UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

7249373810

CHEMISTRY **0620/21**

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 Centre 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.

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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 fertilisers, ... [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]

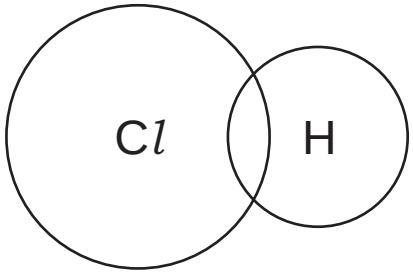
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2 Hydrogen chloride is an acidic gas.

(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 acid + calcium carbonate → ..... + ... + ...
....

[3]

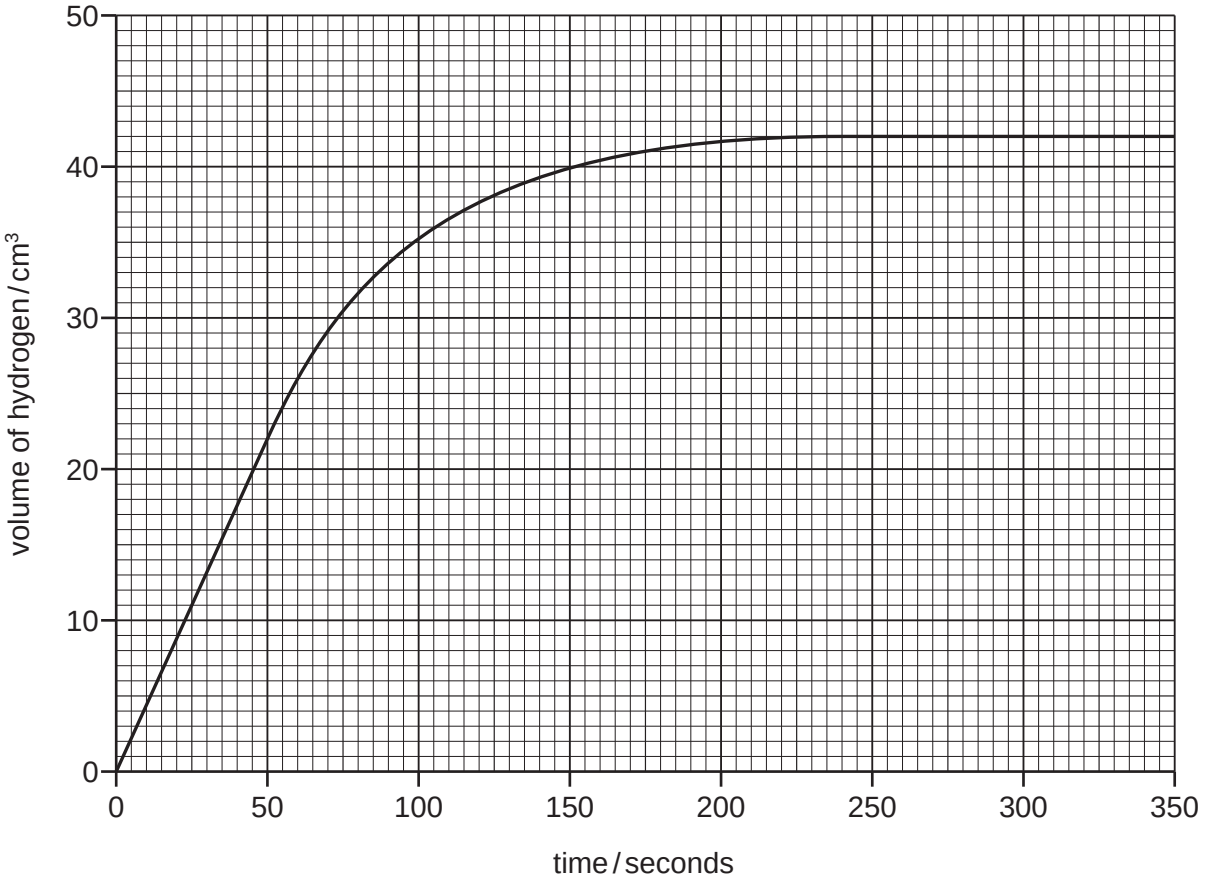
(ii) Complete the symbol equation for the reaction of magnesium oxide with hydrochloric acid. Name the salt which is formed.

$$MgO + ...HCl \rightarrow MgCl_2 + H_2O$$

name of salt ..... [2]

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(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 ..... cm^3 [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.

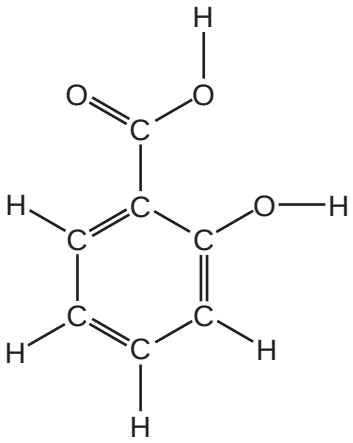
[2]

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

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

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(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.

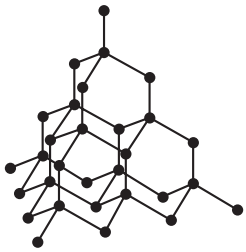
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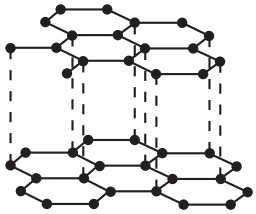
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4 The structures of diamond and graphite are shown below.



