

## How to Answer a “Show the Mechanism” Question and a “Complete the Reaction” Question

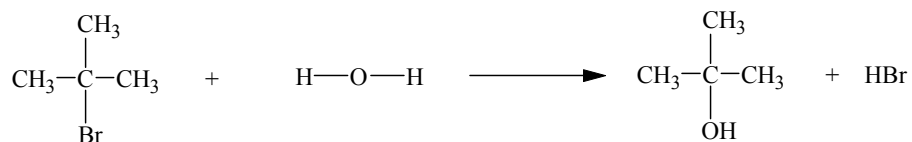
### Show the Mechanism Questions

It is common on organic chemistry exams to have a question that begins something like this: Show the step-by-step mechanism of the reaction of ..... Such questions are referred to as mechanism questions and should be answered in a specific way. Below is an example of a mechanism and a description of how it should be answered.

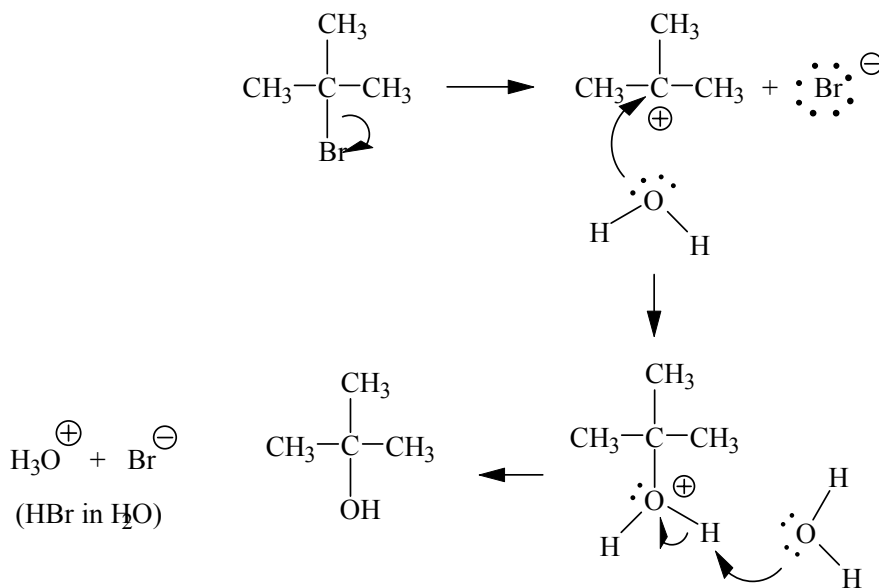
#### Question:

Show the detailed mechanism of the reaction of *t*-butyl bromide with water to form the ether product. Use curved arrow notation and be sure to show any protonation or deprotonation steps that might occur. (See page 252-253 of your text)

**Step 1 – Write out the equation for the reaction using structural formulas.**



**Step 2 – Use curved arrow notation to show each step of the mechanism. Make sure to draw arrows from electrons to atoms to show bond formation or from bonds to atoms to show the breaking of bonds. Never draw a curved arrow toward an unshared electron pair. Be sure to show charges where present.**



### Step 3 – Make sure you have checked the following:

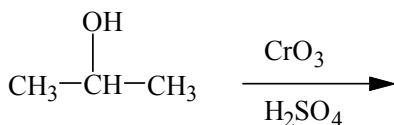
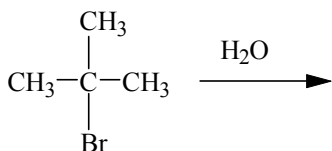
1. All steps of the reaction are shown with the product at the end.
2. Each bond formation, bond breakage, or bond shift is shown using curved arrows.
3. All species that have a charge are shown with the appropriate charge.
4. Unshared electron pairs are shown when important. That is when they are involved in bond formation, breakage, or shift. It is OK to write H<sub>2</sub>O as a product but it is best when learning to actually draw it out, including unshared electrons.
5. When a compound like water attacks and forms a bond the product is a protonated alcohol, R-OH<sub>2</sub><sup>+</sup>, not R-OH. It is important that you show how the protonated alcohol loses the extra H<sup>+</sup> to produce the alcohol. In a reaction sequence question (not a mechanism) you might just write (– H<sup>+</sup>), but this is not adequate in a mechanism question.

### Complete the Reaction Question

Another common type of question on organic chemistry exams is one in which you are asked to complete a reaction by drawing structures of the products of a reaction. In such question you are normally given the reactants and any special conditions or reagents used in the reaction. Answering these question is almost impossible unless you have learned the reactions your instructor has indicated that you should know. In answering these questions it is NOT appropriate to show the mechanism as described above. These questions require that you draw the structural formulas of the product(s) of the reaction.

#### Question:

Complete the following reactions:

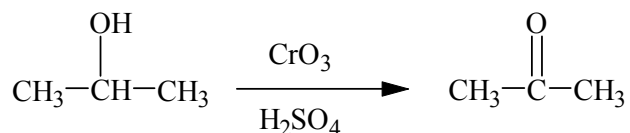
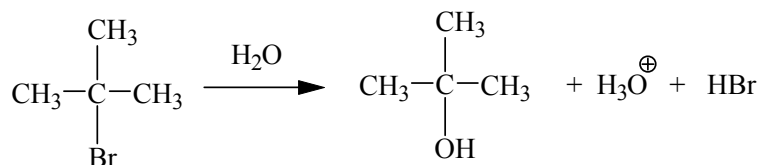


### Step 1 – Examine the reaction for reactants and special conditions.

Look over and under the reaction arrow for clues as to the type of reaction. Although the water in the first reaction does not really give you much of a clue, the chromium compound in the second reaction is a dead giveaway for an oxidation reaction. In the first reaction we must consider the water and the reactant, 2-bromo-2-methylpropane to realize that this is a substitution reaction in which the water will replace the bromine to form an alcohol. In the second reaction we look at the reactant to find if there is a group that can be oxidized. The alcohol is easily oxidized to a ketone. Once we have recognized the reaction types we can easily predict the products.

I find that looking at the reactants and reagents above and below the arrow allows me to almost always predict the general reaction type before I have even looked at the major reactant shown to the left of the arrow. Once I have guessed the reaction type, I just look at the reactant to see what part of the molecule will undergo that type of reaction. The key to being able to do this effectively is to recognize the pattern that is associated with each reaction type. You cannot possibly memorize every reaction you will be shown so you must learn to recognize the patterns.

### Step 2 – Draw structures of the products.



### Step 3 – Important Considerations

1. Non-organic products are often not shown.
2. If the reaction can produce more than one organic product, show all products.
3. If multiple products are produced, indicate which are major products, minor products, or trace products (<5%).
4. Use structural formulas for products and show all hydrogen atoms.
5. Do NOT show the mechanism or use curved arrow notation.
6. Although it is common to show a main reactant to the left of the arrow and other reactants and special conditions above and below the arrow, sometimes multiple reactants are shown to the left of the arrow and only special conditions are shown above and below the arrow.