Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 5 6 3 4 2 8 1 8 2 2 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2017**

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 **14** printed pages and **2** blank pages.

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1 Six different atoms can be represented as follows.

$^{3}_{1}\mathbf{A}$ $^{3}_{2}\mathbf{D}$ $^{12}_{6}\mathbf{E}$ $^{13}_{6}\mathbf{G}$ $^{14}_{7}\mathbf{J}$ $^{19}_{9}\mathbf{L}$

(a) Answer the following questions using atoms from the list. Each atom may be used once, more than once or not at all.

Select **one** atom from the six shown which

(i) has exactly seven protons,

..... [1]

(ii) has exactly six neutrons,

..... [1]

(iii) has more protons than neutrons,

..... [1]

(iv) has the electronic structure [2,5],

..... [1]

(v) is an atom of an element from Group VII of the Periodic Table,

..... [1]

(vi) is an atom of a noble gas.

..... [1]

(b) Two of the six atoms shown are isotopes of each other.

(i) What is meant by the term *isotopes*?

.....

..... [2]

(ii) Which **two** of the six atoms shown are isotopes of each other?

..... [1]

(iii) Why do isotopes have identical chemical properties?

.....

..... [1]

[Total: 10]

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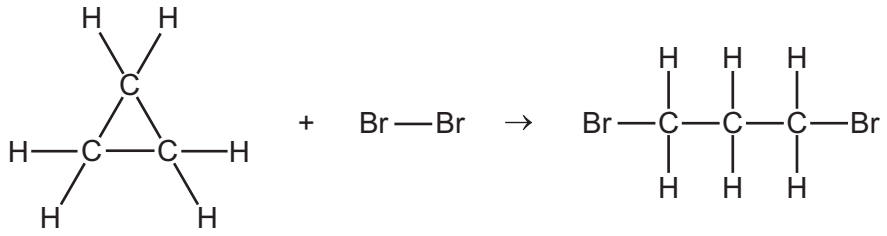
2 Cyclopropane is a colourless gas.
Cyclopropane reacts with bromine at room temperature. The chemical equation for the reaction is shown.



cyclopropane bromine dibromopropane

(a) **(i)** What is the empirical formula of cyclopropane?

..... [1]

(ii) What colour change, if any, would you see when cyclopropane is bubbled into aqueous bromine?

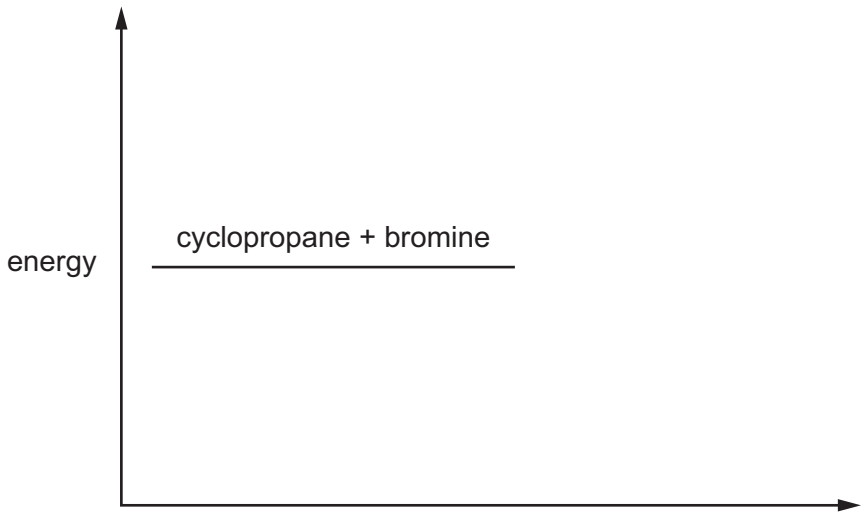
initial colour .....

final colour .....
[2]

(b) The reaction of cyclopropane with bromine is exothermic.

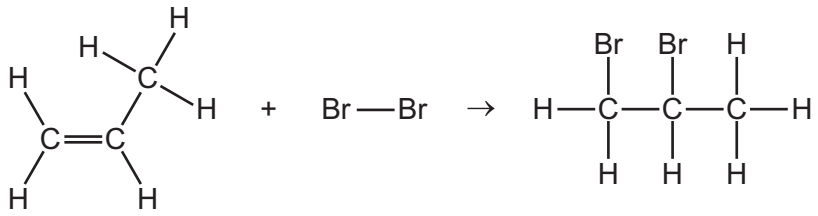
(i) Complete the energy level diagram for this reaction by

- adding the product of the reaction,
- labelling the energy change, ΔH.



[2]

(ii) Propene also reacts with bromine.



Use the bond energies in the table to calculate the energy change, ΔH, for the reaction.

