Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

111122891 8

CHEMISTRY **5070/21**

Paper 2 Theory **October/November 2018**

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 **18** printed pages and **2** blank pages.

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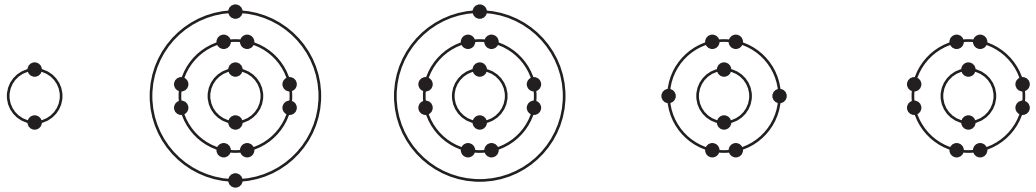
CAMBRIDGE
International Examinations

Section A

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

The total mark for this section is 45.

1 The electronic configurations of five atoms are shown.



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

(a) Which electronic configuration represents each of the following descriptions?

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

(i) a sodium atom

.....[1]

(ii) an atom of a reactive non-metallic element

.....[1]

(iii) an atom with a proton (atomic) number of 12

.....[1]

(iv) an atom of a noble gas which is used to fill balloons

.....[1]

(v) an atom which forms a noble gas electronic configuration when it gains two electrons

.....[1]

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(b) Chlorine has two naturally occurring isotopes.

One isotope of chlorine is represented by the symbol shown.

$$^{37}_{17}Cl$$

(i) Deduce the number of neutrons in one atom of this isotope of chlorine.

.....[1]

(ii) Chlorine has diatomic molecules.

What is the meaning of the term *diatomic*?

.....[1]

[Total: 7]

2 Zinc reacts with aqueous nickel(II) nitrate.

$$Zn(s) + Ni(NO_3)_2(aq) \longrightarrow Zn(NO_3)_2(aq) + Ni(s)$$

(a) (i) By referring to the equation, explain why this is a redox reaction.

.....

.....

.....[2]

(ii) Construct the ionic equation for this reaction.

.....[1]

(b) Draw a labelled diagram to show how a fork made of nickel is electroplated with silver.

[3]

(c) Aqueous ammonia is added, with mixing, to a solution containing zinc ions until no further change occurs.

What observations would be made during this test?

.....

.....

.....[2]

(d) Blocks of zinc are attached to the underside of ships made of iron to stop them from rusting.

Explain how zinc stops the ships from rusting.

.....

.....

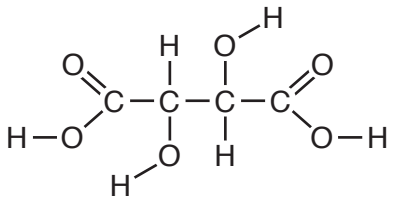
.....[2]

[Total: 10]

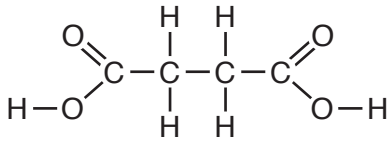
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3 Tartaric acid and succinic acid are colourless organic acids.

The structures of these acids are shown.



tartaric acid



succinic acid

(a) Name the group which is present in tartaric acid but not in succinic acid.

.....[1]

(b) Tartaric acid is reduced to succinic acid by acidified aqueous potassium iodide.

What colour change would you observe in the reaction mixture when this reaction is carried out?

from ..... to ..... [2]

(c) Succinic acid is a weak acid.

What is the meaning of the term *weak acid*?

.....

.....[1]

(d) Succinic acid is neutralised by aqueous sodium hydroxide.

$$C_2H_4(COOH)_2 + 2NaOH \rightarrow C_2H_4(COONa)_2 + 2H_2O$$

Calculate the minimum volume of 0.0200 mol / dm^3 sodium hydroxide required to neutralise 25.0 cm^3 of 0.0500 mol / dm^3 succinic acid.

Give your answer to **three** significant figures.

volume ..... cm^3 [3]

[Total: 7]

4 The alkanes are a homologous series of saturated hydrocarbons.

(a) **(i)** Write the general formula for the alkane homologous series.

.....[1]

(ii) Each member of a particular homologous series has the same general formula.

Give one other characteristic of a homologous series.

.....[1]

(b) What is the meaning of the term *saturated*?

