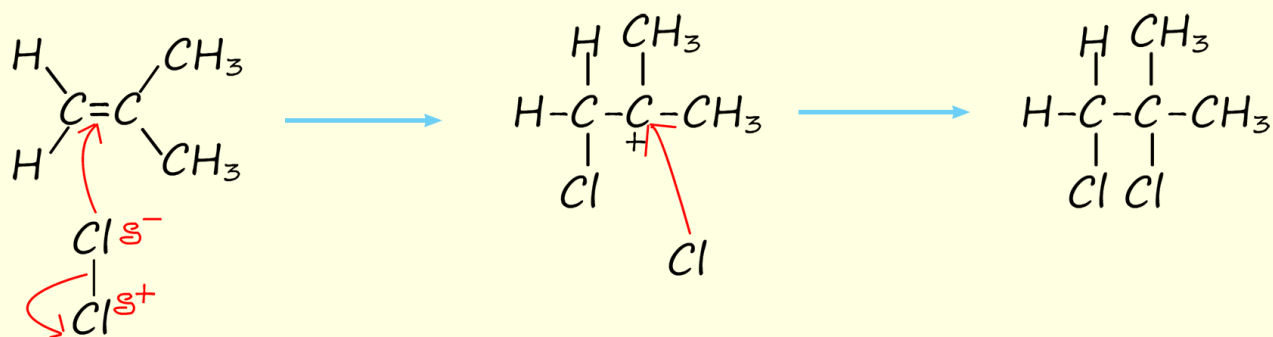


Addition reactions

Answer all the questions below as fully as you can then check your answers

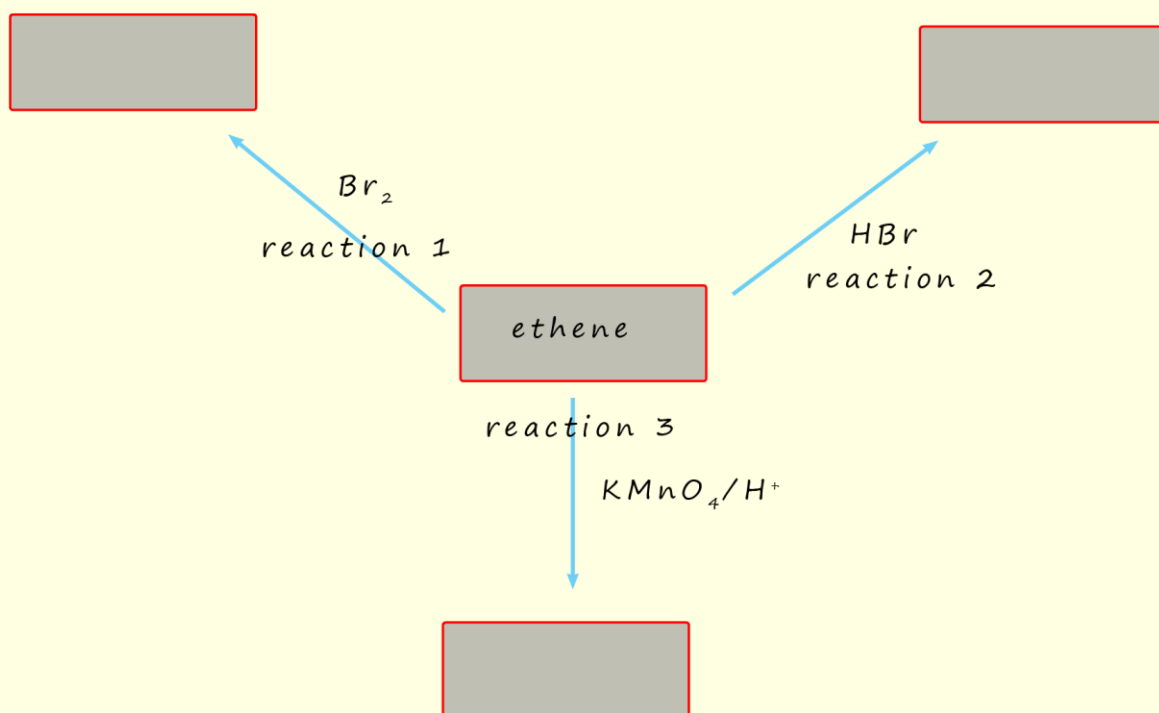
- The conversion of ethene to ethanol can be carried out by direct hydration.
 - Name the catalyst for this reaction and outline the necessary conditions to achieve a high yield of ethanol.
 - Write an equation for this reaction.
 - Outline a mechanism for this reaction.
- A student attempted to draw the mechanism to show the reaction of an unsaturated alkene with chlorine. The mechanism they wrote is shown below.



