UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

3776834834

CHEMISTRY **0620/21**

Paper 2 **October/November 2012**

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.
A copy of the Periodic Table is printed on page 16.

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.

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1	
2	
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Total	

This document consists of **13** printed pages and **3** blank pages.

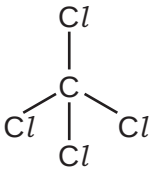
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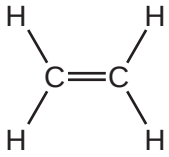
1 The diagram shows the structures of five compounds, **A**, **B**, **C**, **D** and **E**, containing carbon.

A

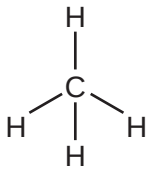
B



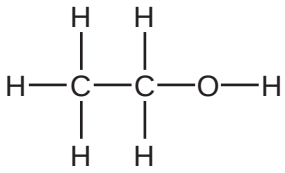
C



D



E



(a) Answer these questions using the letters **A**, **B**, **C**, **D** or **E**.
Each compound can be used once, more than once or not at all.

Which one of these compounds

(i) is an unsaturated hydrocarbon, ... [1]

(ii) is a product of the complete combustion of a hydrocarbon, ... [1]

(iii) belongs to the alcohol homologous series, ... [1]

(iv) is an alkane, ... [1]

(v) is a product of respiration, ... [1]

(vi) is a product of fermentation? ..... [1]

(b) Write the molecular formula of compound **C**. ..... [1]

(c) Compound **B** is inert to most chemical reagents.
It is made by reacting chlorine with carbon disulfide in the presence of an aluminium chloride catalyst.
What do you understand by the following terms?

compound .....

..... [1]

inert ..... [1]

catalyst ..... [1]

[Total: 10]

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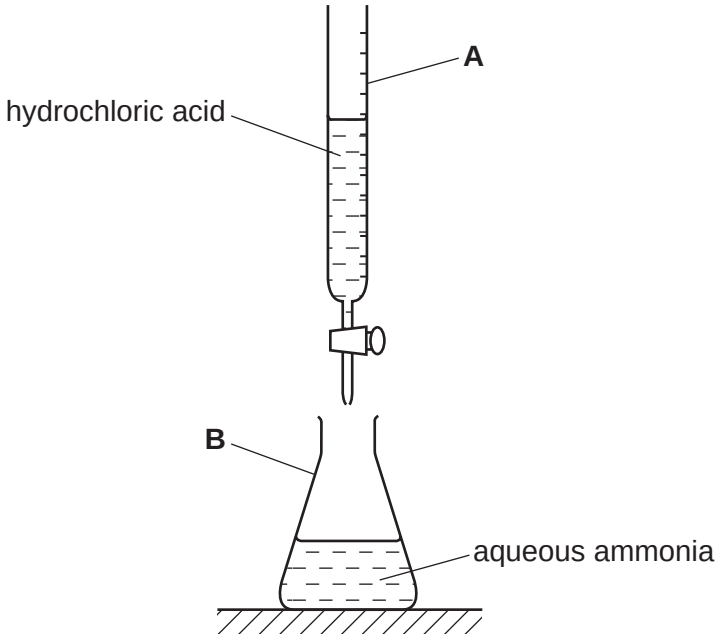
2 Hydrogen chloride, HC*l*, is an acidic gas.

(a) Draw a dot and cross diagram of a molecule of hydrogen chloride.
Show only the outer electrons.

[2]

(b) Hydrogen chloride dissolves in water to form a solution of hydrochloric acid.

A student titrated aqueous ammonia with hydrochloric acid using the apparatus shown below.



(i) State the name of the pieces of apparatus labelled **A** and **B**.

A is a ..... [1]

B is a ..... [1]

(ii) Describe how the pH value of the solution in **B** changes as hydrochloric acid is added until the acid is in excess.

.....

.....

..... [3]

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(iii) Complete the word and symbol equations for this reaction.

ammonia + hydrochloric acid → .....

..... + HCl → NH_4Cl

[2]

(c) Aqueous ammonia is used to test for copper(II) ions.
Describe what happens when you add aqueous ammonia to a solution of copper(II) sulfate until the aqueous ammonia is in excess.

.....

.....

.....

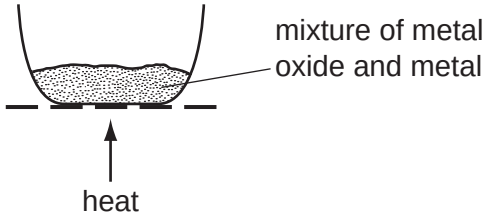
..... [4]

[Total: 13]

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3 The reactivity of different metal oxides was compared by heating them with metals in a crucible.



The results are shown in the table below.

mixture	observations
iron oxide + zinc	reacts
lead oxide + iron	reacts
magnesium oxide + zinc	no reaction

(a) (i) Use the results in the table to suggest the order of reactivity of the metals iron, lead, magnesium and zinc.

most reactive ⟶ least reactive

[2]

(ii) Predict whether iron will react with zinc oxide.
Explain your answer.

