Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5104803745

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **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.

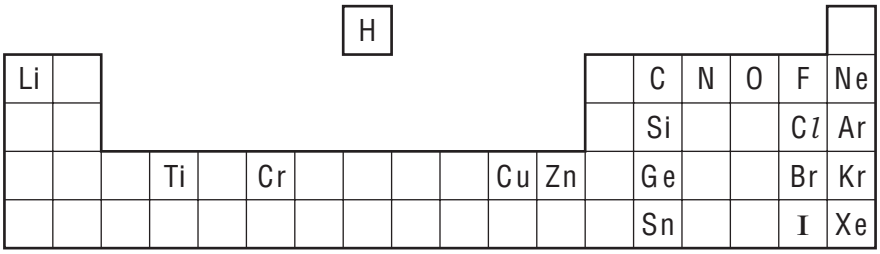
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **16** printed pages.

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CAMBRIDGE International Examinations

1 The diagram shows part of the Periodic Table.



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

(a) Which element

(i) forms 21% of the air,

..... [1]

(ii) reacts with water to form a solution which turns litmus paper from red to blue,

..... [1]

(iii) forms ions of type X^{3+} which when tested with aqueous sodium hydroxide produce a green precipitate,

..... [1]

(iv) is a red-brown liquid at room temperature and pressure,

..... [1]

(v) is a noble gas with only **three** complete electron shells?

..... [1]

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(b) The table gives some information about the properties of four metals.

metal	density in g / cm^3	relative strength	resistance to corrosion	relative electrical conductivity	melting point / °C
chromium	7.2	8	very good	8	1857
copper	8.9	30	good	60	1283
iron	7.9	21	poor	10	1535
titanium	4.5	23	very good	2	1660

Which **one** of these metals is most suitable for making the frame of an aircraft?
Explain your answer using information from the table.

.....

.....

.....

..... [3]

[Total: 8]

2 A scientist analysed the substances present in a 1 dm^3 sample of river water in an agricultural area. The table shows the mass of each ion dissolved in the 1 dm^3 sample.

name of ion	formula of ion	mass / g
calcium	Ca^{2+}	1.2
chloride	Cl^-	0.1
hydrogencarbonate	HCO_3^-	1.0
magnesium	Mg^{2+}	0.5
nitrate	NO_3^-	1.0
sodium	Na^+	
	SO_4^{2-}	0.5
phosphate	PO_4^{3-}	1.2
	Total	6.0

(a) (i) Which negative ion has the highest concentration, in g / dm^3, in this sample of water?

..... [1]

(ii) Give the name of the ion with the formula SO_4^{2-}.

..... [1]

(iii) Calculate the mass of sodium ions in 1 dm^3 of this river water.

..... [1]

(b) Describe a test for nitrate ions.

test .....

.....

result .....

[3]

(c) The sample of river water also contains insoluble materials such as clay and the remains of dead animals and plants.

(i) What method could be used to separate insoluble materials from river water?

..... [1]

(ii) Some of the remains of dead animals and plants contain food materials.

Which **two** of the following substances are constituents of food?
Tick **two** boxes.

alkane	☐
carbohydrate	☐
graphite	☐
protein	☐

[1]

(iii) Particles of clay suspended in river water show Brownian motion.

Describe the movement of these particles.

..... [1]

(d) Most of the nitrate ions in river water come from fertilisers.

(i) Explain why farmers use fertilisers.

.....

..... [2]

(ii) Ammonium nitrate is a fertiliser.
Ammonium nitrate reacts with calcium hydroxide.

ammonium nitrate + calcium hydroxide $\rightarrow$ calcium nitrate + ammonia + water

Explain why adding calcium hydroxide to the soil at the same time as nitrate fertilisers results in loss of nitrogen from the soil.

.....

..... [2]

[Total: 13]

3 Ethanol can be manufactured by fermentation and from ethene.

(a) Describe the manufacture of ethanol by fermentation **and** from ethene.
In your answer include

- the essential conditions required for each reaction,
- **one** or more relevant word equations.

.....

.....

.....

.....

.....

..... [5]

(b) The table shows some properties of different alcohols.

alcohol	formula	melting point / °C	boiling point / °C	relative viscosity
methanol	CH_4O	–94	65	0.54
ethanol	C_2H_6O	–117	79	1.08
propanol	C_3H_8O	–126	98	1.94
butanol	$C_4H_{10}O$	–89	117	2.54
pentanol	$C_5H_{12}O$	–79		3.47

(i) Deduce the state of methanol at room temperature.
Explain your answer.

.....

..... [2]

(ii) Predict the boiling point of pentanol.

..... [1]

(iii) Describe how the relative viscosity changes with the number of carbon atoms in the alcohol.

..... [1]

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(c) (i) Draw the structure of ethanol. Show all of the atoms and all of the bonds.

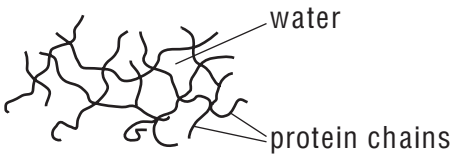
[2]

(ii) Give **one** major use of ethanol.

