Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

5604890866

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 2018**

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 **10** printed pages and **2** blank pages.

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[Turn over

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

1 Sodium and magnesium are the first two elements in the third period.

(a) Sodium and magnesium both react with cold water to produce the same type of product in solution. With sodium the solution is clear but with magnesium it appears cloudy.

(i) Write an equation for the reaction of magnesium with cold water.

..... [1]

(ii) Suggest why the solution is cloudy after the reaction of magnesium with cold water.

.....

..... [1]

(b) Group 2 elements, including magnesium, react with oxygen and with dilute acids. There are trends in both the physical and chemical properties of the elements and their compounds down the group. Reactivity generally increases from Mg to Ba.

(i) Explain why there is a general increase in reactivity from Mg to Ba.

.....

.....

..... [2]

(ii) Give **two** observations for the reaction of magnesium with oxygen. Write an equation for this reaction. Include state symbols.

.....

.....

equation .....
[3]

(iii) Write an equation for the reaction of magnesium with sulfuric acid.

..... [1]

(iv) Suggest why there is a general **decrease** in the melting points of the elements down Group 2.

.....

.....

.....

.....

..... [3]

[Total: 11]

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2 Ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2$, has a relative formula mass, M_r, of 284.

(a) Define the term *relative formula mass*.

.....

.....

.....

..... [2]

(b) One of the cations in ammonium iron(II) sulfate is the ammonium ion, NH_4^+.

(i) Draw a 'dot-and-cross' diagram of an ammonium ion. Show outer shell electrons only.

Use × to show electrons from nitrogen.
Use ● to show electrons from hydrogen.

[2]

(ii) Suggest the shape of an ammonium ion and predict the bond angle.

shape .....

bond angle .....
[2]

(c) In aqueous solution the ammonium ion acts as a weak Brønsted-Lowry acid.

(i) Explain the meaning of the term *weak Brønsted-Lowry acid*.

.....

.....

.....

..... [2]

(ii) Write an equation to show this behaviour of the ammonium ion in water. Include state symbols.

..... [2]

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(d) Mohr's salt, $(NH_4)_2Fe(SO_4)_2 \cdot xH_2O$, is the hydrated form of ammonium iron(II) sulfate.

x represents the number of moles of water in 1 mole of the salt.

A student wanted to determine the value of x. 0.784 g of the hydrated salt was dissolved in water and this solution was acidified.

All of the solution was titrated with 0.0200 mol dm^{-3} potassium manganate(VII). 20.0 cm^3 of this potassium manganate(VII) solution was required for complete reaction with the Fe^{2+} ions.

(i) Use changes in oxidation numbers to balance the equation for the reaction taking place.

$MnO_4^-(aq)$ + ...$Fe^{2+}(aq)$ + ...$H^+(aq)$ → .....$Mn^{2+}(aq)$ + ...$Fe^{3+}(aq)$ + ...$H_2O(l)$ [1]

(ii) State the role of the Fe^{2+} ions in this reaction.

Explain your answer.

.....

..... [2]

(iii) Calculate the amount, in moles, of manganate(VII) ions that reacted.

amount = ... mol [1]

(iv) Calculate the amount, in moles, of Fe^{2+} ions in the sample of the salt.

amount = ... mol [1]

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(v) Calculate the relative formula mass of $(NH_4)_2Fe(SO_4)_2 \cdot xH_2O$.

relative formula mass = ... [1]

(vi) Calculate the value of x.

x = ... [1]

[Total: 17]

3 Most vehicle fuels contain hydrocarbons obtained from crude oil.

(a) (i) State the name of the type of reaction that hydrocarbons undergo when being used as fuels.

..... [1]

(ii) Write an equation for the reaction of octane, C_8H_{18}, as a fuel, as in **(a)(i)**.

..... [2]

(b) The supply of material suitable for use as fuels directly from crude oil is **not** sufficient to meet demand. A process is carried out to make some of the larger hydrocarbon molecules more useful.

(i) Name this process.

..... [1]

As well as producing fuels, this process produces compounds suitable for use in the production of polymers. An example of such a compound is but-2-ene, $CH_3CH{=}CHCH_3$.

(ii) Draw the repeat unit of the polymer that is produced from but-2-ene.