- This mechanism contains errors. Identify as many errors as you can.
- Name the type of reaction which is occurring when chlorine reacts with an alkene.
- Name the final product of this reaction.

3. Draw the mechanism to show how 2-methylprop-1-ene reacts with bromine.
 - a. Bromine is a non-polar molecule; explain how it is able to react with carbon-carbon double bonds present in alkene molecules.
 - b. Name this type of reaction.
 - c. Identify the electrophile and the nucleophile in this reaction.
 - d. Draw the displayed formula for the compound formed when an excess of bromine reacts with penta-1,4-diene.

4. The diagram below shows some reactions of ethene gas.



- a. Complete the three empty grey boxes by writing the names of the products of each of the reactions taking place.
- b. What colour change would be seen in reaction 3 if a test-tube of ethene gas was shaken up with acidified potassium permanganate?
 - i. What type of reaction is occurring when ethene reacts with acidified potassium permanganate?

- c. Write an equation to show what is happening in reaction 3
- d. What do curly arrows show the movement of in a mechanism? Where should curly arrows start and end?
5. Alkenes can react with concentrated sulfuric acid to form alcohols.
- a. Draw the mechanism to show how 2-methylprop-1-ene can react with sulfuric acid to form an alcohol.
- b. Name the alcohol produced in this reaction.
- c. What role does sulfuric acid play in this reaction?
6. 2-methylbut-2-ene can react with hydrogen bromide gas to form 2 structural isomers.
- a. Name and outline the mechanism for the reaction of 2-methylbut-2-ene with hydrogen bromide gas (HBr) to form 2-bromo-2-methylbutane.
- b. Name the other possible product of this reaction.
- c. Draw the structure of the two alcohols that are formed when 2-methylbut-2-ene is hydrated.
7. (Z)-3-methylpent-2-ene reacts with hydrogen bromide gas to form two Halogenalkanes.
- a. Outline a mechanism for the formation 3-bromo-3-methylpentane using the above reagents.

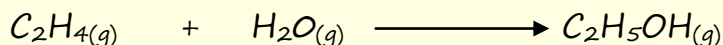
Answers

1. The conversion of ethene to ethanol can be carried out by direct hydration.

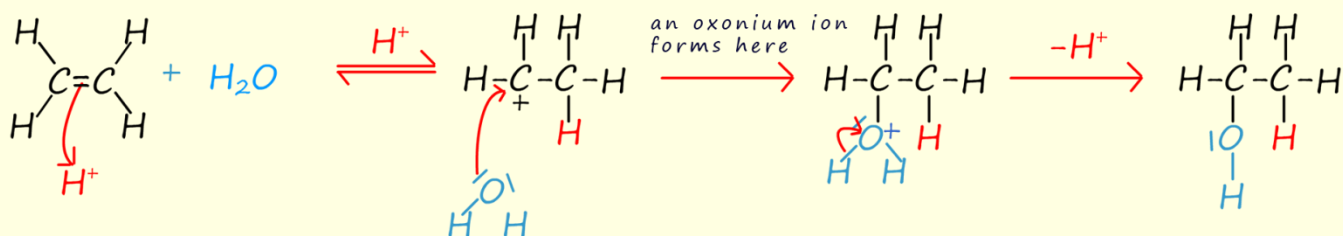
a. Name the catalyst for this reaction and outline the necessary conditions to achieve a high yield of ethanol.

Temperature of 570 degrees Kelvin, 65 atmospheres pressure and phosphoric acid catalyst.

