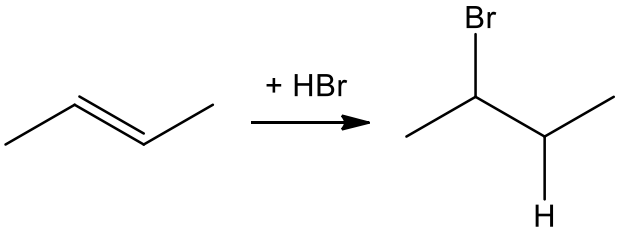
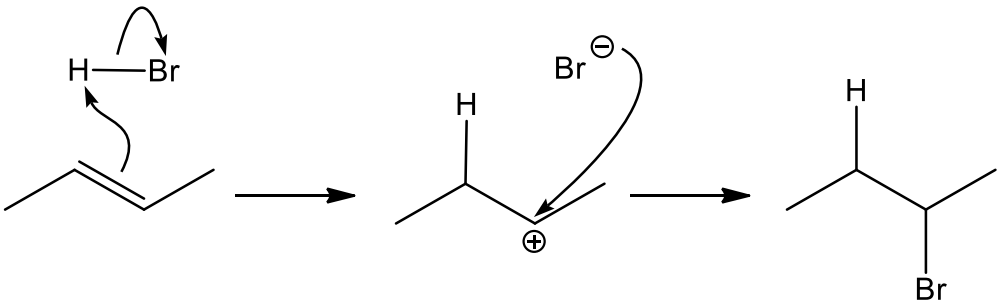
CHEM1002 Worksheet 3: Addition Reactions

Model 1: Addition to Symmetrical Alkenes and Alkynes

In Worksheet 2, we saw that the double bond of an alkene is made up of one strong σ-bond and one weak π-bond. The process in which this π-bond is broken and two new σ-bonds are formed in its place is called an ***addition*** reaction.



The addition reaction usually takes place in two steps. In the first step, an intermediate is formed called a ***carbocation***.



Critical thinking questions

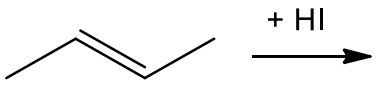
1. In this reaction is the alkene acting as an electrophile or a nucleophile?

c

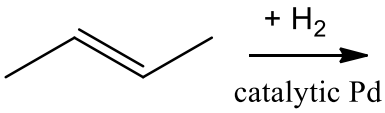
2. Highlight the bonds that are breaking in one colour, and the newly formed bonds in another.

3. Using the scheme above as a model, determine the outcome of the following reactions:

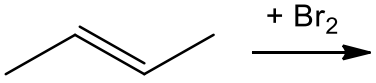
(a)



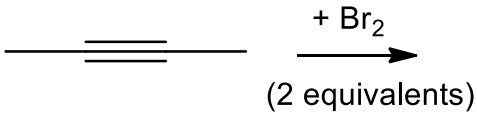
(b)



(c)



(d)

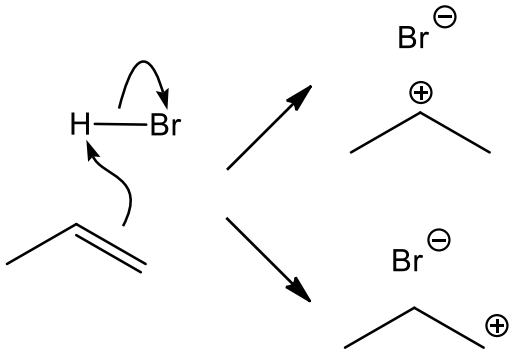


Model 2: Addition to Unsymmetrical Alkenes and Alkynes

The alkene used in Model 1 WAS *symmetrical*: it had the same groups at the two ends of multiple bond.

For *unsymmetrical* alkenes, with different groups at the two ends of the multiple bond, two carbocations may be formed in the first step of the reaction, as illustrated in the scheme opposite.

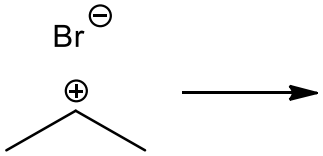
Because of this, there are *two* possible products. However, experimentally, one is formed in much greater amount than the other.

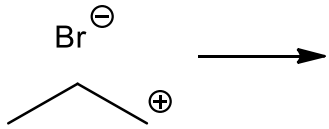


Critical thinking questions

1. Where is the H atom from HBr in the two carbocations? (*Hint*: look back at Model 1).

2. Draw and name the products arising from each of these carbocations.



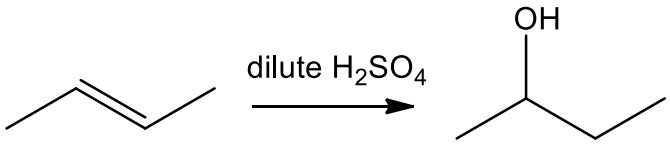


3. Given that the alkyl groups (CH_n groups) stabilize carbocations, which carbocation do you expect to be the most stable in the scheme above?

