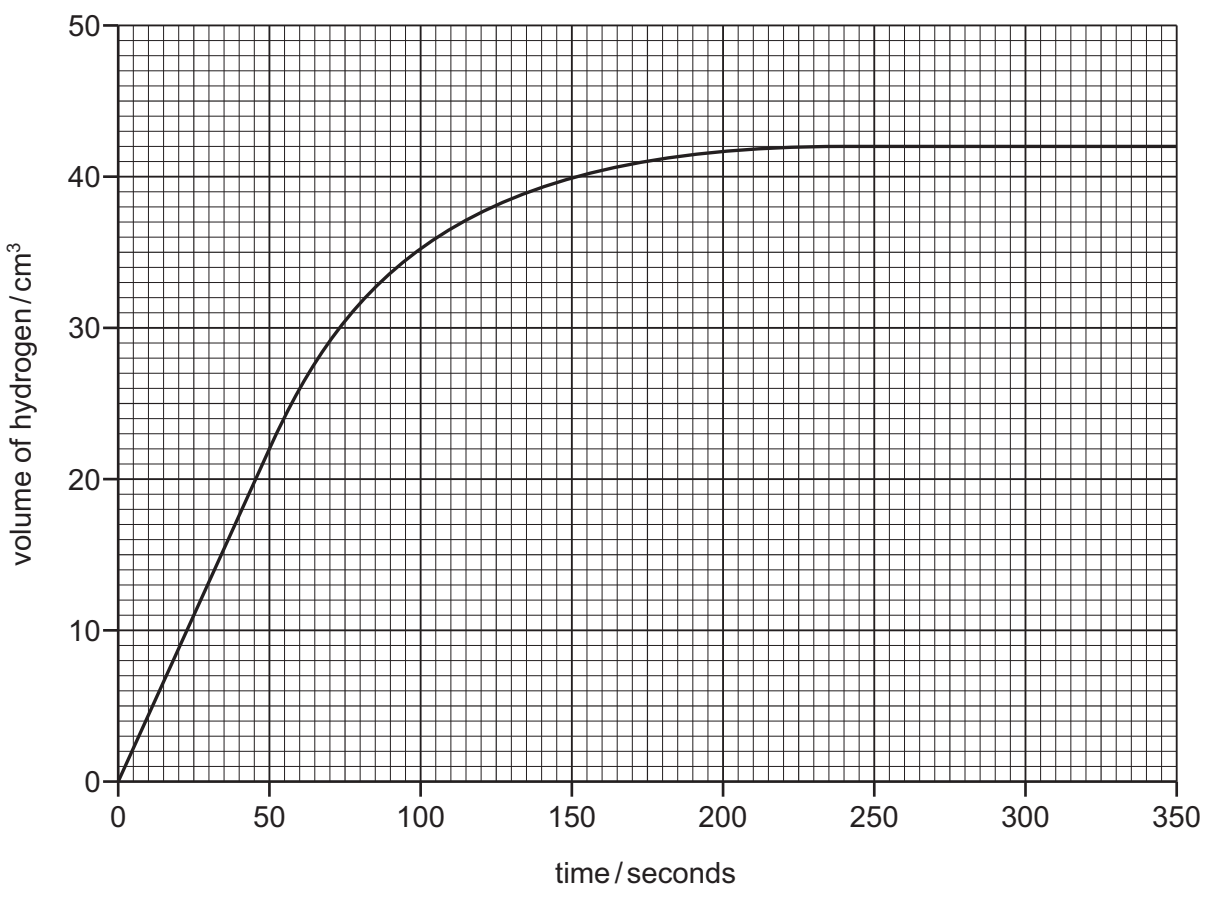
[3]

(ii) Complete the symbol equation for the reaction of magnesium oxide with hydrochloric acid. Name the salt which is formed.



name of salt [2]

(d) A student reacted magnesium with hydrochloric acid to find out how concentration affects the rate of reaction. The magnesium was in excess. He measured the volume of hydrogen produced at various time intervals. The graph shows his results.