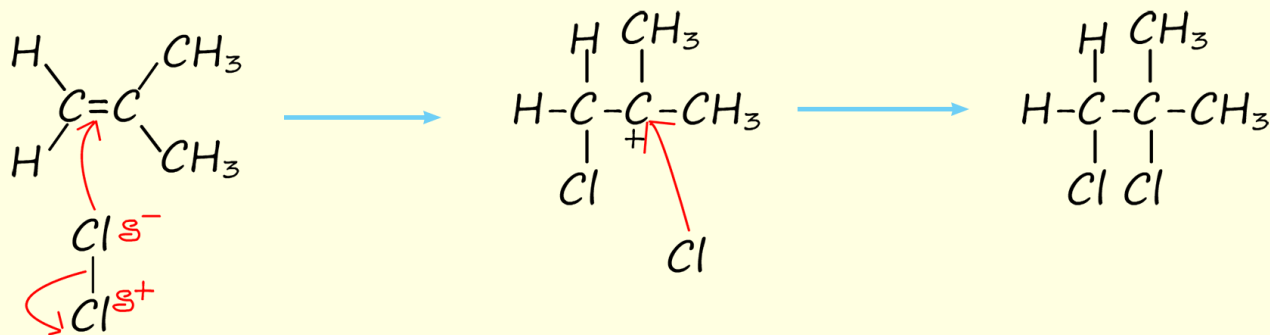
b. Write an equation for this reaction.



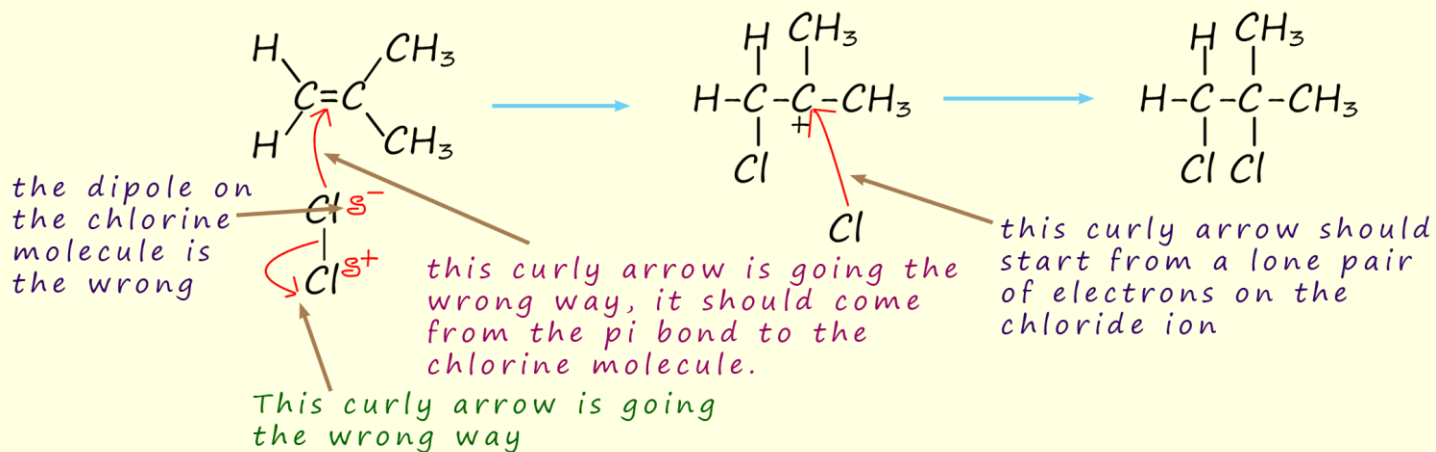
c. Outline a mechanism for this reaction.



2. A student attempted to draw the mechanism to show the reaction of an unsaturated alkene with chlorine. The mechanism they wrote is shown below.



a. This mechanism contains errors. Identify as many errors as you can.

