



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY

0620/31

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.



1 The diagram shows part of the Periodic Table.

												H						
Li												B	C	N	O	F	Ne	
Na												Al	Si	P	S	Cl	Ar	
K	Ca											Cu	Zn				Br	Kr

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) has a smaller proton number than lithium,

..... [1]

(ii) is formed at the cathode when a dilute solution of sulfuric acid is electrolysed,

..... [1]

(iii) has an oxide of the type XO_2 which is used to bleach wood pulp,

..... [1]

(iv) forms ions which when tested with **excess** aqueous sodium hydroxide produce a white precipitate,

..... [1]

(v) is extracted from bauxite?

..... [1]

3

(b) Mercury has several naturally-occurring isotopes. One of these is shown.



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

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

(ii) How many neutrons are there in **one** atom of the isotope ${}_{80}^{204}\text{Hg}$?

..... [1]

(iii) How many protons are there in **one** atom of the isotope ${}_{80}^{204}\text{Hg}$?

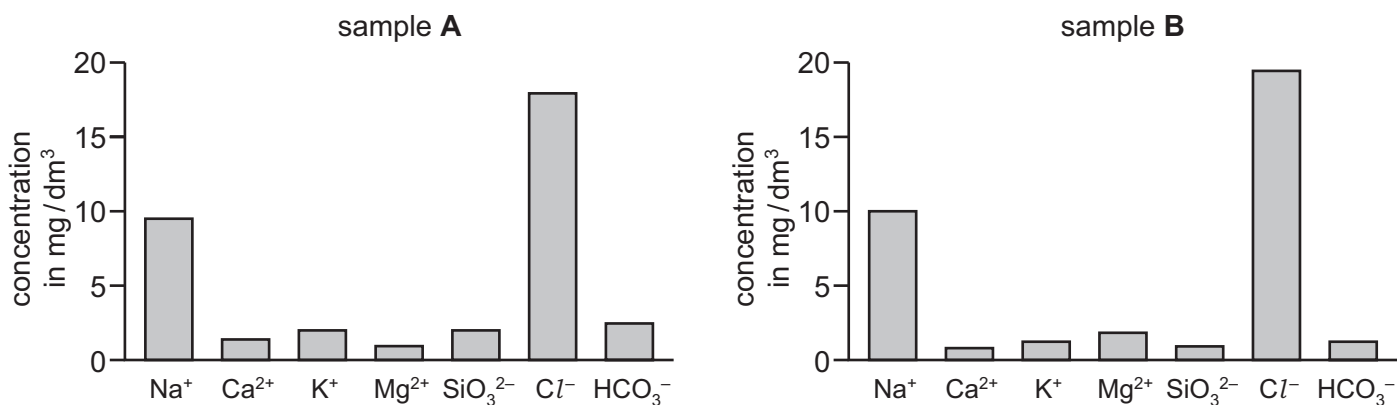
..... [1]

(iv) Determine the number of electrons in the mercury(II) ion, Hg^{2+} .

..... [1]

[Total: 10]

2 The bar charts compare the concentrations of the main ions in two samples of seawater, sample A and sample B.



(a) Use the information in the bar charts to answer the following questions.

(i) Describe **two** differences in the composition of the seawater in sample A and sample B.

.....

 [2]

(ii) Which positive ion has the lowest concentration in sample A?

..... [1]

(iii) Calculate the mass of sodium ions in 200 cm³ of sample B.
 Show all your working. [1 dm³ = 1000 cm³]

mass = mg [2]

(b) Describe a test for sodium ions.

test

result

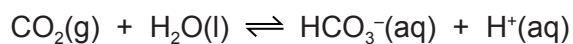
[2]

- (c) River water contains small particles of clay. When these particles are viewed under a microscope they show a random, jumpy motion even when the water is still.

What name is given to this type of movement?

..... [1]

- (d) Carbon dioxide dissolves in water to form a mixture which contains hydrogencarbonate ions and hydrogen ions.



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

..... [1]

- (ii) The solution formed is slightly acidic.

Describe how you would use Universal Indicator paper to determine the pH of this solution.

.....
 [2]

- (iii) Carbon dioxide is a greenhouse gas which causes climate change.

Explain how carbon dioxide contributes to climate change.