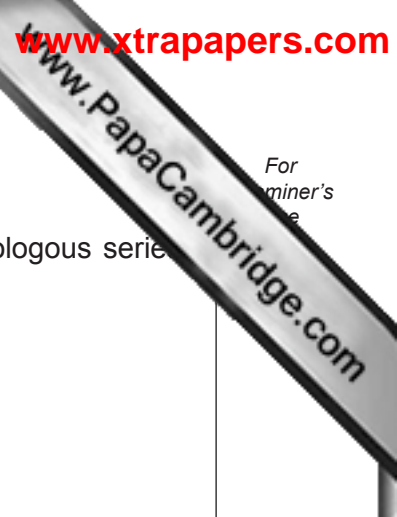


(i) At what time had the reaction just finished?
..... [1]

(ii) What volume of hydrogen gas is given off during the first 50 seconds of the reaction?
volume of hydrogen cm³ [1]

(iii) The student repeated the experiment.
State **two** factors, apart from the concentration of hydrochloric acid, that should be kept constant when repeating the experiment.
1.
2. [2]

[Total: 13]



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3 Organic compounds can be put into groups called homologous series.

(a) Complete the following sentences about organic compounds and homologous series. Use words from the list below.

- carbon chlorine different elements functional
- hydrocarbon hydrogen oxide similar sulfur

Organic compounds usually contain atoms of and

Each homologous series contains compounds with chemical properties due to the presence of the same group. [4]

(b) Ethanol belongs to the alcohol homologous series.

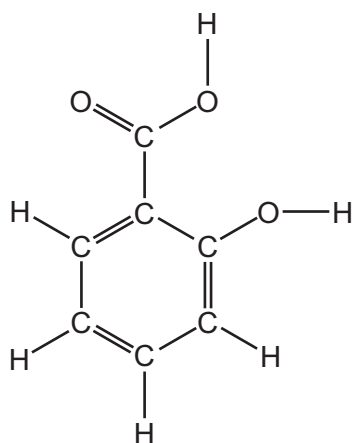
(i) Draw the structure of ethanol, showing all atoms and bonds.

[2]

(ii) State the name of the **two** compounds formed when ethanol burns in excess air.

..... and [2]

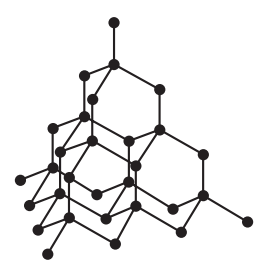
- (c) Salicylic acid is used to make aspirin.
The structure of salicylic acid is shown below.



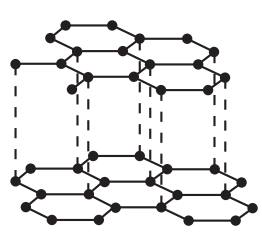
- (i) On this structure, put a ring around the carboxylic acid functional group. [1]
- (ii) How many carbon atoms are there in one molecule of salicylic acid?
..... [1]
- (iii) When making drugs and medicines, it is important that the chemicals used are pure.
State **one** other area of everyday life where purity is important.
..... [1]

[Total: 11]

4 The structures of diamond and graphite are shown below.



diamond



graphite

• = carbon atom

(a) Describe the similarities and differences between these structures.

.....
.....
.....
.....
.....
..... [4]

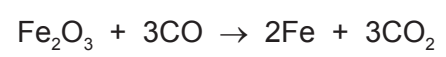
(b) Graphite burns in excess air to form carbon dioxide.
Describe a test for carbon dioxide.

test
result [2]

(c) When graphite is burnt in a limited supply of air, carbon monoxide is formed.
State **one** adverse effect of carbon monoxide on health.

..... [1]

(d) In the blast furnace for the production of iron, carbon monoxide reduces iron(III) oxide.



How does this equation show that carbon monoxide is acting as a reducing agent?