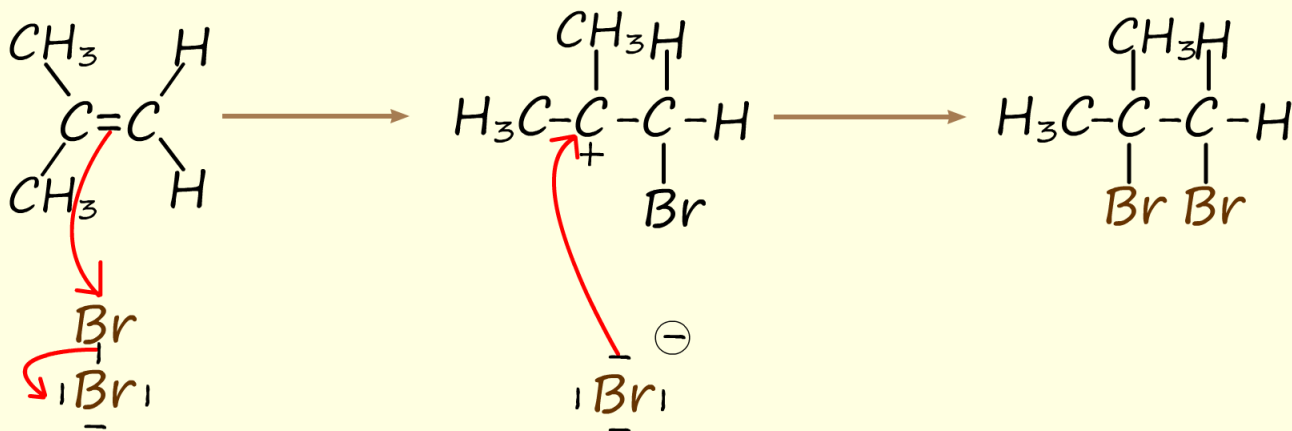


b. Name the type of reaction which is occurring when chlorine reacts with an alkene. *Alkene/unsaturated molecules undergo electrophilic addition reactions*

c. Name the final product of this reaction.

1,2-dichloroethane

3. Draw the mechanism to show how 2-methylprop-1-ene reacts with bromine.



a. Bromine is a non-polar molecule; explain how it is able to react with carbon-carbon double bonds present in alkene molecules.

As the bromine molecule approaches the carbon carbon double bond (C=C) it becomes polarised. The delta positive bromine will attract the electron density in the pi bond in the alkene and attract electron density towards it. This results in the formation of a new carbon bromine covalent bond.

b. Name this type of reaction.

Electrophilic addition

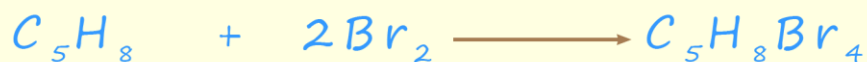
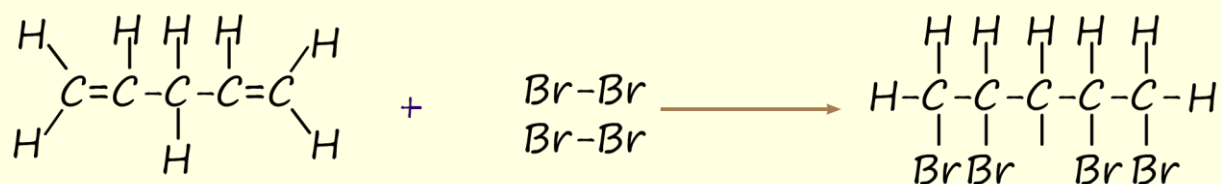
c. Identify the electrophile and the nucleophile in this reaction.

Electrophile is bromine

Nucleophile is the alkene.