..... [1]

- (iv) State the name of **one** other greenhouse gas and give **one** source of this gas.

gas

source

[2]

[Total: 14]

3 Calcium is in Group II of the Periodic Table.

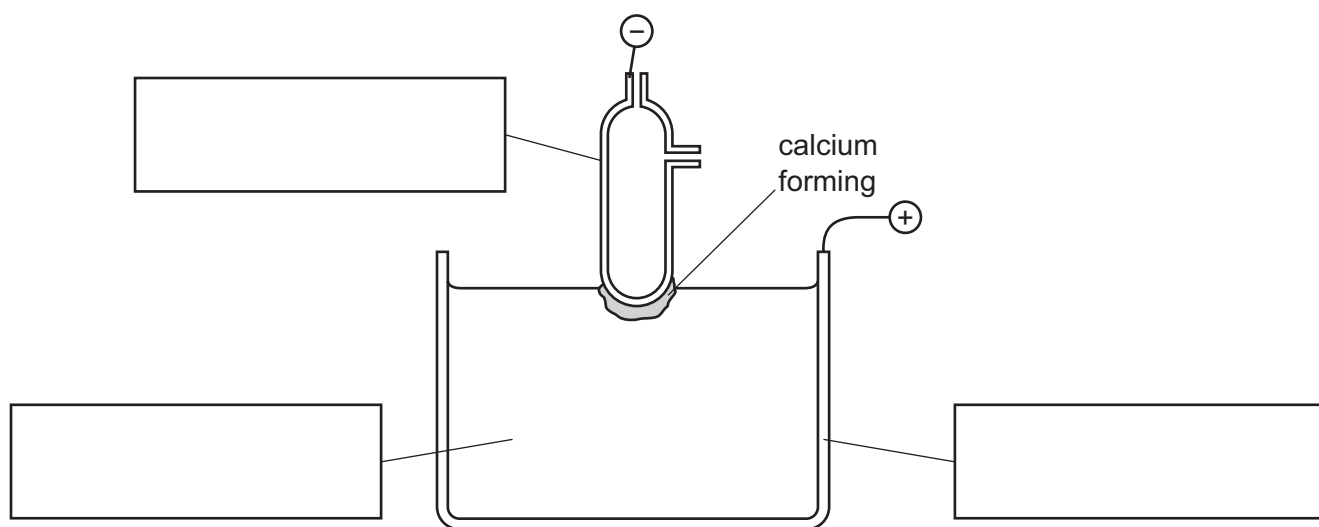
(a) Draw a diagram to show the electronic structure of an atom of calcium.

[2]

(b) Calcium is manufactured by the electrolysis of molten calcium chloride.

Complete the boxes in the diagram to show the

- anode,
- cathode,
- electrolyte.



[2]

(c) Calcium reacts with water to form calcium hydroxide and a gas which 'pops' with a lighted splint.

Complete the chemical equation for this reaction.



[2]

(d) Describe the manufacture and uses of lime (calcium oxide).
Include at least **one** relevant word equation relating to the manufacture or use of lime.

.....

.....

.....

.....

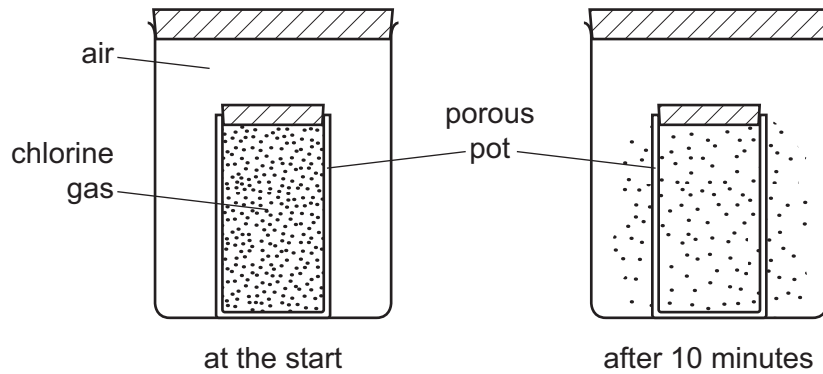
.....

.....

..... [4]

[Total: 10]

- 4 A porous pot has tiny holes in its walls which allow gases to move in or out of the pot. A teacher filled a porous pot with green chlorine gas. The teacher then placed the pot in a large jar of air. After 10 minutes, a green colour was seen outside the porous pot.



- (a) Use the kinetic particle model of matter to explain this observation.

.....

.....

.....

.....

..... [3]

- (b) A porous barrier can be used to separate uranium fluoride molecules containing different isotopes of uranium.

- (i) State the main use of the radioactive isotope ^{235}U .

..... [1]

- (ii) Give **one** medical use of radioactive isotopes.

..... [1]

- (iii) The accurate relative atomic mass of uranium is 238.03.

