Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

1609274387

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 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 **15** printed pages and **1** blank page.

© UCLES 2016

1 The diagram shows part of the Periodic Table.

I	II											III	IV	V	VI	VII	VIII
Li													C	N	O	F	Ne
												Al	Si			Cl	Ar
			Ti		Cr		Fe			Cu	Zn		Ge			Br	Kr
													Sn			I	Xe
													Pb				

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 78% of the air,

..... [1]

(ii) has an oxide which is a product of respiration,

..... [1]

(iii) is used to make food containers because of its resistance to corrosion,

..... [1]

(iv) forms an ion of type X^{3+},

..... [1]

(v) forms an ion whose aqueous solution forms a light blue precipitate on addition of a few drops of aqueous ammonia?

..... [1]

© UCLES 2016

(b) Calcium is an element with several naturally-occurring isotopes.

(i) What is the meaning of the term *element*?

..... [1]

(ii) Two of the isotopes of calcium are

$^{43}_{20}Ca$ and $^{48}_{20}Ca$.

Complete the table to show the number of protons, neutrons and electrons in one atom of each of these isotopes.

	$^{43}_{20}Ca$	$^{48}_{20}Ca$
number of protons		
number of neutrons		
number of electrons		

[3]

(iii) Determine the number of electrons in one calcium ion, Ca^{2+}.

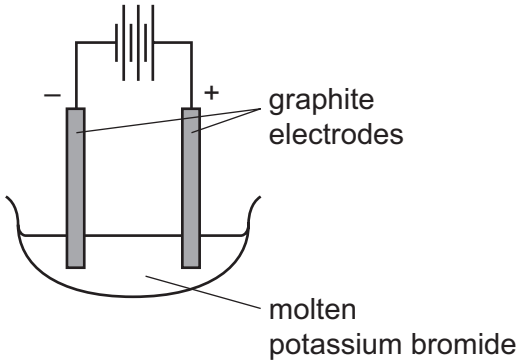
..... [1]

[Total: 10]

© UCLES 2016

[Turn over

2 Molten potassium bromide can be electrolysed using the apparatus shown.



(a) Predict the products of this electrolysis at the

positive electrode (anode), ...

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

(b) (i) Explain why graphite electrodes are used in this electrolysis.

..... [1]

(ii) Give **one** other use of graphite.

..... [1]

(c) When chlorine is bubbled through an aqueous solution of potassium bromide, the solution turns red-brown in colour.

Which substance causes the red-brown colour?

..... [1]

(d) Describe what you would observe when an aqueous solution of potassium bromide is added to an acidified aqueous solution of silver nitrate.

..... [1]

(e) Silver nitrate decomposes when heated. One of the products is nitrogen dioxide.

State **one** adverse effect of nitrogen dioxide on health.

..... [1]

[Total: 7]

© UCLES 2016

3 Many metals react with either cold water or steam.

(a) Describe the reaction of sodium with cold water, and iron with steam.
In your answer describe
- the products formed,
- any observations that can be made.

.....

.....

.....

.....

..... [4]

(b) Iron reacts with hydrochloric acid.

$$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$$

Describe a practical method to investigate the rate of this reaction.
You may draw a labelled diagram.

.....

.....

..... [3]

(c) The experiment in **(b)** was repeated using different sized pieces of iron.
All other conditions remained the same.
The sizes of the pieces of iron were
- large pieces,
- small pieces,
- iron powder.

Complete the table below by writing the sizes of the pieces in the first column.

