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**CHEMISTRY**

Paper 2 Theory

**5070/21**

**May/June 2014**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**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.**

**Section A**

Answer **all** questions.

Write your answers in the spaces provided in the Question Paper.

**Section B**

Answer any **three** questions.

Write your answers in the spaces provided in the Question Paper.

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 copy of the Periodic Table is printed on page 20.

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 **18** printed pages and **2** blank pages.

## Section A

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

The total mark for this section is 45.

**A1** Choose from the following equations to answer the questions below.

- A**  $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$   
**B**  $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$   
**C**  $\text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$   
**D**  $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$   
**E**  $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$   
**F**  $\text{Cu}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s})$   
**G**  $\text{Fe}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{H}_2(\text{g})$   
**H**  $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$   
**I**  $2\text{I}^-(\text{aq}) + \text{Br}_2(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{Br}^-(\text{aq})$   
**J**  $\text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{NH}_3(\text{g})$   
**K**  $4\text{OH}^-(\text{aq}) \rightarrow \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^-$

Each equation can be used once, more than once or not at all.

Give the letter of an equation which

**(a)** shows the formation of gas that turns moist red litmus blue,

..... [1]

**(b)** shows a reaction that forms a white precipitate,

..... [1]

**(c)** shows only reduction,

..... [1]

**(d)** shows the neutralisation of dilute hydrochloric acid by aqueous sodium hydroxide,

..... [1]

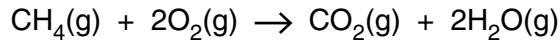
**(e)** shows the reaction at an inert positive electrode when copper(II) sulfate is electrolysed.

..... [1]

[Total: 5]

**A2** A power station burns methane,  $\text{CH}_4$ , which is contaminated by hydrogen sulfide,  $\text{H}_2\text{S}$ .

The equation shows the combustion of methane.



The combustion of the hydrogen sulfide forms water and sulfur dioxide.

**(a)** Construct the equation to show the combustion of hydrogen sulfide.

..... [1]

**(b)** Explain why the burning of the contaminated methane at the power station causes atmospheric problems.

.....

.....

.....

..... [2]

**(c)** A  $1000\text{dm}^3$  sample of the contaminated methane gas burnt at the power station produces  $999\text{dm}^3$  of carbon dioxide and  $1\text{dm}^3$  of sulfur dioxide. All gas volumes are measured at room temperature and pressure.

**(i)** What is the volume of methane, at room temperature and pressure, in the  $1000\text{dm}^3$  of the gas burnt?

volume of methane = .....  $\text{dm}^3$  [1]

**(ii)** What is the volume of hydrogen sulfide, at room temperature and pressure, in the  $1000\text{dm}^3$  of the gas burnt?

volume of hydrogen sulfide = .....  $\text{dm}^3$  [1]

**(iii)** Calculate the percentage, by volume, of hydrogen sulfide in the contaminated methane. You must show your working.

percentage = .....% [2]

(d) The volume of a gas changes if the pressure is increased or the temperature is increased.

(i) Describe and explain qualitatively the effect of increasing the pressure on the volume of a gas if the temperature remains constant.

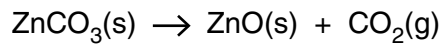
.....  
.....  
..... [2]

(ii) Describe and explain qualitatively the effect of increasing the temperature on the volume of a gas if the pressure remains constant.

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

[Total: 11]

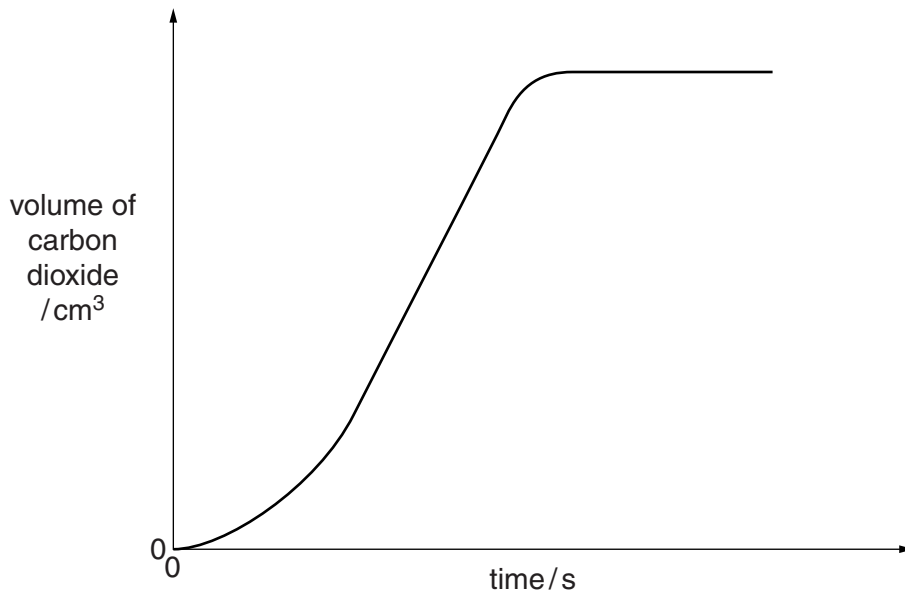
**A3** Zinc carbonate thermally decomposes to form zinc oxide and carbon dioxide.



