Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 2 3 8 4 4 0 0 8 *

CHEMISTRY

0620/31

Paper 3 Theory (Core)

May/June 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.

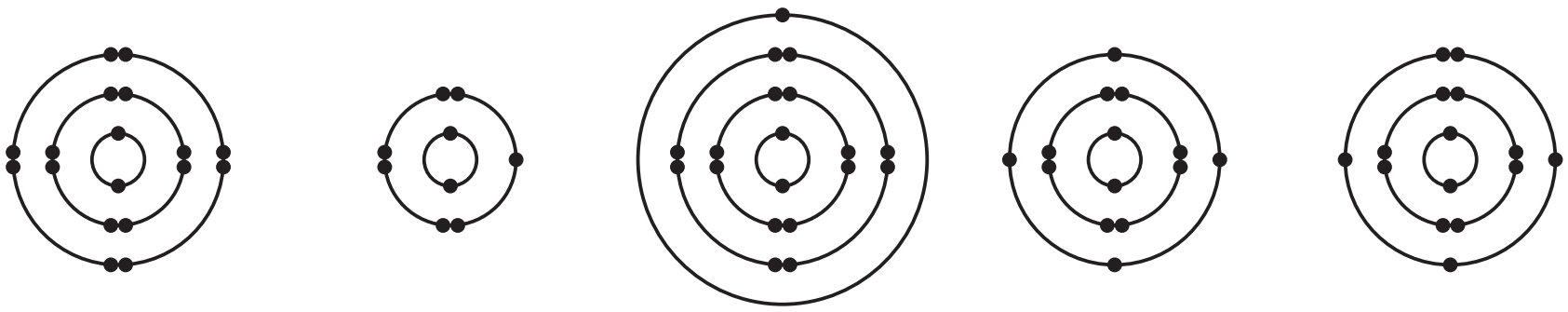
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

CAMBRIDGE International Examinations

[Turn over

1 **(a)** The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



A **B** **C** **D** **E**

Answer the following questions about these atoms.
Each atom may be used once, more than once or not at all.

Which atom, **A**, **B**, **C**, **D** or **E**,

(i) has a complete outer shell of electrons, ... [1]

(ii) has a proton number of 15, ... [1]

(iii) has 4 shells containing electrons, ... [1]

(iv) is a fluorine atom, ... [1]

(v) is an atom of a metallic element? ..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the chlorine atom and bromide ion shown.

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$	17		
$^{79}_{35}Br^-$		44	

[3]

[Total: 8]

2 **(a)** The table shows the ions present in a 1000 cm^3 sample of polluted river water.

ion present	formula of ion	mass present in mg / 1000 cm^3
calcium	Ca^{2+}	2.0
chloride	Cl^-	1.3
hydrogencarbonate	HCO_3^-	2.0
magnesium	Mg^{2+}	1.0
potassium	K^+	4.0
silicate	SiO_3^{2-}	12.0
sodium	Na^+	11.0
	SO_3^{2-}	3.0

Answer these questions using the information from the table.

(i) Which positive ion is present in the highest concentration?

..... [1]

(ii) State the name of the ion SO_3^{2-}.

..... [1]

(iii) Calculate the mass of silicate ions present in 250 cm^3 of this sample.

mass of silicate ions = ... mg [1]

(iv) Calculate the mass of solid formed when all the water is evaporated from the 1000 cm^3 sample.

mass of solid formed = ... mg [1]

(v) Name the compound containing Ca^{2+} ions and HCO_3^- ions.

..... [1]

(b) Describe a test for sodium ions.

test .....

result .....
[2]

(c) The formulae of some chlorides are given.

aluminium chloride, AlCl_3

calcium chloride, CaCl_2

sodium chloride, NaCl

Deduce the formula for magnesium chloride.

..... [1]

(d) Molten calcium chloride can be electrolysed using inert electrodes.