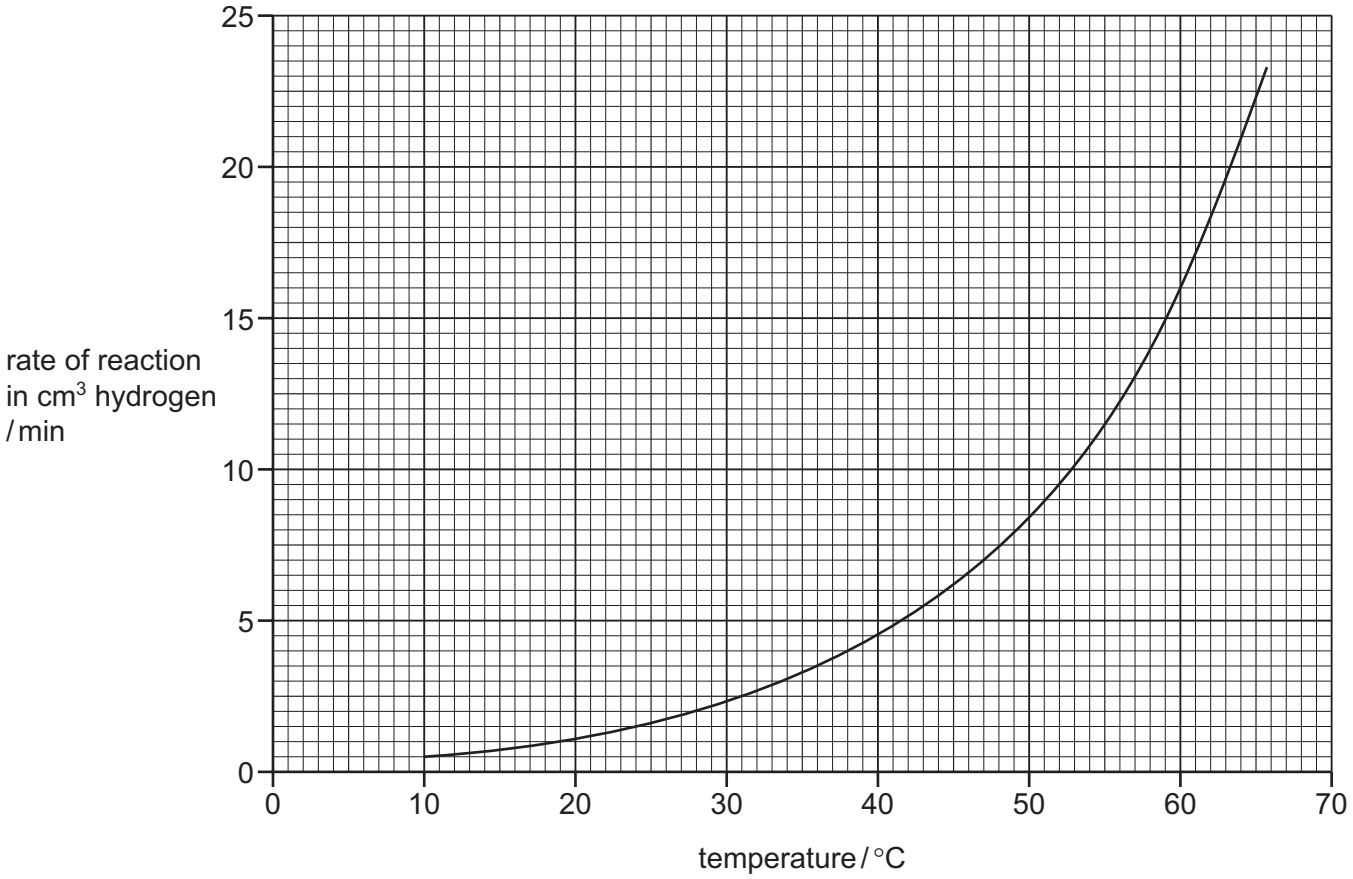
sizes of the pieces of iron	rate of reaction in cm^3 hydrogen / min
	25
	3
	10

[1]

© UCLES 2016

[Turn over

(d) The graph shows the effect of temperature on the rate of the reaction of hydrochloric acid with iron.



(i) Describe the effect of temperature on the rate of this reaction.

.....

..... [2]

(ii) Determine the rate of reaction at 60 °C.

..... cm^3 hydrogen / min [1]

(e) Describe how the concentration of hydrochloric acid affects the rate of its reaction with iron.

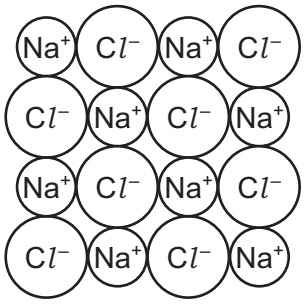
.....