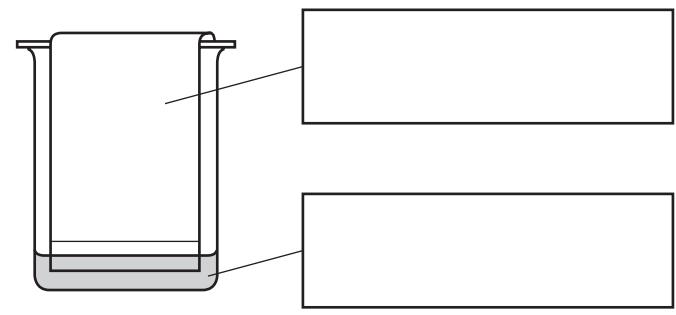
..... [1]

(e) Iron(III) oxide and coke (carbon) are raw materials used in the production of iron.
State the names of **two** other raw materials used in the blast furnace for the production of iron.

1.
2. [2]

[Total: 10]

5 Many plants contain colored pigments.
 A student crushes some plant leaves in alcohol to extract the pigments.
 She then separates the pigments using the apparatus shown below.

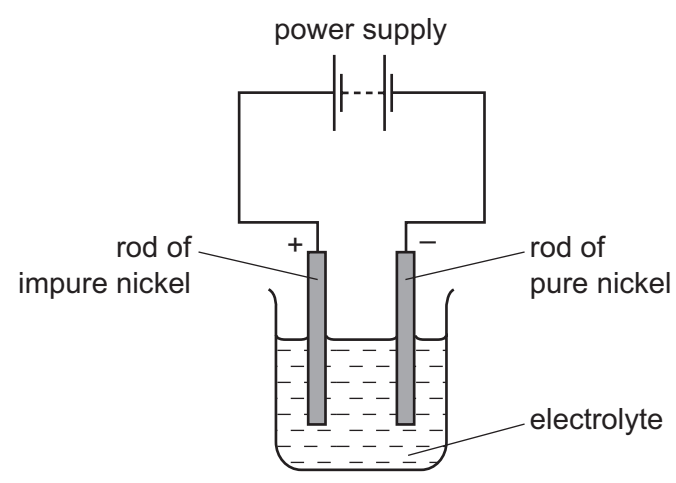


(a) Write the correct labels in the boxes in the diagram above. [2]

(b) Draw an **X** on the diagram above to show where a drop of the pigment solution is placed at the start of the experiment. [1]

(c) After leaving the apparatus for half an hour, the pigments separated from each other. State the name given to this method of separating pigments.
 [1]

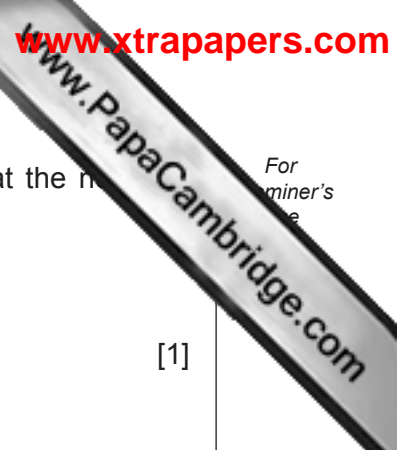
(d) Some plants can absorb nickel from the ground. The nickel can then be extracted from the plants and purified by electrolysis.



(i) Which one of the following is the most suitable electrolyte for this electrolysis. Tick **one** box.

- aqueous copper(II) sulfate
- aqueous nickel(II) sulfate
- solid nickel(II) sulfate
- water

[1]



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(ii) Which one of the following elements is most likely to be formed at the negative electrode during this electrolysis?
Put a ring around the correct answer.

- chlorine
- nickel
- sulfur
- oxygen

[1]

(iii) The positive electrode is called the anode.
State the name of the negative electrode.