[2]

(iii) Name the type of polymerisation that occurs during the production of the polymer in **(ii)**.

..... [1]

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(c) Gases produced in internal combustion engines include carbon monoxide, oxides of nitrogen such as NO_2, and unburnt hydrocarbons.

These gases are removed from the exhaust before they can enter the atmosphere.

(i) State what is used to remove these gases from the exhaust.

..... [1]

(ii) Write **one** equation to show how both carbon monoxide, CO, and nitrogen dioxide, NO_2, are removed from the exhaust.

..... [1]

(iii) State the environmental consequence of allowing unburnt hydrocarbons to enter the atmosphere.

..... [1]

(d) Vehicle fuels are treated to remove sulfur. If sulfur is present in a fuel when it is burned, SO_2 is produced and may be released into the atmosphere where it can form acid rain.

(i) Acid rain can contribute to breathing difficulties.

Identify **two** other consequences of acid rain in the atmosphere.

.....

.....

.....

..... [2]

(ii) NO_2 is involved in the production of acid rain from SO_2.

Give **two** equations which describe how acid rain is formed by the action of NO_2 with SO_2.

.....

..... [2]

(iii) NO_2 is described as a catalyst during this process.

Explain, with the use of an appropriate equation, why NO_2 is described as a catalyst.

.....

..... [2]

[Total: 16]

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[Turn over

4 **W** is $CH_3COCH_2CH_3$.

(a) The reaction between **W** and alkaline aqueous iodine produces a yellow precipitate.

(i) Give the name of the compound formed as a yellow precipitate in this reaction.

..... [1]

(ii) Give the name of **W**.

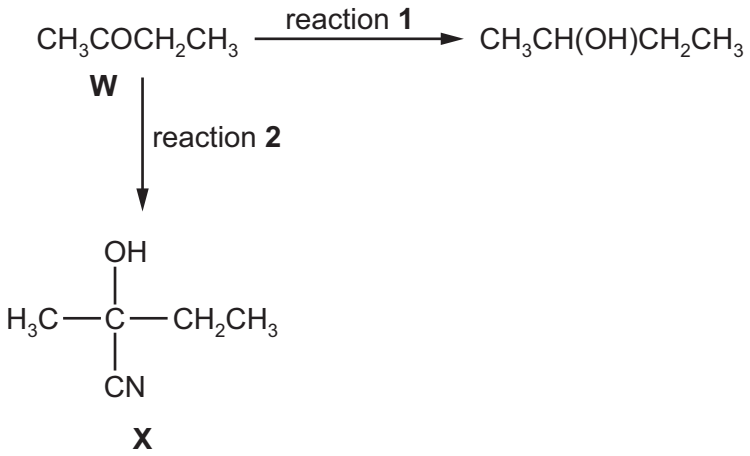
..... [1]

(b) There are two structural isomers of **W** that are also carbonyl compounds.

Draw the structures of these two isomers of **W**.

[2]

Two reactions of **W** are shown.



(c) **(i)** Identify the type of reaction occurring in reaction **1**.

..... [1]

(ii) Identify the reagent for reaction **1**.

..... [1]

(d) Reaction **2** is carried out by adding a mixture of HCN and NaCN to **W**.
The product, **X**, is formed as a mixture of two isomers.

(i) Complete the mechanism for this reaction.

Include the structure of the intermediate formed and all necessary charges, dipoles, lone pairs and curly arrows.

W 

CN^- **X**

[4]

(ii) State the name of the type of isomerism shown by **X**.

..... [1]

(iii) Explain fully why **X** shows this type of isomerism.

.....

.....

.....

..... [2]

Question 4 continues on page 10.

(e) If **X** is treated with ammonia and the product hydrolysed, a compound, **Y**, is obtained that contains 51.3% C, 9.40% H, 12.0% N and 27.3% O by mass.

(i) Show that the empirical formula of **Y** is $C_5H_{11}NO_2$.

[2]

(ii) The empirical formula of **Y** is $C_5H_{11}NO_2$ and the M_r of **Y** is 117.

Deduce the molecular formula of **Y**. You **must** explain your reasoning.

molecular formula = ...

.....

.....

[1]

[Total: 16]

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