..... [1]

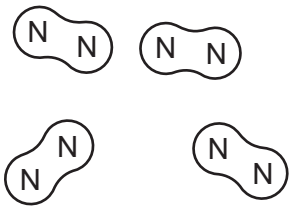
[Total: 12]

© UCLES 2016

4 The structures of sodium chloride and nitrogen are shown below.



sodium chloride



nitrogen

(a) Describe the structure and bonding of these two substances and the differences in
- their volatility,
- their electrical conductivity.

.....

.....

.....

.....

.....

..... [5]

(b) Ammonia is manufactured by reacting nitrogen with hydrogen using a catalyst.

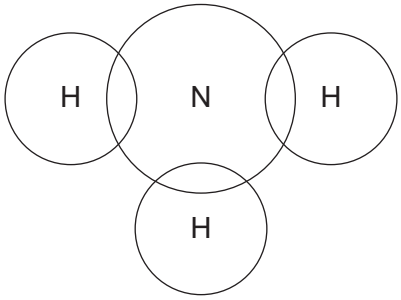
(i) What is the purpose of the catalyst?

..... [1]

(ii) Complete the chemical equation for this reaction.

$$N_2 + ...H_2 \rightarrow .....NH_3$$ [2]

(iii) Complete the electronic structure of a molecule of ammonia.
Show only the outer electrons.



[2]

(iv) Ammonia reacts with copper(II) oxide.

$$2NH_3 + 3CuO \rightarrow 3Cu + 3H_2O + N_2$$

Which compound is reduced in this reaction?
Explain your answer.

.....

..... [2]

[Total: 12]

5 **(a)** The table shows some properties of cobalt, copper, magnesium and tin.

metal	relative heat conduction	density in g / cm^3	melting point / °C	relative strength
cobalt	1.00	8.90	1495	55.0
copper	3.85	8.92	1083	32.0
magnesium	1.50	1.74	649	1.5
tin	0.64	7.28	232	1.0

Answer the questions using the information shown in the table.

(i) Which metal is the best to use for the base of a pan for cooking food?
Use information in the table to give reasons for your answer.

.....

..... [2]

(ii) Which **two** metals in the table are transition elements?
Use information in the table to give reasons for your answer.

.....

..... [2]

(iii) Which metal in the table is most likely to be used in an alloy for aircraft bodies?
Use information in the table to give reasons for your answer.

.....

..... [2]

(b) Some observations about the reactions of the four metals with hydrochloric acid are shown in the table.

metal	observations
cobalt	Bubbles formed very slowly.
copper	No bubbles formed.
magnesium	Many bubbles formed very rapidly.
tin	A steady stream of bubbles formed.

Use the information in the table to put these metals in order of their reactivity with hydrochloric acid.

least reactive ⟶ most reactive

[2]

(c) Crystals of hydrated cobalt(II) sulfate, $CoSO_4.7H_2O$, can be made by reacting dilute sulfuric acid with insoluble cobalt carbonate.

Describe how you could prepare a pure dry sample of cobalt(II) sulfate crystals from dilute sulfuric acid and cobalt(II) carbonate.

.....

.....

.....

.....

..... [4]

(d) When heated, hydrated cobalt(II) sulfate forms an anhydrous salt in a reversible reaction.

(i) Complete the equation for this reaction by inserting the sign for a reversible reaction in the box.

$CoSO_4.7H_2O$ + $CoSO_4$ + $7H_2O$

hydrated cobalt(II) sulfate
pale red

anhydrous cobalt(II) sulfate
dark blue

[1]

(ii) Suggest how you could use this reaction to test for the presence of water.

.....

..... [2]

[Total: 15]

© UCLES 2016

6 Citric acid is found in lemon juice. Citric acid shows typical acidic properties.

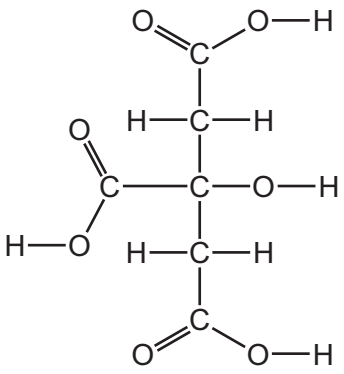
(a) Describe how you could determine the pH of a solution of lemon juice using Universal Indicator.

.....

.....