	C–H	C–C	Br–Br	C–Br	C=C
bond energy in kJ/mol	412	348	193	285	611

energy change = ... kJ/mol [3]

(c) The boiling point of bromine is 59 °C and the boiling point of iodine is 184 °C.

Explain why iodine has a higher boiling point than bromine.

.....

.....

.....

.....

..... [2]

[Total: 10]

3 Magnesium is a metal.

(a) Describe the structure and bonding in magnesium.

.....

.....

.....

..... [3]

(b) Why can magnesium conduct electricity when solid?

.....

.....

.....

..... [2]

(c) Why is magnesium malleable?

.....

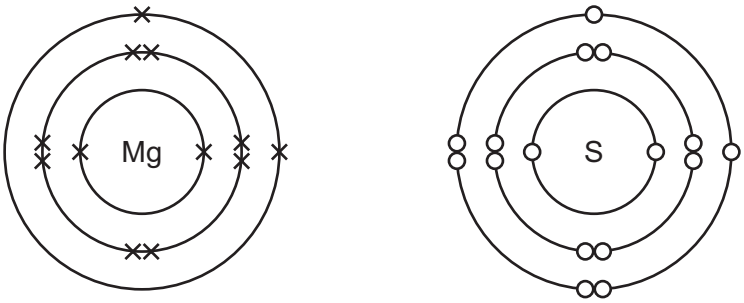
.....

.....

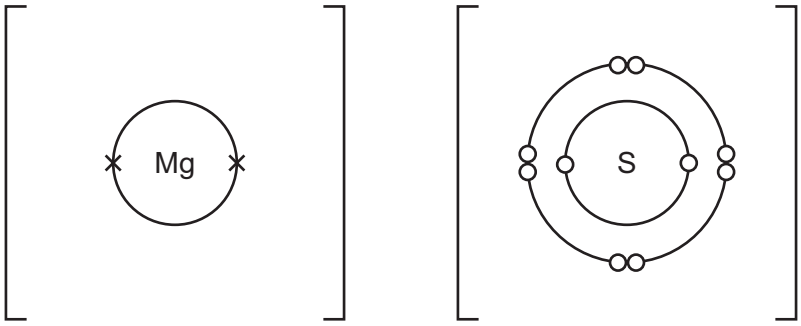
..... [2]

(d) Magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS.

The diagrams show the electronic structures of atoms of magnesium and sulfur.



(i) Complete the diagrams to show the electronic structures of the ions in magnesium sulfide. Show the charges on the ions.



[3]

(ii) Ionic compounds, such as magnesium sulfide, do **not** conduct electricity when solid.
Magnesium sulfide does **not** dissolve in water.
Magnesium sulfide **does** conduct electricity under certain conditions.

State the conditions needed for magnesium sulfide to conduct electricity. Explain why magnesium sulfide conducts electricity under these conditions.

.....

.....

.....

..... [2]

[Total: 12]

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4 Gasoline is used as a fuel for cars. It is a mixture of hydrocarbons.

(a) Name the raw material from which gasoline is obtained.

..... [1]

(b) One of the compounds in gasoline is heptane, C_7H_{16}. Heptane is a saturated hydrocarbon.

(i) What is meant by the term *saturated hydrocarbon*?

saturated .....

.....

hydrocarbon .....

.....
[3]

(ii) To which homologous series does heptane belong?

..... [1]

(iii) Give **two** characteristics of an homologous series.

1 .....

2 .....
[2]

(iv) Complete the chemical equation for the complete combustion of heptane.

$$C_7H_{16} + \text{.....}O_2 \rightarrow \text{.....} + \text{.....}$$

[2]

(c) Car engines produce carbon monoxide and oxides of nitrogen.

(i) Name an environmental problem that is caused by the release of oxides of nitrogen into the air.

..... [1]

(ii) Explain how carbon monoxide and oxides of nitrogen are formed in car engines.

carbon monoxide .....

.....

oxides of nitrogen .....

.....
[3]

(iii) State **one** adverse effect of carbon monoxide on human health.

..... [1]

(iv) Describe and explain how catalytic converters remove oxides of nitrogen from car engine exhaust fumes. You are advised to include a chemical equation in your answer.

.....

.....

.....

.....

.....

..... [3]

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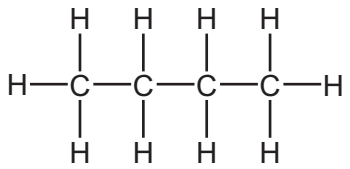
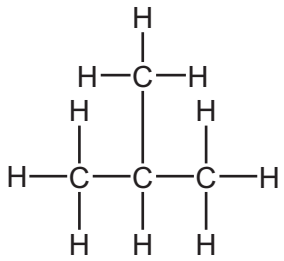
(d) The formula C_4H_{10} represents two structural isomers, **A** and **B**.



