Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2020**

1 hour 15 minutes

You must answer on the question paper.

You will need: Data booklet

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working, use appropriate units and use an appropriate number of significant figures.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

[Turn over

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

1 **(a)** A sample of barium is heated in oxygen.

(i) Describe **two** observations for this reaction.

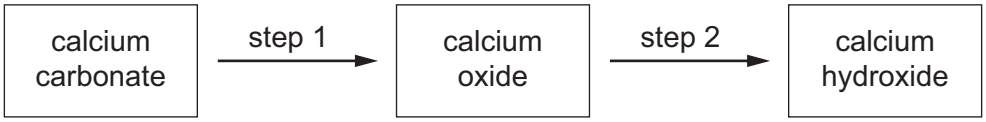
.....

..... [2]

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

..... [1]

(b) Calcium carbonate can be converted into calcium hydroxide in a two-step process.



(i) Describe how the two-step process is carried out to convert calcium carbonate into calcium hydroxide. Include relevant equations.

.....

.....

.....

..... [3]

(ii) Name the type of reaction occurring when calcium carbonate is converted into calcium oxide.

..... [1]

(iii) State **one** common use for both calcium carbonate and calcium hydroxide.

..... [1]

(c) Gallium is a silver-grey solid. Aluminium and gallium share many similar chemical properties

(i) Construct an equation for the reaction of gallium when heated in oxygen to form gallium oxide, Ga_2O_3.

..... [1]

(ii) Deduce the oxidation number of gallium in Ga_2O_3.

..... [1]

(iii) Complete the table by predicting the formula of each gallium-containing product formed when gallium oxide reacts separately with hot aqueous hydrochloric acid and with hot concentrated sodium hydroxide.

reagents and conditions	formula of gallium-containing product
gallium oxide + hot HCl(aq)	
gallium oxide + hot concentrated NaOH(aq)	

[2]

[Total: 12]

2 **(a)** Explain what is meant by the term *relative isotopic mass*.

.....

.....

..... [2]

(b) A sample of copper contains two isotopes, ^{63}Cu and ^{65}Cu. The relative atomic mass of the copper in this sample is 63.55.

Calculate the percentage abundance of each of these isotopes. Show your working.

percentage abundance of ^{63}Cu = ... %

percentage abundance of ^{65}Cu = ... %
[2]

(c) **(i)** Name the type of bonding within a sample of solid copper.

..... [1]

(ii) Draw a labelled diagram to show the bonding within a sample of solid copper.

[2]

(iii) State the electronic configuration of a copper atom.

$1s^2$ ..... [1]

(d) A student is provided with a sample of hydrated copper(II) sulfate, $CuSO_4 \cdot xH_2O$, and is asked to determine the value of x.
The student dissolves a sample of the hydrated copper(II) sulfate in water and adds it to an excess of aqueous potassium iodide to make a total volume of 250.0 cm^3 of solution.

$$2CuSO_4 + 4KI \rightarrow 2CuI + I_2 + K_2SO_4$$

The amount of iodine produced during this reaction is found by titrating a sample of this solution with sodium thiosulfate solution.

25.0 cm^3 of the iodine-containing solution requires 20.0 cm^3 of 0.10 mol dm^{-3} sodium thiosulfate solution.

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$

(i) Calculate the amount, in mol, of copper(II) sulfate present in the original sample of hydrated copper(II) sulfate.

Show your working.

amount of copper(II) sulfate = ... mol [2]

(ii) A total of 7.98 g of $CuSO_4$ is present in 10.68 g of $CuSO_4 \cdot xH_2O$.

Complete each row of the table to calculate the value of x, where x is an integer.

