



# Mastering MarvinJS

*Drawing tool for Mastering Chemistry*

Chris Hess PhD: Executive Acquisitions Editor

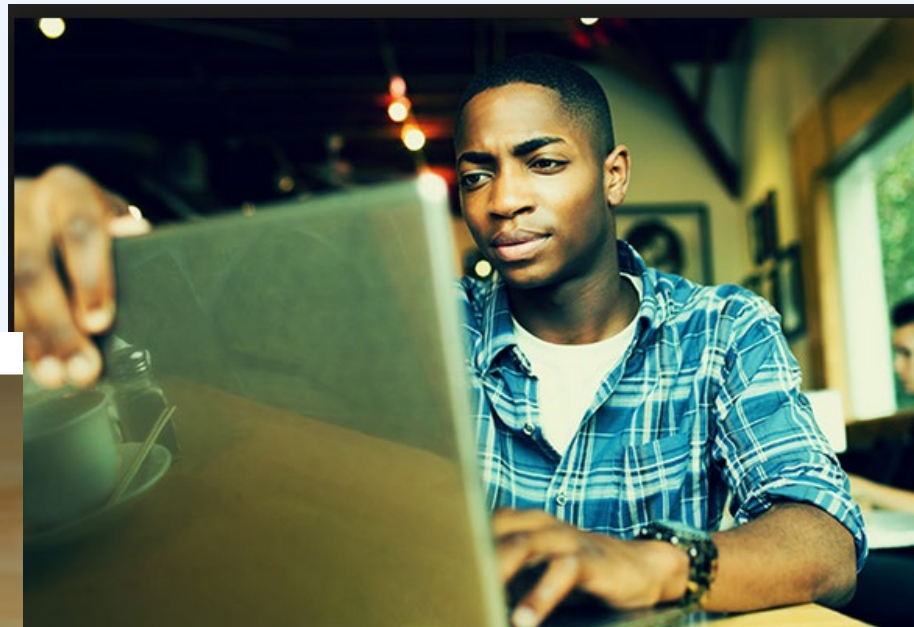
Margaret Trombley: Sr. Content Developer

Meaghan Fallano PhD: Content Developer

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Jeanne Zalesky: Director, Editor in Chief

# Mastering: Over 2.9 million registrations across science and engineering



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Student

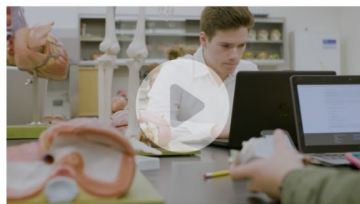
Educator

"It's really helpful when Mastering explains the process of how to think about the problems and how to actually solve them."  
—Student, Mastering Physics

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## MasteringChemistry: 514,433 registrations

# The Power of Mastering

Evaluator: expressionOchemEvals

If  compound in the response is

Compound Label:

Compound: (double-click in the box below to edit with Marvin Sketch)

```
<?xml version="1.0" ?>
<cml>
<MDocument>
```

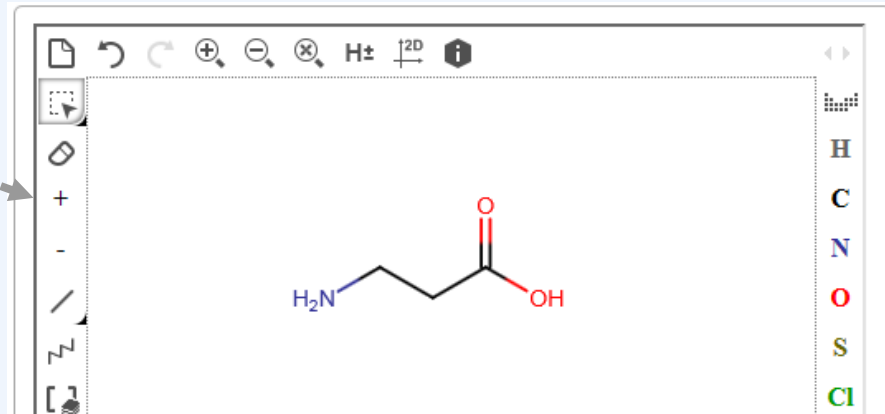
[add @eitherEnantiomer](#) check both enantiomers

[add @resonanceStructures](#) check for both resonance structures as well

[add @sigmaNetworks](#) check for identity of  $\sigma$ -bond networks only

[add @eschewNormalization](#) eschew normalization (aromatization and ylide standardization)

The structure of the amino acid alanine ( $\text{CH}_3\text{CHNH}_2\text{COOH}$ ) contains a hydrogen atom, a methyl group, an amino group, and a carboxylic acid attached to a central carbon. Draw alanine.