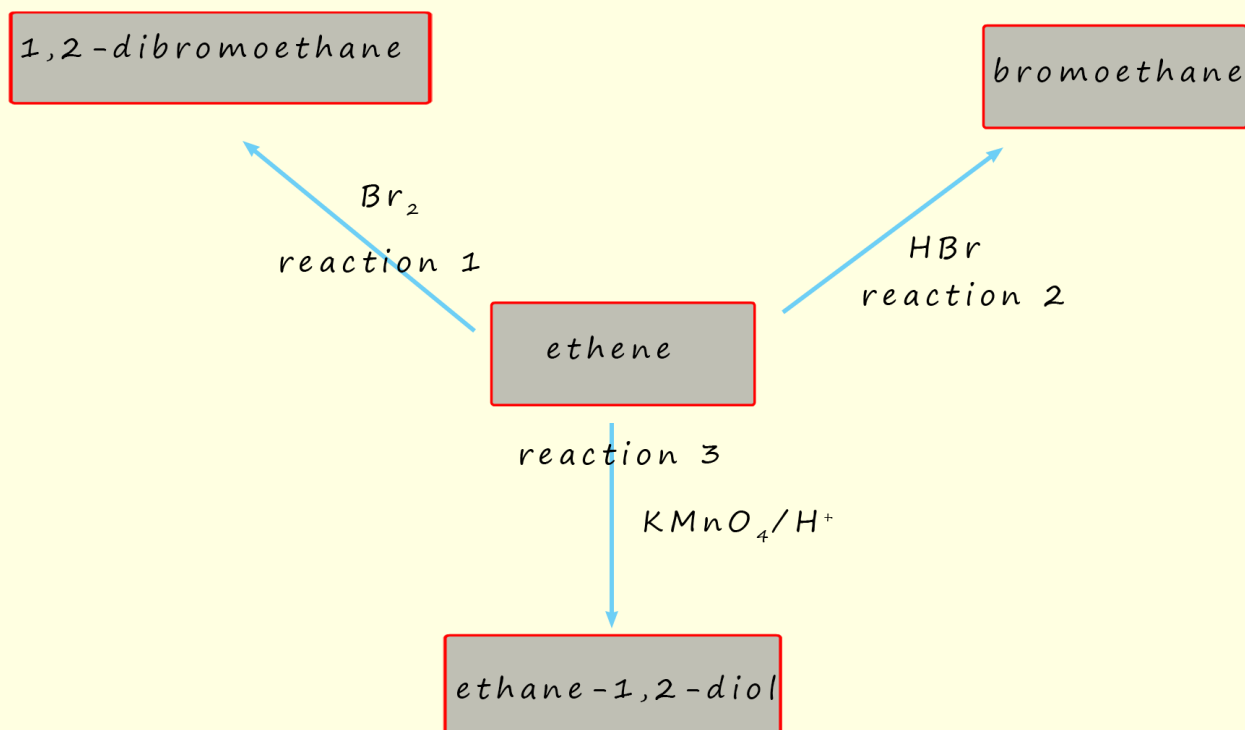
d. Draw the displayed formula for the compound formed when an excess of bromine reacts with penta-1,4-diene.

Below is shown the equation for this reaction



4. The diagram below shows some reactions of ethene gas.

a. Complete the three empty grey boxes by writing the names of the products of each of the reactions taking place.



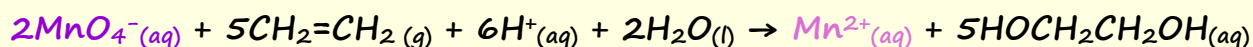
b. What colour change would be seen in reaction 3 if a test-tube of ethene gas was shaken up with acidified potassium permanganate?

The purple permanganate ion (MnO_4^-) would be reduced to form the colourless Mn^{2+} ion.

i. What type of reaction is occurring when ethene reacts with acidified potassium permanganate?

The permanganate ion is reduced and the ethene is oxidised. So the reaction can be described as a redox reaction. Or we could simply say the ethene gas is reduced to form ethane-1,2-diol since we are largely concerned with the reactions of the alkene, ethene.

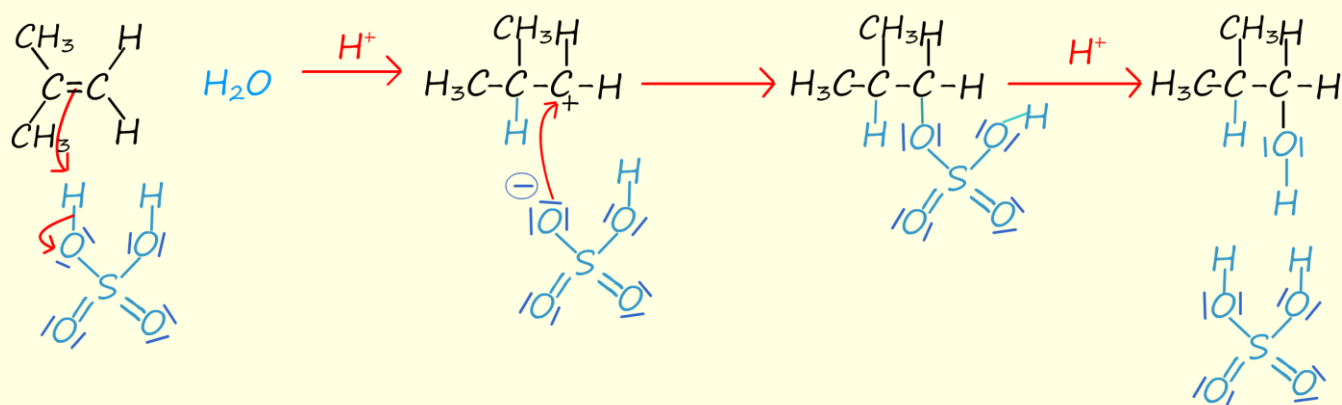
c. Write an equation to show what is happening in reaction 3.



