Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4095387716

CHEMISTRY **0620/21**

Paper 2 **October/November 2014**

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 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.

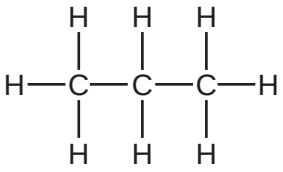
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **16** printed pages.

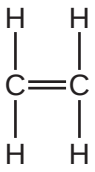
CAMBRIDGE International Examinations

1 The structures of five carbon compounds are shown below.

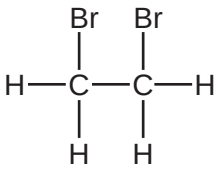
A



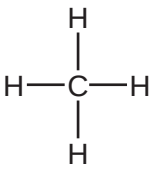
B



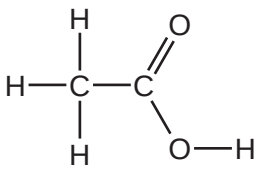
C



D



E



(a) Answer the following questions about these compounds. Each compound may be used once, more than once or not at all.

(i) Which compound, **A**, **B**, **C**, **D** or **E**, is ethanoic acid? ..... [1]

(ii) Which **two** compounds are saturated hydrocarbons? ..... and ..... [1]

(iii) Which compound is the main constituent of natural gas? ..... [1]

(iv) Which compound reacts with steam to form ethanol? ..... [1]

(v) Which compound is causing concern as a greenhouse gas? ..... [1]

(vi) Which **two** compounds are in the same homologous series? ..... and ..... [1]

(b) Deduce the molecular formula for compound **C**.

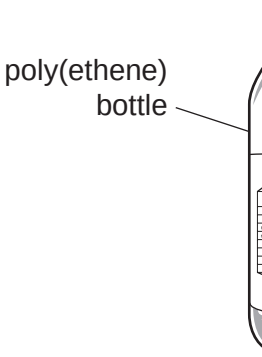
..... [1]

(c) Complete the symbol equation for the complete combustion of compound **A**.

$$C_3H_8 + ...O_2 \rightarrow 3CO_2 + ...H_2O$$ [2]

[Total: 9]

2 The diagram shows a bottle of mineral water. The concentration of the ions present in the water is shown on the label. The pH of the water is also shown.



ions present	concentration in mg / 1000 cm^3
chloride, Cl^-	0.71
X, F^-	0.31
magnesium, Mg^{2+}	0.02
manganese, Mn^{2+}	0.01
Y, NO_3^-	0.70
potassium, K^+	0.44
sodium, Na^+	1.22
pH = 6.6	

(a) (i) Which positively charged ion is present in the highest concentration?

..... [1]

(ii) State the name of:

ion **X** .....

ion **Y** .....

[2]

(iii) Calculate the mass, in mg, of sodium ions in 200 cm^3 of mineral water.

..... mg [1]

(iv) Which **one** of the following phrases best describes the pH of this mineral water?
Tick **one** box.

neutral	☐
strongly acidic	☐
strongly alkaline	☐
weakly acidic	☐
weakly alkaline	☐

[1]

(b) Describe a test for chloride ions.

test .....

result .....

[2]

(c) The mineral water bottle is made of poly(ethene).

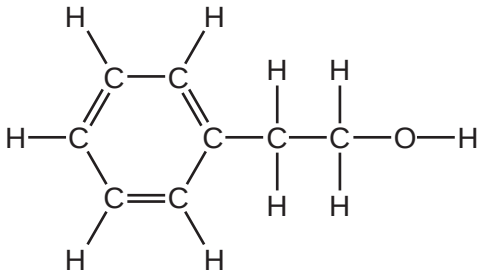
Complete the following sentence about poly(ethene) using words from the list below.

atom ionic monomer polymer reactant saturated

Poly(ethene) is a ..... made by the addition of ..... units.
[2]

[Total: 9]

3 Rose oil contains 2-phenylethanol.
The structure of 2-phenylethanol is shown below.



(a) On the structure above, draw a ring around the alcohol functional group. [1]

(b) When heated with an alkali, 2-phenylethanol forms styrene.
Styrene is an unsaturated compound.
Describe a test for an unsaturated compound.

test .....

result .....
[2]

(c) Rose petals contain a variety of different coloured pigments.
A student wants to identify these pigments.

(i) She grinds up rose petals with a solvent.
Explain why.

.....

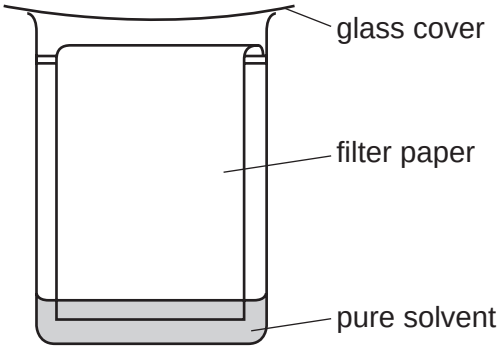
.....