.....[1]

(c) Construct the equation for the complete combustion of pentane, C_5H_{12}.

.....[2]

(d) Draw the structure of a branched alkane with the formula C_5H_{12}. Show all of the atoms and all of the bonds.

[1]

(e) Chlorine reacts with pentane.

$$C_5H_{12} + Cl_2 \rightarrow C_5H_{11}Cl + HCl$$

(i) What name is given to this type of chemical reaction?

.....[1]

(ii) What essential condition is needed for chlorine to react with pentane?

.....[1]

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(f) A hydrocarbon contains 90% carbon by mass.

(i) Deduce the empirical formula of this hydrocarbon.

empirical formula .....[2]

(ii) What additional piece of information is needed to deduce the molecular formula of this hydrocarbon?

.....[1]

[Total: 11]

5 The Periodic Table is an arrangement of elements in groups and periods.

(a) Describe how the position of an element in the Periodic Table is related to its electronic configuration.

.....

.....

.....[2]

(b) Aluminium is an element in Group III of the Periodic Table.

Deduce the electronic configuration of the aluminium ion.

.....[1]

(c) Aluminium reacts with oxygen to form aluminium oxide, Al_2O_3.

(i) Construct the equation for this reaction.

.....[1]

(ii) Aluminium oxide reacts with both acids and alkalis.

Name the type of oxide which reacts with both acids and alkalis.

.....[1]

(d) (i) Draw a 'dot-and-cross' diagram of a molecule of oxygen.

Only draw the outer shell electrons.

[2]

(ii) Describe and explain the difference in the rate of diffusion of the gases oxygen and nitrogen.

.....

.....[1]

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(iii) Oxygen reacts with hydrogen to form water.

Sulfur reacts with hydrogen to form hydrogen sulfide.

Some properties of hydrogen sulfide are listed.

- It is a gas at room temperature.
- It reacts with aqueous sodium hydroxide.
- It is a reducing agent.
- It burns in air.

Describe four ways in which the properties of water differ from those of hydrogen sulfide.

1. .....

2. .....

3. .....

4. .....

[2]

[Total: 10]

Section B

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

The total mark for this section is 30.

6 Some properties of the Group V elements are shown.

element	electrical conductivity of solid	melting point /°C	boiling point /°C
nitrogen	non-conductor	–210	–196
phosphorus	non-conductor	44	281
arsenic	non-conductor		
antimony	poor conductor	631	1587
bismuth	conducts	271	1564

(a) Use the information in the table.

(i) Predict the physical state of nitrogen at –200 °C.

Explain your answer.

.....

.....[2]

(ii) Predict the melting point of arsenic.

.....[1]

(b) Use the information in the table to explain how the structure and bonding in nitrogen differ from the structure and bonding in bismuth.

.....

.....

.....

.....[2]

(c) Antimony, Sb, reacts with chlorine to form antimony(III) chloride.

Construct the equation for this reaction.

.....[1]

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(d) Nitrogen is present in dry air.

(i) State the percentage by volume of nitrogen in dry air.

.....[1]

(ii) Nitrogen oxides are atmospheric pollutants.

The concentration of nitrogen oxides in the exhausts from car engines is decreased by using a catalytic converter.

Describe the reactions that occur in a catalytic converter which help to remove nitrogen oxides from car exhausts.

.....

.....

.....[2]

(iii) State one **other** source of nitrogen oxides in the atmosphere.

.....[1]

[Total: 10]

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[Turn over

7 The products of respiration are carbon dioxide and water.

(a) Complete the equation for respiration.

$$C_6H_{12}O_6 + \text{.....} \rightarrow \text{.....} + \text{.....} \quad [2]$$

(b) Carbon dioxide and methane are greenhouse gases which contribute to global warming.

(i) State one effect on the environment of an increase in global warming.

.....[1]

(ii) Describe how the carbon cycle regulates the amount of carbon dioxide in the atmosphere.

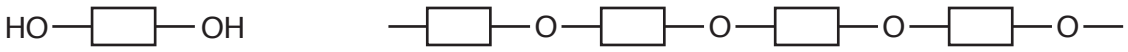
.....

.....

.....

.....[2]

(c) Simple sugars can be polymerised to form starch.



a simple sugar starch

(i) Deduce the formula of the molecule eliminated when simple sugars polymerise to form starch.

.....[1]

(ii) State the reagent and conditions needed to hydrolyse starch into simple sugars.

