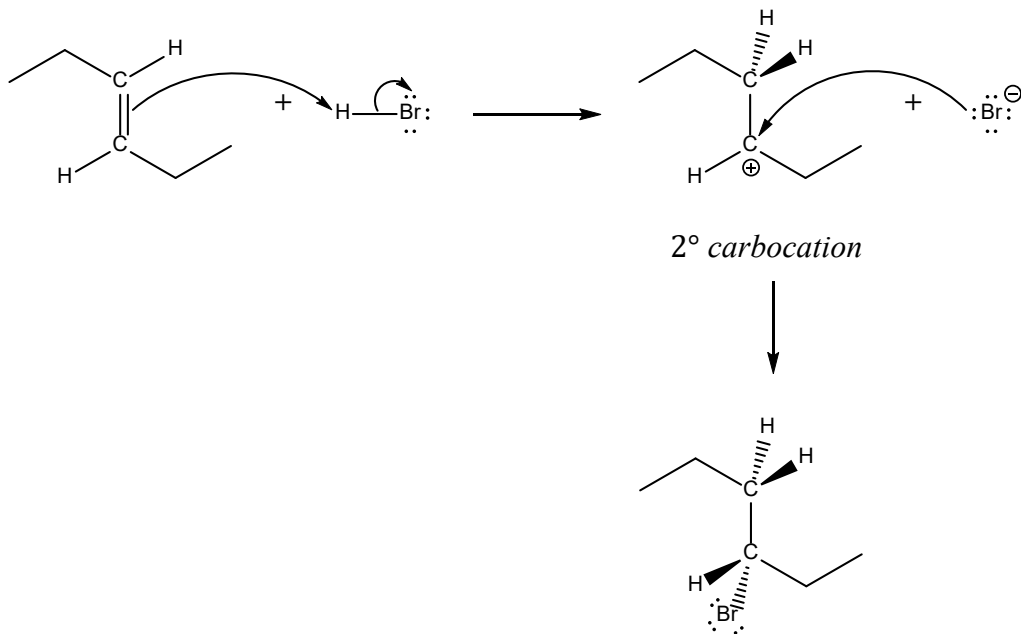


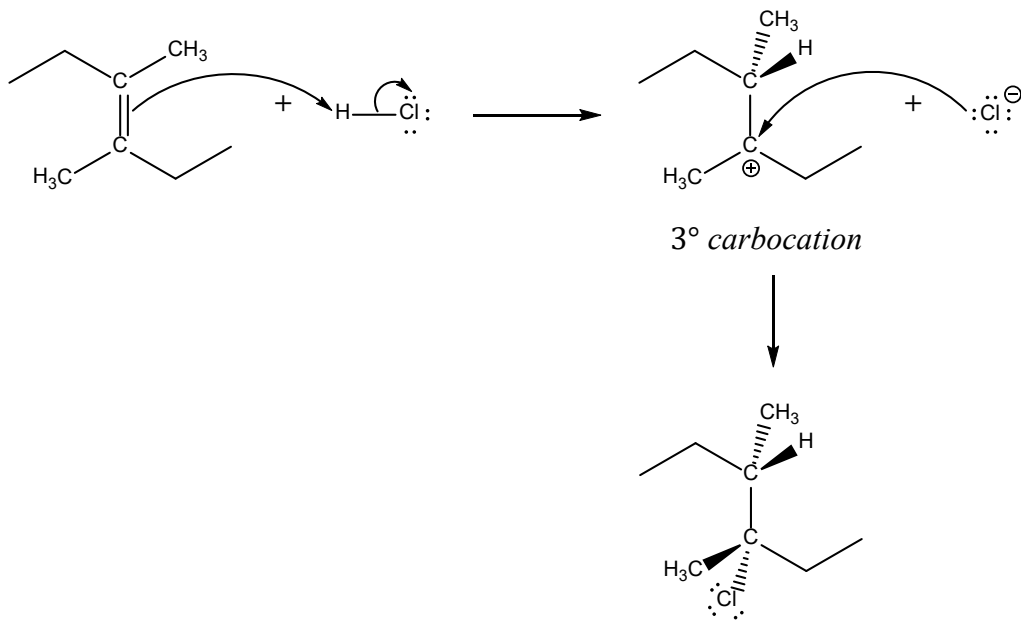
**Answers to Exercise 11.4**  
**Addition of "HX" to Alkenes**

