Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

8786129582

CHEMISTRY **0620/31**

Paper 3 Theory (Core) **October/November 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.

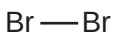
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This document consists of **15** printed pages and **1** blank page.

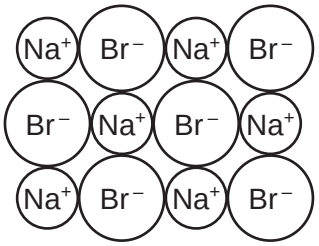
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1 The diagram shows the structures of five substances, **A**, **B**, **C**, **D** and **E**.

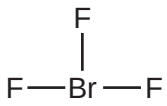
A



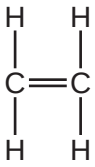
B



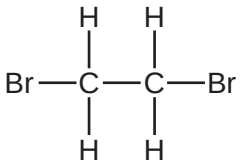
C



D



E



Answer the following questions using only the structures in the diagram.
Each structure may be used once, more than once or not at all.

(a) Which structure, **A**, **B**, **C**, **D** or **E**,

(i) is a diatomic molecule, ... [1]

(ii) contains ions, ... [1]

(iii) decolourises aqueous bromine, ... [1]

(iv) conducts electricity when molten, ... [1]

(v) contains atoms of **two** different halogens? ..... [1]

(b) Bromine is an element.

What is meant by the term *element*?

.....

..... [1]

(c) Bromine melts at –7 °C and boils at 59 °C.

What is the physical state of bromine at –15 °C?
Explain your answer.

.....

..... [2]

[Total: 8]

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2 The table shows the composition of the atmosphere of the planet Neptune.

gas present	percentage of gas in Neptune's atmosphere
helium	19.5
hydrogen	78.8
methane	
other gases	0.2

(a) Complete the table to calculate the percentage of methane in Neptune's atmosphere. [1]

(b) Describe how Neptune's atmosphere differs from the Earth's atmosphere.
Give **three** differences.

1 .....

.....

2 .....

.....

3 .....

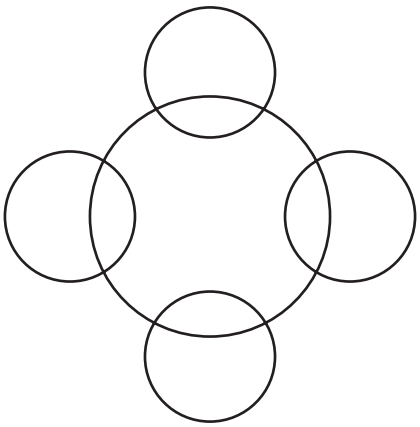
.....

[3]

(c) Methane is a covalent compound.

Complete the diagram to show
- the arrangement of electrons in a molecule of methane,
- the symbols of the atoms present.

Show outer shell electrons only.



[2]

(d) Isotopes of hydrogen are present in Neptune's atmosphere.

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

.....

..... [1]

(ii) An atom of hydrogen has three nucleons.

Deduce the number of protons and neutrons present in **one** atom of this isotope of hydrogen.
Use your Periodic Table to help you.

number of protons .....

number of neutrons .....
[2]

(e) Other gases present in Neptune's atmosphere include ethane and water vapour.

(i) Calculate the relative molecular mass of ethane, C_2H_6.
Use your Periodic Table to help you.

relative molecular mass = ... [2]

(ii) Describe a chemical test for water.

test .....

result .....
[2]

[Total: 13]

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3 The following substances are present in a liquid floor cleaner.

coloured dyes
ethanol
preservatives
sodium carbonate

(a) (i) Balance the chemical equation for the complete combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow .....CO_2 + ...H_2O$$

[2]

(ii) Draw the structure of an ethanol molecule showing all of the atoms and all of the bonds.

[2]

(b) Aqueous sodium carbonate is alkaline.

(i) Which **one** of the following pH values is alkaline?
Put a circle around the correct answer.

pH 3 pH 6 pH 7 pH 10

[1]

(ii) Aqueous sodium carbonate is colourless.

An excess of aqueous sodium carbonate is added to a solution of dilute sulfuric acid and methyl orange.

Describe the colour change.

from ..... to ..... [2]

(iii) The chemical equation for the reaction between sodium carbonate and dilute sulfuric acid is shown.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

Write the word equation for this reaction.

