Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

6396621448

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2016**

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 **16** printed pages.

1 The table gives some information about five substances.

substance	melting point / °C	boiling point / °C	solubility in water	electrical conductivity when molten	electrical conductivity when solid
F	–97	65	very soluble	does not conduct	does not conduct
G	1600	2230	insoluble	does not conduct	does not conduct
H	801	1413	soluble	conducts	does not conduct
I	–57	126	insoluble	does not conduct	does not conduct
J	1085	2562	insoluble	conducts	conducts

(a) Which substance in the table has ionic bonding?

..... [1]

(b) Which substance in the table has a giant covalent structure?

..... [1]

(c) Name a method you could use to separate a mixture of substance **J** and water.

..... [1]

(d) Name a method you could use to obtain substance **F** from a mixture of substance **F** and water.

..... [2]

(e) Describe how you could obtain a solid sample of substance **H** from a mixture of substance **H** and substance **G**.

.....

.....

.....

.....

.....

..... [3]

(f) Substance **J** is a metal.

Describe how substance **J** is able to conduct electricity when it is a solid.

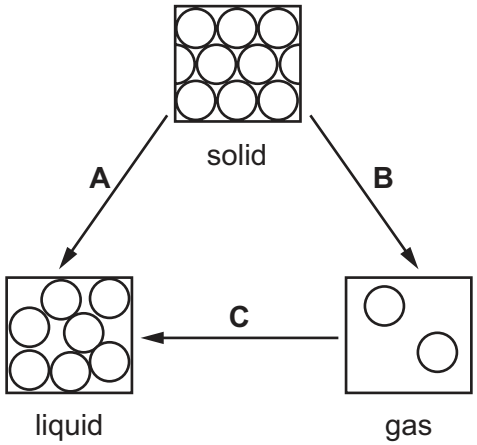
.....

.....

..... [2]

[Total: 10]

2 Matter can exist as solid, liquid or gas. The arrows show some changes of state.



(a) Name the changes of state represented on the diagram.

(i) **A** ..... [1]

(ii) **B** ..... [1]

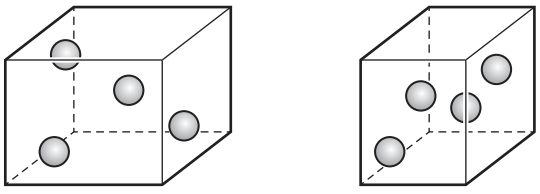
(iii) **C** ..... [1]

(b) Explain why energy has to be supplied to turn a liquid into a gas.

.....

..... [1]

(c) The diagrams represent the same number of particles of a gas in two containers, **D** and **E**, which have different volumes. The two containers are at the same temperature.



In which container will the pressure be higher? Explain your answer.

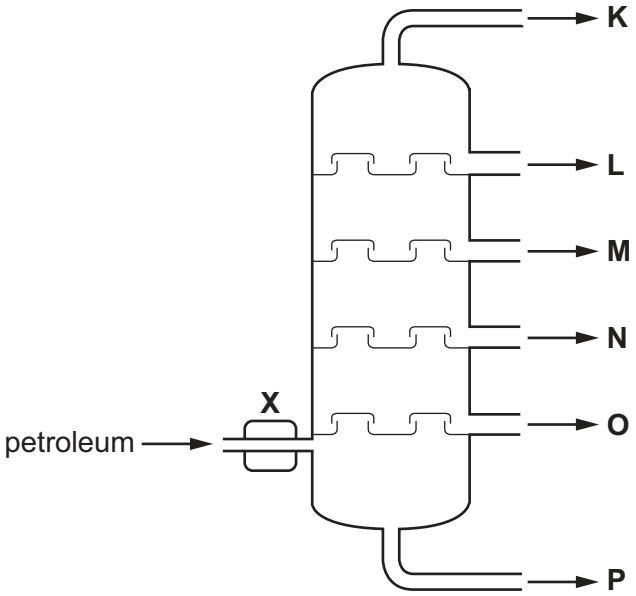
.....

.....

..... [1]

[Total: 5]

3 **(a)** Petroleum is a mixture of hydrocarbons. It is separated into useful fractions by fractional distillation. This can be done using the fractionating column shown.



(i) What happens to the petroleum at point **X**, before it enters the fractionating column?

.....

..... [1]

(ii) State **two** ways in which fraction **O** differs from fraction **L**.

.....

.....

..... [2]

(b) Most of the hydrocarbons obtained from petroleum are alkanes. The alkanes are an homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}.

Give **two** characteristics, other than having the same general formula, of members of an homologous series.