In an experiment, a sample of zinc carbonate is heated in a test-tube using a Bunsen burner.

The total volume of carbon dioxide formed is measured every 10 seconds.

The results are plotted on the graph below.



(a) Suggest why the volume of carbon dioxide does not increase by very much when the zinc carbonate is first heated.

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

(b) How is the graph used to find out when the decomposition has finished?

..... [1]

(c) The same mass of zinc carbonate is heated using a **hotter** Bunsen flame.

On the axes above, draw the graph you would expect from the results of this experiment.

Explain your answer.

.....  
 .....  
 .....  
 ..... [4]

(d) The experiment is repeated with different metal carbonates.

The Bunsen burner flame is not altered and the same number of moles of metal carbonate is used for each experiment.

The table shows the time taken for complete decomposition.

metal carbonate	time for decomposition to finish /s
$\text{CaCO}_3$	360
$\text{FeCO}_3$	60
$\text{ZnCO}_3$	70

Predict and explain the time it would take magnesium carbonate and lead carbonate to decompose.

magnesium carbonate .....s

lead carbonate .....s

explanation .....

.....

.....

..... [2]

[Total: 8]

**A4** Aluminium is manufactured by the electrolysis of aluminium oxide dissolved in molten cryolite.

**(a)** Give the equations for the reactions that occur at the electrodes during this electrolysis.

positive electrode .....

negative electrode ..... [2]

**(b)** Aluminium is a useful metal as it does not corrode in moist air.

Explain why aluminium does not corrode in moist air.

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

**(c)** Underground iron pipes rust easily. This can be prevented by attaching a piece of magnesium to the pipe.

Explain this form of rust prevention.

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

**(d)** Aluminium sulfate is a soluble salt.

Describe how a sample of aluminium sulfate crystals can be prepared from aluminium oxide.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

[Total: 10]

**A5** Ethene has the formula  $C_2H_4$ .

- (a)** Draw a 'dot-and-cross' diagram to show the bonding in a molecule of ethene. Draw only the outer shell electrons.

[2]

- (b)** Describe the manufacture of pure ethanol starting from ethene. Include an equation and the conditions needed.

.....

.....

.....

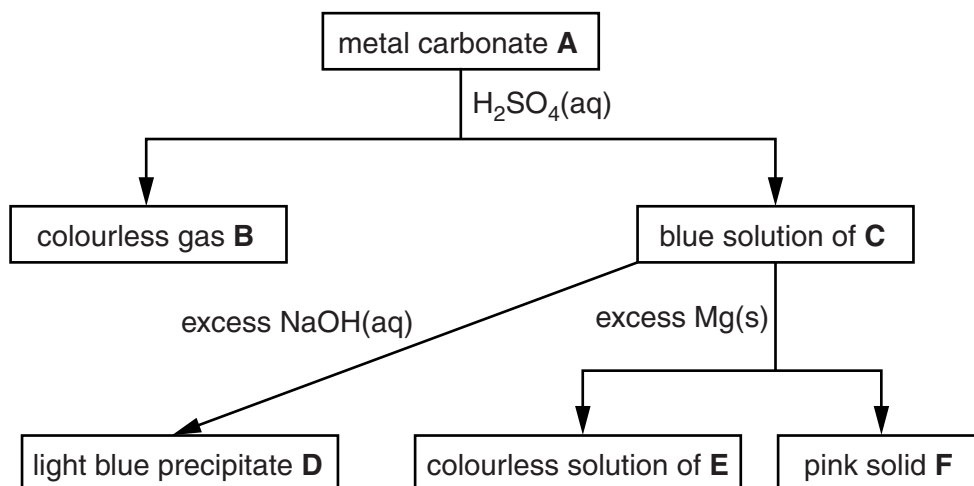
.....

..... [3]

[Total: 5]



**A6** The flow chart shows some reactions of the compounds of a metal.



Identify, by name, each of the substances.