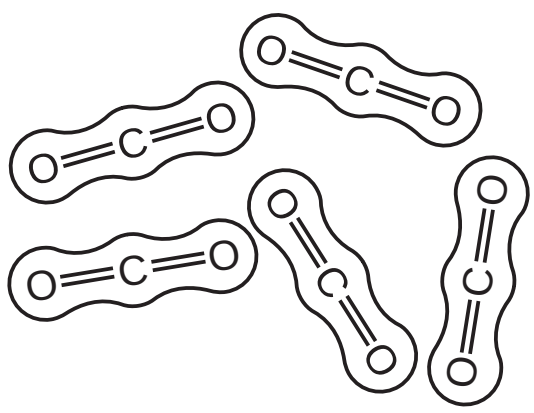
Predict the products of this electrolysis at

the negative electrode (cathode), ...

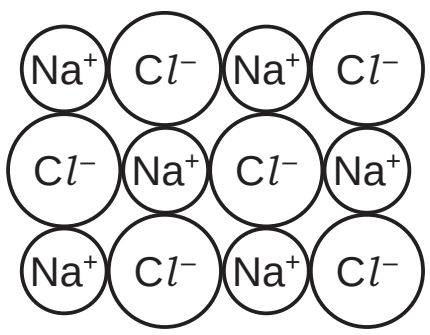
the positive electrode (anode). .....
[2]

[Total: 10]

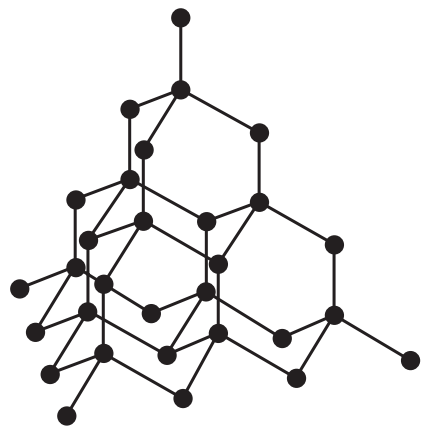
3 The diagram shows part of the structures of three substances, **X**, **Y** and **Z**, at room temperature and pressure.



X



Y



Z

(a) Describe substances **X**, **Y** and **Z** in terms of

- their bonding,
- the arrangement of their particles,
- the motion of their particles.

.....

.....

.....

.....

.....

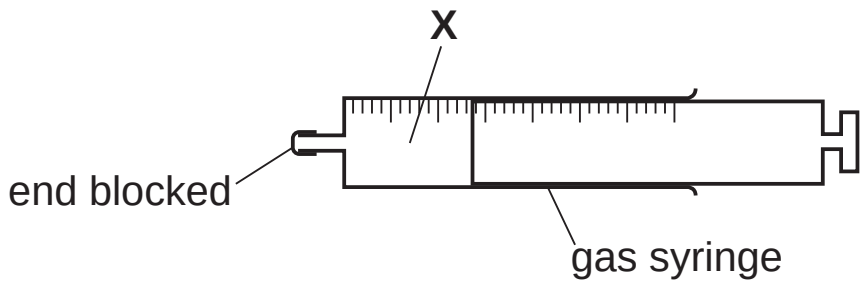
.....

.....

.....

..... [5]

(b) A closed gas syringe contains substance **X**.



Describe what happens to the volume of substance **X** in the syringe when the pressure is increased. The temperature remains constant. Explain your answer in terms of particles.

.....

..... [2]

(c) Substance **Z** is diamond. Diamond is used in jewellery.

Give **one** other use of diamond.

..... [1]

(d) Substance **Y** undergoes physical and chemical changes.

Which **two** of the following are physical changes? Explain your answer.

A Substance **Y** dissolves easily in water.

B An aqueous solution of substance **Y** gives a white precipitate with acidified aqueous silver nitrate.

C Substance **Y** melts at 801 °C.

D Substance **Y** reacts with concentrated sulfuric acid.

.....

.....