.....

.....

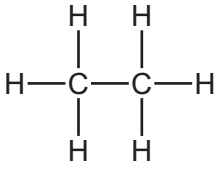
..... [2]

(c) The alkane with the molecular formula C_5H_{12} can exist as a number of structural isomers.

Draw the structures of **two** isomers with the formula C_5H_{12}.

[2]

(d) The alkane ethane has the structure shown.



When a mixture of ethane and chlorine is exposed to ultraviolet light a substitution reaction takes place.

Draw the structure of **one** organic product from this substitution reaction.

[1]

(e) Isoprene is a naturally occurring hydrocarbon.

(i) Explain how the name of isoprene suggests that it contains a C=C double bond.

..... [1]

(ii) A sample of isoprene had the following composition by mass: C, 88.24%; H, 11.76%.

Calculate the empirical formula of isoprene. Show all your working.

empirical formula = ... [3]

(iii) What additional information would be required to calculate the molecular formula of isoprene?

..... [1]

[Total: 13]

4 **(a)** Ammonia, NH_3, is made by reacting nitrogen with hydrogen in the Haber process.

(i) Write a chemical equation for the formation of ammonia in the Haber process.

..... [2]

(ii) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen .....

hydrogen .....
[2]

(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature .....

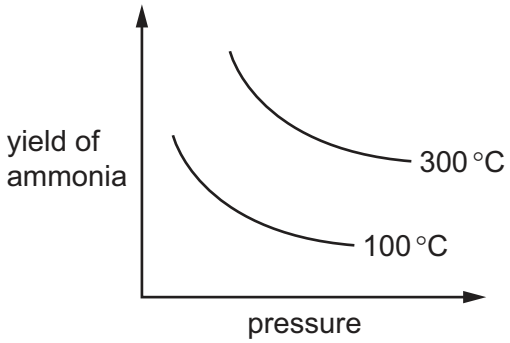
pressure .....
[2]

(b) Ammonia is also made when ammonium carbonate decomposes.

$$(NH_4)_2CO_3(s) \rightleftharpoons 2NH_3(g) + H_2O(g) + CO_2(g)$$

The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



(i) What is meant by the term *equilibrium* for a reversible reaction?

.....

.....

..... [2]

(ii) Using information from the graph, explain whether the reaction is endothermic or exothermic.

.....

..... [1]

(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

.....

.....

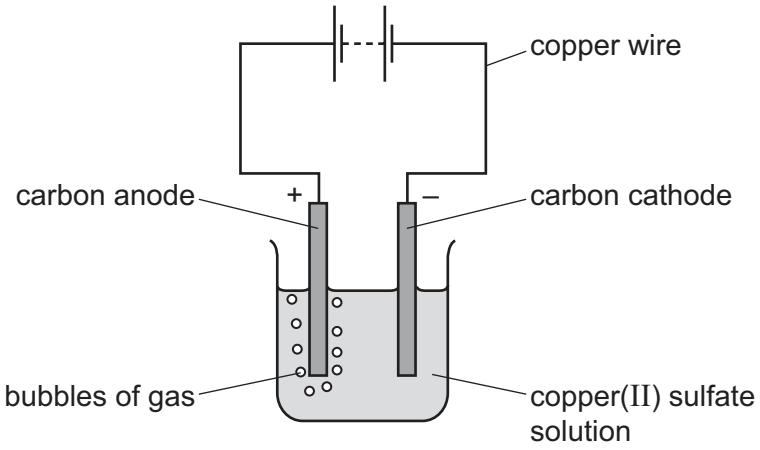
.....

..... [3]

[Total: 12]

[Turn over

5 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(a) A gas was formed at the anode.

Identify this gas and give the test for this gas.

gas .....

test .....

result of test .....

[3]

(b) During electrolysis, electricity passes through the copper(II) sulfate solution.

Solid copper(II) sulfate does not conduct electricity.

Explain **both** of these statements.

.....

.....

.....

.....

..... [3]

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.

anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(i) Which species is reduced during the electrolysis? Explain your answer.

.....

.....

..... [2]

(ii) The masses of the copper electrodes changed during the electrolysis.

State how **and** explain why the masses of the **two** copper electrodes changed.
Use the ionic half-equations to help you.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Explain why, during the electrolysis, the colour of the copper(II) sulfate solution does **not** change.

.....

.....

..... [1]

[Total: 12]

6 Nylon, *Terylene* and proteins are all polymers.

(a) What is a polymer?

.....

.....

..... [2]

(b) Proteins are natural polymers. Proteins are biodegradable.

