

CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

**5070/21**

Paper 2 Theory

**October/November 2016**

**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 compounds to answer the questions below.



Each of these compounds can be used once, more than once or not at all.

Which compound

(a) is an atmospheric pollutant formed by lightning activity,

.....[1]

(b) is the main constituent of natural gas,

.....[1]

(c) dissolves in water to form an aqueous solution which gives a white precipitate on addition of aqueous sodium sulfate,

.....[1]

(d) is a catalyst in the contact process for the manufacture of sulfuric acid,

.....[1]

(e) is a product of the thermal decomposition of limestone?

.....[1]

[Total: 5]

A2 Sulfuric acid is a strong acid.

(a) (i) What is meant by the term *strong acid*?

.....[1]

(ii) Describe how you could measure the pH of dilute sulfuric acid.

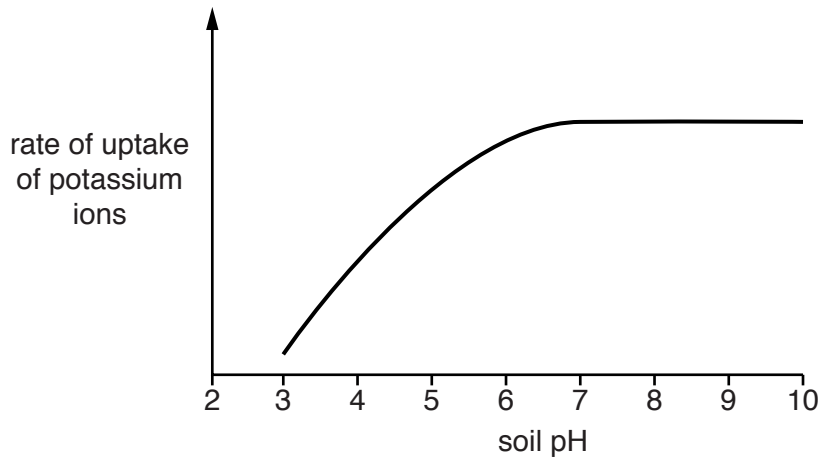
.....  
.....[1]

(b) Many plants cannot grow in soils which are too acidic.

Describe and explain how soils which are too acidic can be treated to reduce the acidity.

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

(c) The graph shows the effect of soil pH on the rate of uptake of potassium ions by plant roots.



Describe how the rate of uptake of potassium ions varies with soil pH.

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

[Total: 5]

**A3** The alcohols are a homologous series with the general formula  $C_nH_{2n+1}OH$ .

**(a)** Deduce the molecular formula of the alcohol having eight carbon atoms.

.....[1]

**(b)** The table shows some information about different alcohols.

alcohol	formula	melting point /°C	boiling point /°C	density in g/cm <sup>3</sup>
ethanol	C <sub>2</sub> H <sub>5</sub> OH	-117	79	0.789
propanol	C <sub>3</sub> H <sub>7</sub> OH	-126	98	0.804
butanol	C <sub>4</sub> H <sub>9</sub> OH	-89	117	
pentanol	C <sub>5</sub> H <sub>11</sub> OH	-79	138	0.815
hexanol	C <sub>6</sub> H <sub>13</sub> OH	-47	158	0.820

**(i)** Describe how the boiling point changes with the number of carbon atoms in the alcohol.

.....[1]

**(ii)** Estimate the density, in g/cm<sup>3</sup>, of butanol.

.....[1]

**(iii)** What is the physical state of pentanol at room temperature and pressure? Explain your answer.

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

**(c)** How does viscosity change in the homologous series of alcohols?

Explain your answer.

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

**(d)** Construct the equation for the complete combustion of propanol.

.....[2]

**(e)** Propanol can be oxidised to propanoic acid.

**(i)** Suggest the oxidising agent and describe the conditions used for this reaction.

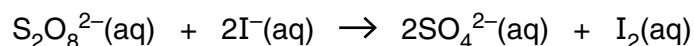
.....  
 .....[2]

(ii) Draw the structure of propanoic acid, showing all the atoms and all the bonds.