[M_r: $CuSO_4$,159.6]

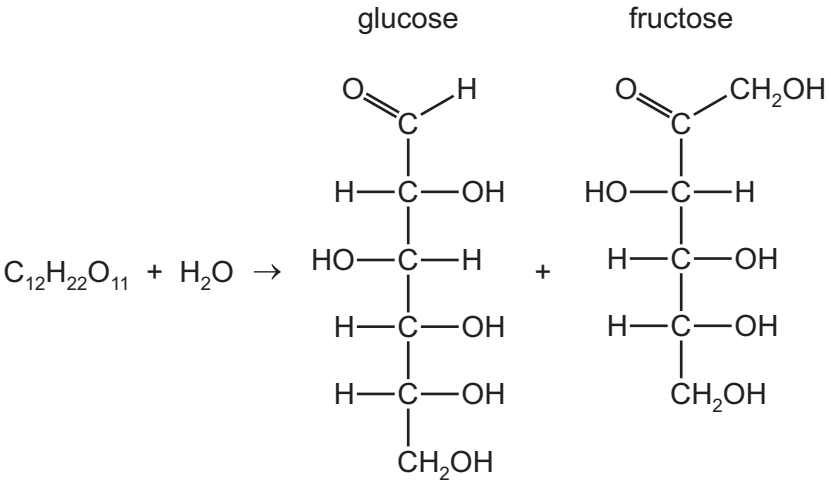
amount of $CuSO_4$ in 10.68 g of $CuSO_4 \cdot xH_2O$	..... mol
amount of H_2O in 10.68 g of $CuSO_4 \cdot xH_2O$	..... mol
value of x	x = ...

[3]

[Total: 13]

[Turn over

3 Sucrose is a white crystalline solid, $C_{12}H_{22}O_{11}$. In reaction **Z**, sucrose reacts with water in th presence of a catalyst, aqueous hydrochloric acid, to form glucose and fructose.



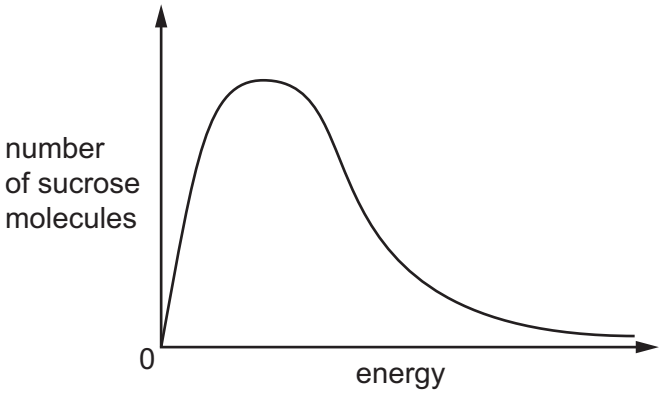
reaction **Z**

(a) (i) Suggest a name for the reaction that occurs when sucrose reacts with water to form glucose and fructose.

..... [1]

(ii) If no catalyst is added in reaction **Z**, the reaction is very slow.

Label the Boltzmann distribution to show the effect of adding a catalyst to the sample of sucrose and water molecules at constant temperature.



Explain your labelled diagram.

.....

.....

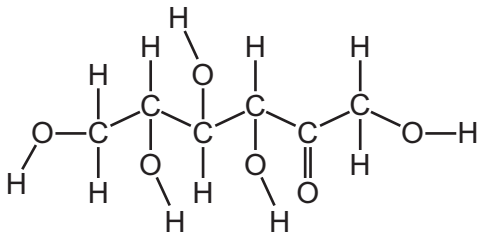
.....
[3]

(b) Both fructose and glucose contain chiral centres.

(i) Explain what is meant by the term *chiral centre*.

..... [1]

(ii) On the diagram of the fructose molecule, label all the chiral centres with an asterisk (*).



[1]

(iii) Determine the empirical formula of fructose.

..... [1]

(c) (i) Explain what is meant by the term *enthalpy change of combustion*.

.....

..... [2]

(ii) Write the equation for the complete combustion of sucrose.

