



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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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.

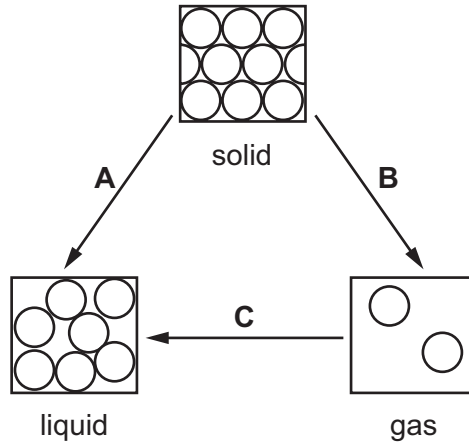
Describe how substance **J** is able to conduct electricity when it is a solid.

.....

 [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]

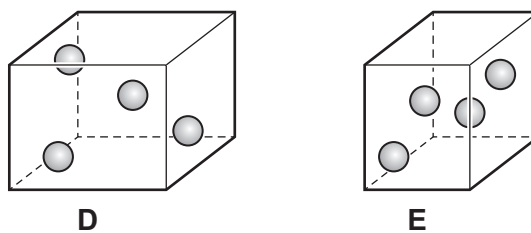
(ii) **B** [1]

(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.



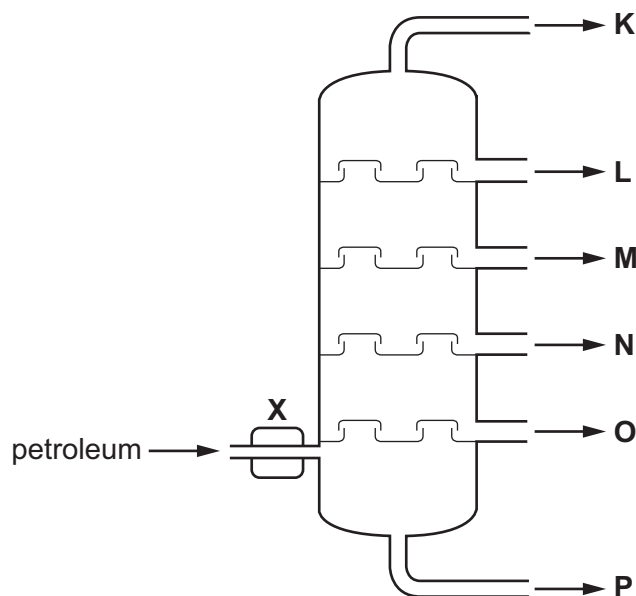
In which container will the pressure be higher? Explain your answer.

.....

 [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]

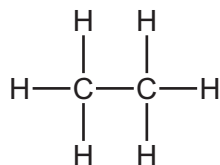
5

(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]

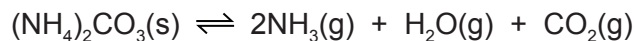
(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature

pressure

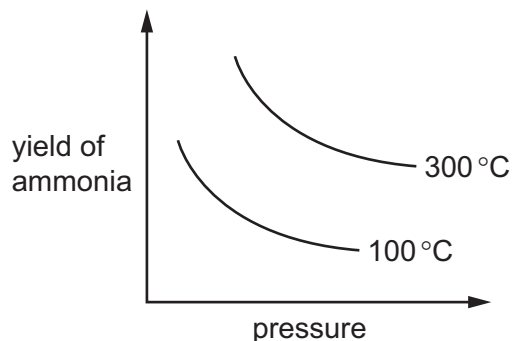
[2]

- (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]

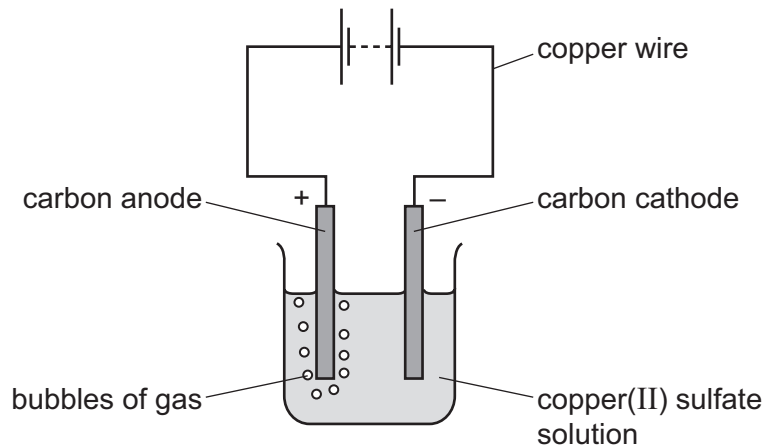
- (iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

 [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.

.....

.....

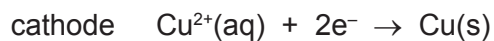
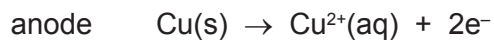
.....

