

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

* 6 3 9 6 6 2 1 4 4 8 *



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.

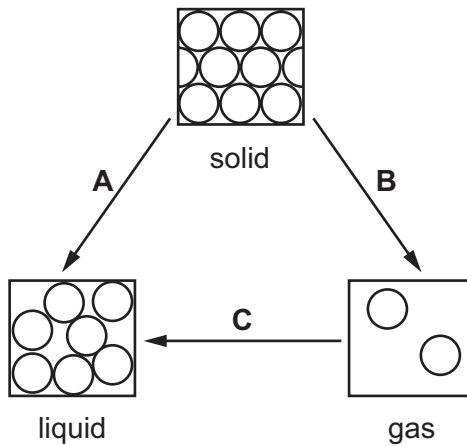
Describe how substance **J** is able to conduct electricity when it is a solid.

.....

 [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]

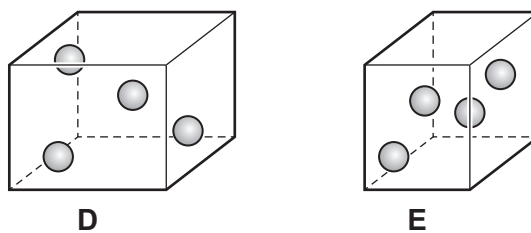
(ii) **B** [1]

(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.



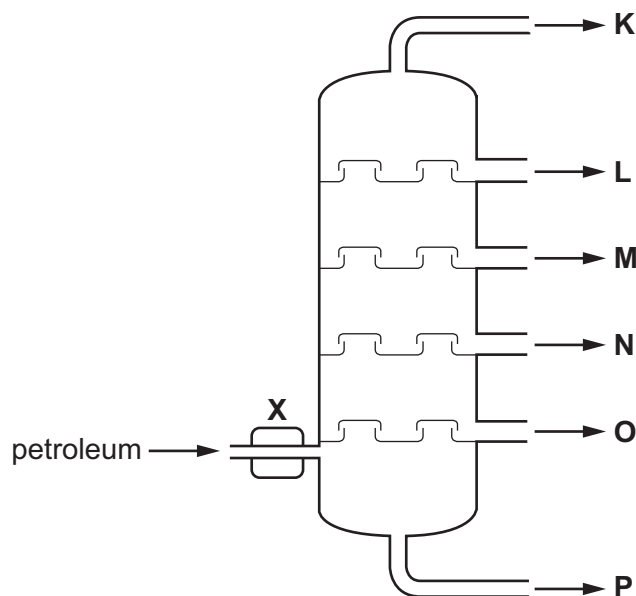
In which container will the pressure be higher? Explain your answer.

.....

 [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.

.....

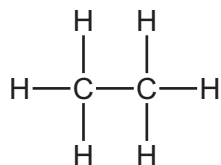
 [2]

(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]

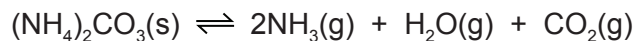
(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature

pressure

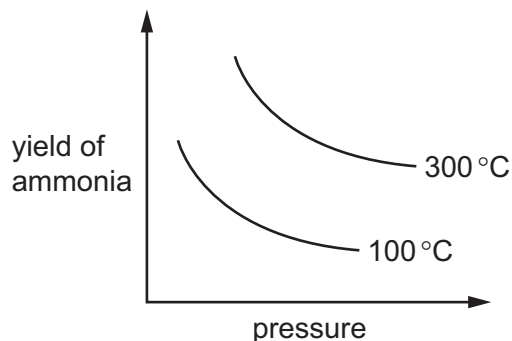
[2]

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



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]

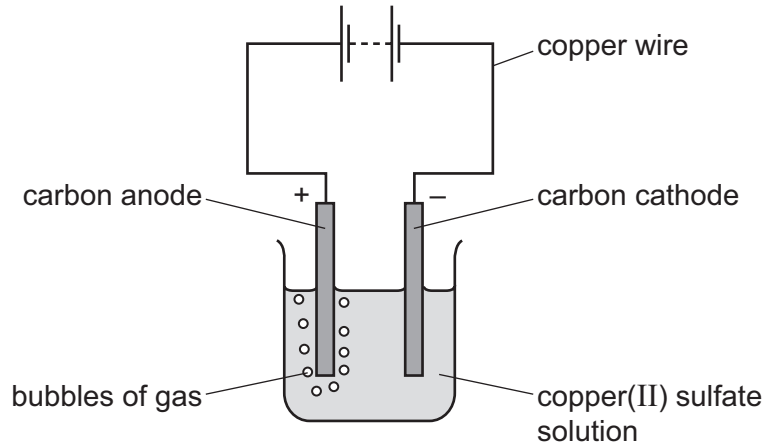
(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

 [3]

[Total: 12]

- 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.

