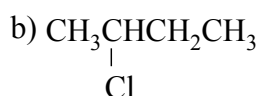


Chemguide – answers

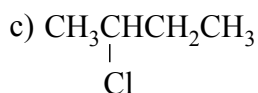
ALKENES: REACTIONS WITH HYDROGEN HALIDES

1. When a compound HX is added to an unsymmetrical alkene, the hydrogen becomes attached to the carbon with the most hydrogens attached to it already. (If you have already learned a more complicated version of this, that's fine. I would suggest you learn this simpler version as well – it is what you are most likely to need to use.)

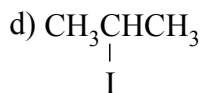
2. a) $\text{CH}_3\text{CH}_2\text{Br}$



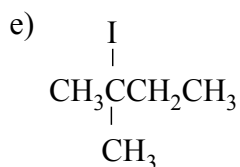
(It doesn't matter if you have flipped the molecule over so that the chlorine is next door to the right-hand CH_3 group, or whether you have placed the chlorine up or down relative to the chain.)



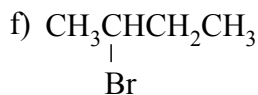
(The chlorine must be on one of the middle carbons and not an end one. The hydrogen will attach to the carbon with the most hydrogens on already, which will be a CH_2 group at the end of the chain. It doesn't matter whether the chlorine is above or below the chain, or if you have flipped the molecule over left to right.)



(The iodine must be attached to the middle carbon for the same reason as in part (c).)



(As before, there are several ways of drawing this, but in each case, the extra CH_3 group and the iodine must both be on the same carbon atom in the middle of the chain.)



(If the alkene is pure, the HBr adds on according to Markovnikov's Rule – just the same as the addition of HCl in part (c).)

g) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$

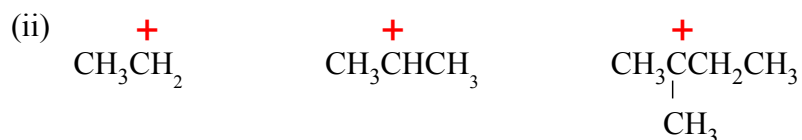
(If you have chosen to attach the bromine to the left-hand carbon in the chain, that is OK. In a simple structure like this, we would normally write it with the carbon chain first, though.)

Chemguide – answers

3. a) The rate increases – HF is particularly slow.
- b) The bond strength of the hydrogen-halogen bond falls as you go from HF to HI, with the HF bond being especially strong. This bond has to be broken during the reaction. The weaker the bond, the easier the reaction.
- c) The rate increases.
- d) (i) The carbon-carbon double bond consists of a sigma bond (with the electrons held on the line between the two nuclei) and a pi bond (where the electrons are above and below the plane of the molecule). The pi bond is an area of negativity which is attractive to anything with a degree of positive charge. Alkyl groups attached to the double bond will increase the amount of negativity around the bond as they push electrons towards it.

The three molecules are $\text{CH}_2=\text{CH}_2$ $\text{CH}_3\text{CH}=\text{CH}_2$ $\begin{array}{c} \text{CH}_3\text{C}=\text{CHCH}_3 \\ | \\ \text{CH}_3 \end{array}$

In ethene, there are no extra alkyl groups; in propene there is one; in 2-methylbut-2-ene there are three (two on the left-hand carbon plus one on the right). So attractiveness to something with some positive charge increases across this series of compounds.



In the first ion there is one alkyl group pushing electrons towards the carbon with the positive charge. In the second one there are two, and in the third, three (two methyl and an ethyl group). Each alkyl group cuts down the amount of the positive charge located on the one carbon, and spreads it around the whole ion. (If alkyl groups push electrons away from themselves, they will become slightly positive themselves.)

The more you can spread the charge around on an ion, the more stable it becomes, and the easier it is to form. That reduces the activation energy of the reaction and makes it happen faster.