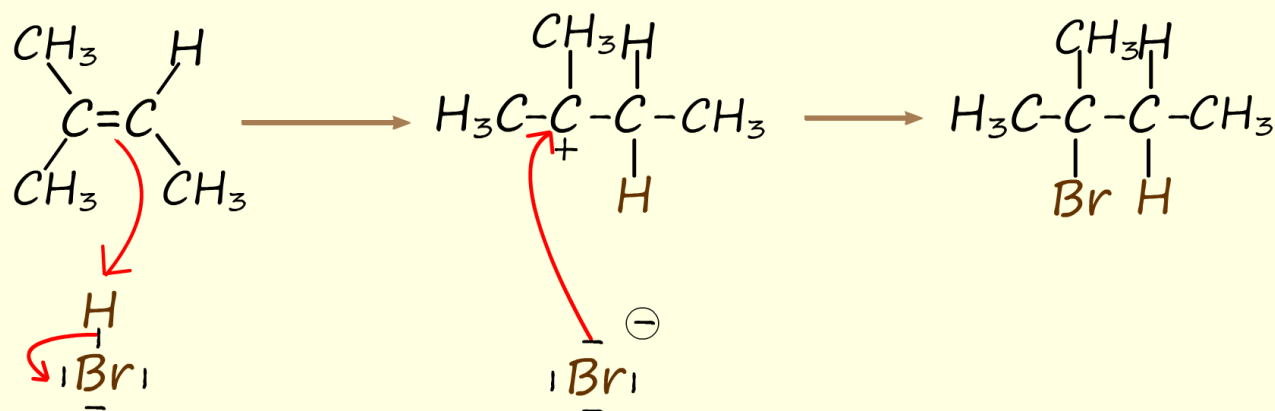
d. What do curly arrows show the movement of in a mechanism? Where should curly arrows start and end?

Curly arrows show the movement of a pair of electrons, they show where new bonds are being formed. They should start on lone pairs or centres of electron density such as a pi bond in an alkene. They should end on the atom where the new bond is being formed if it carries a charge or half-way between two atoms where a new covalent bond will be forming

5. Alkenes can react with concentrated sulfuric acid to form alcohols.
- a. Draw the mechanism to show how 2-methylprop-1-ene can react with sulfuric acid to form an alcohol.