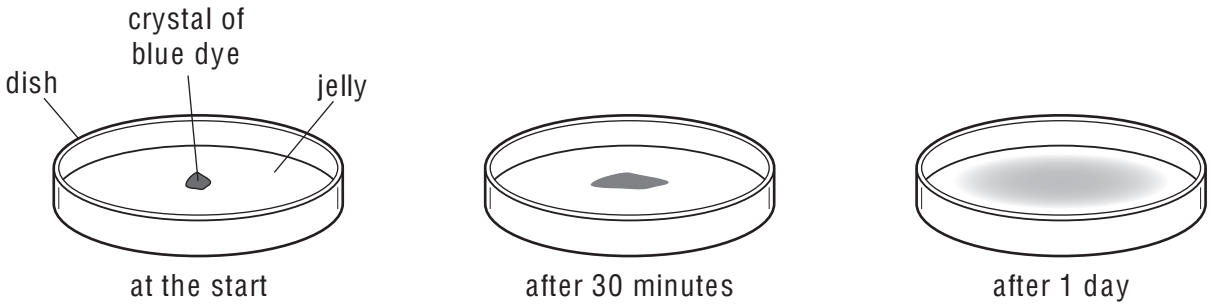
..... [1]

[Total: 12]

4 Jelly is a mixture of water and protein chains.



(a) A crystal of blue dye was placed on top of some jelly.
After 30 minutes some of the blue colour could be seen in the jelly.
After 1 day the blue colour had spread out further into the jelly.



Use the kinetic particle model of matter to explain these observations.

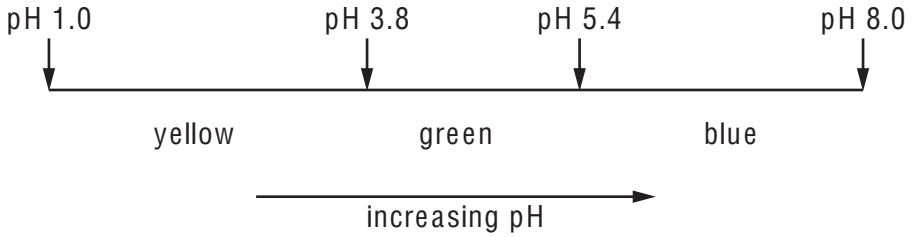
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..... [3]

(b) The diagram shows the colour changes of the indicator bromocresol green at different pH values.

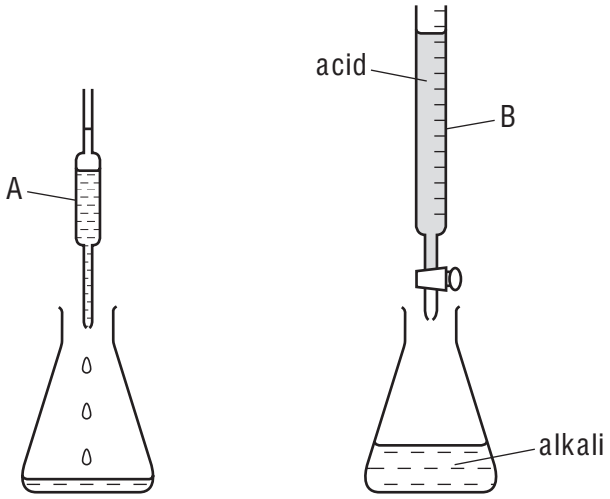


Predict the colour of bromocresol green

in pure water, ...

in a strongly acidic solution. .....
[2]

(c) The concentration of an alkali can be found by titrating it with an acid using the apparatus shown.

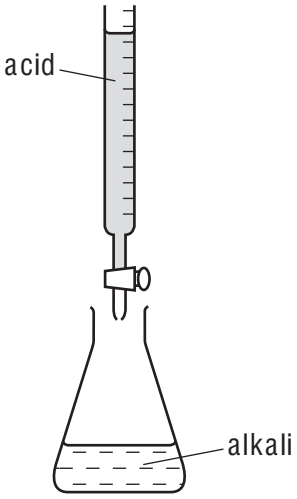


(i) State the names of the pieces of glassware labelled **A** and **B**.

A .....

B .....
[2]

(ii) Describe how you would carry out a titration using the apparatus shown.



.....

.....

.....

.....

.....

..... [3]

[Total: 10]

5 Lime (calcium oxide) is made by heating limestone (calcium carbonate).

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

(a) (i) Is this reaction exothermic or endothermic?
Explain your answer.

.....

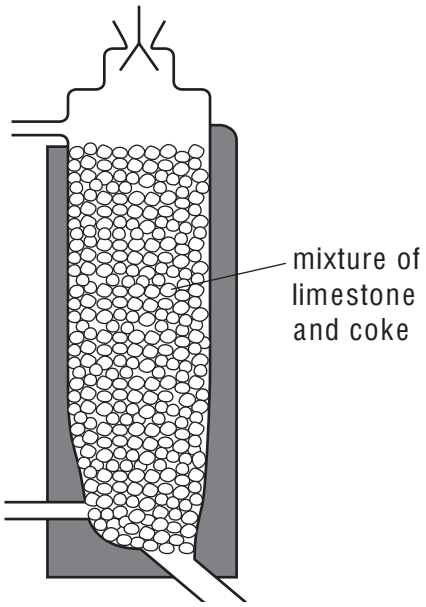
..... [1]

(ii) The reaction is reversible.