1.  
(a)

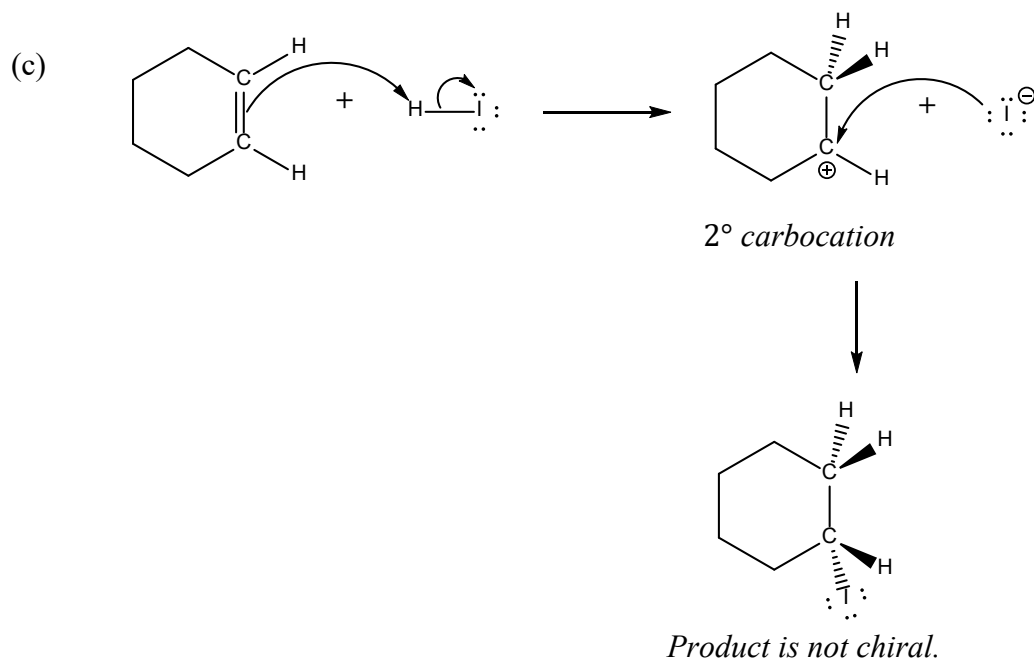


*Product is chiral. You may draw either enantiomer.*

(b)

