Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

7139395965

CHEMISTRY **5070/22**

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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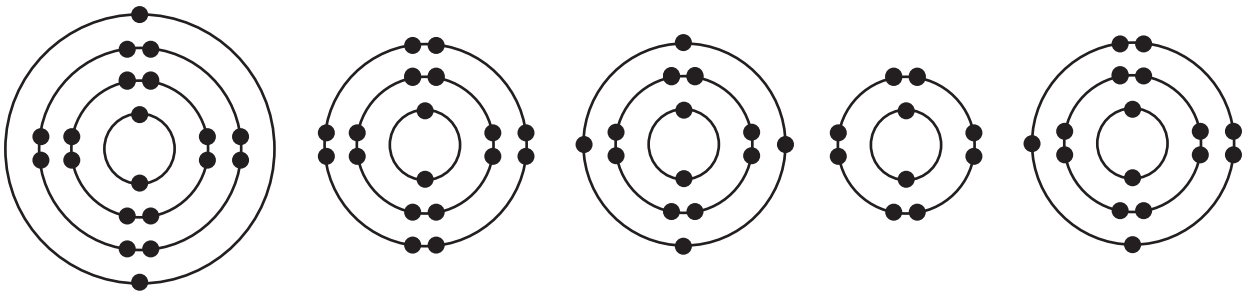
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Section A

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 sulfur atom

.....[1]

(ii) a metal atom

.....[1]

(iii) an atom with a proton number of 14

.....[1]

(iv) an atom of a noble gas with three occupied electron shells

.....[1]

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

.....[1]

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(b) The element germanium has five naturally occurring isotopes.

An isotope of germanium is represented by the symbol shown.

$^{76}_{32}Ge$

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

.....

.....[1]

(ii) Deduce the number of neutrons in one atom of this isotope of germanium.

.....[1]

[Total: 7]

2 Magnesium reacts with aqueous copper(II) sulfate.

$$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$$

(a) (i) Explain by referring to the equation, why this is a redox reaction.

.....

.....[2]

(ii) Construct the ionic equation for this reaction.

.....[1]

(b) Pure copper can be made by the electrolysis of aqueous copper(II) sulfate, using one pure copper electrode and one impure copper electrode.

Draw a labelled diagram of this electrolysis.

[3]

(c) What observations are made when adding aqueous ammonia to a solution containing copper(II) ions, slowly with mixing, until no further change occurs?

.....

.....

.....[2]

(d) Blocks of magnesium are attached to underground pipes made of iron to stop them rusting.

Explain how the magnesium stops the pipes rusting.

.....

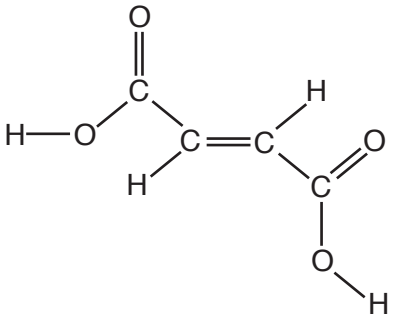
.....

.....[2]

[Total: 10]

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3 The structure of fumaric acid is shown.



(a) How does this structure show that fumaric acid is an unsaturated compound?

.....[1]

(b) Fumaric acid is oxidised by acidified aqueous potassium manganate(VII).

What colour change would you observe in the reaction mixture when excess aqueous fumaric acid is added to acidified aqueous potassium manganate(VII)?

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

(c) Fumaric acid is neutralised by aqueous sodium hydroxide.

$$C_2H_2(COOH)_2 + 2NaOH \rightarrow C_2H_2(COONa)_2 + 2H_2O$$

(i) Write the ionic equation for this reaction.

.....[1]

(ii) Calculate the volume of 0.0500 mol / dm^3 sodium hydroxide required to neutralise 20.0 cm^3 of 0.0200 mol / dm^3 fumaric acid.

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

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

[Total: 7]

4 The alkenes are a homologous series of unsaturated hydrocarbons.

(a) Describe two characteristics of a homologous series.

1. .....

