

Infra-red

Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Infra-red
Booklet	Question Paper

Time Allowed: 13 minutes

Score: /11

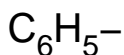
Percentage: /100

Grade Boundaries:

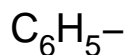
1. (a) Chemists from the University of Cambridge have used Au₅₅ nanoparticles to catalyse a reaction of oxygen with phenylethene (styrene), C₆H₅-CH=CH₂, (*Nature*, 2008). Three products, **A**, **B** and **C**, were observed. Use the following observations to complete the structure of **A**, **B** and **C**.

- The phenyl (C₆H₅-) group remains unchanged in **A**, **B** and **C**.
- **A** has the molecular formula C₇H₆O;
- **B** and **C** both have the molecular formula C₈H₈O.
- When warmed with Tollens' reagent (ammoniacal silver nitrate) compound **A** produces a silver mirror but compounds **B** and **C** do not.
- The infra-red spectra of compounds **A** and **B** each have an intense peak at around 1700 cm⁻¹ but that of compound **C** does not.
- None of the compounds' infra-red spectra show any broad signals above 3000 cm⁻¹.
- Compound **C** is the most reactive and unstable of the three. It contains a ring of three atoms.

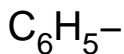
structure of **A**



structure of **B**



Structure of **C**



[3]

- (b) (i) Draw a dot-cross diagram for the hydroxonium ion, H₃O⁺, showing only outer-shell electrons.

[2]

(ii) Alkyl oxonium ions are analogues of H_3O^+ where the oxygen atom is bonded to alkyl groups rather than to hydrogen atoms. The tripropyl oxonium ion is a typical alkyl oxonium ion.

- Write down the molecular formula of the tripropyl oxonium ion.

.....

- Deduce the m/z of the molecular ion peak in its mass spectrum.

.....

- Deduce the number of signals in its ^{13}C NMR spectrum.

.....

[3]

(iii) Oxatriquinane is an alkyl oxonium ion whose synthesis was reported recently (*Journal of the American Chemical Society*, 2008). It was found to be surprisingly stable in water, and has:

- a molecular formula of $\text{C}_9\text{H}_{15}\text{O}^+$
- only two signals in its ^{13}C NMR spectrum
- no carbon-carbon multiple bonds
- multiple rings in its structure.

Suggest a structure for oxatriquinane.

[1]

(c) Chemists have recently synthesised the smallest “beakers” for carrying out chemical reactions (*Nature Chemistry*, 2009). The “beakers” are the junctions from a network of hollow polymer nanofibres. The volume of the beakers is about $4 \times 10^{-18} \text{ dm}^3$.

(i) A “beaker” is full of a solution of glucose of concentration $5 \times 10^{-4} \text{ mol dm}^{-3}$. Calculate the amount (in moles) of glucose in the “beaker”.

..... mol [1]

(ii) Use your answer to part (i) to calculate the number of glucose molecules in the “beaker”.

..... [1]

[Total: 11]