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Chemistry

Assessment Unit A2 3A

assessing

Module 6A: Synoptic Paper

[A2C31]



FRIDAY 29 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all five** questions.

Section A contains a Planning Exercise.

Section B contains **four** questions assessing different aspects of the specification.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.

Quality of written communication will be assessed in question 1.

Figures in brackets printed down the right-hand side of pages indicate the mark awarded to each question or part question.

A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	

Total Marks	
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Section A

1 Planning Exercise

Preparation of antimony(III) bromide

Antimony(III) bromide, SbBr_3 , is an off-white solid with a melting point of 97°C and a boiling point of 280°C . The solid is corrosive and is harmful by inhalation. It decomposes in water, but is soluble in organic solvents such as 1,1,1-trichloroethane.

The elements, antimony and bromine, combine directly when heated together under reflux.

You are provided with standard laboratory apparatus and the following chemicals:

antimony granules
bromine (density 3.1 g cm^{-3})
1,1,1-trichloroethane

Plan how you could prepare 5 g of pure antimony(III) bromide based on the mass of bromine used.

Your plan should include:

(a) the relevant equation;

_____ [2]

(b) a calculation to show the volume of bromine needed assuming a 75% yield;

_____ [4]

Section B

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

2 At the Kyoto Summit in 1997 an agreement was reached to limit pollution, including that due to sulphur hexafluoride, SF₆, which is one of the most potent greenhouse gases.

(a) The industrial preparation of sulphur hexafluoride involves the combustion of molten sulphur, S₈, in fluorine.

(i) Write an equation for this reaction including state symbols.

_____ [2]

(ii) The product is contaminated with disulphur decafluoride, S₂F₁₀, which disproportionates on heating:



Explain, using the oxidation states of sulphur, how this reaction may be classified as disproportionation.

_____ [3]

(iii) The sulphur tetrafluoride, SF₄, is removed by alkaline hydrolysis forming sulphite ions, fluoride ions and water.
Write an equation for this reaction.

_____ [2]

(iv) Describe how you could test for the presence of sulphite ions in solution.

_____ [3]

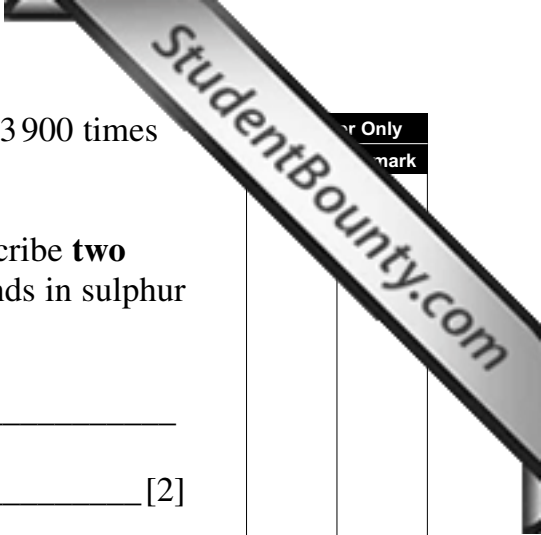
(b) Sulphur hexafluoride has a global warming effect that is 23 900 times greater than carbon dioxide.

(i) Sulphur hexafluoride absorbs infra-red radiation. Describe **two** effects this absorbed radiation has on the covalent bonds in sulphur hexafluoride.

[2]

(ii) Calculate the volume of carbon dioxide, measured at 20 °C and one atmosphere pressure, which will have the same global warming effect as 1 tonne of sulphur hexafluoride.
(1 tonne = 1000 kg)

[3]



For Only
mark

3 Human urine is a complex mixture which includes urea, uric acid, hippuric acid and magnesium ions.

(a) The hydrolysis of urea, NH_2CONH_2 , produces ammonium carbonate as the only product and is catalysed by the enzyme urease.

(i) Write an equation for this hydrolysis.

_____ [1]

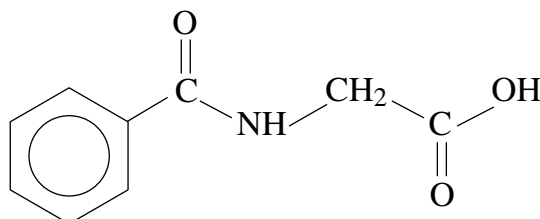
(ii) Draw a labelled enthalpy level diagram to show the catalysed and uncatalysed reaction pathways. Assume the reaction is endothermic.



(b) An excess accumulation of uric acid in the body can lead to a type of arthritis known as gout. Uric acid is a weak acid with a pK_a value of 3.89. Calculate the pH of a 0.05 M solution of uric acid.

 _____ [3]

(c) Hippuric acid derives its name from the Greek word *hippos* which means horse, since the acid is found in relatively high concentrations in horses' urine. The acid has the structure:



(i) Deduce the molecular formula of hippuric acid.

_____ [1]

(ii) Explain why hippuric acid is soluble in water.

_____ [2]

(iii) The acid can be hydrolysed to form benzoic acid and glycine.
Explain why glycine is not optically active.