..... [3]

[Total: 11]

4 Chlorine is an element in Group VII of the Periodic Table.

(a) Chlorine is a diatomic molecule.

Explain what is meant by the term *diatomic*.

..... [1]

(b) Aqueous chlorine reacts with aqueous potassium bromide.

$$Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$$

(i) How does this equation show that chlorine is more reactive than bromine?

..... [1]

(ii) Aqueous potassium bromide and aqueous potassium chloride are both colourless.

Predict the colour change when aqueous chlorine reacts with aqueous potassium bromide.

..... [1]

(iii) Complete the chemical equation for the reaction of aqueous bromine with aqueous potassium iodide.

$$Br_2 + 2KI \rightarrow \text{.....} + \text{.....}$$

[2]

(c) Describe a test for iodide ions.

test .....

result .....

[2]

(d) Chlorine is used to make the polymer PVC.

(i) Give **one** other use of chlorine.

..... [1]

(ii) The monomer used to make PVC is made by the thermal decomposition of dichloroethane.

$$CH_2Cl–CH_2Cl \rightarrow CH_2=CHCl + HCl$$

Explain what is meant by the term *thermal decomposition*.

.....

..... [2]

(iii) PVC is a non-biodegradable plastic.

Describe **two** pollution problems caused by non-biodegradable plastics.

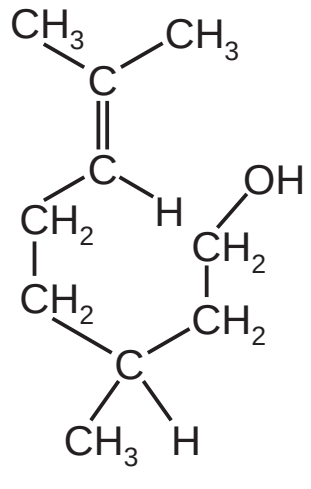
1 .....

2 .....
[2]

[Total: 12]

5 Citronellol is found in rose oil.

The structure of citronellol is shown.



(a) On the structure shown draw a circle around the alcohol functional group. [1]

(b) How many hydrogen atoms are there in **one** molecule of citronellol?

..... [1]

(c) What feature of the citronellol structure shows that it is unsaturated?

..... [1]

(d) The table shows the properties of some alkanes.

alkane	number of carbon atoms in one molecule	melting point in °C	boiling point in °C	density of liquid alkane in g / cm^3
methane	1	–182	–162	0.466
ethane	2	–183	–88	0.572
propane	3	–188		0.585
butane	4		0	0.601
pentane	5	–130	36	0.626

(i) Describe how the density of the liquid alkanes varies with the number of carbon atoms in one molecule.

..... [1]

(ii) Predict the boiling point of propane.

..... [1]

(iii) Why would it be difficult to predict the melting point of butane from the information in the table?

..... [1]

(iv) What is the state of pentane at 30 °C? Explain your answer.

.....

..... [2]

(v) Alkanes are hydrocarbons.

What is the meaning of the term *hydrocarbon*?

..... [2]

(vi) Draw the structure of ethane. Show all of the atoms and all of the bonds.

[1]

(vii) Complete the chemical equation for the combustion of propane.

$$C_3H_8 + ...O_2 \rightarrow .....CO_2 + 4H_2O$$

[2]

[Total: 13]

6 **(a)** The table shows the properties of some metals.

metal	density in g / cm^3	melting point in °C	relative strength	relative electrical conductivity	cost
aluminium	2.7	660	7.0	4.0	expensive
iron	7.9	1535	21.0	1.1	cheap
lead	11.3	328	1.5	0.5	expensive
silver	10.5	962	2.0	6.7	very expensive
tungsten	19.4	3420	12.0	2.0	expensive

Use the information in the table to answer the questions.

(i) Which metal would be most useful for making overhead power cables?
Give **two** reasons for your answer.

metal .....

reason 1 .....

reason 2 .....
[2]

(ii) Why is iron and **not** tungsten used to reinforce concrete?