2. .....
[2]

(b) Construct the equation for the complete combustion of butene, C_4H_8.

.....[2]

(c) Draw the structure of a branched alkene with the formula C_4H_8. Show all of the atoms and all of the bonds.

[1]

(d) Butene reacts with hydrogen in the presence of nickel.

(i) Name the product formed.

.....[1]

(ii) What is the purpose of the nickel?

.....[1]

(iii) State one other condition needed for this reaction.

.....[1]

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(e) A hydrocarbon contains 85.7% carbon by mass.

(i) Deduce the empirical formula of this hydrocarbon.

[2]

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

.....[1]

[Total: 11]

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[Turn over

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

(a) What are the factors that determine the position of an element in the Periodic Table?

.....

.....

.....

.....[2]

(b) Phosphorus is an element in Group V of the Periodic Table.

Deduce the electronic configuration of a phosphide ion, P^{3-}.

.....[1]

(c) Phosphine, PH_3, is a covalent compound.

(i) Draw a 'dot-and-cross' diagram of phosphine.

Only draw the outer shell electrons.

[2]

(ii) Some properties of phosphine are listed.

- gas at room temperature
- almost insoluble in water
- reacts with hydrogen chloride
- has no effect on litmus paper
- decomposes to form hydrogen and phosphorus only when warmed gently

Describe two ways in which the properties of ammonia are **different** from those of phosphine.

1. .....

2. .....
[2]

(iii) Construct the equation for the thermal decomposition of phosphine.

.....[1]

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(iv) Describe and explain the difference in the rate of diffusion of the gases ammonia and phosphine at the same temperature and pressure.

.....

.....

.....[1]

(v) Phosphine burns in oxygen to form phosphorus(V) oxide.

Is phosphorus(V) oxide an acidic, basic or amphoteric oxide? Give a reason for your answer.

.....

.....[1]

[Total: 10]

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[Turn over

Section B

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

The total mark for this section is 30.

6 Some properties of Group VI elements are shown.

element	density at room temperature in g/cm^3	melting point /°C	boiling point /°C	electrical conductivity of solid
oxygen	0.0013	–219	–183	very poor
sulfur	2.1	115	445	poor
selenium		221	685	poor
tellurium	6.2	450	988	quite good
polonium	9.2	254	962	good

(a) (i) Use the information in the table to suggest the density of selenium at room temperature.

.....[1]

(ii) Use the information in the table to deduce the physical state of oxygen at –190 °C.

Explain your answer.

physical state .....

explanation .....

.....

[2]

(b) (i) Describe the trend in the electrical conductivity of the Group VI elements.

.....

.....[1]

(ii) There is a trend in the melting points of the Group VI elements.

Which element does not follow this trend?

Use the data in the table to explain your answer.

element .....

explanation .....

.....[1]

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(c) Use the information in the table to explain how the structure and bonding in oxygen differs from the structure and bonding in polonium.

.....

.....

.....

.....[2]

(d) Sulfur dioxide is an atmospheric pollutant.

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

.....[1]

(ii) Describe and explain how sulfur dioxide contributes to acid rain.

.....

.....

.....[2]

[Total: 10]

7 Plants remove carbon dioxide from the air during photosynthesis.

(a) (i) Complete the equation for photosynthesis.

..... + ... → $C_6H_{12}O_6$ + ...O_2 [2]

(ii) State two conditions required for photosynthesis to happen.

1. .....

2. .....
[2]

(iii) Explain how photosynthesis can provide a renewable energy source.

.....

.....[1]

(b) The structure of a simple sugar is shown.



Starch is made by the polymerisation of simple sugars.

During this polymerisation, water is formed.

(i) What type of polymerisation occurs?

.....[1]

(ii) Draw the partial structure of starch.

You must show at least two repeat units.