Using specific evaluators, authors can write targeted feedback geared toward specific student answers.

**✘ Incorrect; Try Again**

In amino acids such as alanine, an amino group ( $-\text{NH}_2$ ), a hydrogen atom, the R group (methyl in alanine), and a carboxylic acid group ( $-\text{COOH}$ ) are all bonded to a central carbon. Your structure should contain a methyl group. It may help to start with the central carbon atom and draw each group off of the one atom.

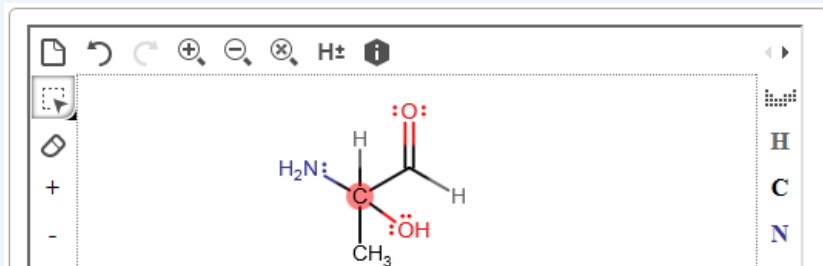
# The Power of Mastering

Evaluator: expressionOchemEvalFormula

if if the response has

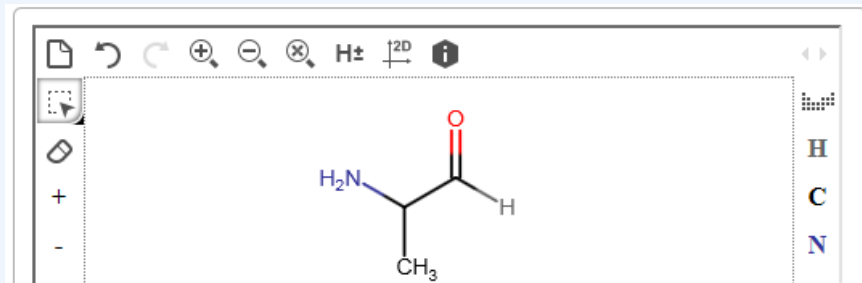
the molecular formula

Feedback can also be authored for more general criteria



**✘ Incorrect; Try Again**

At least one of the atoms in your response has an invalid valence. If you don't see an atom highlighted in red, look for an atom that violates the octet rule, or try expanding your shortcut groups



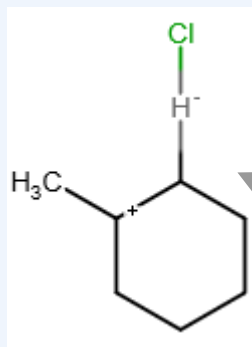
**✘ Incorrect; Try Again**

The structure you have drawn does not have the correct number of atoms of each element present in alanine. Make sure you draw a structure with the molecular formula  $C_3H_7NO_2$ .

And there is also system generated feedback for basic drawing issues.

# The Power of Mastering

System generated prediction of structure based on curved arrow placement



Reaction mechanism diagram showing the addition of  $\text{HCl}$  to 1-methylcyclohexene. The first step, highlighted in a red box, shows the alkene reacting with  $\text{HCl}$ . A curved arrow starts from the double bond and points to the hydrogen atom, and another curved arrow starts from the  $\text{H-Cl}$  bond and points to the chlorine atom. The second step shows the resulting carbocation intermediate with a methyl group and a hydrogen atom on the same carbon, and a chlorine atom on the adjacent carbon. The third step shows the final product, 1-chloro-1-methylcyclohexane.

**✘ Incorrect; Try Again**

Too many electrons are being shared with the highlighted atom, leading to products that have an atom with a total electron count more than the maximum.