[1]

[Total: 11]

**A4** Peroxodisulfate ions,  $\text{S}_2\text{O}_8^{2-}$ , react with iodide ions in aqueous solution.



The table shows how the relative rate of this reaction changes when different concentrations of peroxodisulfate ions and iodide ions are used.

experiment	concentration of $\text{S}_2\text{O}_8^{2-}$ in $\text{mol}/\text{dm}^3$	concentration of $\text{I}^-$ in $\text{mol}/\text{dm}^3$	relative rate of reaction
1	0.008	0.02	1.7
2	0.016	0.02	3.3
3	0.032	0.02	6.8
4	0.008	0.04	3.4
5	0.008	0.08	6.9

**(a)** Use the information in the table to describe how increasing the concentration of each of these ions affects the relative rate of reaction.

peroxodisulfate ions .....

.....

iodide ions .....

.....

[2]

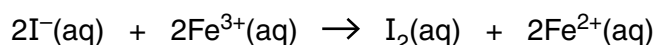
**(b)** Iron(III) ions,  $\text{Fe}^{3+}$ , catalyse this reaction.

Explain how catalysts increase the rate of a reaction.

.....

.....[1]

**(c)** Iron(III) ions react with iodide ions.



**(i)** Explain how iron(III) ions are acting as an oxidising agent in this reaction.

.....

.....[1]

**(ii)** What colour change is observed when this reaction happens?

.....[1]

(iii) Describe a test for iron(III) ions.

test .....

observation .....

[2]

(d) Iron(II) ions react with peroxodisulfate ions. The products are iron(III) ions and sulfate ions.

Construct the equation for this reaction.

.....[1]

[Total: 8]

**A5** Potassium chlorate,  $KClO_3$ , decomposes to form potassium chloride and oxygen.



(a) Calculate the percentage by mass of oxygen in potassium chlorate.

[2]

(b) Calculate the maximum volume of oxygen formed at room temperature and pressure when 12.25 g of potassium chlorate is completely decomposed.

[3]

(c) Potassium chloride can be made by reacting potassium with chlorine.

(i) Explain in terms of gain and loss of electrons, how potassium ions and chloride ions are formed when potassium reacts with chlorine.

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

(ii) Predict **two** physical properties of potassium chloride.

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

[Total: 10]



**A6** Dry air contains nitrogen, oxygen, argon and other gases.

**(a)** State the percentage compositions by volume of nitrogen and oxygen present in dry air.

nitrogen ..... %

oxygen ..... %

[1]

**(b)** The formula for oxygen gas is O<sub>2</sub>.

**(i)** Draw a 'dot-and-cross' diagram of an oxygen molecule.

Show only the outer shell electrons.

[1]

**(ii)** What is the formula of argon gas?

.....[1]

**(c)** Titanium is extracted from titanium(IV) chloride by reduction with molten sodium in an argon atmosphere and not in air.

Suggest why this reaction is carried out in an argon atmosphere and not in air.

.....

.....[2]

**(d)** State one other use of argon.

.....[1]

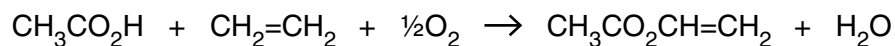
[Total: 6]

## Section B

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

The total mark for this section is 30.

**B7** Ethenyl ethanoate,  $\text{CH}_3\text{CO}_2\text{CH}=\text{CH}_2$ , is manufactured by passing a mixture of ethanoic acid, ethene and oxygen over a catalyst at  $200^\circ\text{C}$ .

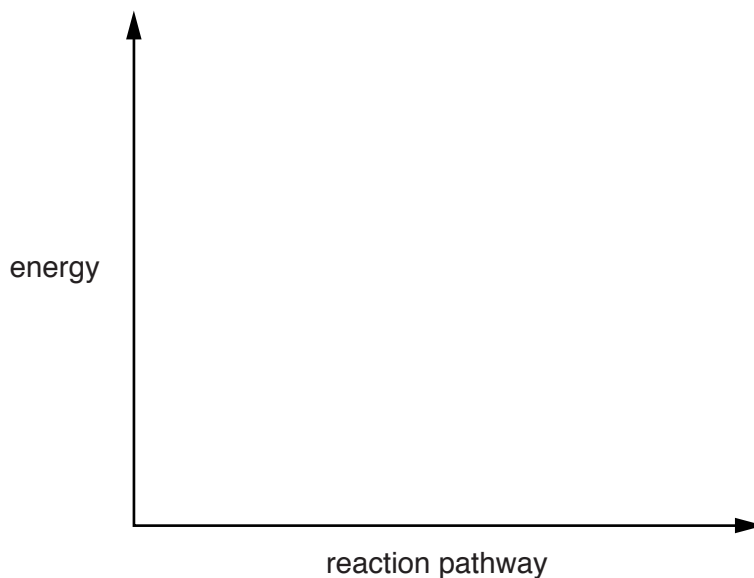


The reaction is exothermic.