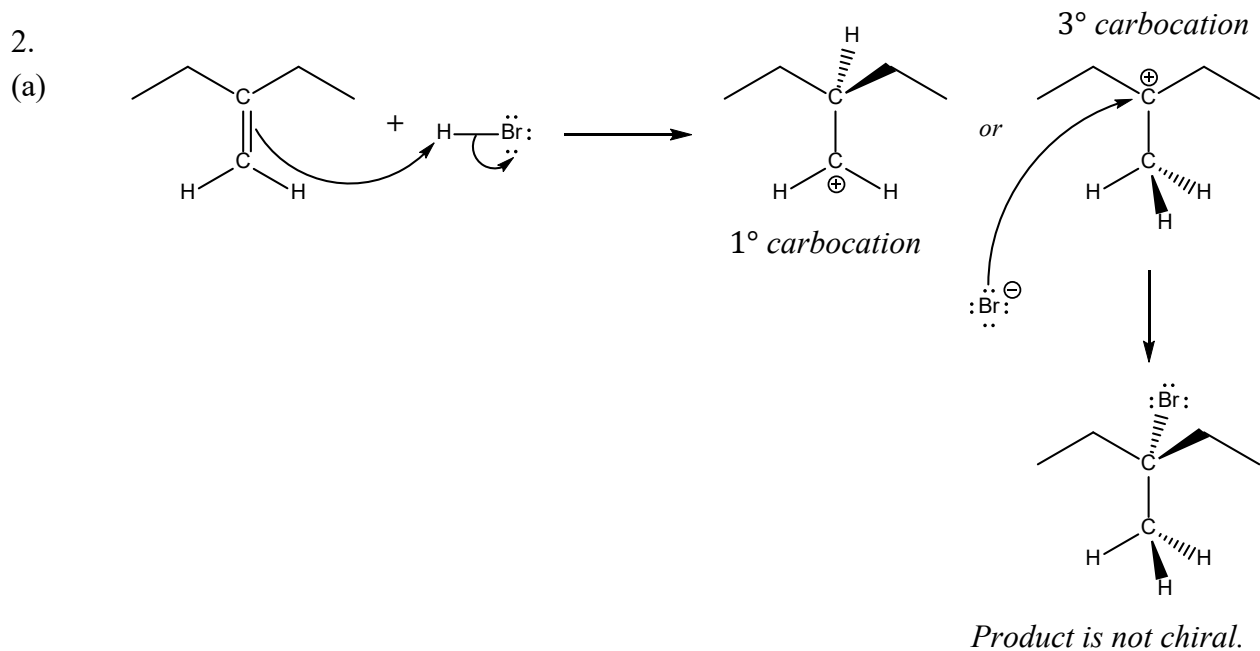


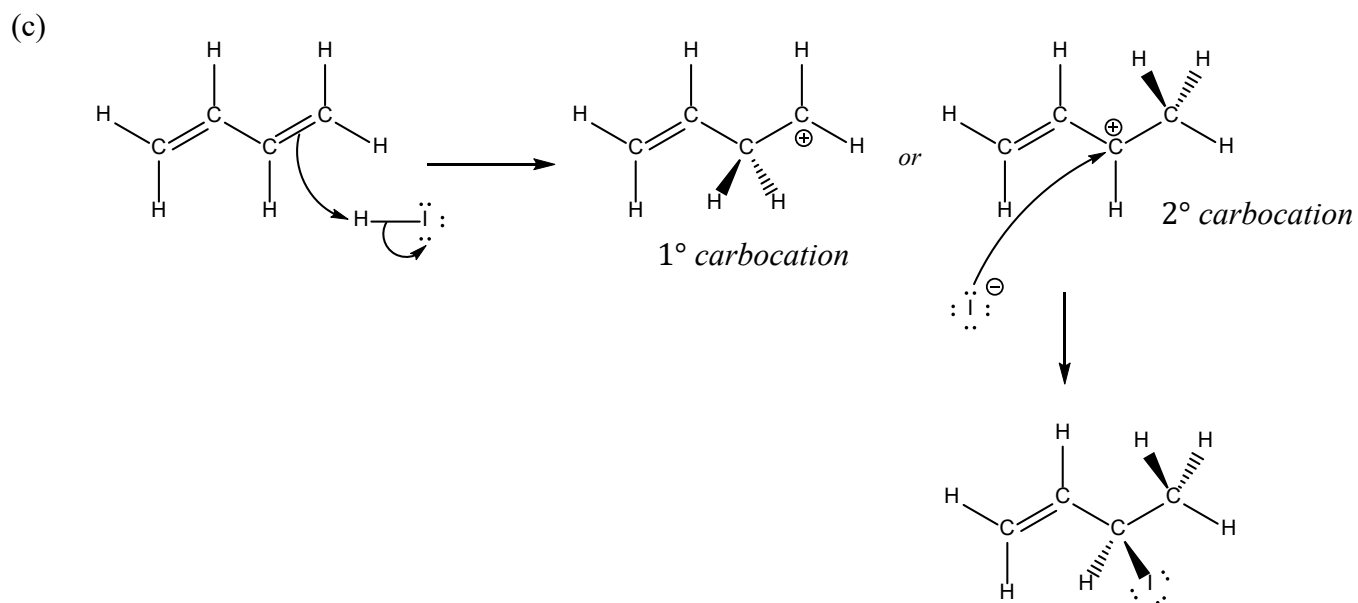
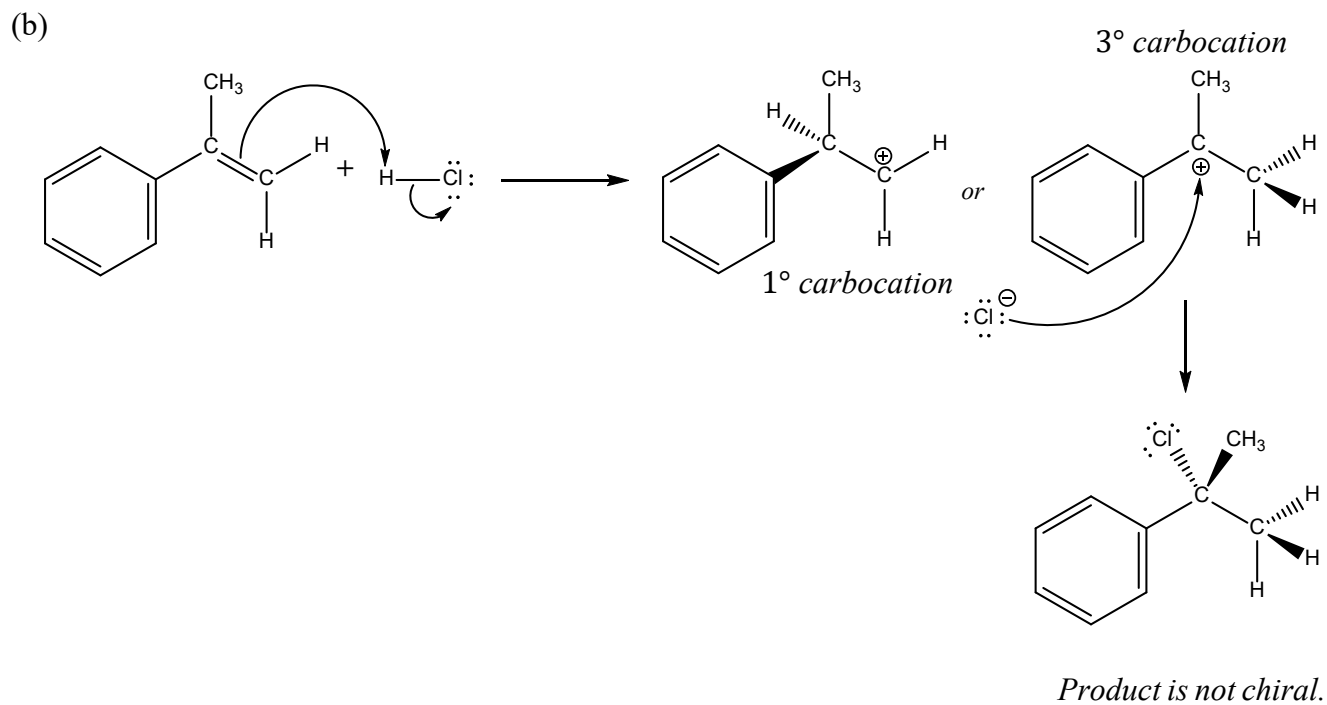
*Product contains 2 chirality centers.*  
*You may draw any of the four possible stereoisomers.*



A primary ( $1^\circ$ ) carbocation has one carbon atom attached to the carbon with the positive charge. A secondary ( $2^\circ$ ) carbocation has two carbon atoms attached to the carbon with the positive charge. A tertiary ( $3^\circ$ ) carbocation has three carbon atoms attached to the carbon with the positive charge.