When you draw any curved arrow, pay attention to the atoms contributing electrons. Select the Electron flow arrow from the toolbar on the left, and then click on a curved arrow to rotate through them. Any dotted-line indicates the atoms associated with the flow of electrons.

[See the products](#) Mastering has calculated from the electron-flow arrows in the highlighted stage.

Some of your electron-flow arrows are incorrect. If one of the boxes is colored red, the electron-flow arrows in that box probably do not lead to the compounds in the subsequent box.

Cl  
Br  
I  
P  
F

# Scaffolded Learning

Draw the aldehyde produced from the oxidation of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}_2\text{OH}$

Hints step students through the problem. Socratic hints guide students much like instructor office hours.

▼ **Hint 1.** Identify processes associated with oxidation or reduction

Oxidation and reduction are defined as the loss and gain of electrons, respectively. In organic chemistry, it is common to associate redox reactions with the gain or loss of oxygen or hydrogen. Classify these processes as being associated with oxidation or reduction.

Drag each item to the appropriate bin.

Reset Help

gain of hydrogen gain of oxygen loss of hydrogen loss of oxygen

Oxidation Reduction

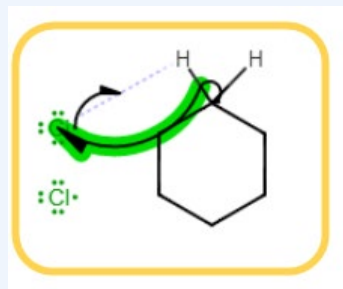
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[Request Answer](#)

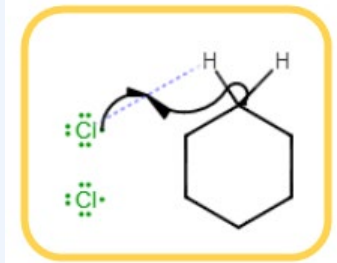
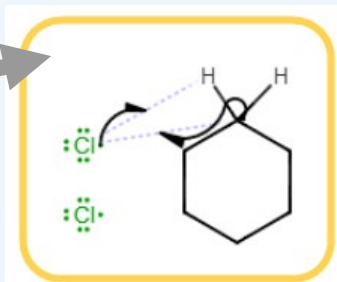
► **Hint 2.** Draw the alcohol that is oxidized

► **Hint 3.** Identify the general structure of an aldehyde

# Electron Flow Arrows

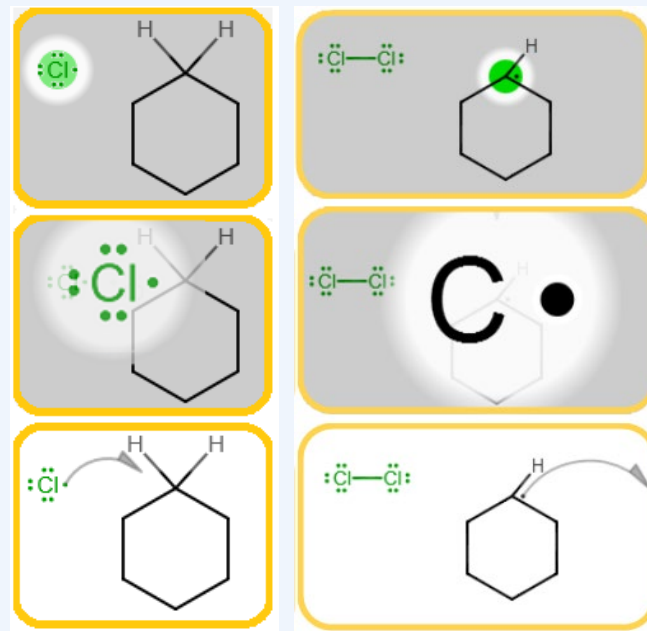


or



After drawing initial electron flow arrow, student clicks to specify the correct bond.

Dotted line maintains visual confirmation of bond.

