Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4698471249696

CHEMISTRY **9701/23**

Paper 2 Structured Questions AS Core **May/June 2015**

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.

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

1 Neon is a noble gas.

(a) Complete the full electronic configuration of neon.

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

(b) **(i)** Explain what is meant by the term *first ionisation energy*.

.....

.....

..... [3]

(ii) Explain why the first ionisation energy of neon is greater than that of fluorine.

.....

..... [2]

(c) Neon has three stable isotopes.

isotope	mass number	percentage abundance
1		9.25
2	20	90.48
3	21	0.27

(i) Define the term *relative atomic mass*.

.....

..... [2]

(ii) Use the relative atomic mass of neon, 20.2, to calculate the mass number of isotope 1.

mass number = ... [2]

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(d) A mixture of neon and argon has a mass of 0.275 g. The mixture was placed in a gas syringe at a temperature of 25 °C and a pressure of 100 kPa. Under these conditions the mixture was found to occupy a volume of 200 cm^3.

(i) Calculate the average M_r of the mixture.

average M_r = ... [2]

(ii) Use your answer to **(i)** to calculate the percentage of neon in the mixture.
Give your answer to **three** significant figures.

percentage of neon = ... % [1]

(e) Neon and argon can both be obtained by fractional distillation of liquid air as they have different boiling points.

Neon has a boiling point of 27.3 K. The boiling point of argon is 87.4 K.

(i) Name the force that has to be overcome in order to boil neon or argon and explain what causes it.

.....

.....

..... [3]

(ii) Explain why argon has a higher boiling point than neon.

.....

.....

..... [2]

[Total: 18]

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[Turn over

2 The elements in Group II, and their compounds, show a variety of trends in their properties.

(a) Magnesium, calcium and barium all react with cold water to form hydroxides.

(i) Describe and explain the trend in reactivity of these three elements with cold water.

.....

.....

.....

.....

..... [3]

(ii) Give the equation for the reaction of magnesium with cold water.

..... [1]

(iii) Suggest why the water eventually turns cloudy during the reaction of magnesium with cold water.

.....

..... [1]

(iv) Suggest the equation for the reaction of hot magnesium with steam.

..... [1]

(b) The oxides of magnesium, calcium and barium all react with dilute nitric acid to form nitrates.

(i) Give the equation for the reaction of magnesium oxide with nitric acid.

..... [1]

(ii) State the trend in thermal stability of the nitrates of Group II.

.....

..... [1]

(iii) Give the equation for the thermal decomposition of magnesium nitrate.

..... [1]

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(iv) Apart from lithium nitrate, the nitrates of the Group I elements decompose in a different way to those of the Group II elements.

The equation for the thermal decomposition of potassium nitrate is

$$2KNO_3 \rightarrow 2KNO_2 + O_2$$

By identifying any changes in oxidation number, explain which element is reduced and which is oxidised in this decomposition.

.....

.....

.....

..... [3]

(c) A refractory material is one that does not decompose or melt at very high temperatures. Over 50% of magnesium oxide production is for use as a refractory material.

Explain why magnesium oxide has a very high melting point.

.....

.....

..... [2]

(d) The word 'lime' is usually used to refer to a range of calcium-containing compounds that have a range of uses.

(i) Write equations to show how calcium carbonate can be converted into calcium hydroxide by a two-step process.

.....

..... [2]

A garden pond, with a total volume of 8000 dm^3, has been contaminated in such a way that its pH has fallen to 4. This means that the concentration of hydrogen ions, H^+, in the water is 1×10^{-4} mol dm^{-3}.

(ii) Write an ionic equation for the neutralisation reaction that occurs between hydrogen ions and carbonate ions, CO_3^{2-}.

..... [1]

(iii) Use your equation to calculate the mass of powdered calcium carbonate that would need to be added to the pond to neutralise the acidity.

mass = ... g [2]

[Total: 19]

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3 **A**, **B**, **C**, **D**, **E** and **F** are all structural isomers with the molecular formula C_4H_8O.

(a) **A**, **B** and **C** all give an orange precipitate when treated with 2,4-DNPH but only **A** and **B** give a brick-red precipitate when warmed with Fehling's solution.

(i) Draw the **skeletal** formulae of **A**, **B** and **C**.

A	B	C

[3]

(ii) Name the type of structural isomerism shown by **A** and **B**.

..... [1]

(iii) State what you would **see** when a sample of **A** is warmed with Tollens' reagent.

..... [1]

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(b) **D**, **E** and **F** all decolourise bromine and effervesce slowly with sodium metal.

E shows geometrical isomerism. Only **D** has a branched chain.

None of these isomers contains an oxygen atom bonded to a carbon atom involved in π bonding.

None of these isomers contains a chiral centre.

(i) Give the structures of **D**, **E** and **F**. Show the two stereoisomers of **E** and label the stereoisomerism shown.

D	
E	**E** .....
F	

[5]

(ii) Identify the gas produced during the reaction of each of these isomers with sodium metal.

..... [1]

(c) Another compound, **G**, C_3H_6O, contains the same functional group as **A**.

Give equations for the reactions of **G** with each of acidified potassium dichromate(VI) and sodium tetrahydridoborate, $NaBH_4$, using [O] or [H] as appropriate.

(i) reaction with acidified potassium dichromate(VI)

C_3H_6O + ... $\rightarrow$ ..... [1]

(ii) reaction with $NaBH_4$

C_3H_6O + ... $\rightarrow$ ..... [1]

[Total: 13]

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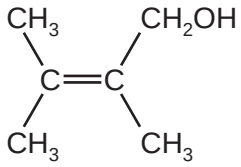
[Turn over

4 The structure of **H** is shown.



H

(a) **H** reacts with both cold, dilute, acidified potassium manganate(VII) and with hot, concentrated, acidified potassium manganate(VII).

(i) Give the structure of the organic product of the reaction of **H** with cold, dilute, acidified potassium manganate(VII).

[1]

(ii) Give the structures of the organic products of the reaction of **H** with hot, concentrated, acidified potassium manganate(VII).

[2]

(b) **(i)** Complete the reaction scheme to show the mechanism of the reaction of **H** with bromine to form **J**.

Include all necessary curly arrows, lone pairs and charges.

J

[3]

(ii) Explain the origin of the dipole on the bromine molecule.

.....

..... [1]

J is formed as an equimolar mixture of isomers.

(iii) State the type of isomerism shown by **J**.

..... [1]

(iv) Draw the structures of the two isomers of **J**.

[2]

[Total: 10]

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