..... [2]

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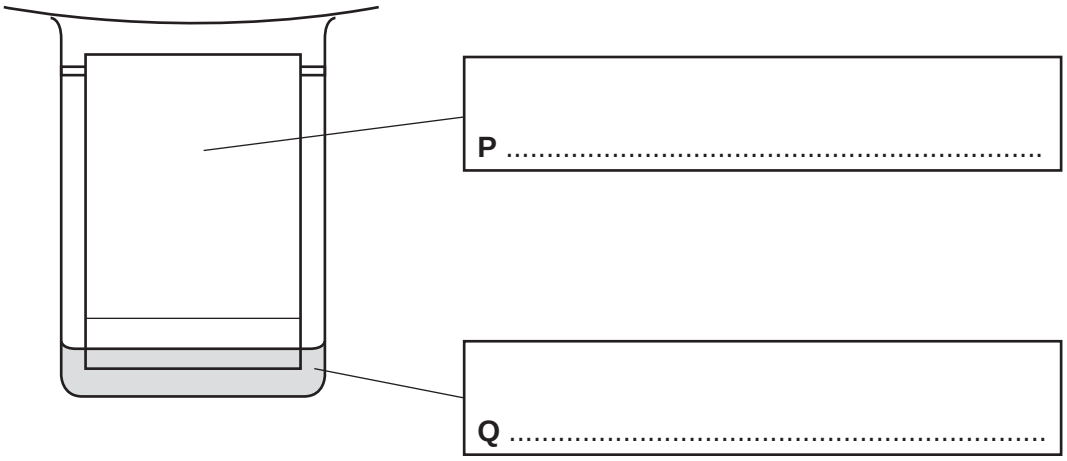
[Turn over

(c) Preservatives stop the growth of bacteria and fungi.

State the name of an acidic gas used to preserve food.

..... [1]

(d) The coloured dyes in the liquid floor cleaner can be separated using the apparatus shown.



(i) Complete the boxes to label **P** and **Q**. [2]

(ii) State the name of this method of separation.

..... [1]

(iii) On the diagram, put an **X** to show where the mixture of coloured dyes is placed at the start of the experiment. [1]

[Total: 14]

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4 The table shows the properties of four substances.

substance	boiling point	electrical conductivity of solid	electrical conductivity when molten	density in g / cm^3
graphite				2.25
iodine	low	does not conduct	does not conduct	4.93
potassium	high		conducts	0.86
zinc chloride	high	does not conduct	conducts	2.91

(a) Complete the table to show the electrical conductivity of solid graphite and solid potassium. [2]

(b) Give **one** piece of evidence from the table that shows that iodine is a simple covalent substance.

..... [1]

(c) What information in the table shows that zinc chloride is an ionic compound?

.....

..... [2]

(d) Molten zinc chloride can be electrolysed.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). ..... [2]

(e) Aqueous iodine is formed when aqueous chlorine is added to aqueous potassium iodide.

Use ideas about reactivity to explain why this reaction occurs.

.....

..... [1]

[Total: 8]

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[Turn over

5 Titanium is extracted from an ore which contains titanium(IV) oxide, TiO_2.

(a) (i) Balance the chemical equation for the first step in this extraction.

$$TiO_2 + ...C + ...Cl_2 \rightarrow TiCl_4 + 2CO$$

[2]

(ii) Explain why the conversion of carbon to carbon monoxide is an oxidation reaction.

..... [1]

(b) Titanium is a transition element.
Sodium is a Group I element.

Describe **two** differences in the physical properties of titanium and sodium.

1 .....

.....

2 .....

.....
[2]

(c) The properties and relative reactivity with water of some Group I elements are shown in the table.

element	density in g / cm^3	melting point in °C	relative reactivity with water
lithium	0.53	181	
sodium		98	forms bubbles rapidly but does not burst into flames
potassium	0.86		forms bubbles very rapidly and bursts into flames
rubidium	1.53	39	reacts explosively

(i) Complete the table
- for the relative reactivity of lithium with water,
- to predict the melting point of potassium.

[2]

(ii) Describe the general trend in the density of the Group I elements.

..... [1]

(d) Is lithium oxide an acidic oxide or a basic oxide?
Explain your answer.