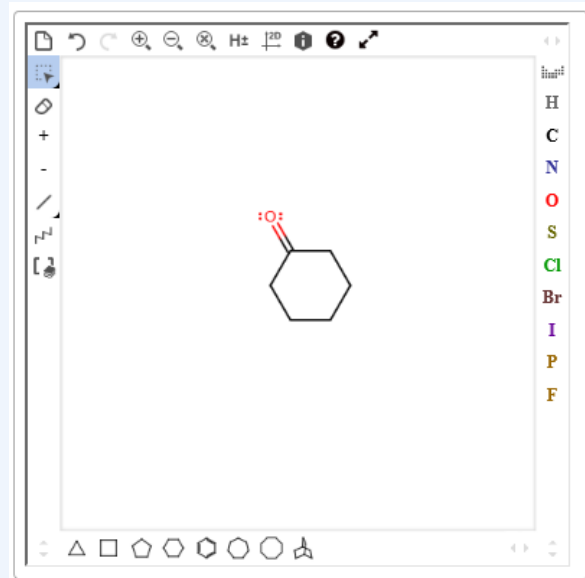
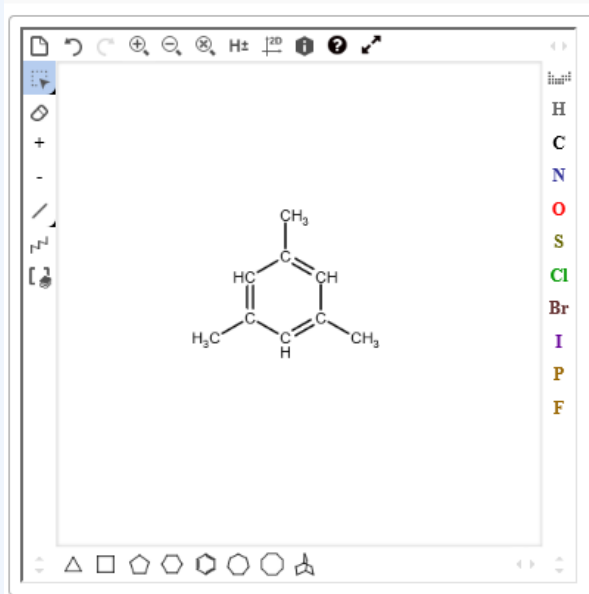


Students select electron(s) when showing flow.

# Custom Display

- **Skeletal2D or Skeletal3D**
- Ability to control showing:
  - Lone pairs
  - Valence errors
  - C and/or H
  - R,S labels

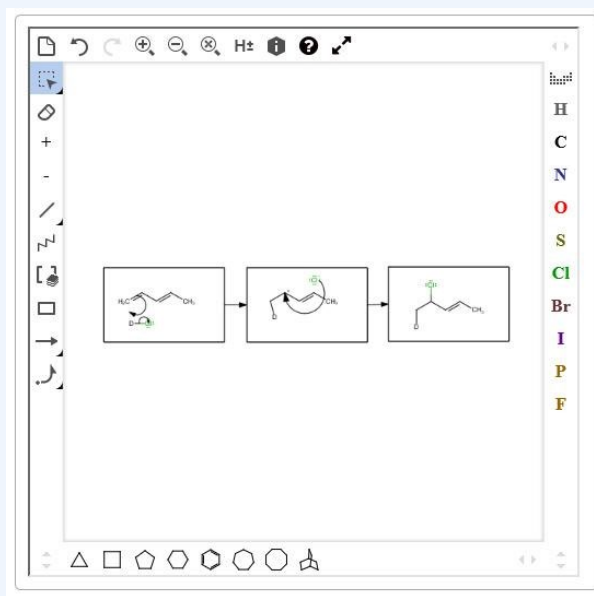
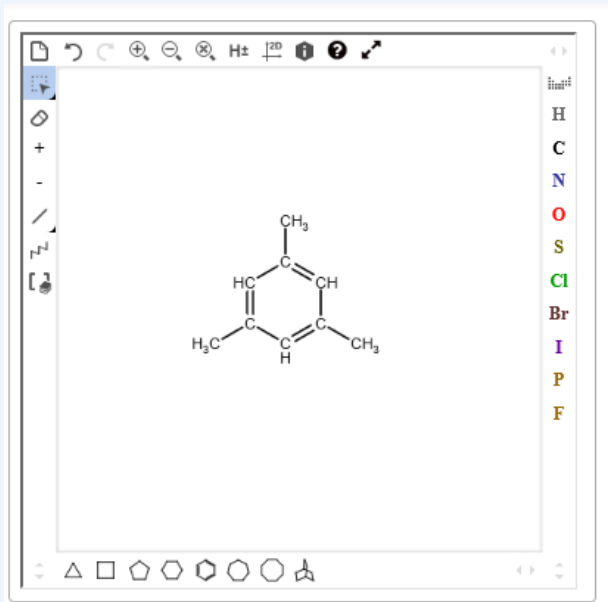
Applet Size: <small>small</small> Width: 500 Height: 500		
Question Properties		Marvin Initialization Parameters
<a href="#">add @noValenceErrors</a> No valence errors	<a href="#">add @preloadFigure</a> Preload figure	<a href="#">add @showLonePairs</a> Show lone pairs
<a href="#">add @showRSLLabels</a> Show R,S labels	<a href="#">add @threeDim</a> Three dimensional	showAllHandC <input type="checkbox"/> Implicit H mask
Pre-Text: <input type="text"/>		Post-Text: <input type="text"/>
Correct answer: (double-click in the box below to edit with Marvin Sketch)		
<input type="text"/>		
<a href="#">add expressions</a>		





