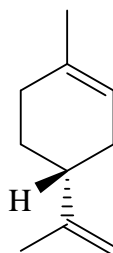
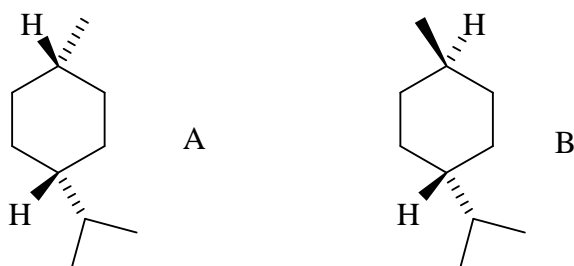


**Marks**  
**9**

- Consider the isomer of limonene shown below.



Show the major organic products formed when limonene is treated with excess  $H_2$  in the presence of a Pd/C catalyst. Pay particular attention to any relevant stereochemistry. Identify which would be the major product and explain why it forms preferentially.

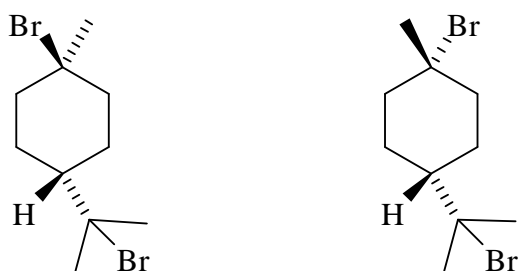


**Isomer A would be the major product.**

**The reaction takes place on the surface of the catalyst. The isopropyl group provides steric hindrance to the side of the ring that is *cis* to this group.**

**Both H's therefore are delivered to the other side of the molecule.**

Use Markovnikov's rule to predict the two major products of the reaction between limonene and excess HBr. Draw these isomers and identify the isomeric relationship between them. Specify the optical activity (active or inactive) of each isomer.



**They are diastereoisomers. Both isomers are optically inactive.**

At what  $m/z$  would the molecular ion of one of these isomers appear in its mass spectrum? Explain your answer.

**Br exists as two isotopes  $^{79}\text{Br}$  and  $^{81}\text{Br}$ , which occur in approximately equal amounts.**

**There would be 3 molecular ion peaks at  $m/z$  296, 298 and 300 due to the ions containing 2  $^{79}\text{Br}$  atoms, 1  $^{79}\text{Br}$  and 1  $^{81}\text{Br}$  atom and 2  $^{81}\text{Br}$  atoms, respectively.**