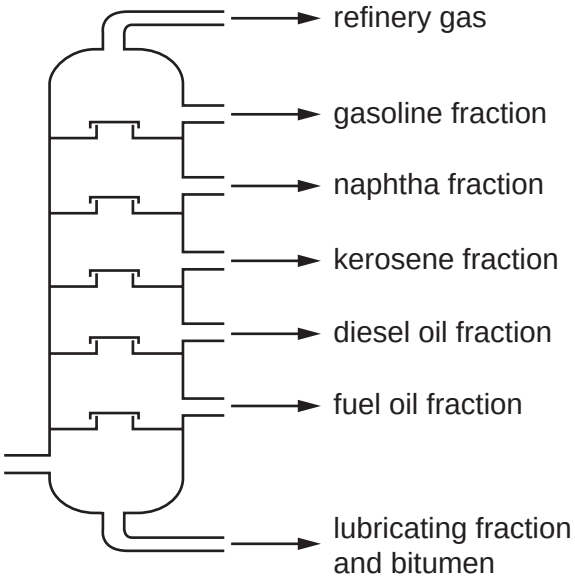
.....

..... [1]

[Total: 9]

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6 The diagram shows a fractionating column used for the fractional distillation of petroleum.



(a) Describe the fractional distillation of petroleum.

In your answer, include

- where the petroleum enters the fractionating column,
- the relative temperatures in the fractionating column (higher or lower),
- the relative boiling points of the fractions (higher or lower),
- the changes in physical state which occur.

.....

.....

.....

.....

.....

.....

..... [4]

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[Turn over

(b) Alkenes can be made by cracking the kerosene fraction.

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

.....

..... [2]

(ii) When butane is cracked, ethene and gas **X** are produced.

$$C_4H_{10} \rightarrow 2C_2H_4 + \mathbf{X}$$

State the name of gas **X**.

..... [1]

(c) Complete the sentence about the bonding in butane.

All the bonds in butane are single ..... chemical bonds. [1]

(d) Ethene is used to make poly(ethene).

Which **one** of the following words describes poly(ethene)?
Put a circle around the correct answer.

gas **monomer** **polymer** **solvent**

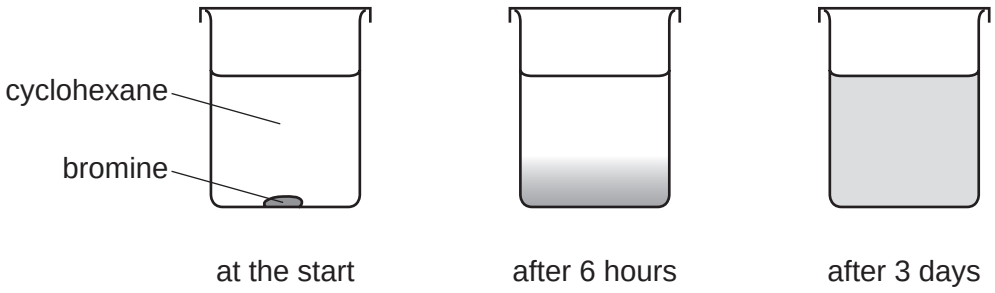
[1]

[Total: 9]

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7 Bromine is a red-brown liquid which is soluble in cyclohexane.

(a) A few drops of liquid bromine were placed at the bottom of a beaker containing cyclohexane. After 3 days, a red-brown colour had spread throughout the beaker.



Explain these observations using the kinetic particle model.

.....

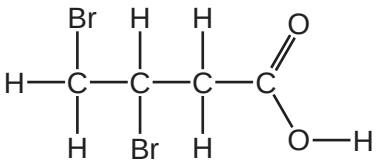
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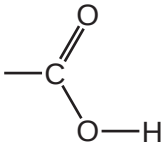
..... [3]

(b) The structure of a compound containing bromine is shown.



(i) Deduce the molecular formula of this compound showing the number of carbon, hydrogen, oxygen and bromine atoms.

..... [1]

(ii) State the name of the  functional group.

..... [1]

(c) The relative atomic mass of bromine is 80.

Complete the definition of relative atomic mass using terms from the list.

6

12

an atom

an element

a molecule

average

carbon

hydrogen

total

Relative atomic mass is the ..... mass of naturally occurring atoms

of ..... on a scale where ..... of the ^{12}C isotope has

a mass of exactly ..... units. [4]

(d) Dilute hydrobromic acid reacts with magnesium ribbon.

(i) Suggest **three** ways of increasing the rate of this reaction.

1 .....

2 .....

3 .....

[3]

(ii) Hydrobromic acid reacts with oxygen. The products are water and bromine.

