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.

CAMBRIDGE International Examinations

[Turn over

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]

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

$^{204}_{80}Hg$

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

.....

..... [2]

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

..... [1]

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

..... [1]

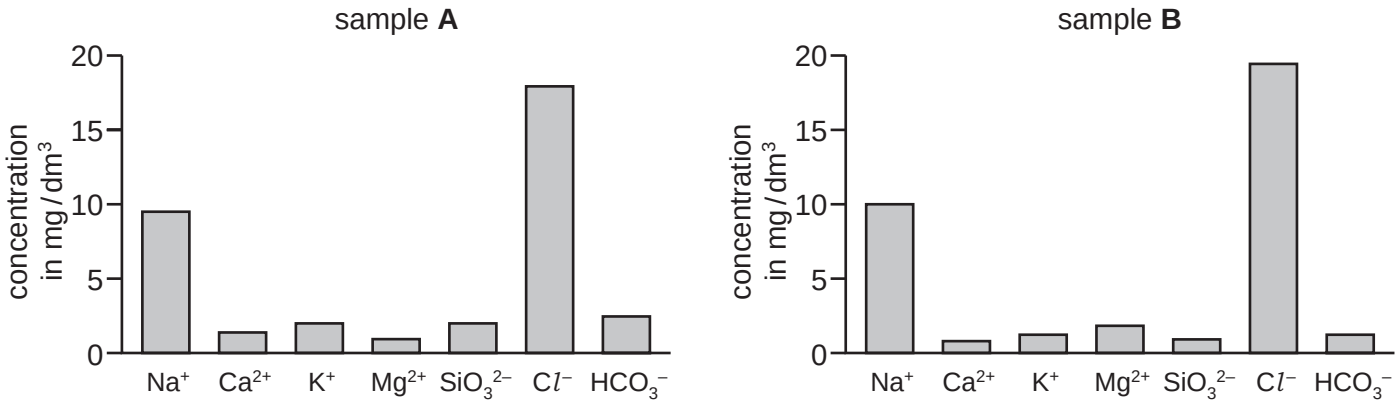
(iv) Determine the number of electrons in the mercury(II) ion, Hg^{2+}.

..... [1]

[Total: 10]

[Turn over

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 cm^3 of sample **B**.
Show all your working. [1 dm^3 = 1000 cm^3]

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.

$$CO_2(g) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$$

(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.

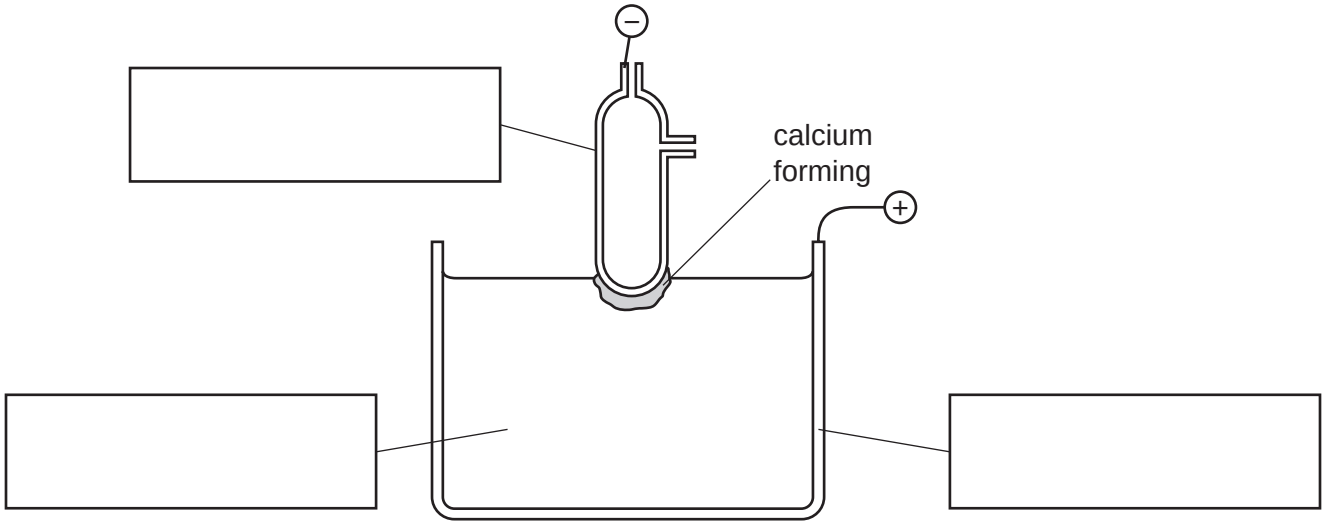
(a) Draw a diagram to show the electronic structure of an atom of calcium.

[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.

$$Ca + ...H_2O \rightarrow Ca(OH)_2 + ...$$

[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.

.....

.....

.....