.....

..... [1]

(b) Which two of the following statements about metals are correct?
Tick **two** boxes.

Metals conduct electricity and heat. ☐

All Group IV elements show metallic properties. ☐

Magnesium is extracted by heating its oxide with carbon. ☐

All metals have high densities. ☐

Iron is a transition element. ☐

[2]

(c) Sand and salt (sodium chloride) are both solids.

(i) Describe the arrangement and movement of the particles in a solid.

arrangement .....

movement ..... [2]

(ii) Describe how you could separate the sand from a mixture of sand and salt. Give full details of how this is carried out.

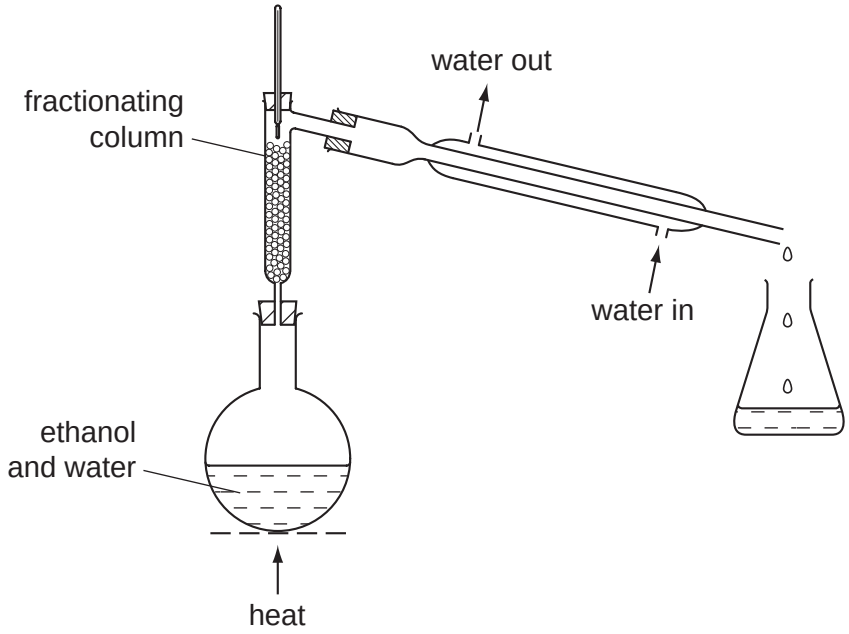
.....

.....

.....

..... [3]

(d) The diagram below shows the apparatus used to separate ethanol and water from a mixture of ethanol and water.



Complete the following sentences about this separation using words from the list below.

condenser	**crystallisation**	**distillation**	**flask**	**heavy**
higher	**lower**	**solid**	**volatile**	**vapour**

Fractional ..... is used to separate a mixture of water and ethanol. The temperature at the top of the fractionating column is ..... than the temperature at the bottom. The more ..... liquid evaporates and moves further up the column. It eventually reaches the ..... where the ..... changes to a liquid. [5]

[Total: 15]

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4 Lithium has two naturally-occurring isotopes, $^{6}_{3}Li$ and $^{7}_{3}Li$.

(a) What do you understand by the term *isotope*?

.....

..... [1]

(b) Draw a **labelled** diagram to show the atomic structure of an atom of $^{7}_{3}Li$.

Show the particles in the nucleus as well as the electrons.

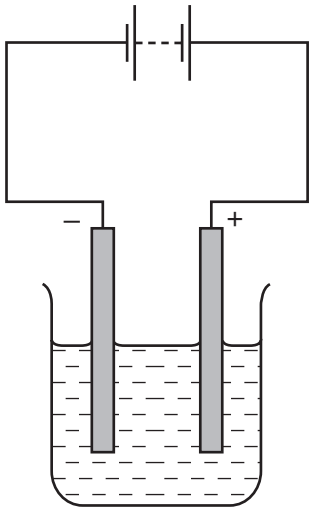
[5]

(c) Lithium reacts with oxygen to form lithium oxide, Li_2O.
Complete the equation for this reaction.

.....Li + ... → .....Li_2O

[3]

(d) Aqueous lithium chloride is electrolysed using the apparatus shown below.



(i) On the diagram above, label:

- the electrolyte
- the anode. [2]

(ii) What do you understand by the term *aqueous*?

..... [1]

(iii) Explain why aqueous lithium chloride is able to conduct electricity.

