Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3401069089

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2017**

1 hour 30 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 20.

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.

This document consists of **19** printed pages and **1** blank page.

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CAMBRIDGE International Examinations

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 (a) Choose from the following elements to answer the questions.

aluminium
carbon
hydrogen
iron
magnesium
nitrogen
oxygen
sodium
vanadium

Each element may be used once, more than once or not at all.

Which element:

(i) is a catalyst in the Haber process,

.....[1]

(ii) makes up 21% of dry air,

.....[1]

(iii) can be formed when hydrocarbons are cracked,

.....[1]

(iv) forms aqueous ions with a 3+ charge which give a white precipitate when added to aqueous ammonia,

.....[1]

(v) has an atom with only three electrons in its outer shell?

.....[1]

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(b) Complete the table to show the number of electrons and neutrons in the potassium atom and in the oxide ion.

	number of electrons	number of neutrons
$^{41}_{19}K$		
$^{17}_{8}O^{2-}$		

[4]

[Total: 9]

A2 Sodium chloride, NaC*l*, and magnesium chloride, MgCl_2, are both ionic compounds.

(a) Describe the arrangement of the ions and the type of attractive forces between the ions in solid magnesium chloride.

arrangement .....

type of attractive forces .....
[2]

(b) Explain why solid magnesium chloride does not conduct electricity but aqueous magnesium chloride does conduct.

.....

.....

.....[2]

(c) State the electronic configuration of a magnesium ion and of a chloride ion.

magnesium ion .....

chloride ion .....
[2]

(d) Chlorine and hydrogen are manufactured by the electrolysis of concentrated aqueous sodium chloride.

Chlorine is released at the positive electrode and hydrogen is released at the negative electrode.

(i) Why are hydrogen ions and **not** sodium ions discharged at the negative electrode?

.....

.....[1]

(ii) Construct the equation for the reaction at the negative electrode.

.....[1]

(iii) Describe a test for chlorine.

test .....

result .....
[2]

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(e) (i) Give the formulae of the four ions present in aqueous sodium chloride.

.....[1]

(ii) Suggest why the solution becomes alkaline as the electrolysis proceeds.

.....

.....[2]

[Total: 13]

A3 Metals have characteristic physical properties such as good electrical and thermal conductivity.

(a) Give two **other** physical properties which are characteristic of metals.

1. .....

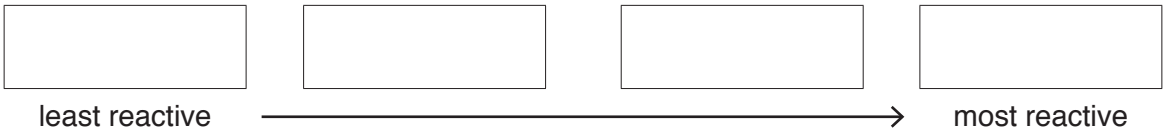
2. .....

[2]

(b) The table gives some observations about the reactions of four metals with water.

metal	observations
cerium	reacts slowly with cold water
iron	reacts with steam when red-hot
magnesium	reacts slowly with hot water
sodium	reacts rapidly with cold water

Put these metals in order of their reactivity with water.



[1]

(c) The equation for the reaction of iron with steam is shown.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

(i) Calculate the maximum mass of Fe_3O_4 that can be formed when 39.2 g of iron reacts with excess steam.

Give your answer to three significant figures.

mass of Fe_3O_4 = ... g [3]

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(ii) Calculate the maximum volume of hydrogen, in dm^3, produced by this reaction, when measured at room temperature and pressure.

volume of hydrogen = ... dm^3 [2]

(d) Pure iron can be obtained by the following reaction.

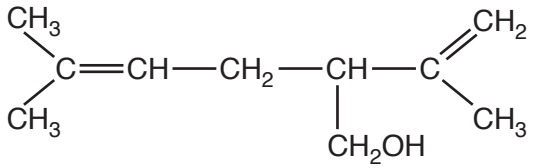
$$Fe(CO)_5 \rightarrow Fe + 5CO$$

Give one hazard associated with this reaction.

