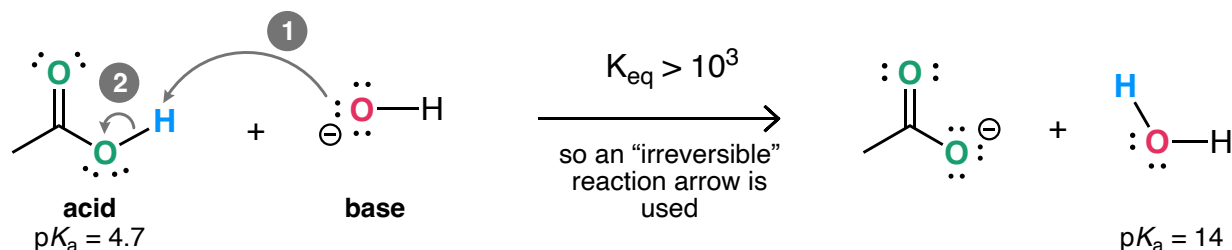


## Arrows

This worksheet should help reinforce the physical meaning of the curved-arrow reaction mechanisms you learn in organic chemistry 1.

### Example

An acid-base reaction is shown with the curved-arrow mechanism. The table below describes the physical meaning of each arrow in the mechanism.



Arrow	Bonds broken	Bonds formed
1	none	$\text{O}-\text{H}$ sigma bond
2	$\text{O}-\text{H}$ sigma bond	none

### Description of curved-arrow mechanism:

The first arrow indicates the use of a lone pair on the negatively charged oxygen atom (red) to deprotonate the H in the acid, forming a new  $\text{O}-\text{H}$  sigma bond

The second arrow indicates that the  $\text{O}-\text{H}$  sigma bond in the acid breaks and the electrons become a lone pair on the oxygen atom (green).

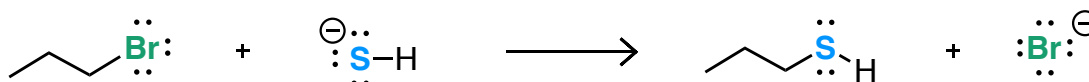
**Use of irreversible reaction arrow:** The forward reaction was described using an irreversible reaction arrow (  $\longrightarrow$  ).

The irreversible arrow is used above because the reaction is highly favorable: reacting an acid with  $pK_a$  of 4.7 and forming an acid with  $pK_a$  of 14. Typically, going from something more reactive to less reactive (more stable) constitutes a favorable process.

## 1. S<sub>N</sub>2 Reaction

An S<sub>N</sub>2 reaction is shown below with starting materials and products. Answer each item below.

- Provide the curved arrow mechanism
- Fill in the table with the meaning of each curved arrow using the example above as a guideline
- Describe the mechanism in your own words
- Describe the use of the irreversible or reversible forward reaction arrow



Arrow	Bonds broken	Bonds formed
1		
2		

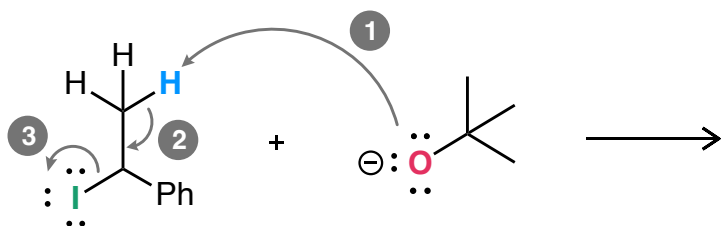
**Description of curved-arrow mechanism:**

**Use of irreversible reaction arrow:** The forward reaction was described using an irreversible reaction arrow (  $\longrightarrow$  ). Describe why.

## 2. E2 Reaction

A curved arrow mechanism for an E2 reaction is shown below and involves three arrows, labeled 1-3.

- Provide the curved arrow mechanism
- Fill in the table with the meaning of each curved arrow using the example above as a guideline
- Describe the mechanism in your own words
- Describe the use of the irreversible or reversible forward reaction arrow



Arrow	Bonds broken	Bonds formed
1		
2		
3		

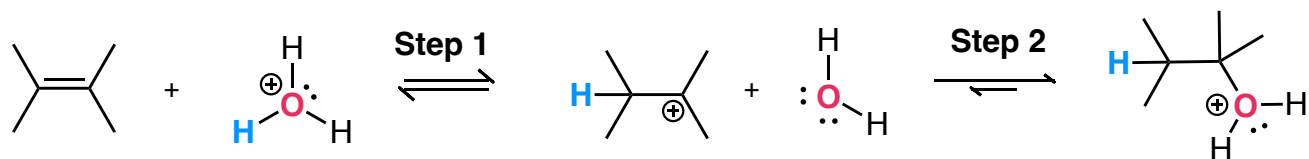
**Description of curved-arrow mechanism:**

**Use of irreversible reaction arrow:** The forward reaction was described using an irreversible reaction arrow (  $\longrightarrow$  ). Describe why.

### 3. Addition Reaction

Two steps of an addition reaction are shown below.

- Provide the curved arrow mechanism
- Fill in the table with the meaning of each curved arrow using the example above as a guideline
- Describe the mechanism in your own words
- Describe the use of the irreversible or reversible forward reaction arrow



#### Step 1

Arrow	Bonds broken	Bonds formed
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1

2

#### Step 2

Arrow	Bonds broken	Bonds formed
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1

**Description of curved-arrow mechanism in step 1:**

**Description of curved-arrow mechanism in step 2:**

**Use of reversible reaction arrow in step 1:** Step 1 of the reaction above was described using an irreversible reaction arrow ( $\rightleftharpoons$ ). Describe why.