.....

.....

..... [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]

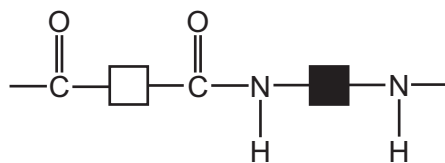
(ii) What is meant by the term *biodegradable*?

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

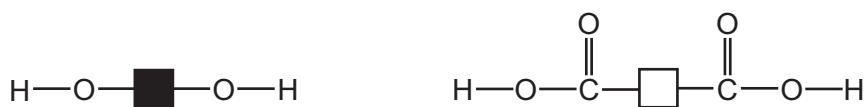
(iii) Name another natural polymer.

..... [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.

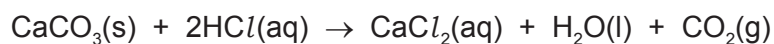


Draw a diagram to show the repeat unit of *Terylene*.

[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]

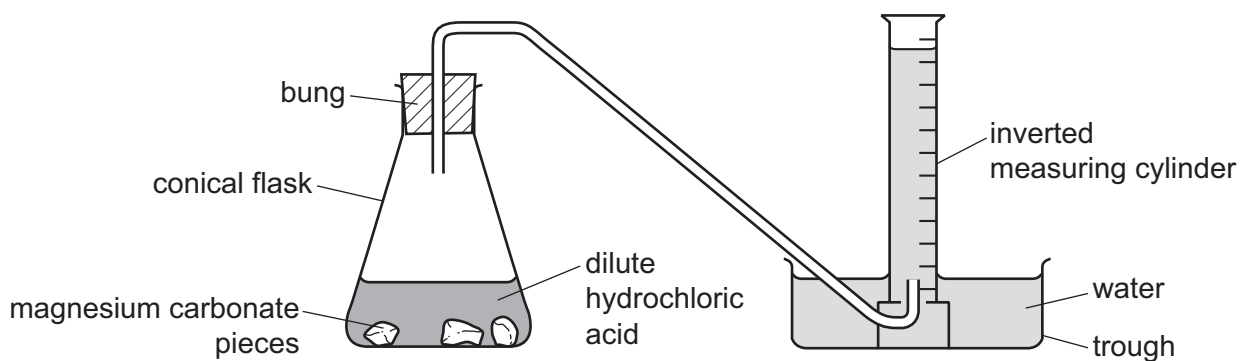
[Total: 6]

Question 8 starts on the next page.

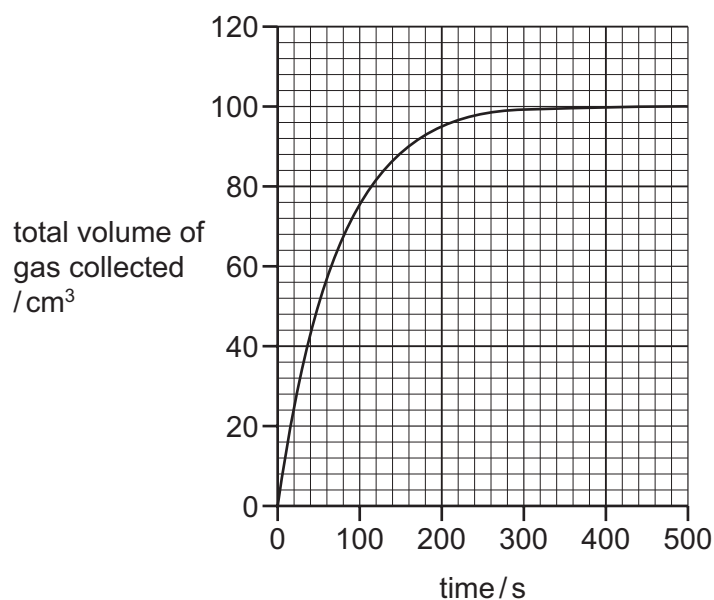
- 8 Magnesium carbonate reacts with dilute hydrochloric acid.



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]

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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
1	2	3	4	5	6	7	8	9	10
H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
Key									
atomic number atomic symbol name relative atomic mass									
11	12	13	14	15	16	17	18		
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40		
19	20	21	22	23	24	25	26	27	28
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59
37	38	39	40	41	42	43	44	45	46
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106
55	56	57–71	72	73	74	75	76	77	78
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195
87	88	89–103	104	105	106	107	108	109	110
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —
30									
Zn zinc 65									
47									
Cd cadmium 112									
79									
Te tellurium 128									
83									
Bi bismuth 209									
84									
Po polonium —									
114									
Fl flerovium —									
82									
Pb lead 207									
81									
Tl thallium 204									
80									
Hg mercury 201									
79									
Au gold 197									
111									
Rg roentgenium —									
112									
Cn copernicium —									

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).