**(a)** Draw an energy profile diagram for this reaction on the axes shown.

On your diagram label

- the reactants and products,
- the enthalpy change for the reaction,
- the activation energy.



[3]

**(b)** Ethenyl ethanoate is an unsaturated compound.

Describe a chemical test for an unsaturated compound.

test .....

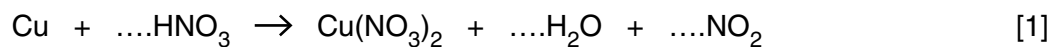
observation .....

[2]

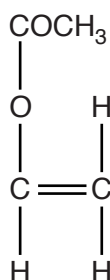
(c) The catalyst used in the manufacture of ethenyl ethanoate contains copper.

Copper reacts with concentrated nitric acid.

Complete the equation for this reaction.



(d) The structure of ethenyl ethanoate is shown.



Draw the structure of the addition polymer formed from ethenyl ethanoate.

[2]

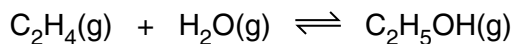
(e) State **two** pollution problems caused by non-biodegradable plastics.

.....

.....[2]

[Total: 10]

**B8** Ethanol can be manufactured by reacting ethene with steam in a closed reaction vessel.

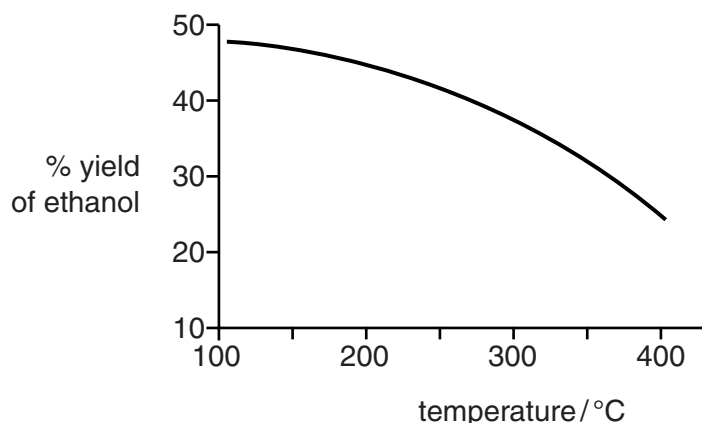


The reaction is exothermic.

**(a)** State **two** conditions for this reaction.

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

**(b)** The graph shows the percentage yield of ethanol at different temperatures.



**(i)** Describe how, and explain why, the percentage yield changes with temperature.

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

**(ii)** Suggest why the reaction is carried out at 300 °C and not at 200 °C.

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

**(c)** Describe how, and explain why, the position of equilibrium changes when the pressure is increased.

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

(d) Ethanol reacts with methanoic acid,  $\text{HCO}_2\text{H}$ , to form ethyl methanoate and water.

Construct the equation for this reaction.

.....[1]

[Total: 10]

**B9** Tin and silver are metals.

**(a)** State **two** properties which are characteristic of most metals.

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

**(b)** Draw a labelled diagram to show how a tin rod can be electroplated with silver.

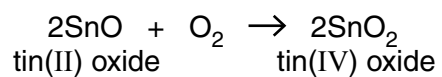
[3]

**(c)** A 9.50 g sample of a chloride of tin contains 5.95 g of tin.

Deduce the empirical formula of this chloride of tin.

empirical formula .....[2]

(d) Tin(II) oxide reacts with oxygen to form tin(IV) oxide.



When a sample of 13.5g of tin(II) oxide is reacted with oxygen, 12.7g of tin(IV) oxide is formed.

Calculate the percentage yield of tin(IV) oxide.

..... % [3]

[Total: 10]





(e) Predict the products of electrolysis of molten lithium oxide at

the anode (positive electrode), .....

the cathode (negative electrode). .....

[1]

[Total: 10]



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