



CANDIDATE  
NAME

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**CHEMISTRY**

9701/21

Paper 2 Structured Questions AS Core

May/June 2014

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 8 printed pages.

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

- 1 (a) Explain what is meant by the term *ionisation energy*.

.....  
 .....  
 ..... [3]

- (b) The first seven ionisation energies of an element, **A**, in  $\text{kJ mol}^{-1}$ , are

1012 1903 2912 4957 6274 21269 25398.

- (i) State the group of the Periodic Table to which **A** is most likely to belong. Explain your answer.

.....  
 .....  
 .....  
 ..... [2]

- (ii) Complete the electronic configuration of the element in Period 2 that is in the same group as **A**.

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

- (c) Another element, **Z**, in the same period of the Periodic Table as **A**, reacts with chlorine to form a compound with empirical formula  $\text{ZCl}_2$ . The percentage composition by mass of  $\text{ZCl}_2$  is **Z**, 31.13; **Cl**, 68.87.

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

.....  
 .....  
 ..... [2]

- (ii) Calculate the relative atomic mass,  $A_r$ , of **Z**.  
 Give your answer to **three** significant figures.

$A_r$  of **Z** = ..... [2]

(d) The chlorides of elements in Period 3 of the Periodic Table show different behaviours on addition to water, depending on their structure and bonding.

(i) Write equations to show the behaviour of sodium chloride,  $\text{NaCl}$ , and silicon chloride,  $\text{SiCl}_4$ , when separately added to an excess of water.

$\text{NaCl}$  .....

$\text{SiCl}_4$  .....

[2]

(ii) State and explain the differences in behaviour of these two chlorides when added to water, in terms of their structure and the bonding found in the compounds.

.....

.....

.....

.....

.....

..... [4]

(e) Sulfur reacts with fluorine to form  $\text{SF}_6$ . State the shape and bond angle of  $\text{SF}_6$ .

shape of  $\text{SF}_6$  .....

bond angle of  $\text{SF}_6$  .....

[2]

[Total: 18]

- 2 The commonest form of iron(II) sulfate is the heptahydrate,  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ . On heating at  $90^\circ\text{C}$  this loses **some** of its water of crystallisation to form a different hydrated form of iron(II) sulfate,  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ .

3.40 g of  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$  was dissolved in water to form  $250\text{ cm}^3$  of solution.

A  $25.0\text{ cm}^3$  sample of this solution was acidified and titrated with  $0.0200\text{ mol dm}^{-3}$  potassium manganate(VII).

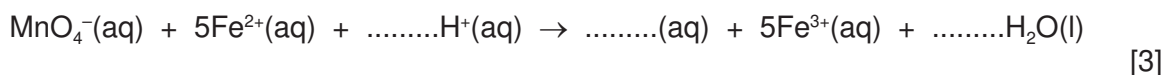
In this titration  $20.0\text{ cm}^3$  of this potassium manganate(VII) solution was required to react fully with the  $\text{Fe}^{2+}$  ions present in the sample.

- (a) The  $\text{MnO}_4^-$  ions in the potassium manganate(VII) *oxidise* the  $\text{Fe}^{2+}$  ions in the acidified solution.

- (i) Explain, in terms of electron transfer, the meaning of the term *oxidise* in the sentence above.

.....  
..... [1]

- (ii) Complete and balance the ionic equation for the reaction between the manganate(VII) ions and the iron(II) ions.



- (b) (i) Calculate the number of moles of manganate(VII) used in the titration. [1]

- (ii) Use the equation in (a)(ii) and your answer to (b)(i) to calculate the number of moles of  $\text{Fe}^{2+}$  present in the  $25.0\text{ cm}^3$  sample of solution used. [1]

- (iii) Calculate the number of moles of  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$  in 3.40 g of the compound. [1]

- (iv) Calculate the relative formula mass of  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ . [1]

- (v) The relative formula mass of anhydrous iron(II) sulfate,  $\text{FeSO}_4$ , is 151.8.  
Calculate the value of  $x$  in  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ . [1]

[Total: 9]

3 (a) In this question, **K**, **L** and **M** refer to a halogen atom or halide ion.  
For each part question, read the information and complete the answer lines below.

(i) When concentrated sulfuric acid is added to solid Na**K**, white fumes are produced that turn damp blue litmus paper red. No other colour changes are observed.

identity of **K** = .....

equation for reaction .....

explanation of observation .....

..... [3]

(ii) When silver nitrate solution is added to an aqueous solution of Na**L**, a precipitate forms that remains after the addition of concentrated ammonia solution.

identity of **L** = .....

colour of precipitate .....

equation for reaction ..... [3]

(iii) **M**<sub>2</sub> is a liquid at room temperature with a boiling point higher than that of chlorine but lower than that of iodine.

identity of **M** = .....

explanation .....