Note that both carbon atoms in each double bond are explicitly drawn as well as the groups attached to them. You will find that doing this makes it easier to ensure that the charge is drawn on the correct carbon atom (since it will not have a complete octet).



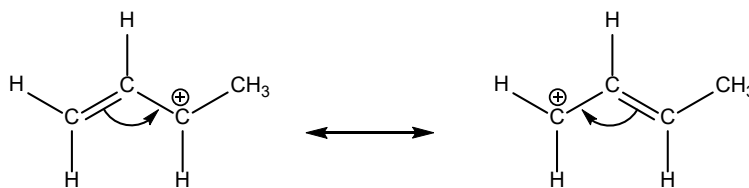


*Product is chiral. You may draw either enantiomer.*

*There is another possible product of this reaction. It would be formed by the iodide anion attacking the carbon atom bearing a positive charge in the other resonance structure of the 2° carbocation. See solution to question 3.*

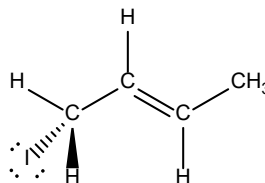
3. In 2(b) and 2(c), the carbocation shown as more stable is resonance-stabilized in addition to being favoured by inductive effects.

The 2° carbocation intermediate in 2(c) has its positive charge delocalized (shared) over two carbon atoms:

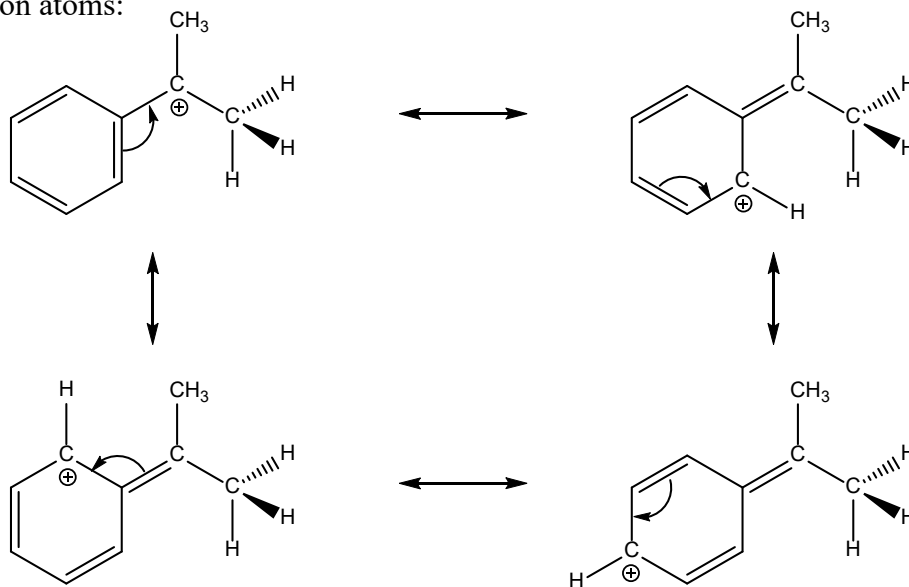


When a positively charged carbon atom is next to an alkene, allowing for this sort of resonance stabilization, that's called an allylic carbocation.

Delocalization of positive charge means that *trans*-2-butene can also form in 2(c) (and, to a lesser extent, the *cis*-isomer).



The 3° carbocation intermediate in 2(b) has its positive charge delocalized (shared) over four carbon atoms:



When a positively charged carbon atom is next to a benzene ring, allowing for this sort of resonance stabilization, that's called a benzylic carbocation. It is important to note that delocalization of the positive charge is only possible when the positively charged carbon atom is *\*next to\** the benzene ring – not if it were part of it.

This does not result in other addition products because reactions in which benzene rings stop being benzene rings are highly unfavourable. So, only the option that preserves the benzene ring is observed.