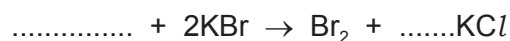
Define the term *relative atomic mass*.

.....

..... [2]

(c) Chlorine reacts with potassium bromide to form bromine and potassium chloride.

(i) Complete the chemical equation for this reaction.



[2]

(ii) Give **one** use of chlorine.

..... [1]

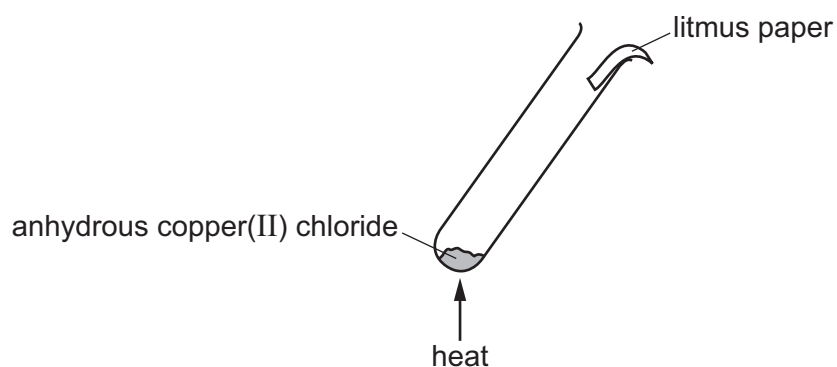
(iii) Chlorine forms an oxide with the formula Cl_2O_7 .

Is this oxide an acidic or a basic oxide?

Explain your answer.

..... [1]

(iv) A teacher heated a test-tube containing anhydrous copper(II) chloride. A piece of damp litmus paper was placed at the top of the test-tube.



The anhydrous copper(II) chloride decomposed and chlorine was formed.

Describe the colour change of the litmus paper.

..... [1]

[Total: 12]

5 The table shows the properties of some steels.

steel	percentage of carbon in the steel	relative strength	melting point range/°C	ease of corrosion
A	1.0	8.0	1430–1460	corrodes easily
B	0.50	6.5	1430–1450	corrodes fairly easily
C	0.25	5.0	1410–1430	corrodes fairly easily
D	0.10	4.0	1440–1450	resistant to corrosion

(a) Use the information in the table to answer the following questions.

(i) What is the relationship between the percentage of carbon in the steel and its strength?

..... [1]

(ii) State whether there is a relationship between the percentage of carbon in the steel and its melting point range.
Explain your answer.

.....
..... [1]

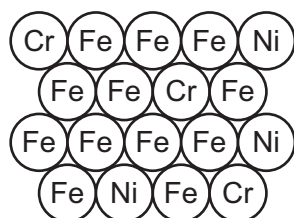
(iii) Which steel would be best to use for making a bicycle chain?
Explain your answer.

.....
..... [1]

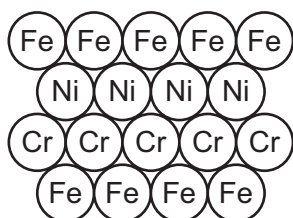
(b) Steel is an alloy.

Which **one** of the diagrams best represents an alloy?

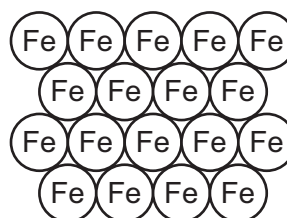
Draw a ring around the correct answer.



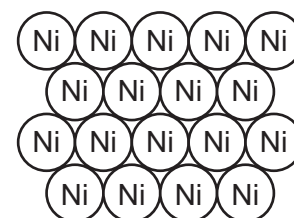
A



B



C



D

[1]

(c) High voltage electricity cables are made from aluminium with a steel core.

(i) Apart from conducting electricity, what is the purpose of the steel core?

..... [1]

(ii) Aluminium is a good electrical conductor.

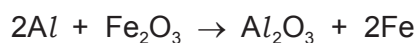
Give **one** other use of aluminium and state a property of aluminium which makes it suitable for this use.

use

property

[2]

(d) Aluminium powder reacts with powdered iron(III) oxide. The equation for this reaction is shown.

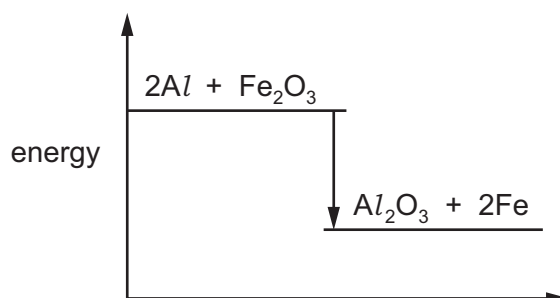


(i) Which substance is oxidised in this reaction?
Explain your answer.

