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Organic Chemistry

SN1 Reaction and Carbocation Stability

Given Question: Which is LEAST likely to rearrange during an SN1 reaction?

Introduction:

An SN1 reaction involves the formation of a carbocation intermediate, which can undergo rearrangement to form a more stable carbocation. Depending on the structure of the starting material, the likelihood of rearrangement varies.

Step-by-Step Solution:

Step 1: Identification of the Brominated Compounds

- First structure: Benzyl bromide (Structure with a benzene ring attached to a carbon with a bromine substituent).
- Second structure: Cyclohexyl bromide (Structure with a bromine attached to a carbon which is part of a six-membered ring).
- Third structure: Tertiary bromide (Structure with a bromine attached to a tertiary carbon – carbon bonded to three other carbons).
- Fourth structure: Bromoalkane with a secondary carbon (Structure with a bromine attached to a secondary carbon – carbon bonded to two other carbons).

Step 2: Carbocation Formation and Stability

- Benzyl bromide forms a benzyl carbocation.
- Cyclohexyl bromide forms a cyclohexyl carbocation.
- Tertiary bromide forms a more stable tertiary carbocation.
- The secondary bromide forms a secondary carbocation.

Supporting Statement: Assess the stability of each formed carbocation for potential rearrangement.

Step 3: Criteria for Rearrangement

- Benzyl carbocation is highly stabilized due to resonance with the aromatic ring.
- Cyclohexyl carbocation has the possibility of ring strain alleviation.
- Tertiary carbocation is relatively stable with less likelihood of rearranging.
- Secondary carbocation has a higher likelihood of rearrangement compared to tertiary and benzyl carbocations.

Supporting Statement: Benzyl carbocation has resonance stabilization, making it particularly stable.

Step 4: Determining the Least Likely to Rearrange

- Benzyl carbocation (structure one) is stabilized by resonance and is less likely to rearrange.
- Cyclohexyl bromide (structure two) might rearrange due to ring strain.
- Tertiary bromide (structure three) generally does not rearrange.
- Secondary bromide (structure four) often does rearrange to form more stable carbocations.

Supporting Statement: Benzyl carbocations' stability due to resonance reduces the likelihood of rearrangement.

Final Solution:

The compound least likely to rearrange during an SN1 reaction is the first structure, **benzyl bromide**. This is because the resulting benzyl carbocation is resonance stabilized and highly stable, reducing the tendency for any rearrangement.

Thus, the correct answer is the first structure representing benzyl bromide.