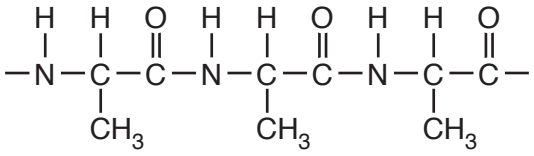
.....

.....[2]

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(d) The amino acid alanine can form polymers.

Part of the structure of poly(alanine) is shown.



(i) On the diagram, draw a circle around all of the atoms in one amide linkage. [1]

(ii) Draw the structure of the monomer used to make poly(alanine).

[1]

[Total: 10]

8 Chromium is a transition element.

Sodium is an element in Group I of the Periodic Table.

(a) Explain how both chromium and sodium conduct electricity.

.....

.....[1]

(b) Describe two differences in the physical properties of chromium and sodium.

1. .....

2. .....
[2]

(c) An alloy of iron and chromium is stronger than pure iron.

Use ideas about the structure of metals to explain why the alloy is stronger.

.....

.....

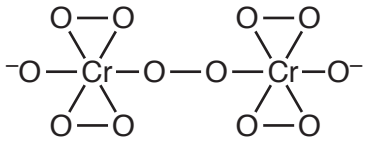
.....[2]

(d) Molten chromium reacts with steam to form chromium(III) oxide, Cr_2O_3, and hydrogen.

Construct the equation for this reaction.

.....[1]

(e) The structure of an ion containing chromium is shown.



Write the formula for this ion.

.....[1]

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(f) Adding dilute acid to yellow $CrO_4^{2-}(aq)$ forms orange $Cr_2O_7^{2-}(aq)$.

The ionic equation for this reaction is shown.

$$\underset{\text{yellow}}{2CrO_4^{2-}(aq)} + 2H^+(aq) \rightleftharpoons \underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(l)$$

(i) Describe and explain what you would observe when a few drops of concentrated aqueous sodium hydroxide are added to the orange solution.

.....

.....

.....[2]

(ii) Suggest why a change in pressure has no effect on the reaction shown.

.....[1]

[Total: 10]

9 Cerium is a metal with a relative atomic mass of 140.

Cerium powder reacts with sulfuric acid.

$$2Ce(s) + 3H_2SO_4(aq) \longrightarrow Ce_2(SO_4)_3(aq) + 3H_2(g)$$

(a) Describe and explain, using ideas about collisions between particles, how the rate of this reaction changes when the concentration of sulfuric acid is decreased.

All other conditions stay the same.

.....

.....

.....[2]

(b) Describe and explain how the rate of this reaction changes when large pieces of cerium are used instead of cerium powder.

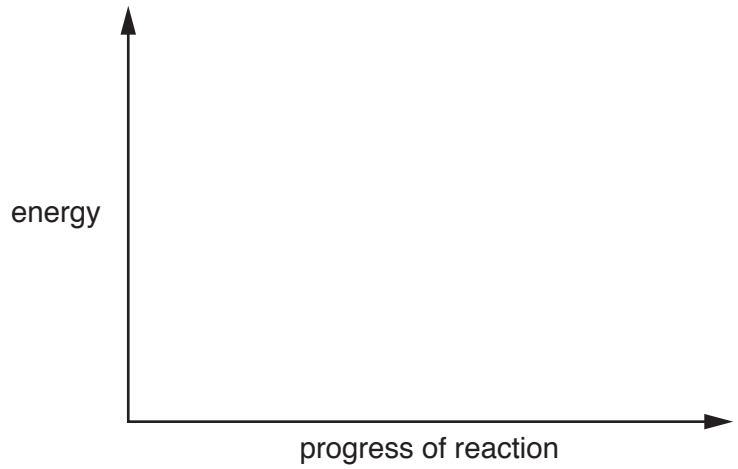
All other conditions stay the same.

.....

.....[1]

(c) The reaction of cerium with sulfuric acid is exothermic.

Complete the energy profile diagram to show the enthalpy change for this reaction.



[2]

(d) Calculate the maximum volume of hydrogen, in dm^3, formed when 12.6 g of cerium reacts with excess sulfuric acid at room temperature and pressure.

[A_r: Ce, 140]

volume ..... dm^3 [3]

(e) The formula of cerium carbonate is $Ce_2(CO_3)_3$.

Calculate the percentage by mass of cerium in cerium carbonate.

..... % [2]

[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.).