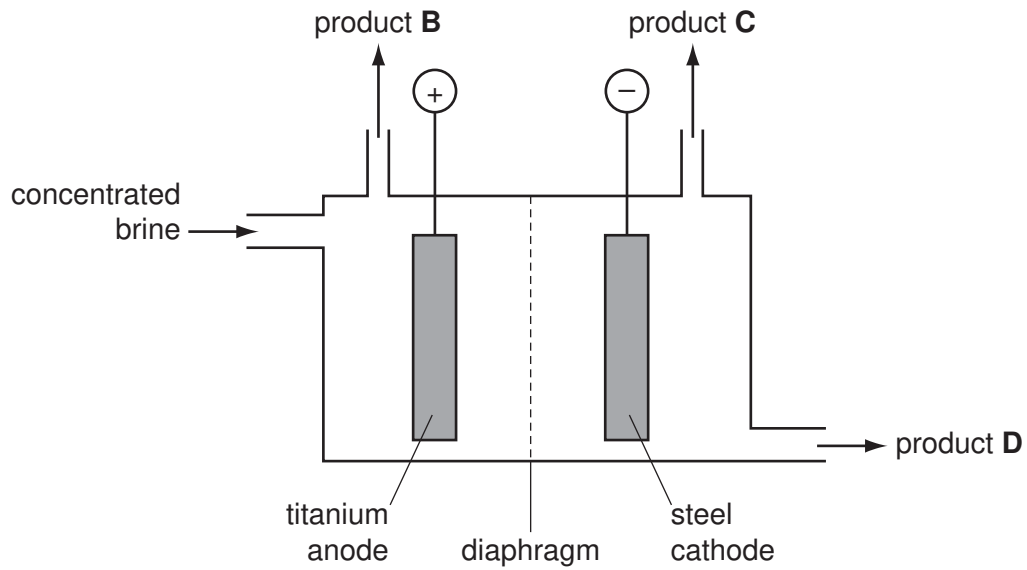
.....

.....

.....

..... [2]

(b) The diagram below is a simplified representation of a diaphragm cell.



(i) Identify each of the products.

**B** .....

**C** .....

**D** .....

[3]

(ii) Give the equations for the two electrode reactions.

anode .....

cathode .....

[2]

[Total: 13]

4 Alkanes and alkenes both react with bromine.

(a) Explain how and why bromine can be used to distinguish between an alkene and an alkane.

.....  
 .....  
 ..... [2]

(b) The reaction of ethane with bromine forms a mixture of products.

(i) State the essential conditions for this reaction to occur.

..... [1]

(ii) Give the full name of the mechanism of this reaction.

..... [2]

(iii) Give the equation for a **termination** step that could occur, producing a **hydrocarbon**.

..... [1]

(iv) Give the equation for one **propagation** step involved in the formation of dibromoethane from bromoethane during this reaction.

..... [1]

(c) The reaction of ethene with bromine forms a single product.

(i) Give the full name of the mechanism of this reaction.

..... [2]

(ii) Complete the diagram below to illustrate this mechanism.  
 Include all relevant charges, partial charges, curly arrows and lone pairs.

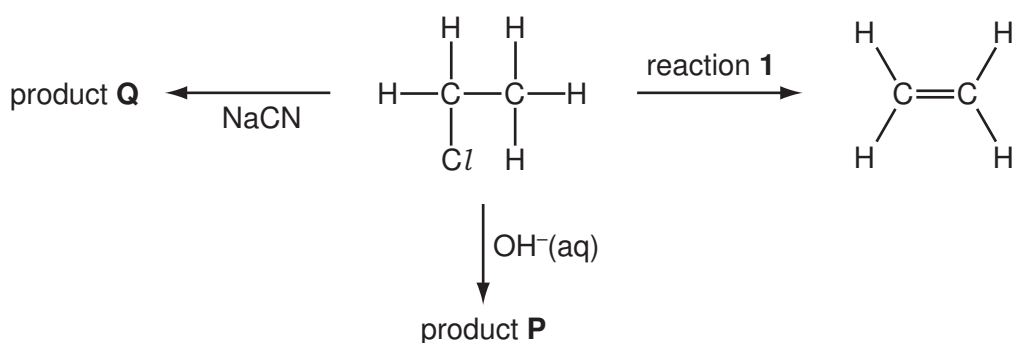


[4]

- (d) Chloroethene can be polymerised to form a polymer commonly known as PVC. Draw a diagram of the structure of PVC including **three** repeat units.

[2]

- (e) Chloroethane undergoes a series of reactions as shown in the diagram below.



- (i) Give the reagent and conditions necessary for reaction 1.

.....  
 ..... [2]

- (ii) Give the **skeletal** formula of product P.

[1]

- (iii) Give the **displayed** formula and the name of product Q.

..... [2]

[Total: 20]