A



B

(i) Name isomer **A**.

..... [1]

(ii) What is meant by the term *structural isomers*?

.....

.....

..... [2]

(iii) Isomer **B** reacts with chlorine in a substitution reaction.

Give the conditions required for the reaction to occur and draw the structures of **two** possible products, **one** of which is organic and **one** of which is **not** organic.

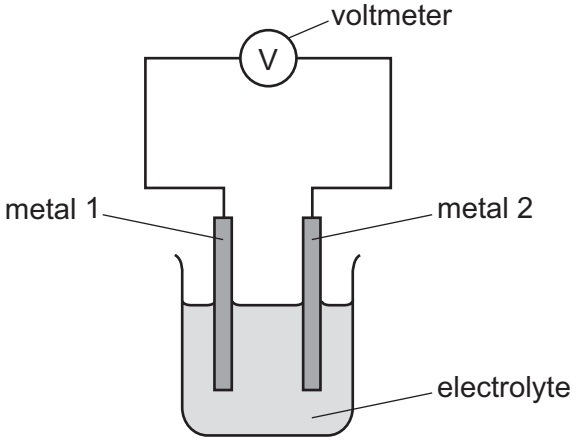
conditions .....

structures of products

[3]

[Total: 23]

5 The diagram shows a simple cell.



The simple cell was used with different metals as electrodes. The voltages were recorded in the table.

- If the voltage measured is positive then metal 2 is more reactive than metal 1.
- If the voltage measured is negative then metal 1 is more reactive than metal 2.

		metal 2				
		beryllium	cobalt	nickel	silver	vanadium
metal 1	beryllium	0.0 V	–1.6 V	–1.6 V	not measured	–0.7 V
	cobalt		0.0 V	0.0 V	–1.1 V	0.9 V
	nickel			0.0 V	–1.1 V	0.9 V
	silver				0.0 V	2.0 V
	vanadium					0.0 V

- The more reactive metal is oxidised.
- The bigger the difference in reactivity of the metals, the larger the reading on the voltmeter.

(a) In a simple cell using nickel and silver, the nickel is oxidised.

(i) Define *oxidation* in terms of electrons.

..... [1]

(ii) Nickel forms ions with a charge of +2.

Write an ionic half-equation to show the oxidation of nickel.

..... [1]

(iii) What will happen to the mass of the nickel electrode when the nickel is oxidised?

.....

..... [1]

(b) Use the data in the table to answer the following questions.

(i) Which of the metals in the table is the most reactive?
Explain your answer.

.....

..... [2]

(ii) State which **two** different metals have the same reactivity.

..... [1]

(iii) Predict the voltage produced by a simple cell with beryllium as metal 1 and silver as metal 2.

.....

..... [2]

(c) Describe how the simple cell in the diagram can be used to show that magnesium is more reactive than beryllium. Explain your answer.

.....

.....

.....

..... [2]

[Total: 10]

6 Barium carbonate, $BaCO_3$, is an insoluble solid.

(a) When barium carbonate is heated strongly, it undergoes thermal decomposition. One of the products is barium oxide.

(i) Write a chemical equation for the thermal decomposition of barium carbonate.

..... [1]

(ii) Suggest the pH of the solution formed when barium oxide is added to water.

..... [1]

(iii) Barium nitrate decomposes on heating in the same way as magnesium nitrate decomposes.

Name the **two** gaseous products formed when barium nitrate is heated.

.....

..... [2]

(b) Aqueous sodium carbonate is added to aqueous barium nitrate.

(i) Write a chemical equation for the reaction of aqueous sodium carbonate with aqueous barium nitrate.

..... [2]

(ii) Describe how a pure sample of barium carbonate could be obtained from the resulting mixture.

.....

.....

.....

..... [3]

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(c) Barium carbonate reacts with dilute hydrochloric acid.

$$BaCO_3 + 2HCl \rightarrow BaCl_2 + CO_2 + H_2O$$

9.85 g of barium carbonate were added to 250 cm^3 of 1.00 mol / dm^3 hydrochloric acid. This is an excess of hydrochloric acid.

(i) Calculate how many moles of barium carbonate were used in this experiment.

moles of barium carbonate = ... mol [2]

(ii) Deduce how many moles of carbon dioxide were made when all the barium carbonate had reacted.

moles of carbon dioxide = ... mol [1]

(iii) Calculate the volume of carbon dioxide formed in **(c)(ii)** at room temperature and pressure, in dm^3.

volume of carbon dioxide = ... dm^3 [1]

(iv) Calculate how many moles of hydrochloric acid there were **in excess**.

excess moles of hydrochloric acid = ... mol [2]

[Total: 15]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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 –		

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.).

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