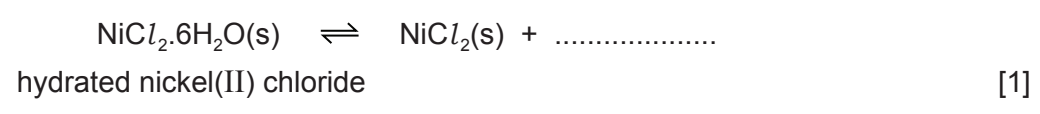
..... [1]

(e) Electroplating is used to put a thin layer of one metal on top of another by electrolysis.
Give **two** reasons for electroplating metals.

1.

2. [2]

(f) (i) Hydrated nickel(II) chloride is green in color.
When hydrated nickel(II) chloride is heated gently, it changes color from green to white.
Complete the symbol equation for this reaction.

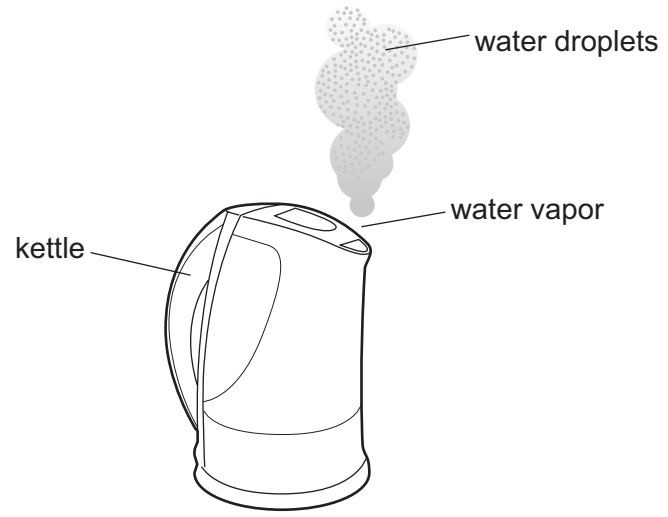


(ii) What does the sign \rightleftharpoons mean?
..... [1]

(iii) How can you obtain a sample of green nickel(II) chloride starting with white nickel(II) chloride?
..... [1]

[Total: 12]

6 The diagram shows a kettle of boiling water.



As the water vapor cools it turns back to water droplets.

(a) Describe this change of state in terms of the kinetic particle theory. In your answer, include

- the difference in the closeness of the water molecules as the water vapor changes to water,
- the difference in the motion of the water molecules as the water vapor changes to water.

.....

.....

.....

.....

.....

[4]

(b) Water is a common solvent in the laboratory.

(i) What is meant by the term *solvent*?

..... [1]

(ii) State the name of the solvent whose formula is C₂H₅OH.

..... [1]

(c) When ammonium chloride dissolves in water the temperature of the solution falls. State the name of the energy change which results in the temperature falling.

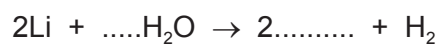
..... [1]

- (d) Which one of the following conducts electricity.
Tick **one** box.

aqueous ammonium chloride	<input type="checkbox"/>
solid ammonium chloride	<input type="checkbox"/>
ammonia gas	<input type="checkbox"/>
chlorine gas	<input type="checkbox"/>

[1]

- (e) (i) Complete the symbol equation for the reaction of lithium with water to form lithium hydroxide and hydrogen.



[2]

- (ii) When 14 g of lithium react with water, 4 g of hydrogen are formed.
Calculate the mass of hydrogen formed when 70 g of lithium react with water.

[1]

[Total: 11]

7 The table shows some properties of seven different substances.

substance	density /g per cm ³	relative strength	relative electrical conductivity	relative thermal conductivity
aluminum	2.7	15	42	200.0
ceramic	2.5	15	does not conduct	1.6
copper	8.9	20	63	385.0
iron	7.9	25	11	80.0
lead	11.4	15	5	38.0
poly(ethene)	0.9	1	does not conduct	0.3
steel	7.8	90	2	25.0

(a) Use the information in this table to answer the following questions.