.....

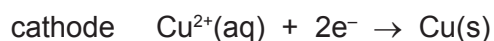
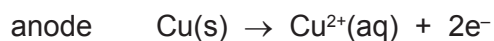
.....

.....

.....

..... [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.



- (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]

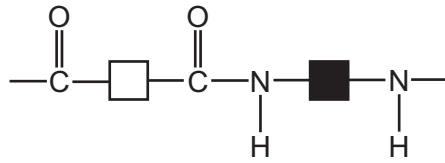
(ii) What is meant by the term *biodegradable*?

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

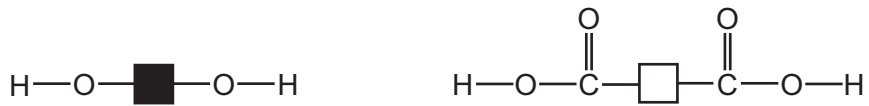
(iii) Name another natural polymer.

..... [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.



An excess of calcium carbonate was added to 50.0 cm³ of 0.500 mol/dm³ 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 dm³, of carbon dioxide made in this reaction at room temperature and pressure (r.t.p.).

..... dm³ [1]

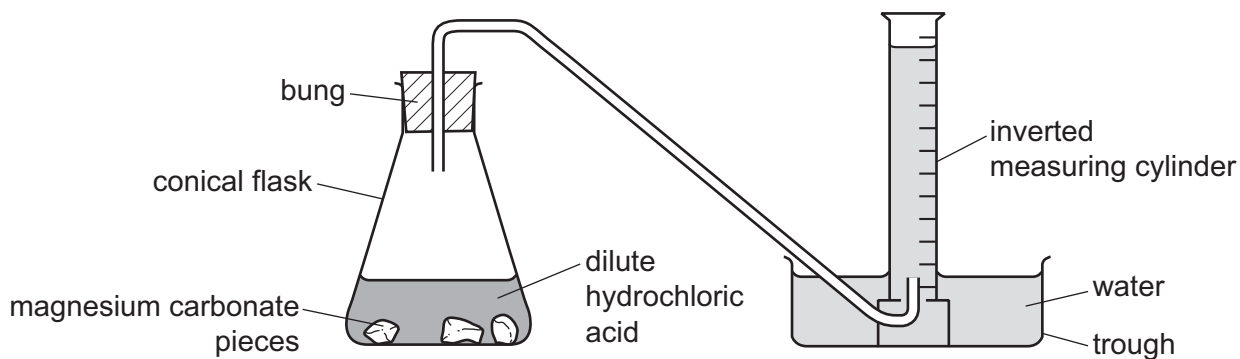
[Total: 6]

Question 8 starts on the next page.

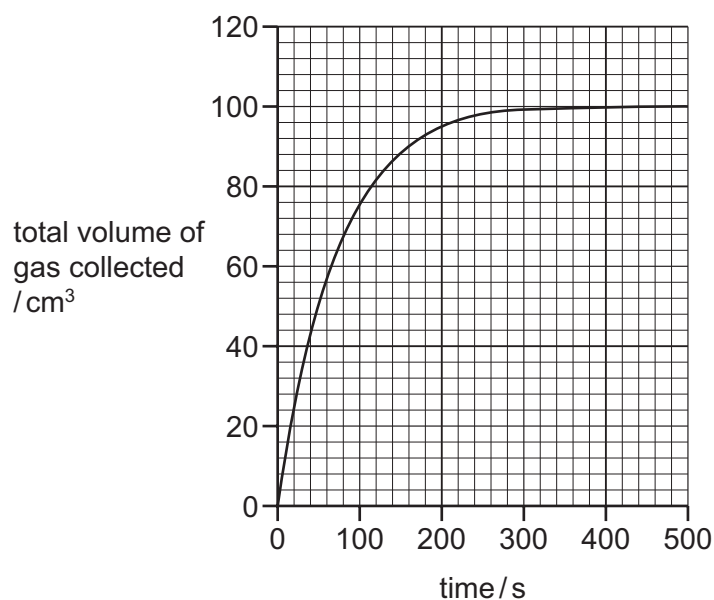
- 8 Magnesium carbonate reacts with dilute hydrochloric acid.



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.



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]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

The Periodic Table of Elements

		Group																																			
I	II	III	IV	V	VI	VII	VIII																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																				
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36										
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222		
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Fr francium —	Ra radium —	Ac actinium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Uu unbinilium —	Uub unbibium —	Uut untrium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —	Uuq unquadium —		

Group

1
H
hydrogen
1

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 dm³ at room temperature and pressure (r.t.p.).