Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9764510146

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

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.
You may lose marks if you do not show your working or if you do not use appropriate units.
A Data Booklet is provided.

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 **11** printed pages and **1** blank page.

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[Turn over

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

1 **(a)** A sample contains three different types of atom: $^{40}_{18}Ar$, $^{40}_{19}K$ and $^{40}_{20}Ca$.

(i) State fully, in terms of the numbers of subatomic particles, what these three atoms have in common.

.....

..... [1]

(ii) State fully, in terms of the numbers of **all** subatomic particles, how these three atoms **differ** from each other.

.....

..... [1]

(b) A sample of sulfur contains only two isotopes, ^{32}S and ^{34}S. The relative atomic mass of this sample is 32.09.

isotope	isotopic mass
^{32}S	32.0
^{34}S	34.0

Calculate the percentage abundance of the isotopes present in this sample.

% abundance ^{32}S = ...

% abundance ^{34}S = ...
[3]

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(c) The electronic configuration of a sulfur atom is $1s^2 2s^2 2p^6 3s^2 3p^4$.

(i) Identify which orbital in a sulfur atom has the lowest energy.

..... [1]

(ii) Sketch the shape of a p orbital.

[1]

(iii) During the process of ionisation a sulfur atom loses an electron.

$$S(g) \rightarrow S^+(g) + e^- \qquad \Delta H = 1000\,kJ\,mol^{-1}$$

Identify the orbital from which this electron is removed. Explain your answer.

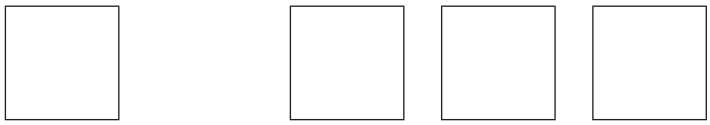
orbital .....

explanation .....

.....

[2]

(d) (i) Complete the diagram to show the arrangement of electrons within the third shell of a phosphorus atom.



[1]

(ii) Explain why the first ionisation energy of sulfur is less than that of phosphorus.

.....

.....

.....

..... [2]

[Total: 12]

2 Iodine is an element in Group 17 of the Periodic Table.

(a) (i) At room temperature, iodine solid has a lattice structure.

Describe the arrangement of the iodine molecules within the solid.

.....

..... [1]

(ii) List **all** of the forces of attraction present in solid iodine and identify which of these are overcome when solid iodine is heated to produce iodine vapour.

force(s) of attraction present

.....

.....

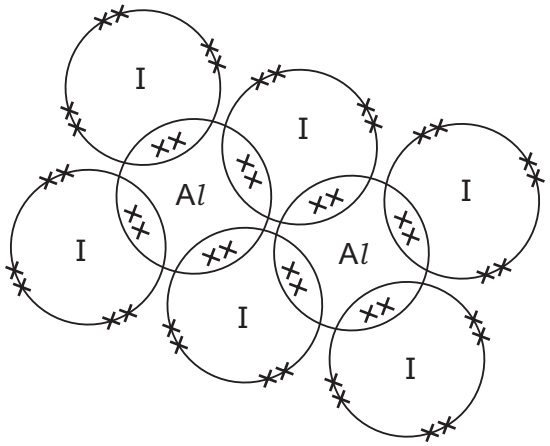
force(s) of attraction overcome

.....

.....
[2]

Iodine reacts with aluminium to form a white solid, Al_2I_6.

(b) The diagram shows the arrangement of the outer electrons within a molecule of Al_2I_6.



(i) How many co-ordinate (dative covalent) bonds are made when a molecule of Al_2I_6 is formed from its atoms?

..... [1]

(ii) Describe how co-ordinate (dative covalent) bonds form within this molecule.

.....

.....

..... [1]

(c) In a reaction between hydrogen iodide and concentrated sulfuric acid, the products are hydrogen sulfide, sulfur, iodine and water.

(i) Write an equation for this reaction.

You may wish to use oxidation numbers to help you.

..... [2]

(ii) Explain, with reference to oxidation numbers, why this reaction is a redox reaction.

.....

.....

..... [2]

[Total: 9]

3 **(a)** Magnesium reacts with oxygen to form magnesium oxide.

State **two** observations that would be made when magnesium is heated strongly and placed in a gas jar of pure oxygen.

.....

..... [1]

(b) Acid indigestion is caused by an excess of hydrochloric acid in the stomach.
Magnesium oxide is commonly found in indigestion tablets.

(i) Give the equation to show how magnesium oxide relieves acid indigestion.