..... [2]

(b) The structure of citric acid is shown below.



(i) On the diagram, draw a ring around a carboxylic acid functional group. [1]

(ii) State the name of **one** other carboxylic acid.

..... [1]

(c) Calcium citrate can be prepared by neutralising aqueous citric acid with excess calcium carbonate.

(i) Complete the word equation for this reaction.

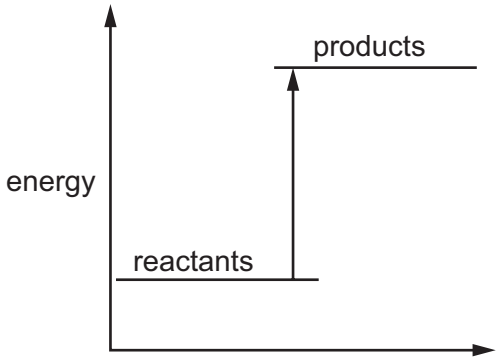
citric acid	+	calcium carbonate	→	calcium citrate	+		+	

[2]

(ii) Suggest how you could separate the excess calcium carbonate from the rest of the solution.

..... [1]

(d) The energy level diagram for the reaction of citric acid with sodium hydrogen carbonate is shown below.



Is this reaction exothermic or endothermic?
Give a reason for your answer.

.....

..... [1]

(e) Both citric acid and ethanol can be manufactured by fermentation.

(i) Complete the chemical equation for the fermentation of glucose to form ethanol.

$$C_6H_{12}O_6 \rightarrow .....C_2H_5OH + ...CO_2$$ [2]

(ii) State **two** conditions needed for fermentation.

.....

..... [2]

(iii) Complete the table below and calculate the relative molecular mass of glucose.

type of atom	number of atoms	relative atomic mass	
carbon	6	12	$6 \times 12 = 72$
hydrogen			
oxygen			

relative molecular mass = ... [2]

[Total: 14]

© UCLES 2016

7 Rhenium is a metal.

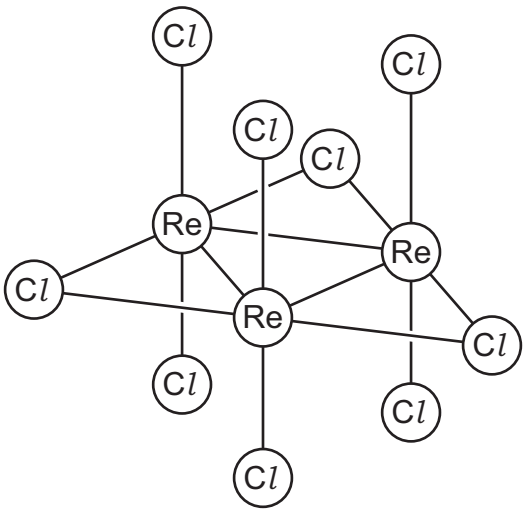
(a) Describe **three** physical properties of rhenium.

.....

.....

..... [3]

(b) The structure of a rhenium chloride molecule is shown.



Determine the simplest formula for this chloride of rhenium.

..... [1]

(c) Rhenium oxide is a yellow solid which undergoes sublimation at a low temperature.

What is the meaning of the term *sublimation*?

..... [1]

(d) Rhenium oxide reacts with water to form perrhenic acid.
Perrhenic acid is strongly acidic.

(i) Which **one** of the following pH values represents an acidic solution?
Draw a ring around the correct answer.

pH 2 pH 7 pH 9 pH 14

[1]

(ii) Perrhenic acid reacts with potassium hydroxide.

Complete the word equation for this reaction.

perrhenic acid	+	potassium hydroxide	→	potassium perrhenate	+	

[1]

(iii) Which **one** of the following compounds will react with perrhenic acid?
Tick **one** box.

ethane	☐
hydrochloric acid	☐
potassium carbonate	☐
sodium chloride	☐

[1]

(e) Potassium perrhenate has a similar formula to potassium manganate(VII).
Potassium manganate(VII) decomposes to give off oxygen.

Describe a test for oxygen.

test .....

result .....

[2]

[Total: 10]

© UCLES 2016

BLANK PAGE

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.

© UCLES 2016

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.)