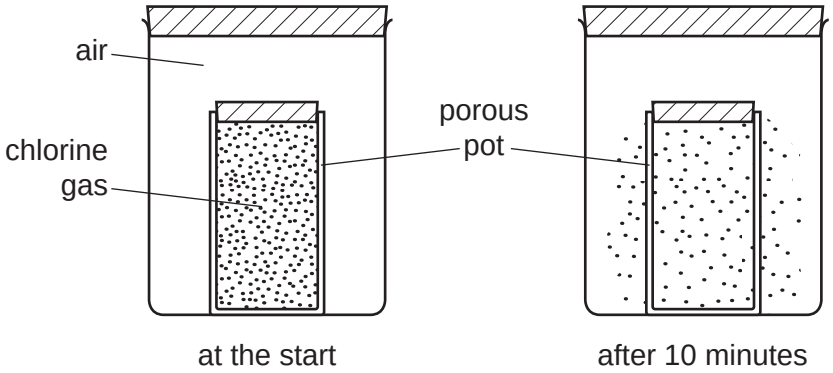
.....

.....

..... [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.

..... + 2KBr → Br_2 + ...KCl

[2]

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

..... [1]

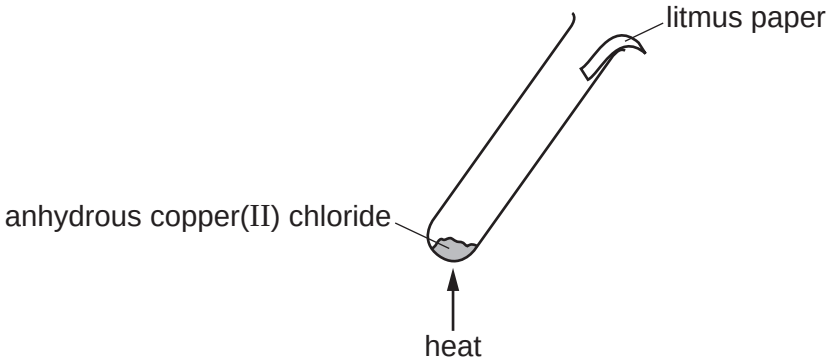
(iii) Chlorine forms an oxide with the formula Cl_2O_7.

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]

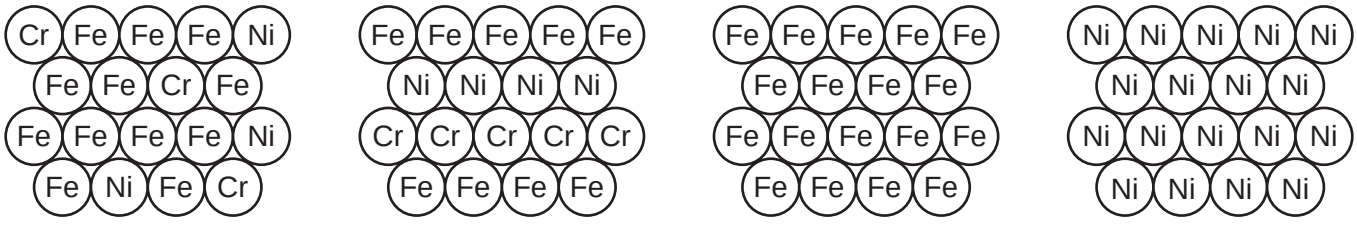
(iii) Which steel would be best to use for making a bicycle chain?
Explain your answer.

.....

..... [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.

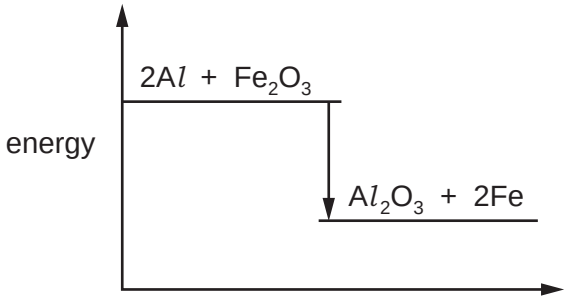
$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$$

(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_2O_2	8	101	1.22
ethanoic acid	$C_2H_4O_2$	17	118	1.05
propanoic acid	$C_3H_6O_2$	–21	141	0.99
butanoic acid	$C_4H_8O_2$	–5	164	0.96
pentanoic acid	$C_5H_{10}O_2$	–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.

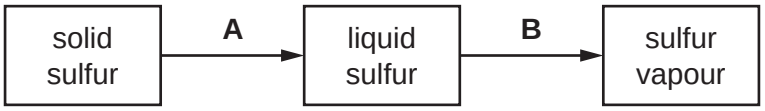
The reaction of sodium with ethanoic acid is a ..... change.

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]

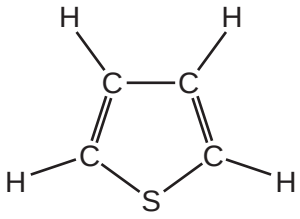
(d) Some compounds of sulfur are found in coal.

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]

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.).