**A** .....

**B** .....

**C** .....

**D** .....

**E** .....

**F** .....

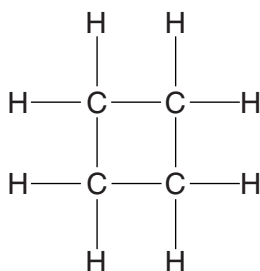
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## Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

**B7** Cyclobutane has the following structure.



(a) What evidence from the structure indicates that cyclobutane is a saturated compound?

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

(b) Deduce the empirical formula for cyclobutane.

..... [1]

(c) Cyclobutane has several isomers which are alkenes.

Draw the structure, showing all the atoms and all the bonds, of one of these isomers.

[1]

(d) The complete combustion of one mole of cyclobutane releases 2702 kJ of heat energy.

(i) Construct an equation for the complete combustion of cyclobutane.

..... [2]

(ii) Calculate the heat energy released when 600 dm<sup>3</sup> of cyclobutane, at room temperature and pressure, is completely combusted.

heat energy = ..... kJ [2]

(iii) Explain, in terms of the energy associated with bond breaking and bond making, why the combustion of cyclobutane is exothermic.

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

[Total: 10]

**B8** Butanoic acid,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ , and ethanoic acid,  $\text{CH}_3\text{CO}_2\text{H}$ , are both weak acids.

**(a)** Explain, with the aid of an equation, what is meant by the term *weak acid*.

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

**(b)** Butanoic acid reacts with magnesium.

Name the gas formed and describe the chemical test for the gas.

gas .....

chemical test .....  
..... [2]

**(c)** Butanoic acid reacts with magnesium carbonate.

Give the formula of the magnesium salt formed in the reaction of butanoic acid with magnesium carbonate.

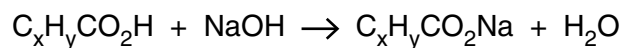
..... [1]

**(d)** Ethanoic acid reacts with ethanol to make an organic compound.

Draw the structure, showing all the atoms and all the bonds, of this organic compound.

[1]

- (e) A solution containing 0.172 g of an unknown carboxylic acid,  $C_xH_yCO_2H$ , is titrated with  $0.100 \text{ mol/dm}^3$  aqueous sodium hydroxide. The volume of sodium hydroxide solution needed to exactly neutralise the acid is  $23.2 \text{ cm}^3$ .



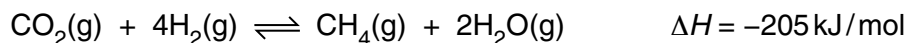
Calculate the relative formula mass,  $M_r$ , of the carboxylic acid and suggest its identity.

relative formula mass = .....

identity of the acid ..... [4]

[Total: 10]

- B9** When carbon dioxide reacts with hydrogen in a sealed container, an equilibrium mixture is obtained.



This reaction is exothermic.

- (a)** Describe and explain what happens to the rate of the forward reaction when the pressure is increased. The temperature remains constant.

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

- (b)** Describe and explain what happens to the position of equilibrium when the temperature is increased. The pressure remains constant.

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

- (c)** In an experiment, 220 g of carbon dioxide and an excess of hydrogen are reacted in a sealed container until an equilibrium is established.

A mass of 46 g of methane is produced.

- (i)** Calculate the mass of methane that should have been made if the percentage yield was 100%.

mass of methane = ..... g [2]

- (ii)** Calculate the percentage yield of methane in this experiment.

percentage yield = .....% [1]

(d) The experiment with 220 g of carbon dioxide and an excess of hydrogen is repeated but this time a catalyst is added.

(i) State what happens, if anything, to the position of equilibrium compared with the non-catalysed reaction.

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

(ii) Describe and explain what happens to the rate of reaction compared with the non-catalysed reaction.

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

[Total: 10]

**B10** Francium, Fr, is a highly reactive element in Group I of the Periodic Table.

The table shows some information about two isotopes of francium.

atomic symbol	number of protons	number of electrons	number of neutrons
${}^{223}_{87}\text{Fr}$	87	.....	136
.....	87	.....	138

(a) Complete the table. [2]

(b) Construct an equation to show the reaction of francium with water.

..... [1]

(c) Francium oxide,  $\text{Fr}_2\text{O}$ , contains  $\text{Fr}^+$  and  $\text{O}^{2-}$  ions.

(i) Describe how a francium ion and an oxide ion are formed from a francium atom and an oxygen atom.

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

(ii) Predict **two** physical properties of francium oxide.

1. ....  
 2. .... [2]



(d) Describe, with the aid of a labelled diagram, the structure of a metal and use it to explain why francium is a good conductor of electricity.

.....

.....

..... [3]

[Total: 10]



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