..... [2]

(ii) She then filters the solution through some glass wool.
Suggest why she does not use filter paper.

..... [1]

(d) The student uses the apparatus shown below to identify the different pigments in the mixture.



(i) State the name of this method of separating the pigments.

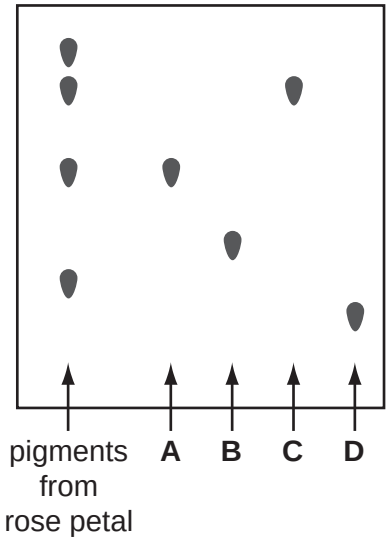
..... [1]

(ii) On the diagram above, draw a spot, ●, to show where the mixture of pigments is placed at the start of the experiment. [1]

(iii) What is the purpose of the glass cover?

..... [1]

(iv) The student also puts four spots of pure pigments, **A**, **B**, **C** and **D**, onto the filter paper. The diagram below shows the results of her experiment.



Which of the pigments, **A**, **B**, **C** and **D**, are present in the rose petals?

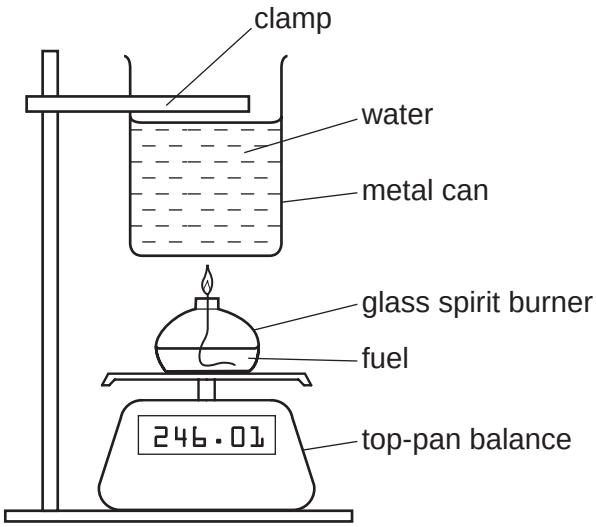
..... [1]

(e) The solvent used in the experiment is ethanol.
Draw the structure of a molecule of ethanol showing all atoms and bonds.

[2]

[Total: 12]

4 A student wants to compare the energy released when different fuels are burned.
He measures the increase in temperature of the water in a metal can when the fuels are burned.



(a) What piece of apparatus is missing from the diagram above?

..... [1]

(b) State **two** things the student should keep the same when burning each fuel.

.....

.....

..... [2]

(c) Suggest why the water in the can should be stirred.

.....

..... [1]

(d) What happens to the reading on the top-pan balance as the fuel burns?
Give a reason for your answer.

.....

..... [2]

[Turn over

(e) The results of burning four fuels, **D**, **E**, **F** and **G**, are shown in the table below.

fuel	temperature of water at start of experiment / °C	temperature of water at end of experiment / °C
D	20	45
E	19	43
F	16	44
G	21	46

Which fuel produced the greatest temperature rise in the water?

..... [1]

(f) The metal can is made of mild steel coated with tin.

(i) Steel is an alloy.
What is meant by the term *alloy*?

.....

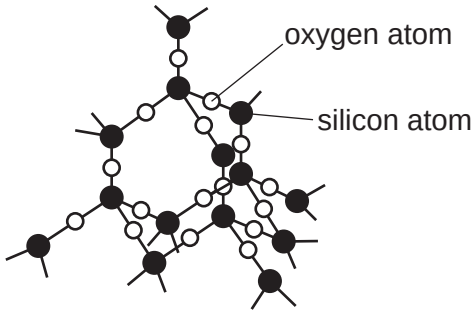
..... [1]

(ii) Why does the tin prevent the steel can from rusting?

.....

..... [2]

(g) Glass is made from silicon(IV) oxide.
Part of the structure of silicon dioxide is shown below.



Which **one** of the following best describes the structure of silicon dioxide?
Tick **one** box.

giant covalent ☐
giant ionic ☐
simple atomic ☐
simple molecular ☐

[1]

[Total: 11]

5 **(a)** Describe how acids react with metals and with metal oxides.

In your answer:
- refer to a particular metal and metal oxide,
- illustrate your answer with at least one word equation.

.....

.....

.....

.....