.....

..... [2]

(ii) The energy level diagram for this reaction is shown.



Is this reaction exothermic or endothermic?
Explain your answer.

.....

..... [1]

[Total: 10]

- 6 (a) Describe the characteristic properties of acids.
In your answer you should refer to the reactions of acids with metals, bases, carbonates and indicators.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

- (b) The table shows some properties of the first five members of the carboxylic acid homologous series.

acid	molecular formula	melting point /°C	boiling point /°C	density in g/cm ³
methanoic acid	CH ₂ O ₂	8	101	1.22
ethanoic acid	C ₂ H ₄ O ₂	17	118	1.05
propanoic acid	C ₃ H ₆ O ₂	-21	141	0.99
butanoic acid	C ₄ H ₈ O ₂	-5	164	0.96
pentanoic acid	C ₅ H ₁₀ O ₂	-34		0.93

- (i) How does the density of the carboxylic acids vary with the number of carbon atoms in the molecule?

..... [1]

- (ii) Suggest a value for the boiling point of pentanoic acid.

..... [1]

- (iii) Determine the state of ethanoic acid at 15 °C.
Explain your answer.

.....

..... [2]

- (iv) Draw the structure of the functional group present in carboxylic acids.
Show all of the atoms and all of the bonds.

[1]

- (v) Calculate the relative molecular mass of butanoic acid.
Show all your working.

[2]

- (c) Identify the following as either physical changes or chemical changes by writing either 'physical' or 'chemical' in the spaces provided.

The condensation of ethanoic acid vapour to liquid ethanoic acid is a change.

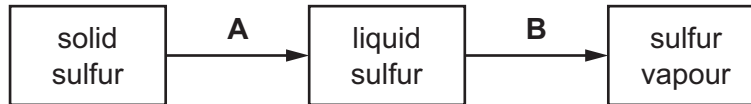
The reaction of sodium with ethanoic acid is a change.

The dissolving of a salt in water is a change.

[2]

[Total: 14]

- 7 The diagram shows the changes of state when sulfur is heated.



- (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 sulfur vapour.

arrangement

motion

[2]

- (c) Give **one** use of sulfur.

..... [1]

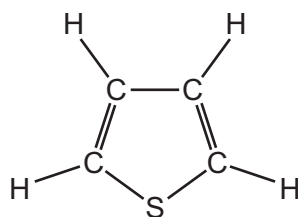
- (d) Some compounds of sulfur are found in coal.

Explain why the presence of sulfur in coal has an adverse effect on human health when the coal is burnt.

.....

..... [2]

- (e) One of the compounds of sulfur in coal is thiophene.
The structure of thiophene is shown.



- (i) Determine the formula of thiophene.

..... [1]

- (ii) Thiophene can be made in the laboratory by heating ethyne, C_2H_2 , with hydrogen sulfide, H_2S , in the presence of a catalyst.

What is the purpose of the catalyst?

..... [1]

- (iii) When 2.6 g of ethyne react with excess hydrogen sulfide, 4.2 g of thiophene are formed.

Calculate the mass of thiophene formed when 15.6 g of ethyne react with excess hydrogen sulfide.

[1]

[Total: 10]

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.

The Periodic Table of Elements

Group														
I	II	III	IV	V	VI	VII	VIII							
1	2	3	4	5	6	7	8	9	10	11				
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20							
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	29				
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	Cu copper 64				
37	38	39	40	41	42	43	44	45	46	47				
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	Ag silver 108				
55	56	57–71	72	73	74	75	76	77	78	79				
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	Au gold 197				
87	88	89–103	104	105	106	107	108	109	110	111				
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —				
<p style="text-align: center;">Key</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>H</td> <td>hydrogen</td> </tr> </table> <p style="text-align: center;">atomic number atomic symbol name relative atomic mass</p>											1	1	H	hydrogen
1	1													
H	hydrogen													
30	31	32	33	34	35	36	37	38	39	40				
Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84	54	53	52	51				
48	49	50	51	52	53	54	55	56	57	58				
Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131	86	85	84	83				
80	81	82	83	84	85	86	87	88	89	90				
Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	—	—	—	—				
112	113	114	115	116	117	118	119	120	121	122				
Cn copernicium —	Nh nihonium —	Fl flerovium —	Mc moscovium —	Lv livermorium —	Ts tennessine —	Og oganesson —	—	—	—	—				

lanthanoids

actinoids

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
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.).