Balance the chemical equation for this reaction.

$$.....HBr + O_2 \rightarrow 2H_2O + 2Br_2$$

[1]

[Total: 13]

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8 Ammonia is manufactured by combining nitrogen and hydrogen at high temperature and pressure.

$$\text{nitrogen} + \text{hydrogen} \overset{\text{catalyst}}{\rightleftharpoons} \text{ammonia}$$

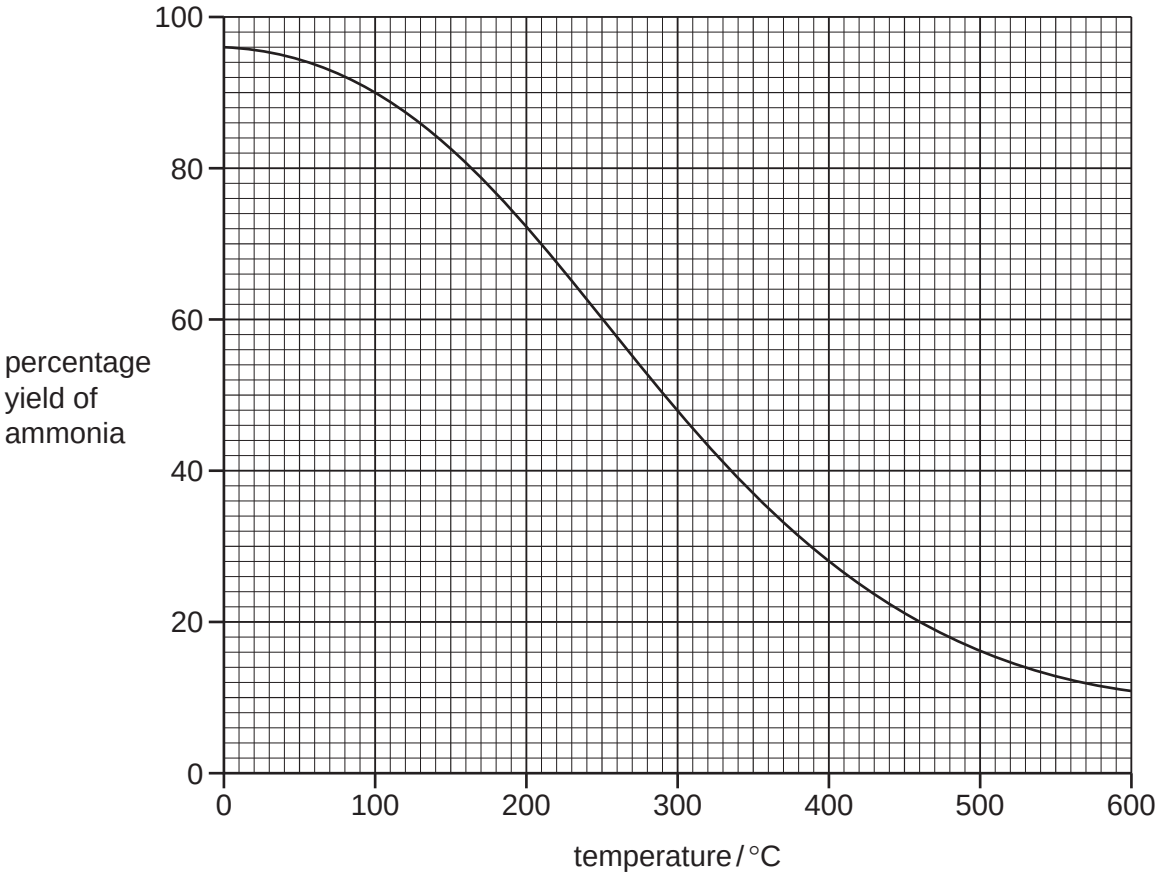
(a) (i) What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(ii) What is the purpose of the catalyst?

..... [1]

(b) The graph shows the percentage yield of ammonia at different temperatures.



(i) Describe how the percentage yield of ammonia changes with temperature.

..... [1]

(ii) Deduce the percentage yield of ammonia at 400 °C.

..... [1]

(c) Copper(II) oxide reacts with ammonia.

copper(II) oxide + ammonia → copper + nitrogen + water

When 20 g of copper(II) oxide react with an excess of ammonia, 16 g of copper are formed.

Calculate the mass of copper formed when 140 g of copper(II) oxide react with an excess of ammonia.

..... g [1]

(d) Ammonia is used in the manufacture of nylon.

Give **one** use of nylon.

..... [1]

[Total: 6]

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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.).