_____ [1]

(d) The magnesium content of a sample of urine can be determined by titration with standard edta solution.

(i) Name the indicator used in this titration and state the colour change at the end point.

_____ [2]

(ii) Human urine typically contains 0.01 g of magnesium per 100 cm³. Calculate the volume of 0.02M edta solution required to react completely with 100cm³ of urine.

_____ [3]

4 Propanone and propanal are structural isomers which, despite both containing a carbonyl group, exhibit significant differences in their chemistry.

(a) The two compounds may be readily distinguished from one another by either chemical or spectroscopic means.

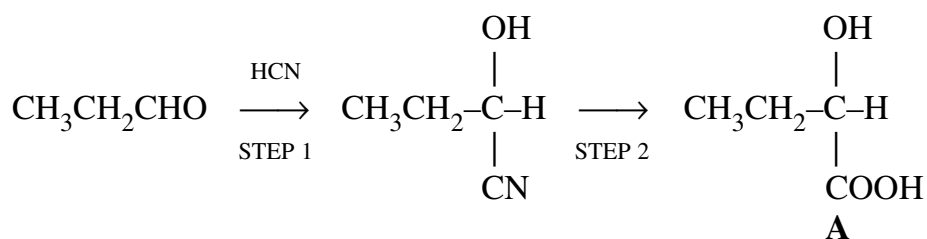
(i) Describe how to distinguish between these two compounds using a suitable chemical reaction, naming any reagent(s) and noting expected observations.

[3]

(ii) How would n.m.r. spectroscopy distinguish between propanone and propanal?

[2]

(b) Propanal reacts with hydrogen cyanide to form 2-hydroxybutanenitrile which itself may be hydrolysed as shown in the following flow scheme:



(i) Draw a flow scheme for the mechanism in Step 1.

[3]

(ii) Name a reagent used to hydrolyse the 2-hydroxybutanenitrile in Step 2.

_____ [1]

(iii) Give the systematic name for A.

_____ [1]

(c) Both aldehydes and ketones undergo a condensation reaction with hydroxylamine, NH_2OH , in a similar way to 2,4-dinitrophenylhydrazine.

(i) Draw the structure of the organic product formed when ethanal reacts with hydroxylamine.

[1]

(ii) An unknown ketone reacts with hydroxylamine to form a compound with the following composition:

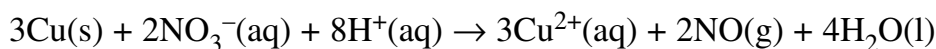
element	%
C	45.38
H	4.20
N	23.53
O	26.89

Deduce the empirical formula of the product.

_____ [3]

5 Nitrogen forms five different oxides in addition to a number of ions in which nitrogen is joined to oxygen.

(a) Nitrogen(II) oxide may be prepared by the action of 50% nitric acid on copper:



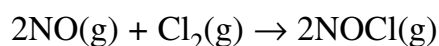
(i) State **two** observations which can be made during this reaction.

 _____ [2]

(ii) Describe how you could test for the presence of copper(II) ions in solution.

 _____ [2]

(iii) Nitrogen(II) oxide reacts with chlorine according to the equation:



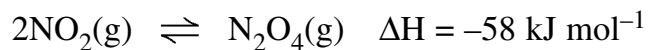
The reaction is third order overall with a rate constant of $1.7 \times 10^{-5} \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$. Calculate the initial rate of reaction when the concentration of each reactant is 0.1 M.

 _____ [2]

(iv) Nitrogen(II) oxide reacts with ozone to form nitrogen(IV) oxide and oxygen. Write the equation for this reaction.

_____ [1]

(b) Nitrogen(IV) oxide is able to dimerise according to the equilibrium:



(i) State and explain the effect that lowering the temperature will have on the partial pressure of nitrogen(IV) oxide, NO_2 , at equilibrium.

_____ [2]

(ii) State the effect of increasing the total pressure on the position of the equilibrium.

_____ [1]

(c) Solid nitrogen(V) oxide, N_2O_5 , is ionic, existing as $\text{NO}_2^+\text{NO}_3^-$. The NO_2^+ ion has the same electronic structure as carbon dioxide.

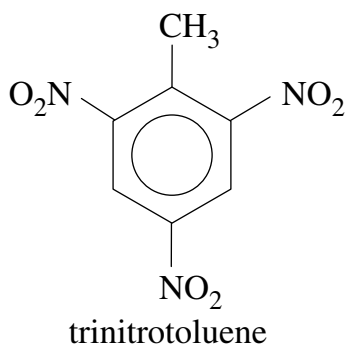
(i) Name the NO_2^+ ion.

_____ [1]

(ii) Draw a dot and cross diagram to show the bonding in the NO_2^+ ion.

[2]

- (iii) The NO_2^+ ion attacks the benzene ring in the nitration of toluene to form trinitrotoluene.



Name the mechanism by which this nitration takes place and suggest the systematic name for trinitrotoluene.

name of mechanism _____ [2]

systematic name _____ [1]

THIS IS THE END OF THE QUESTION PAPER

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