

Unknown samples of three carboxylic acids, labelled X, Y and Z, are analysed to determine their identities.

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- Both Y and Z react rapidly with bromine in the absence of UV light, but X does not. A 0.100 g sample of Y reacts with the same amount of bromine as a 0.200 g sample of Z.
- Separate 0.100 g samples of X, Y and Z are titrated with 0.0617 mol L⁻¹ sodium hydroxide solution. The titre volumes are shown.

Acid	X	Y	Z
Volume of NaOH (mL)	21.88	22.49	22.49

- Both Y and Z can undergo hydration reactions in the presence of a suitable catalyst. Two products are possible for the hydration of Y, but only one product is possible with Z.

Identify which structures 1, 2 and 3 in the table are acids X, Y and Z. Justify your answer with reference to the information provided.

	Structure 1	Structure 2	Structure 3
Molar mass (g mol ⁻¹)	72.062 g mol ⁻¹	74.078 g mol ⁻¹	144.124 g mol ⁻¹
Acid (X, Y or Z)			

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Identify

- Recognise and name.

Tips

Analyse the Bromine Reaction: Determine which acids react with bromine in the absence of UV light. Recall that only compounds with double bonds (alkenes) can undergo addition reactions with bromine.

Interpret the Titration Data: Compare the titration volumes of NaOH to identify the relative molar masses. Acids with higher molar masses or more acidic protons will require larger titration volumes.

Consider Hydration Reaction Outcomes: Check the structures for symmetry. Symmetrical compounds produce only one product in a hydration reaction.

Use Molar Mass to Confirm Structures: Use the molar masses provided in the table to match with the acids X, Y, and Z, ensuring consistency with the reactions described.

Bromine Test (Addition Reaction): A test used to identify unsaturated hydrocarbons (compounds with double or triple bonds). A positive test is indicated by the decolorisation of bromine water.

Hydration Reaction: A chemical reaction where water is added to a molecule, often in the presence of a catalyst, resulting in the formation of alcohols from alkenes.

Diprotic Acid: An acid that can donate two protons (H⁺) per molecule in a reaction, such as sulfuric acid or a dicarboxylic acid. This property influences titration data significantly.

[Link to NESAs Marking Guidelines and Sample Answer](#)