..... [1]

[Total: 13]

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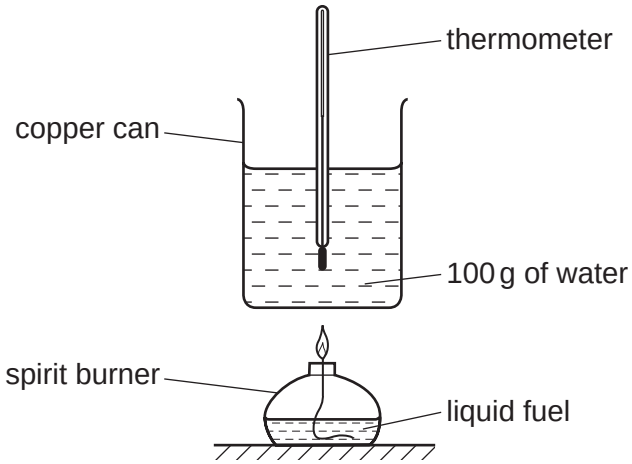
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5 **(a)** Match the fuel on the left with the information on the right.
The first one has been done for you.

uranium-236	a fuel with a relative molecular mass of 2
hydrogen	the main constituent of natural gas
methane	a nuclear 'fuel'
fuel oil	fuel for aircraft
kerosene	fuel for ships

[4]

(b) Two students investigated some fuels to find which gave off the most energy.
They tested four liquid fuels using the apparatus shown below.



(i) In each experiment, the amount of fuel burnt was the same.
Suggest **one** other factor that should be kept the same in each experiment.

..... [1]

(ii) The students used the thermometer to stir the water.
Suggest why it is important to keep the water stirred.

..... [1]

(iii) The results are shown in the table below.

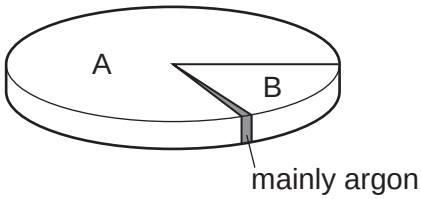
fuel	initial temperature of the water / °C	final temperature of the water / °C
ethanol	24	40
propanol	24	42
paraffin	22	33
petroleum spirit	20	40

Which fuel transfers the most energy to the water?
Explain your answer.

.....

..... [2]

(c) Air is needed for fuels to burn.
The pie chart below shows the composition of the air.



State the name of

gas A, ...

gas B. ..... [2]

(d) Argon is a noble gas.

(i) State **one** use for argon.

..... [1]

(ii) To which period in the Periodic Table does argon belong?

..... [1]

(iii) Describe the chemical properties of argon.

..... [1]

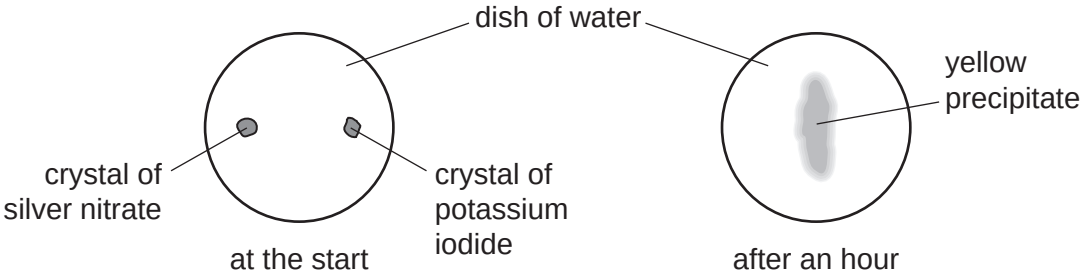
[Total: 13]

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6 A student placed a crystal of silver nitrate and a crystal of potassium iodide in a dish of water. After an hour she observed that

- the crystals had disappeared,
- a yellow precipitate had appeared near the middle of the dish.



(a) Use your knowledge of the kinetic particle theory and reactions between ions to explain these observations.

.....

.....

.....

.....

..... [4]

(b) Potassium iodide reacts with aqueous chlorine.
Complete the equation for this reaction.

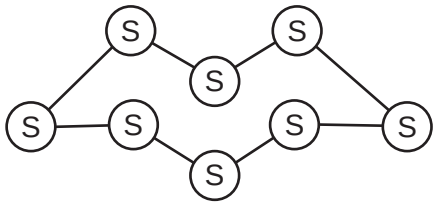
$$2KI + \text{.....} \rightarrow \text{.....}KCl + I_2$$

[2]

[Total: 6]

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7 The diagram shows one molecule of sulfur.



(a) How many atoms are there in **three** molecules of sulfur?

..... [1]

(b) Calculate the relative molecular mass of sulfur.

[1]

(c) Explain how acid rain is formed when fossil fuels containing sulfur are burnt.
In your answer, include

- the name of a fossil fuel which contains sulfur,
- the gas formed when sulfur burns,
- the reactions which lead to the formation of acid rain.

.....

.....

.....

.....

..... [4]

(d) Potassium sulfate can be used as a fertiliser.
The potassium in this fertiliser is an important element for plant growth.
Name **two** other **elements**, important for plant growth, which are present in most fertilisers.

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

(e) Describe a test for sulfate ions.

test .....

result ..... [2]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
																4 **He** Helium 2
					1 **H** Hydrogen 1						11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
	7 **Li** Lithium 3	9 **Be** Beryllium 4									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
	23 **Na** Sodium 11	24 **Mg** Magnesium 12									70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
	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	112 **Cd** Cadmium 48	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
	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	a = relative atomic mass
X	X = atomic symbol
b	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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