..... [1]

(ii) Name the type of reaction that occurs in **(b)(i)**.

..... [1]

(c) Magnesium oxide is described as a ceramic material. It has a high melting point.

State and explain why ceramic materials such as magnesium oxide have high melting points.

.....

.....

..... [2]

(d) Magnesium oxide can be made from magnesium carbonate in a one-step reaction using heat.

(i) Write an equation for this reaction. Include state symbols.

..... [1]

(ii) Name the type of reaction occurring during this process.

..... [1]

[Total: 7]

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4 Release of sulfur dioxide, SO_2, into the atmosphere causes acid rain.

(a) Explain why high levels of SO_2 may be found in the atmosphere near power stations that burn fossil fuels.

.....

.....

..... [2]

(b) The SO_2 released can be converted in the atmosphere into sulfuric acid, H_2SO_4, by reaction with nitrogen dioxide gas, NO_2, and water, H_2O.

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

$$SO_3 + H_2O \rightarrow H_2SO_4$$

During one year, 1590 tonnes of SO_2 was released into the atmosphere by a fossil-fuel burning power station.

(i) Use the equations to calculate how many tonnes of H_2SO_4 were formed in the atmosphere. Assume that all of the SO_2 released was converted into H_2SO_4.

mass of H_2SO_4 = ... tonnes [2]

(ii) Describe how NO_2 is also produced by these power stations.

.....

..... [2]

(iii) State one natural cause of NO_2 being formed in the atmosphere.

..... [1]

(iv) Explain why NO_2 can be described as a catalyst in the oxidation of atmospheric SO_2.

.....

.....

..... [2]

[Total: 9]

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[Turn over

5 Halogenoalkanes react with a number of different reagents in nucleophilic substitution reactions.

(a) A sample of potassium cyanide dissolved in ethanol is added to a sample of 1-bromobutane, $CH_3(CH_2)_3Br$, and heated under reflux. A nucleophilic substitution reaction occurs and compound **A** is formed.

(i) Name compound **A**.

..... [1]

(ii) What is meant by the term *nucleophile*?

.....

..... [1]

(iii) Identify the nucleophile in this reaction.

..... [1]

(iv) Explain why this reaction is described as a substitution reaction.

.....

..... [1]

(b) State the reagent(s) and conditions needed for $CH_3(CH_2)_3Br$ to react to form $CH_3(CH_2)_3NH_2$.

reagent(s) .....

conditions .....

[2]

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(c) Equal amounts of three different halogenoalkanes are added to three separate test-tubes. An equal amount of aqueous silver nitrate and ethanol is added to each test-tube. The time taken for a precipitate to form is recorded for each halogenoalkane.

halogenoalkane	time taken for precipitate to form / s
$(CH_3)_3CCl$	460
$(CH_3)_3CBr$	190
$(CH_3)_3CI$	40

(i) Describe and explain the trend in reactivity of the different halogenoalkanes shown in this experiment.

.....

.....

..... [2]

(ii) All three halogenoalkanes tend to react via the S_N1 mechanism.

Explain why the S_N1 mechanism is favoured.

.....

.....

.....

..... [3]

(iii) Identify a halogenoalkane which tends to react with an aqueous solution of silver nitrate and ethanol via the S_N2 mechanism.

..... [1]

[Total: 12]

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[Turn over

6 **(a)** Three alkenes, **X**, **Y** and **Z**, have the same molecular formula.

(i) Describe what is seen when aqueous bromine is added to **X**.

..... [1]

X, **Y** and **Z** are reacted separately with hot, concentrated, acidified manganate(VII) ions until no further reaction occurs. The carbon-containing products are shown in the table.

alkene	carbon-containing products
X	CO_2 + $(CH_3)_2CO$
Y	CO_2 + $CH_3CH_2CO_2H$
Z	CH_3CO_2H

(ii) Draw the structures of **X**, **Y** and **Z**.

X **Y** **Z**

[3]

(iii) Deduce the molecular formula of **X**, **Y** and **Z**.

..... [1]

(b) The structures of **V** and **W** are shown.

$CH_3(CH_2)_2CH_2OH$ **V**

$(CH_3)_3COH$ **W**

(i) Name the class of compound that **V** and **W** each belong to.

V .....

W .....

[2]

(ii) **V** and **W** both react with sodium metal.

Write an equation for the reaction of **V** with sodium metal.

..... [1]

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(iii) Name a reagent used to distinguish **V** from **W**. Describe any observations.

reagent .....

observations with **V** .....

observations with **W** .....

[3]

[Total: 11]

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