4. Given your answers to Q3, which of the two products you drew in Q2 will be the major product?

This is Markovnikov's rule. It states that in an addition to an unsymmetrical alkene, the hydrogen will go predominately to the end that already has the most hydrogen atoms.

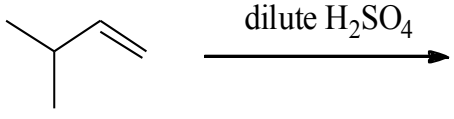
Another reaction you would have seen is the hydration of alkenes which is carried out using aqueous sulfuric acid. This is also an addition reaction but H_2SO_4 is *not* added across the double bond.



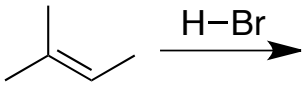
5. What is being added across the double bond? (Remember that atoms are added to *both* ends.)

6. Use Markovnikov's rule to predict the major product in the following addition reactions.

(a)



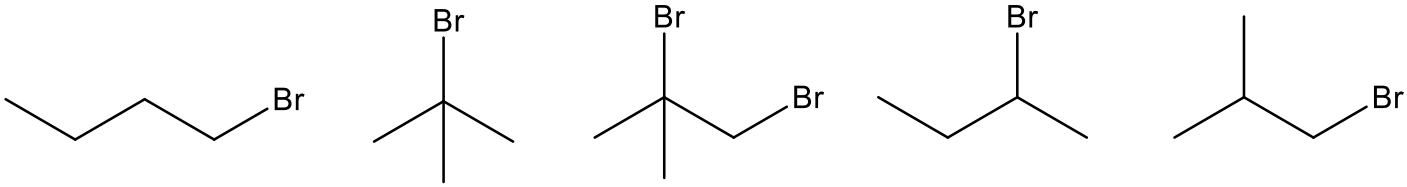
(b)



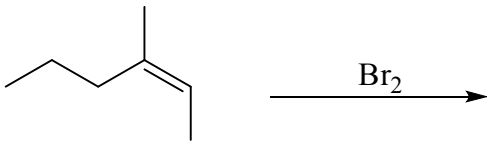
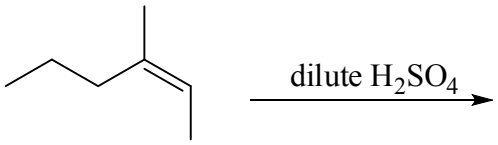
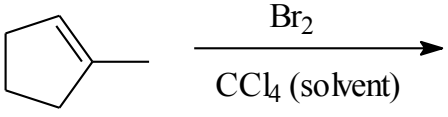
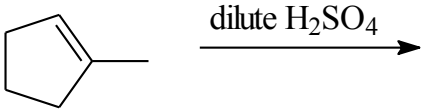
7. For the reaction in Q6(b), draw the reaction mechanism using curly arrows. (*Hint*: look back again at Model 1 if you are stuck - but try to do it work it out for yourself first!)

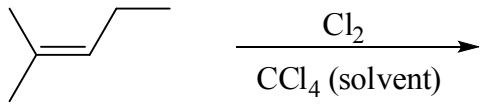
Exercises

1. What is the major product from the addition of HBr to 1-butene?



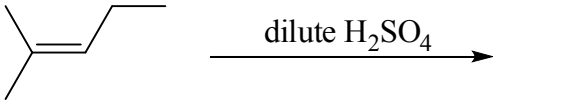
(a) (b) (c) (d) (e)

• Give the name of the starting material where indicated and the constitutional formula of the major organic product formed in each of the following reactions.	**Marks**
 **Name:**	**2**
	**1**
 **Name:**	**2**
	**1**

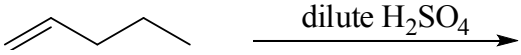


Name:

2



1



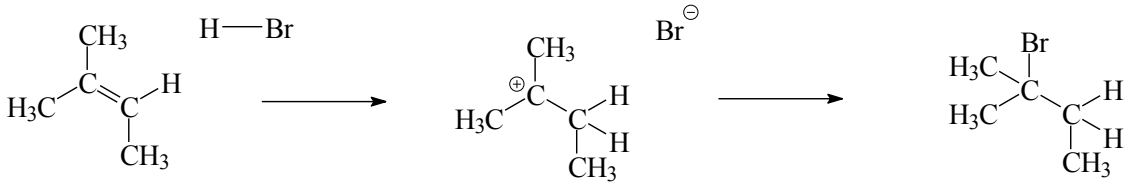
Name:

2

CHEM1102 2008-J-13 June 2008

Marks 2

- The incomplete proposed mechanism for the reaction of 2-methyl-2-butene with HBr is shown below. Complete the mechanism by adding curly arrows to illustrate the bonding changes that take place.



Which one of the two reactants is the electrophile?

CHEM1102 2009-J-12 June 2009

Marks 3

- Give the mechanism of the reaction that occurs when 1-methylcyclohexene is converted to 1-bromo-1-methylcyclohexane by the addition of HBr. Give the structure of the intermediate carbocation that is formed and indicate (with curly arrows) all the bonding changes that occur.