(i) Name the type of linkage in proteins.

..... [1]

(ii) What is meant by the term *biodegradable*?

.....

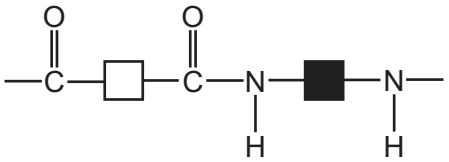
.....

..... [2]

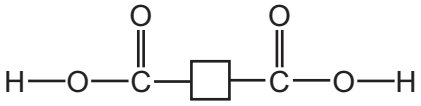
(iii) Name another natural polymer.

..... [1]

(c) Nylon and *Terylene* are synthetic polymers.
The repeat unit of nylon can be shown as



Terylene can be made from the monomers shown.



Draw a diagram to show the repeat unit of *Terylene*.

[3]

[Total: 9]

7 Calcium chloride can be made by reacting calcium carbonate with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of calcium carbonate was added to 50.0 cm^3 of 0.500 mol / dm^3 hydrochloric acid. The solution was filtered to remove the excess calcium carbonate.

(a) How many moles of HCl were used in this reaction?

..... mol [2]

(b) Deduce the number of moles of carbon dioxide gas made in this reaction.

..... mol [1]

(c) Calculate the mass of carbon dioxide made in this reaction.

..... g [2]

(d) Calculate the volume, in dm^3, of carbon dioxide made in this reaction at room temperature and pressure (r.t.p.).

..... dm^3 [1]

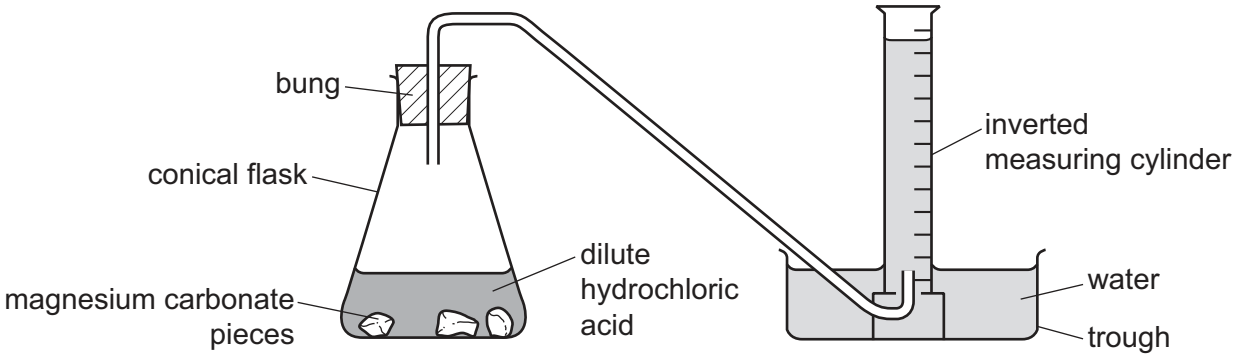
[Total: 6]

Question 8 starts on the next page.

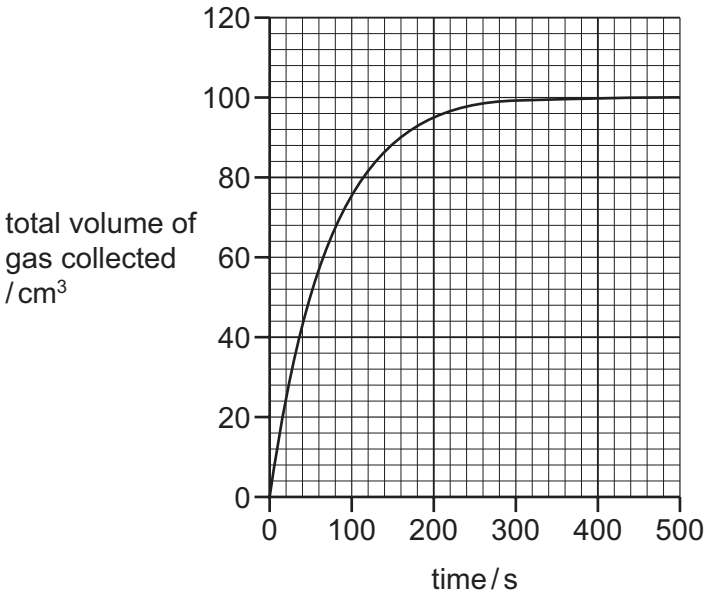
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction .....

.....

.....

total volume of gas .....

.....

.....

[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 13]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

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

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