..... [4]

(b) When metals react with hydrochloric acid, the temperature of the reaction mixture increases.
Which **one** of the following words best describes this reaction?
Draw a ring around the correct answer.

endothermic **exothermic** **isotopic** **radioactive**

[1]

(c) Uranium is a metal which has several radioactive isotopes. Some of these are used as sources of energy.
State **one** other use of radioactive isotopes.

..... [1]

(d) Complete the table below to show the number of protons, neutrons and electrons in two isotopes of uranium.

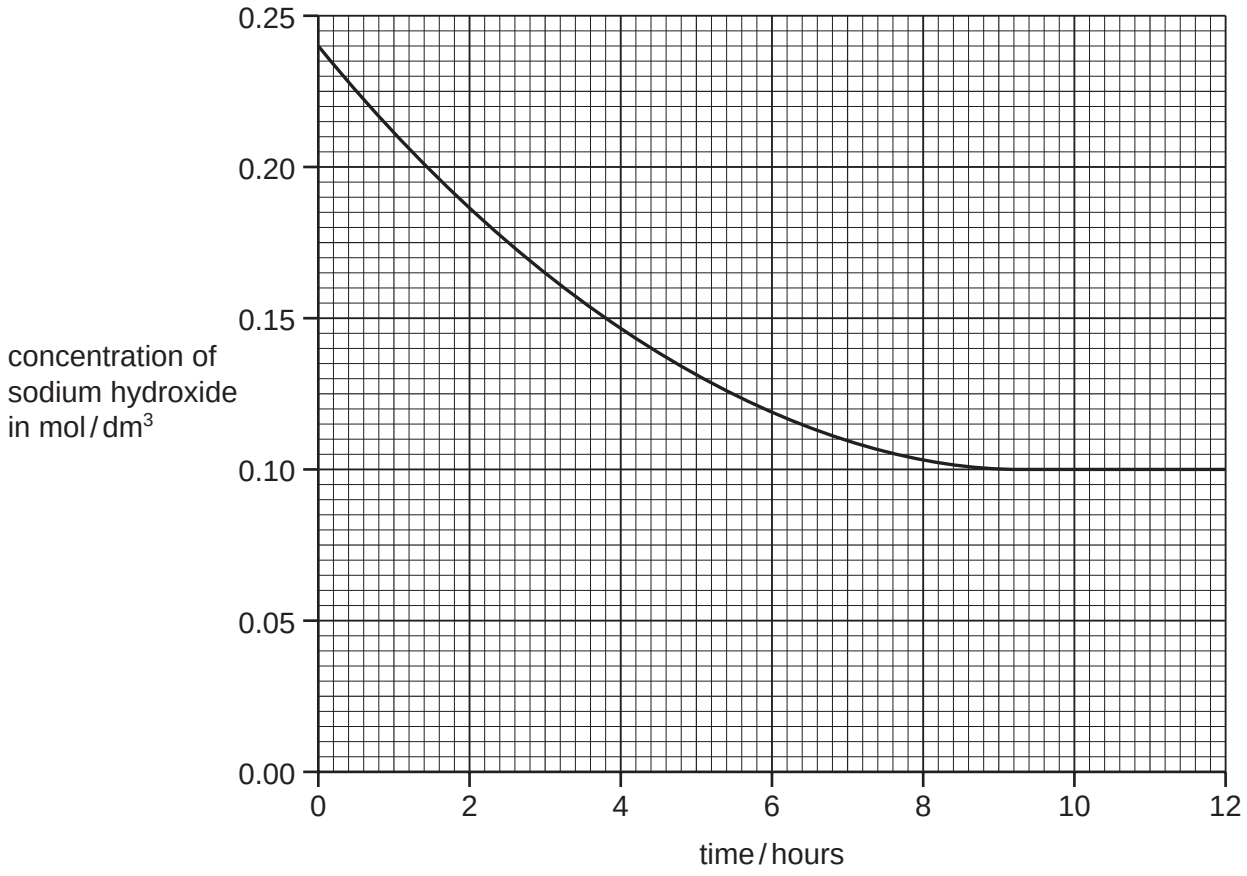
isotope	$^{235}_{92}U$	$^{238}_{92}U$
protons		
neutrons		
electrons		

[3]

[Total: 9]

[Turn over

6 The organic compound 1-bromobutane reacts with excess sodium hydroxide to form butan-1-ol.
A scientist studied the rate of this reaction by finding out how the concentration of sodium hydroxide changed with time.
The graph below shows the results.



(a) (i) Describe how the concentration of sodium hydroxide changes with time.

.....

..... [2]

(ii) Determine the time it took for the concentration of sodium hydroxide to fall to 0.15 mol / dm^3.

..... [1]

(iii) At what time was the reaction complete?