.....[1]

[Total: 9]

A4 Lavandulol is found in lavender plants.



(a) **(i)** Give the molecular formula for lavandulol.

.....[1]

(ii) Lavandulol contains an –OH group.

Name the homologous series of compounds which contain the –OH group.

.....[1]

(b) Lavandulol is an unsaturated compound.

Describe a test for an unsaturated compound.

test .....

result .....
[2]

(c) Lavender flowers contain a variety of coloured compounds. These can be extracted from the flowers to give a solution of the coloured compounds.

Describe how to use paper chromatography to identify these coloured compounds.

You may use a labelled diagram in your answer.

.....

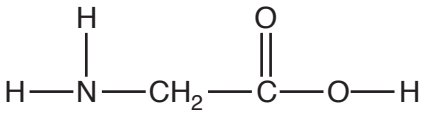
.....

.....

.....[3]

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(d) Compound **G** is found in the leaves of lavender plants.



Compound **G** can undergo polymerisation.

Draw a section of the polymer to show two repeat units.

[2]

[Total: 9]

A5 Dilute ethanoic acid reacts with sodium carbonate.

Sodium ethanoate, CH_3COONa, and two other compounds are formed.

(a) Construct the equation for this reaction.

.....[2]

(b) The reaction of dilute ethanoic acid with sodium carbonate is endothermic.

Explain in terms of bond making and bond breaking why this reaction is endothermic.

.....

.....

.....

.....[2]

(c) Ethanoic acid reacts with alcohols to form esters.

Give one use of esters.

.....[1]

[Total: 5]

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Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B6 At high temperatures, hydrogen reacts with iodine to form hydrogen iodide.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \quad \Delta H = +53.0\ kJ/mol$$

(a) Describe and explain the effect, if any, on the position of equilibrium when

(i) the pressure is increased,

.....

.....

.....[2]

(ii) the temperature is decreased.

.....

.....

.....[2]

(b) Hydrogen iodide reacts with water to form a strong acid, hydriodic acid, HI(aq).

(i) What is meant by the term *strong acid*?

.....

.....[1]

(ii) Construct the equation for the dissociation of hydrogen iodide molecules into ions.

.....[1]

(c) Hydrogen iodide reacts with ethene to form iodoethane.

$$CH_2{=}CH_2 + HI \rightarrow CH_3\,CH_2I$$

What is the name of this type of reaction?

.....[1]

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(d) The table shows some properties of five alkenes.

alkene	formula	melting point /°C	boiling point /°C
ethene	C_2H_4	–168.9	–103.6
propene	C_3H_6		–47.3
butene	C_4H_8	–185.2	–6.2
pentene	C_5H_{10}	–165.0	30.0
hexene	C_6H_{12}	–139.7	63.4

(i) How does the boiling point change as the number of carbon atoms in the formula of the alkenes increases?

.....[1]

(ii) What is the physical state of butene at –7 °C? Explain your answer.

.....

.....[1]

(iii) Why is it difficult to predict the melting point of propene using only the information from the table?

.....[1]

[Total: 10]

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[Turn over

B7 The table shows the melting points and relative electrical conductivities of three elements from Period 3 of the Periodic Table.

property	element		
	magnesium	silicon	sulfur
melting point /°C	649	1410	113
relative electrical conductivity	good conductor	poor conductor	does not conduct

(a) Use ideas of structure and bonding to explain

(i) the difference in the melting points of magnesium and sulfur,

.....

.....

.....

.....[2]

(ii) the difference in the electrical conductivity of magnesium and sulfur.

.....

.....

.....[2]

(b) Silicon has a structure similar to diamond.

Explain why silicon has a high melting point.

.....

.....[2]

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(c) A 40.5 g sample of a chloride of sulfur contains 21.3 g of chlorine.

(i) Deduce the empirical formula of this chloride of sulfur.

empirical formula .....[3]

(ii) The relative molecular mass of this chloride is 135.