(i) Which substance is the best conductor of heat?

..... [1]

(ii) Suggest why copper is preferred to iron for electrical wiring in houses.

..... [1]

(iii) What property of ceramic makes it a good electrical insulator?

..... [1]

(iv) Which pure metal in the table conducts electricity least well?

..... [1]

(v) Suggest why steel rather than iron is used in making machinery.

..... [1]

(vi) Which metal in the table is the most dense?

..... [1]

(b) A solution of a metal salt reacts with aqueous sodium hydroxide to form a white precipitate. The white precipitate is soluble in excess aqueous sodium hydroxide.

(i) Which one of the following ions is most likely to be present in the salt?
Put a ring around the correct answer.

- calcium**
- copper(II)**
- iron(II)**
- zinc**

[1]

(ii) State the name of the white precipitate.

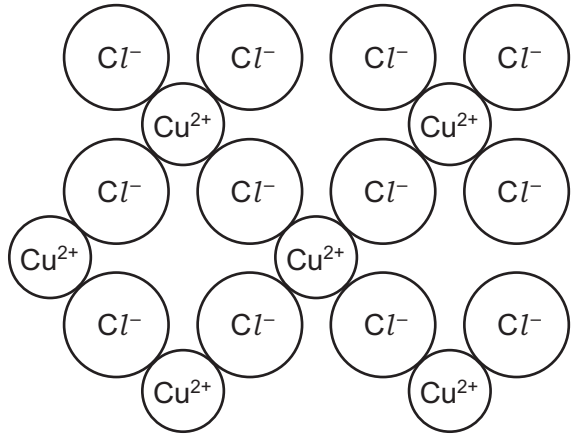
..... [1]

(c) Copper(II) chloride can be made by the action of hydrochloric acid on copper(II) oxide. Put the statements, **A**, **B**, **C** and **D**, about this preparation in the correct order.

- A** Leave the saturated solution to crystallize.
- B** Filter the solution to remove excess copper(II) oxide.
- C** Add excess copper(II) oxide to hydrochloric acid and warm.
- D** Evaporate the filtrate to the crystallization point.

..... [1]

(d) The structure of copper(II) chloride is shown below.



Write the simplest formula for copper(II) chloride.

..... [1]

(e) Suggest the product formed at each electrode when molten copper(II) chloride is electrolyzed.

at the positive electrode

at the negative electrode [2]

(f) When copper(II) chloride is heated strongly, a gas is given off. The gas is green in color and bleaches litmus paper. State the name of this gas.

..... [1]

[Total: 13]

DATA SHEET
The Periodic Table of the Elements

Group		I	II	III	IV	V	VI	VII	0
		1 H Hydrogen 1							2 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4								20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12			11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20			27 Al Aluminum 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38			56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	80 Br Bromine 35	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56			55 Mn Manganese 25	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	85 At Astatine 85	86 Rn Radon 86
226 Fr Francium 87	227 Ra Radium 88			77 Ir Iridium 77	75 Re Rhenium 75	78 Pt Platinum 78	79 Au Gold 79		
				76 Os Osmium 76	75 Re Rhenium 75	80 Hg Mercury 80	81 Tl Thallium 81		
				91 Zr Zirconium 40	91 Zr Zirconium 40	106 Pd Palladium 46	108 Ag Silver 47		
				93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	112 Cd Cadmium 48		
				181 Ta Tantalum 73	186 Re Rhenium 75	192 Ir Iridium 77	201 Hg Mercury 80		
				178 Hf Hafnium 72	184 W Tungsten 74	195 Pt Platinum 78	204 Pb Lead 82		
				139 La Lanthanum 57	184 W Tungsten 74	207 Pb Lead 82			
				227 Ac Actinium 89					

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	152 Eu Europium 63	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	238 U Uranium 92	238 U Uranium 92	94 Pu Plutonium 94	96 Cm Curium 96	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	102 No Nobelium 102	103 Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

a	X
b	X

Key
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

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