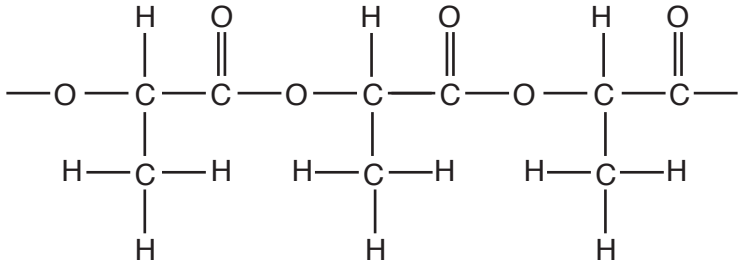
[2]

(iii) Name the process by which starch is converted into simple sugars.

.....[1]

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(c) The partial structure of poly(lactic acid) is shown.



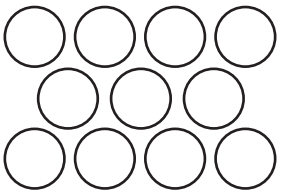
On the diagram, draw a ring around all of the atoms in one ester linkage. [1]

[Total: 10]

8 Bismuth is a metallic element in Group V of the Periodic Table.

(a) Complete the diagram to show the structure and bonding in a typical metal.

Label your diagram.



[2]

(b) Describe three physical properties which are typical of most metals.

1. .....

2. .....

3. .....

[2]

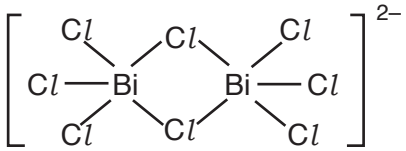
(c) Bismuth reacts with chlorine to form bismuth(III) chloride, $BiCl_3$.

Construct the equation for this reaction.

.....[1]

(d) When bismuth reacts with molten bismuth(III) chloride, an ion is formed.

The structure of this ion is shown.



Write the formula of this ion.

.....[1]

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(e) A white precipitate of BiOCl is formed when colourless BiCl_3 is added to water.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq)$$

(i) Describe and explain what you would observe when a few drops of concentrated hydrochloric acid are added to this mixture.

.....

.....

.....[2]

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

.....[1]

(f) Bismuth is used in alloys.

What is the meaning of the term *alloy*?

.....

.....[1]

[Total: 10]

9 Sulfuric acid reacts with zinc to form zinc sulfate and hydrogen.

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

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

All other conditions stay the same.

.....

.....

.....[2]

(b) Describe and explain, using ideas about collisions between particles, how the rate of this reaction changes when the temperature is decreased.

All other conditions stay the same.

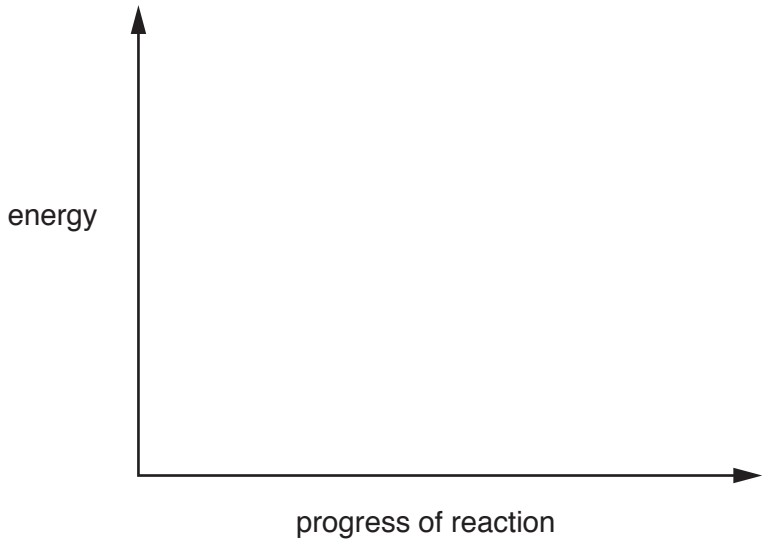
.....

.....

.....[2]

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

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



[2]

(d) Calculate the maximum volume of hydrogen, in dm^3, formed when 4.55 g of zinc reacts with excess sulfuric acid at room temperature and pressure.

volume ..... dm^3 [2]

(e) The formula of zinc phosphate is $Zn_3(PO_4)_2$.

Calculate the percentage by mass of zinc in zinc phosphate.

..... % [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.).