What information in the equation shows that this reaction is reversible?

..... [1]

(b) The diagram shows a furnace for making lime.



(i) On the diagram, write

- the letter **C** to show where the waste gases exit the furnace,
- the letter **L** to show where the lime is removed from the furnace.

[2]

(ii) Suggest a reason for adding coke (carbon) to the furnace.

..... [1]

(c) Explain why farmers use lime to treat acidic soils.

.....

..... [2]

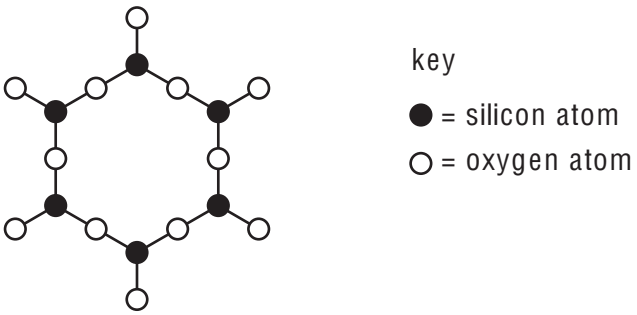
(d) Limestone is used to manufacture cement. The limestone is mixed with clay and heated to 1500 °C. It is then mixed with calcium sulfate and crushed.

(i) Describe the test for sulfate ions.

test .....

result .....
[2]

(ii) Concrete is a mixture of cement, silicates and water. Part of the structure of a silicate is shown.



Deduce the formula for this silicate.

..... [1]

(e) Concrete contains small amounts of calcium oxide.
This can react with rainwater to form calcium hydroxide.

(i) Calcium hydroxide is strongly alkaline.

What is the most likely pH of a strongly alkaline solution?
Draw a ring around the correct answer.

pH 2 pH 6 pH 7 pH 12

[1]

(ii) The calcium hydroxide on the surface of a piece of concrete reacts with carbon dioxide in the air.

Complete the chemical equation for this reaction.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + ...$$

[1]

(iii) Limewater is an aqueous solution of calcium hydroxide. A teacher left an open beaker of limewater in the laboratory.
After a week, the solution in the beaker was pH 7 and a white precipitate was observed.

Use the information in **(e)(i)** and **(e)(ii)** to help you explain these observations.

.....

.....

.....

.....

.....

..... [3]

[Total: 15]

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6 The Periodic Table is a method of classifying elements.

(a) (i) In what order are the elements arranged in the Periodic Table?

..... [1]

(ii) How does the character of the elements change from left to right across a period?

..... [1]

(iii) Describe **two** trends in the properties of the elements going down Group I.

.....

.....

..... [2]

(b) The halogens are a group of elements with diatomic molecules.

(i) Chlorine reacts with an aqueous solution of sodium iodide.

$$Cl_2 + 2NaI \rightarrow I_2 + 2NaCl$$

What colour change would be observed in the solution?

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

(ii) Astatine, At_2, is a halogen.

Suggest why astatine does **not** react with aqueous potassium iodide.

..... [1]

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

(i) Complete the chemical equation for this reaction.

$$Cl_2 + \text{.....} \rightarrow \text{.....}HCl$$

[2]

(ii) Draw a diagram to show the electronic structure of a molecule of hydrogen chloride.
Show only the outer shell electrons.

[2]

(iii) Hydrochloric acid reacts with lithium hydroxide.

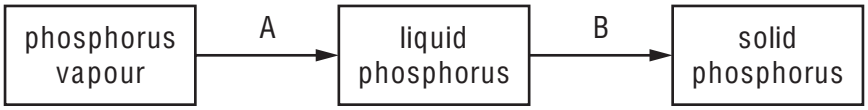
Complete the word equation for this reaction.

hydrochloric acid	+	lithium hydroxide	→		+	

[2]

[Total: 13]

7 The diagram shows the changes of state when phosphorus is cooled slowly to room temperature.



(a) Give the names of the changes of state labelled **A** and **B**.

A .....

B .....
[2]

(b) Describe the arrangement and motion of the particles in solid phosphorus.

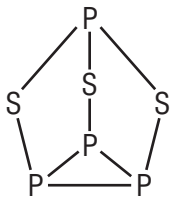
arrangement .....

motion .....
[2]

(c) Is phosphorus(V) oxide an acidic oxide or basic oxide?
Explain your answer.

..... [1]

(d) Phosphorus sulfide is a covalent molecule.



Predict **two** properties of phosphorus sulfide.

.....

..... [2]

(e) Many metal ores contain sulfides.
When zinc sulfide is heated in air the following reaction takes place.

zinc sulfide + oxygen → zinc oxide + sulfur dioxide

Explain why this reaction may be harmful to the environment.

.....

..... [2]

[Total: 9]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).

PMT