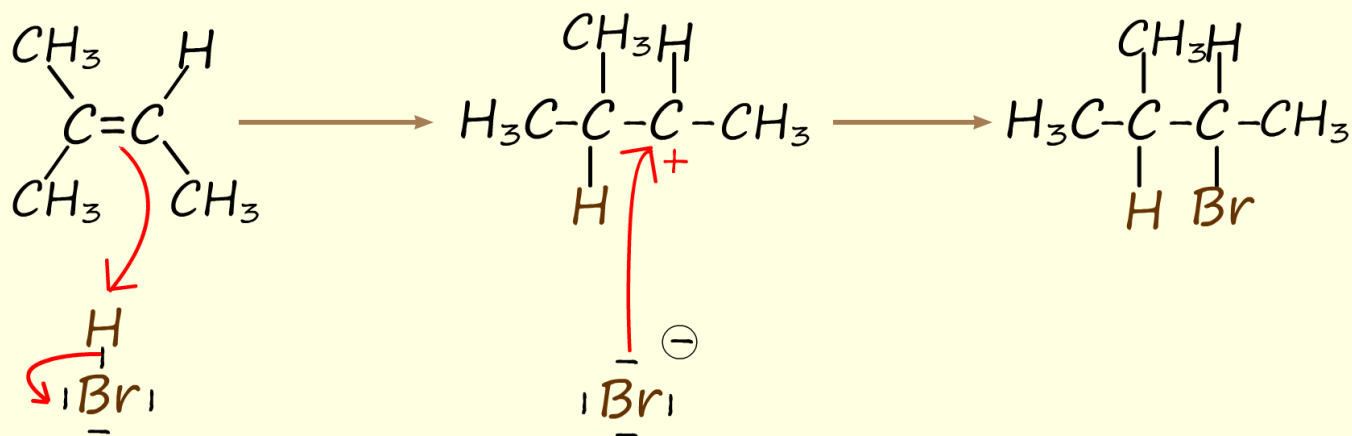


- b. Name the alcohol produced in this reaction.
2-methylpropan-1-ol
- c. What role does sulfuric acid play in this reaction?
Catalyst. The sulfuric acid starts and ends the reaction unchanged.
6. 2-methylbut-2-ene can react with hydrogen bromide gas to form 2 structural isomers.
- a. Name and outline the mechanism for the reaction of 2-methylbut-2-ene with hydrogen bromide gas (HBr) to form 2-bromo-2-methylbutane.



b. Name the other possible product of this reaction.

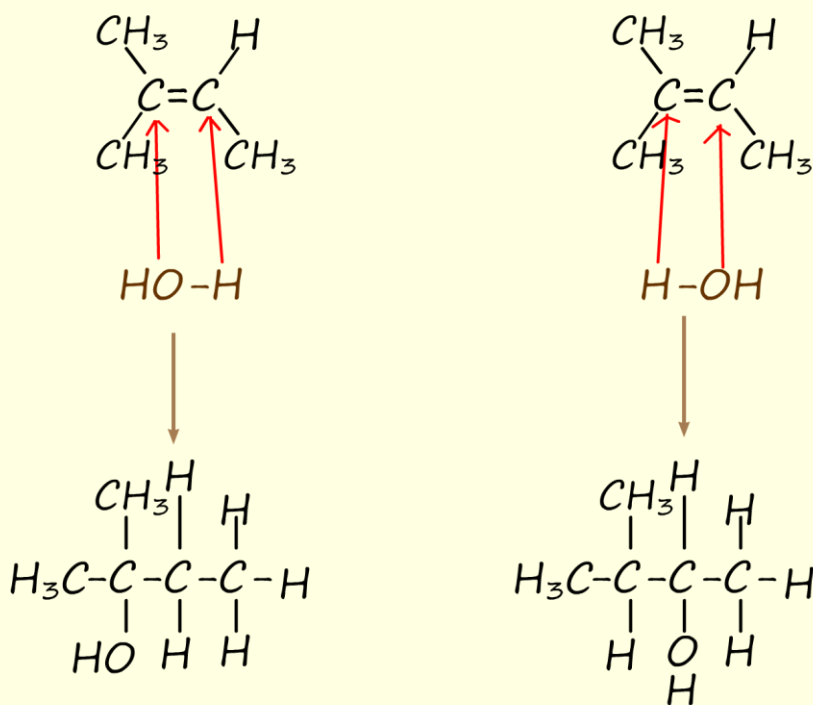
The other isomer will be obtained by simply swapping the carbon atom in the carbon carbon double bond (C=C) in which the hydrogen and bromine atoms add. This is shown below:



The product this time will be 1-bromo-2-methylbutane

c. Draw the structure of the two alcohols that are formed when 2-methylbut-2-ene is hydrated.

The two alcohols are produced by simply swapping the carbon atoms in the C=C to which the hydroxyl and hydrogen groups become attached. This is shown opposite.



7. (Z)-3-methylpent-2-ene reacts with hydrogen bromide gas to form two Halogenalkanes.

a. Outline a mechanism for the formation 3-bromo-3-methylpentane using the above reagents.

This question is similar to question 6b.