..... [1]

(iii) The front part of a space rocket is called a nose cone. The nose cone gets **very** hot as the space rocket moves through the air.

Which metal is best to make a space rocket nose cone? Explain your answer.

..... [1]

(b) Tungsten is a transition element.

State **two** physical properties of transition elements which are **not** shown by Group I elements.

1 .....

2 .....
[2]

(c) When extremely hot tungsten reacts with oxygen, tungsten(VI) oxide is formed.

Balance the chemical equation for this reaction.

$$.....W + ...O_2 \rightarrow 2WO_3$$

[2]

(d) Some information about the reaction of four metals with oxygen is given.

cobalt:	reacts slowly at high temperatures
iron:	thin wire burns when heated strongly
magnesium:	burns when heated
tungsten:	reacts very slowly at extremely high temperatures

List these metals in order of their reactivity. Put the least reactive metal first.

least reactive ⟶ **most** reactive

[2]

(e) The table compares the time taken for reaction of an alloy with ethanoic acid, nitric acid and phosphoric acid, each at three different concentrations. The time taken for the alloy to decrease in mass by 1.0 g was measured. All other conditions were kept the same.

acid	time taken for reaction / hours		
	concentration of acid 0.04 mol / dm^3	concentration of acid 0.02 mol / dm^3	concentration of acid 0.01 mol / dm^3
ethanoic acid	92	190	410
nitric acid	2	6	18
phosphoric acid	19	39	80

(i) How does the concentration of acid affect the rate of reaction?

.....

..... [1]

(ii) Which acid reacts most rapidly with the alloy?

..... [1]

(iii) Predict how long it would take for the alloy to decrease in mass by 1.0 g using phosphoric acid of concentration 0.03 mol / dm^3.

time taken = ... hours [1]

(iv) Suggest which **one** of these pH values is the pH of concentrated aqueous ethanoic acid. Draw a circle around the correct answer.

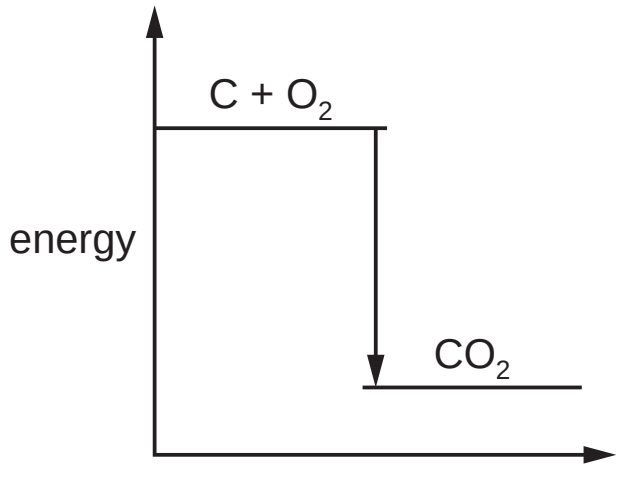
pH 4 pH 7 pH 10 pH 13

[1]

[Total: 14]

7 Carbon is an element in Group IV of the Periodic Table. It reacts with oxygen to form carbon dioxide.

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



Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

(b) Carbon monoxide, carbon dioxide and methane are all atmospheric pollutants.

- Give the sources of these gases.
- Describe the effects that both carbon dioxide and methane have on the environment.
- State an adverse effect of carbon monoxide on health.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) Calcium carbonate decomposes to form calcium oxide (lime) and carbon dioxide.

(i) State **one** use of calcium oxide.

..... [1]

(ii) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
Show all your working.
Use your Periodic Table to help you.

relative formula mass = ... [2]

(d) Carbon and magnesium are both insoluble in water.
Carbon does **not** react with hydrochloric acid but magnesium reacts to form a soluble salt and a gas which escapes into the air.

Suggest how you could prepare a pure dry sample of carbon from a mixture of carbon powder and magnesium powder.

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

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.).