Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6485603039

CHEMISTRY **0620/33**

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.

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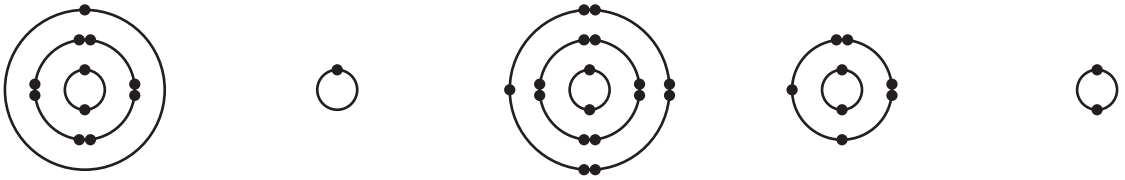
1 **(a)** The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



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) is in Group VIII of the Periodic Table, ... [1]

(ii) is a chlorine atom, ... [1]

(iii) has 17 protons in its nucleus, ... [1]

(iv) is an atom of an element in the same period as carbon, ... [1]

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

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

	number of electrons	number of neutrons	number of protons
$^{26}_{12}Mg$	12		
$^{44}_{20}Ca^{2+}$		24	

[3]

[Total: 8]

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

ion present	formula of ion	mass present in mg / 1000 cm^3
calcium	Ca^{2+}	52
chloride	Cl^-	10
hydrogencarbonate	HCO_3^-	50
magnesium	Mg^{2+}	
sodium	Na^+	12
sulfate	SO_4^{2-}	10
	NO_3^-	8
	total	150

Answer these questions using the information from the table.

(i) Calculate the mass of magnesium ions in the 1000 cm^3 sample of mineral water.

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

(ii) Which negative ion is present in the highest concentration?

..... [1]

(iii) State the name of the ion NO_3^-.

..... [1]

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

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

(b) When nitrate ions are warmed with aqueous sodium hydroxide and aluminium foil, ammonia gas is given off.

Describe a test for ammonia gas.

test .....

result .....
[2]

(c) The formulae of some bromides are given.

aluminium bromide, $AlBr_3$

magnesium bromide, $MgBr_2$

sodium bromide, NaBr

Deduce the formula for calcium bromide.

..... [1]

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

(i) Predict the products of this electrolysis at

the negative electrode (cathode), ...

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

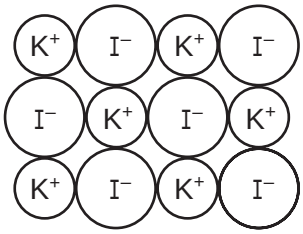
(ii) Graphite electrodes are inert.

Give the name of **one** other substance that can be used to make an inert electrode.

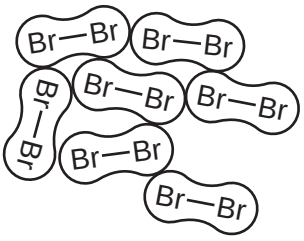
..... [1]

[Total: 10]

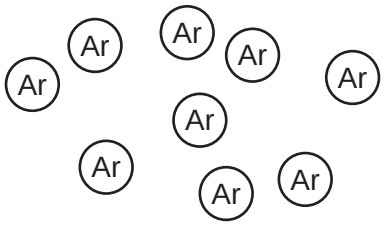
3 The diagram shows part of the structures of three substances, **P**, **Q** and **R**, at room temperature and pressure.



P



Q



R

(a) Describe substances **P**, **Q** and **R** in terms of

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

.....

.....

.....

.....

.....

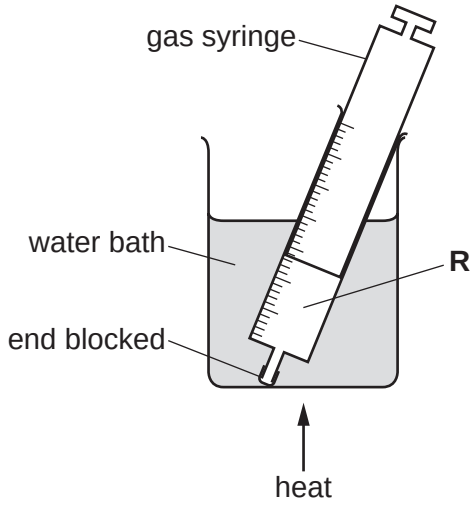
.....

.....

.....

..... [5]

(b) A closed gas syringe contains substance **R**. The syringe is heated in a water bath.



Describe what happens to the volume of substance **R** in the syringe. The pressure remains constant. Explain your answer in terms of particles.

.....

..... [2]

(c) Substance **P** undergoes physical and chemical changes.

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

A Substance **P** reacts with concentrated sulfuric acid.

B Iodine forms when chlorine is added to an aqueous solution of substance **P**.