..... [1]

(iv) On the grid above, draw a line to show how the concentration of sodium hydroxide changes when the concentration of 1-bromobutane in the reaction mixture is increased.
All other conditions remain the same.

[2]

(v) Increasing the concentration of 1-bromobutane increases the rate of this reaction.
Suggest **one** other way of increasing the rate of this reaction.

..... [1]

(b) The concentration of aqueous sodium hydroxide can be found by titrating samples of the reaction mixture with hydrochloric acid.
Describe how you would carry out this titration.

In your answer, refer to:
- a burette,
- a volumetric pipette,
- an acid-base indicator solution.

.....

.....

.....

.....

..... [4]

(c) Hydrochloric acid is made by dissolving hydrogen chloride gas, HC*l*, in water.
Draw a dot-and-cross diagram to show a molecule of hydrogen chloride.
Show hydrogen electrons as x.
Show chlorine electrons as ●.

[2]

[Total: 13]

[Turn over

7 Fertilisers usually contain compounds of nitrogen, phosphorus and potassium.

(a) Why do farmers use fertilisers?

..... [1]

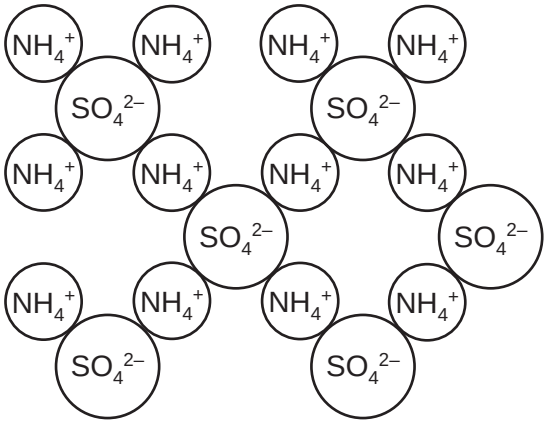
(b) Many fertilisers contain ammonium sulfate.
Ammonium sulfate is made by reacting aqueous ammonia with sulfuric acid.
What type of chemical reaction is this?

..... [1]

(c) Aqueous ammonia reacts with nitric acid to make another compound often found in fertilisers.
State the name of this compound.

..... [1]

(d) The structure of ammonium sulfate is shown below.



Deduce the simplest ratio of ammonium and sulfate ions in ammonium sulfate.

..... [1]

(e) Ammonium salts react with alkalis. For example:

$$\text{ammonium sulfate} + \text{sodium hydroxide} \rightarrow \text{sodium sulfate} + \text{ammonia} + \text{water}$$

Use this information to explain why adding slaked lime to fields which have fertilisers spread on them may result in loss of nitrogen.

.....

.....

..... [2]

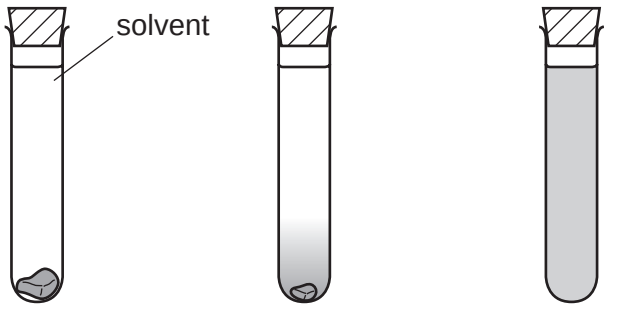
(f) Many fertilisers contain potassium chloride.
When molten potassium chloride is electrolysed, two products are formed.
Complete the table below to show the name of the electrodes and the products formed.

charge on the electrode	name of the electrode	product formed at the electrode
positive		
negative		

[3]

[Total: 9]

8 **(a)** A student placed a crystal of iodine in a test tube of solvent.
After two minutes, a dense violet colour was observed at the bottom of the test-tube. After three hours, the violet colour had spread throughout the solvent.



Use the kinetic particle theory to explain these observations.

In your answer, refer to:
- the arrangement and motion of the molecules in the iodine crystal,
- the arrangement and motion of the molecules in the solution,
- the names of the processes which are occurring.

.....

.....

.....

.....

..... [4]

(b) Astatine, At, is below iodine in Group VII of the Periodic Table.

(i) The table shows the states of the Group VII elements at room temperature.

element	state
fluorine	gas
chlorine	gas
bromine	liquid
iodine	solid

Use this information to deduce the state of astatine at room temperature.

..... [1]

(ii) Astatine is radioactive. A lot of heat is given off due to this radioactivity.
The small samples of astatine that have been isolated are often liquid.
Suggest why they are often liquid.

..... [1]

(iii) Although few compounds of astatine have been made, scientists think that sodium astatide will react with iodine.
Complete the equation for this reaction.

$$I_2 + ...NaAt \rightarrow 2NaI + ...$$

[2]

[Total: 8]

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 †															

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

Key: a **X** b

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.).