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.

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

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]

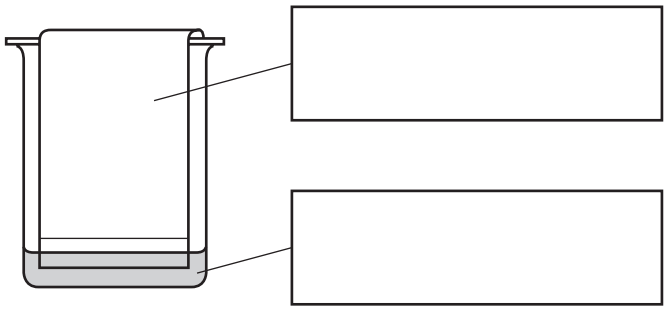
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5 Many plants contain coloured pigments.
A student crushes some plant leaves in alcohol to extract the pigments.
She then separates the pigments using the apparatus shown below.



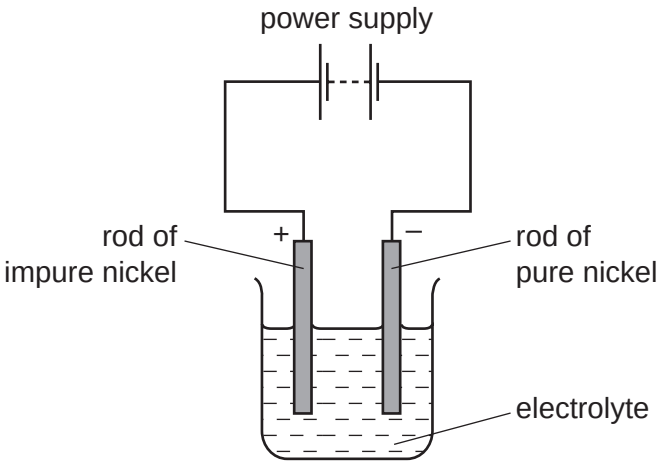
(a) Write the correct labels in the boxes in the diagram above. [2]

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

$NiCl_2.6H_2O(s) \rightleftharpoons NiCl_2(s) + ...$

hydrated nickel(II) chloride [1]

(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?

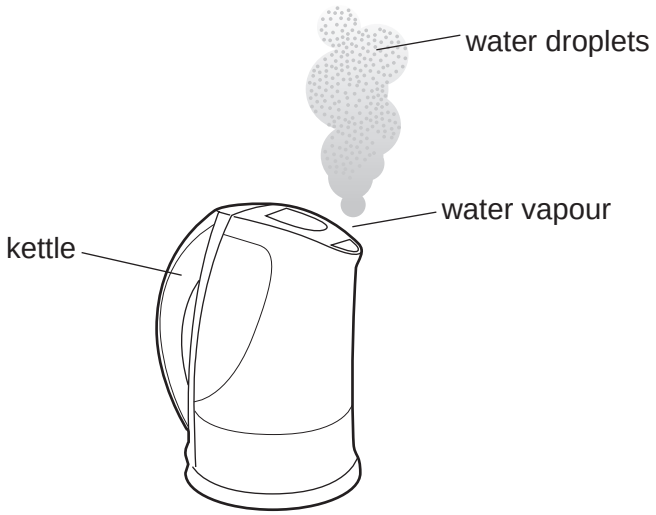
..... [1]

[Total: 12]

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6 The diagram shows a kettle of boiling water.



As the water vapour 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 vapour changes to water,
- the difference in the motion of the water molecules as the water vapour 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 C_2H_5OH.

..... [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]

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

aqueous ammonium chloride	☐
solid ammonium chloride	☐
ammonia gas	☐
chlorine gas	☐

[1]

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

$$2Li + ...H_2O \rightarrow 2..... + H_2$$

[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]

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7 The table shows some properties of seven different substances.

substance	density / g per cm^3	relative strength	relative electrical conductivity	relative thermal conductivity
aluminium	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]

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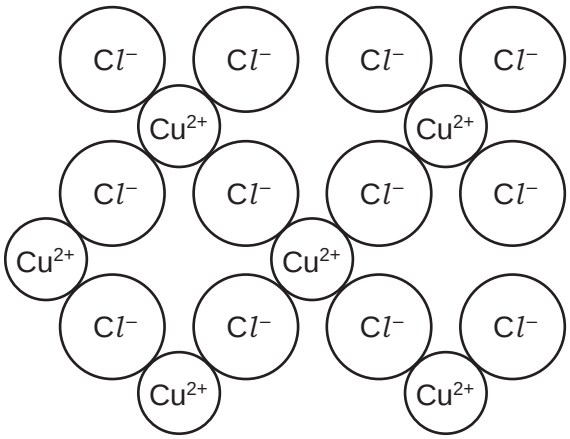
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(c) Copper(II) chloride can be made by the action of hydrochloric acid on copper(II) oxide. Put the statements, **A**, **B**, **C** and **D**, about this preparation in the correct order.

A Leave the saturated solution to crystallise.
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 crystallisation 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 electrolysed.

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 colour and bleaches litmus paper.
State the name of this gas.

..... [1]

[Total: 13]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key: a above **X**, b below

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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