..... [1]

The enthalpy change of reaction **Z**, ΔH_r, can be calculated using the enthalpy change of combustion data given in the table.

substance	enthalpy change of combustion, ΔH_c / kJ mol^{-1}
sucrose	–5643
glucose	–2805
fructose	–2810

(iii) Use the data in the table to calculate the enthalpy change for the reaction occurring when sucrose reacts with water, ΔH_r. You should draw a labelled Hess' cycle to show your working.

ΔH_r = ... kJ mol^{-1} [2]

[Total: 12]

4 Hexane, C_6H_{14}, is a colourless liquid.
Two test-tubes contain equal amounts of hexane. 1 cm^3 of bromine, $Br_2(aq)$, is added to both test-tubes. One test-tube is kept in the dark and the other is exposed to sunlight.

The table describes the appearance of each test-tube after one hour.

test-tube conditions	observations
in the dark	no change, mixture remains orange
in sunlight	colour of mixture fades to pale yellow

(a) The test-tube in the dark is kept cool and is not exposed to ultraviolet light.

Explain the observations for the test-tube kept in the dark.

.....

..... [2]

(b) In sunlight, bromine reacts with hexane by a mechanism which occurs via a series of steps.

(i) State the name of the mechanism of the reaction that occurs.

..... [1]

(ii) Give an equation which shows a propagation step in this reaction in which hexane produces $\bullet C_6H_{13}$.

..... [1]

(iii) Give an equation which shows a propagation step in this reaction that produces 1-bromohexane.

..... [1]

(iv) Give an equation which shows a termination step in this reaction that produces 1-bromohexane.

..... [1]

(c) **A** and **B** are different straight chain alkenes with molecular formula, C_6H_{12}.

A does not show stereoisomerism.

A reacts with potassium manganate(VII) to form hexane-1,2-diol.

(i) Draw the structural formula of **A**.

[1]

(ii) State the conditions needed for this reaction of **A**.

..... [2]

(d) **B** reacts with hydrogen gas in the presence of a platinum catalyst to produce hexane.

(i) Name the type of reaction occurring.

..... [1]

(ii) In terms of σ and π bonds, describe any similarities and differences in the type of carbon-carbon bonds in **B** and the type of carbon-carbon bonds in hexane.

.....

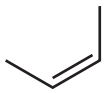
.....

..... [2]

[Total: 12]

5 **C**, **D** and **E** are isomers of each other.
They are made by passing an alcohol vapour over an aluminium oxide catalyst.

C



D

E

(a) **(i)** Name the type of reaction occurring.

..... [1]

(ii) Draw the displayed formula of the alcohol used in this reaction.

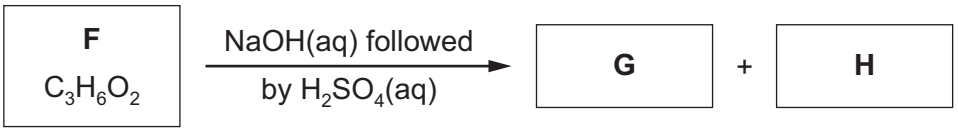
[2]

(iii) Name the isomers **C**, **D** and **E**.

isomer	name
C	
D	
E	

[2]

(b) **F** is an organic molecule which has the molecular formula $C_3H_6O_2$.
When **F** is heated with NaOH(aq) followed by H_2SO_4(aq) the products **G** and **H** are made.



Separate samples of **G** and **H** are added to

- Na_2CO_3(aq)
- sodium metal
- alkaline aqueous iodine.

The observations are described in the table.

reagent(s)	**G**	**H**
Na_2CO_3(aq)	colourless bubbles of gas produced	no visible reaction
Na(s)	colourless bubbles of gas produced	colourless bubbles of gas produced
alkaline aqueous iodine	no visible reaction	yellow precipitate forms

(i) Complete the table to identify the functional groups present in **F**, **G** and **H**.

	functional group
F	
G	
H	

[3]

(ii) Name the yellow precipitate formed when alkaline aqueous iodine reacts with **H**.

..... [1]

(iii) Draw the structures of **G** and **H**.

G	**H**

[2]

[Total: 11]

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