Deduce the molecular formula of this chloride.

molecular formula .....[1]

[Total: 10]

B8 Potassium nitrate, potassium sulfate and potassium phosphate are used in fertilisers.

(a) Calculate the percentage by mass of potassium in potassium sulfate, K_2SO_4.

..... % by mass [2]

(b) Describe a test for sulfate ions.

test .....

result .....
[2]

(c) Explain why nitrates in solid fertilisers spread onto soil are able to leach through the soil easily.

.....[1]

(d) Nitrates are responsible for eutrophication.

What is meant by the term *eutrophication*?

.....

.....

.....[2]

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(e) Dilute phosphoric acid, $H_3PO_4(aq)$, reacts with aqueous potassium hydroxide to make potassium phosphate.

$$H_3PO_4(aq) + 3KOH(aq) \rightarrow K_3PO_4(aq) + 3H_2O(l)$$

A student titrates 25.0 cm^3 of $H_3PO_4(aq)$ with 0.200 mol/dm^3 KOH(aq).

12.5 cm^3 of KOH(aq) is required to react exactly with the $H_3PO_4(aq)$.

Calculate the concentration of the $H_3PO_4(aq)$.

concentration of $H_3PO_4(aq)$ = ... mol/dm^3 [3]

[Total: 10]

B9 Nitrogen(V) oxide decomposes on heating to form nitrogen(IV) oxide and oxygen.

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

(a) The table shows how the rate of reaction varies with the concentration of N_2O_5.

concentration of $N_2O_5(g)$ in mol/dm^3	rate in $mol/dm^3/s$
3.2	6.39
1.6	3.15
0.8	1.63

(i) Describe how the rate of this reaction changes with the concentration of N_2O_5.

.....

.....[1]

(ii) Explain your answer to **(a)(i)** in terms of collision theory.

.....

.....

.....[2]

(iii) Describe and explain the effect of increasing the temperature on the rate of this reaction.

.....

.....

.....[2]

(b) Sulfur dioxide is an atmospheric pollutant.

(i) Describe one source of the sulfur dioxide in the atmosphere.

.....[1]

(ii) The oxidation of sulfur dioxide to sulfur trioxide in the atmosphere is catalysed by nitrogen(IV) oxide.

$$SO_2 + NO_2 \rightarrow SO_3 + NO$$

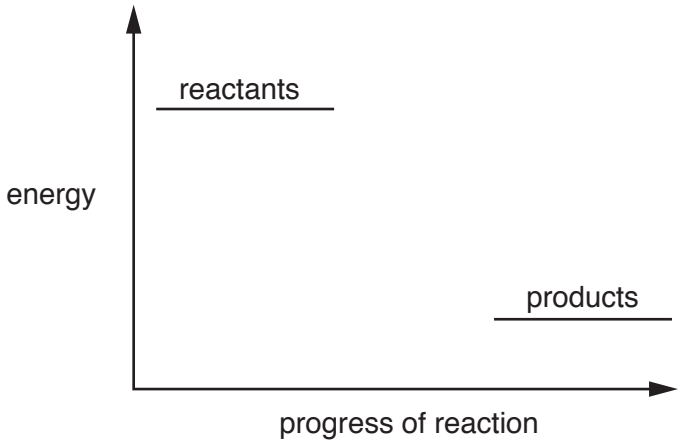
$$NO + \tfrac{1}{2}O_2 \rightarrow NO_2$$

Nitrogen(IV) oxide speeds up the rate of reaction. Which other property of a catalyst is shown by these equations?

.....[1]

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(c) (i) An incomplete energy profile diagram for the oxidation of sulfur dioxide to sulfur trioxide is shown.



On the diagram:

- draw and label the pathway for the uncatalysed reaction,
- draw and label the pathway for the catalysed reaction. [2]

(ii) Is the reaction in **(c)(i)** exothermic or endothermic?

Explain your answer.

.....

.....[1]

[Total: 10]

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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.).