C Substance **P** boils at 1330 °C.

D Substance **P** dissolves easily in water.

.....

.....

..... [3]

(d) Graphite has a giant covalent structure containing layers of carbon atoms.
Graphite is used to make inert electrodes for electrolysis.

State **one** other use of graphite and explain how this use is related to its structure.

.....

..... [2]

[Total: 12]

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4 Iron is extracted from its ore by heating the ore with carbon in a blast furnace.

(a) (i) State the name of an ore of iron.

..... [1]

(ii) In the blast furnace, iron(III) oxide is reduced by carbon monoxide.

Explain how the carbon monoxide is formed in the blast furnace.

.....

..... [2]

(iii) Balance the chemical equation for this reaction.

$$Fe_2O_3 + 3CO \rightarrow .....Fe + ...CO_2$$

[2]

(iv) How does this equation show that iron(III) oxide is reduced?

..... [1]

(v) Calculate the relative formula mass of iron(III) oxide, Fe_2O_3.
Show all your working.
Use your Periodic Table to help you.

relative formula mass = ... [2]

(b) Iron reacts with hydrochloric acid to form iron(II) chloride and a gas which 'pops' with a lighted splint.

(i) Identify this gas.

..... [1]

(ii) Suggest a practical method for investigating the rate of this reaction involving collection of the gas.
You may include a labelled diagram in your answer.

.....

.....

.....

..... [3]

(c) Describe a test for iron(II) ions.

test .....

result .....
[2]

(d) Give **two** advantages of recycling steel.

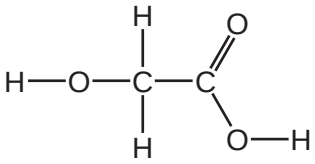
1 .....

2 .....
[2]

[Total: 16]

5 Glycolic acid is found in the stalks of sugar-cane plants.

The structure of glycolic acid is shown.



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

(b) Give the molecular formula of glycolic acid showing the number of carbon, hydrogen and oxygen atoms.

..... [1]

(c) Suggest how you could obtain a solution containing glycolic acid from sugar-cane plants.

.....

.....

..... [3]

(d) Nitric acid can oxidise glycolic acid.

What is the meaning of the term *oxidation*?

..... [1]

(e) The table shows the properties of some carboxylic acids.

carboxylic acid	number of carbon atoms in one molecule	melting point in °C	boiling point in °C	density in g / cm^3
methanoic acid	1	8	101	1.220
ethanoic acid	2	17	118	1.049
propanoic acid	3	–21		0.993
butanoic acid	4	–5	164	0.958

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

..... [1]

(ii) Predict the boiling point of propanoic acid.

..... [1]

(iii) What is the state of butanoic acid at –10 °C? Explain your answer.

.....

..... [2]

[Total: 10]

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

alloy	density in g / cm^3	relative hardness	relative strength	relative electrical conductivity	cost
J	7.8	4.0	24.0	1.1	cheap
K	2.8	2.5	7.5	3.8	expensive
L	11.3	0.2	1.5	0.5	cheap
M	10.2	5.5	16.5	0.2	very expensive

Use the information in the table to answer the questions.

(i) Which alloy would be most useful for making a bridge?
Give **two** reasons for your answer.

alloy .....

reason 1 .....

reason 2 .....
[2]

(ii) Which alloy is best to make the tips of high-speed drills?
Give **one** reason for your answer.

alloy .....

reason .....
[1]

(iii) Which alloy is best to make aircraft bodies?
Give **one** reason for your answer.

alloy .....

reason.....
[1]

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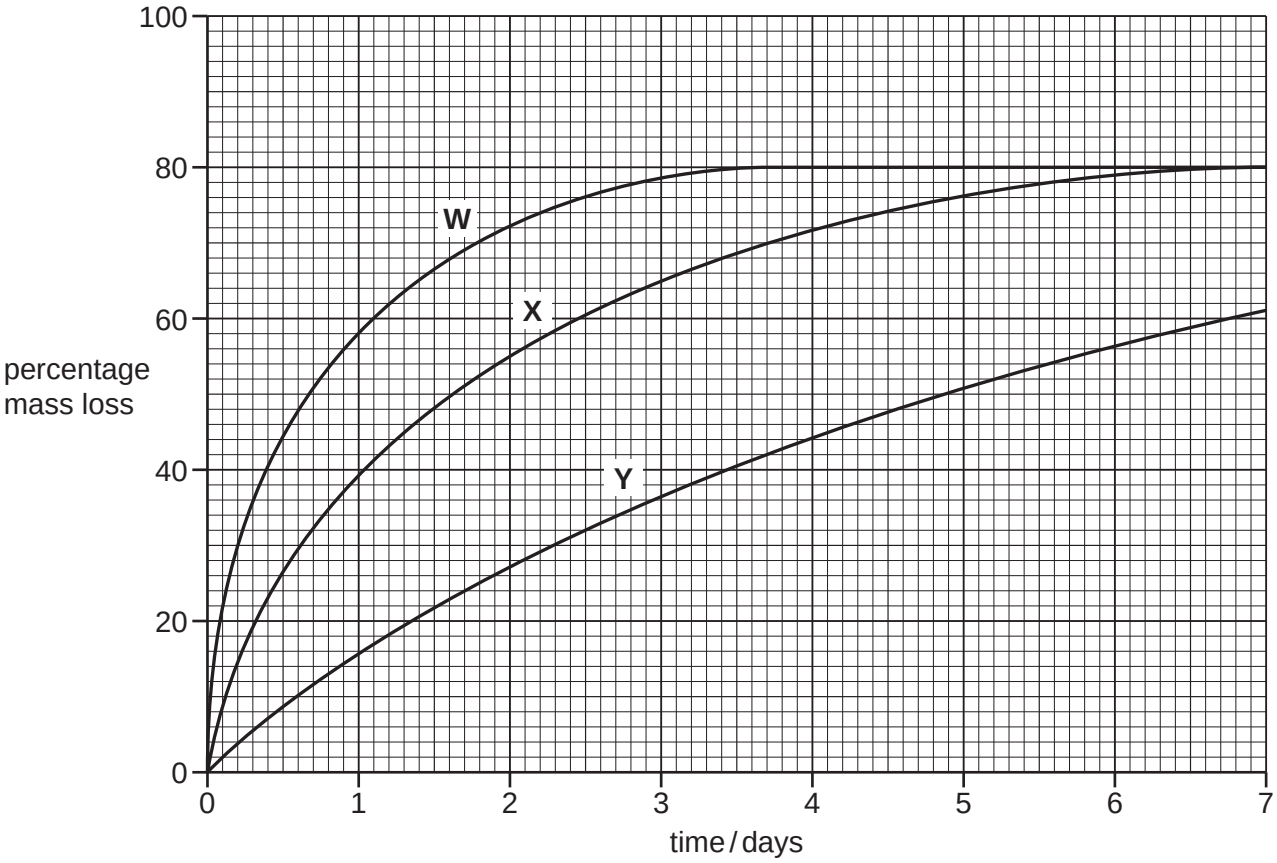
(b) A student took pieces of four different steel alloys, **W**, **X**, **Y** and **Z**, each of the same mass, and placed them separately into hydrochloric acid. The concentration of acid was the same in each case and the metal was in excess. All other conditions were kept the same.

The student measured the mass of each alloy at intervals as the reaction proceeded and calculated the percentage mass loss.

The results for alloys **W**, **X** and **Y** are shown on the graph.



(i) Alloy **Z** reacts faster with hydrochloric acid than alloy **W**.

On the graph, draw a line which could represent the percentage mass loss of alloy **Z** with time.

[2]

(ii) Which alloy showed the least percentage mass loss after 3 days?

..... [1]

(iii) How long did it take for alloy **X** to lose 40% of its mass?

..... [1]

(iv) Suggest how the following factors affect the rate of mass loss.

increasing the temperature .....

increasing the concentration of the acid .....

[2]

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(c) The concentration of an acid can be found by titrating it with aqueous sodium hydroxide.

Suggest which **one** of these pH values is the pH of concentrated aqueous sodium hydroxide. Draw a circle around the correct answer.

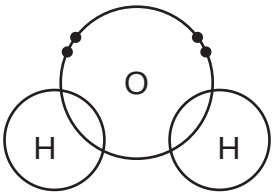
pH 1 pH 3 pH 7 pH 12

[1]

[Total: 11]

7 Water is a simple covalent compound.

(a) Complete the diagram to show the electrons in the covalent bonds in a water molecule.



[1]

(b) Give **two** physical properties which distinguish a simple covalent compound from an ionic compound.

1 .....

2 .....

[2]

(c) Some information about the reaction of four metals with water is given.

cerium:	reacts slowly with cold water
iron:	reacts with steam only when extremely hot
lithium:	reacts rapidly with cold water
magnesium:	reacts slowly with hot water

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

least reactive ⟶ **most** reactive

[2]

(d) (i) State the conditions needed for iron to rust.

.....

..... [2]

(ii) State **two** methods of rust prevention.

1 .....

2 .....
[2]

(e) Starting with an aqueous solution of copper(II) sulfate, describe how you could obtain a pure dry sample of copper(II) sulfate crystals.

.....

.....

.....

..... [2]

(f) Carbon dioxide and water are formed when hydrocarbons burn.

Complete the chemical equation for the combustion of butene.

$$C_4H_8 + 6O_2 \rightarrow .....CO_2 + ...H_2O$$

[2]

[Total: 13]

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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