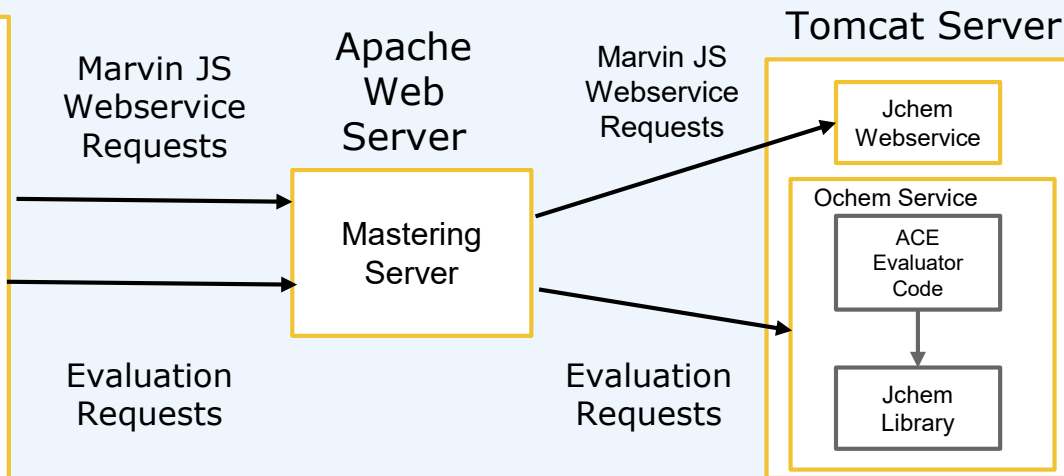
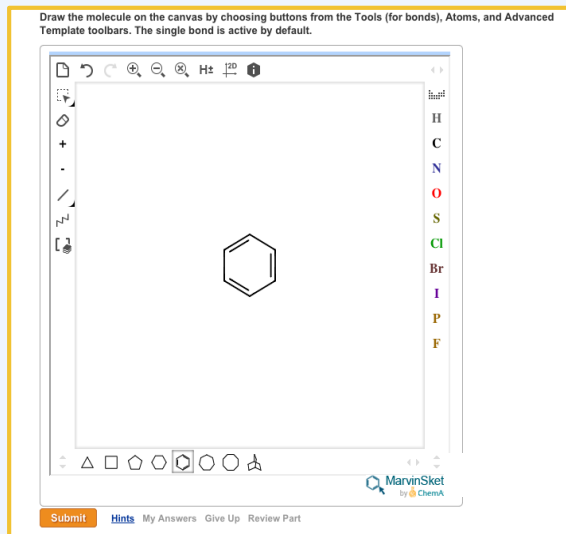
# Custom Display

- **Skeletal2D, Skeletal3D, Mechanism**
- Toolbars adjust to each answer type



# Basic System Architecture - MarvinJS/Mastering

## Marvin JS UI



# Accessibility

- WCAG 2.0 AA accessibility standards
- Not totally achieved, but ahead of our competitors
- Drawing tools like MarvinJS yield particular challenges

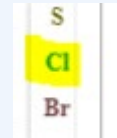
All user actions should be announced by a screen reader



Ensure every button has:

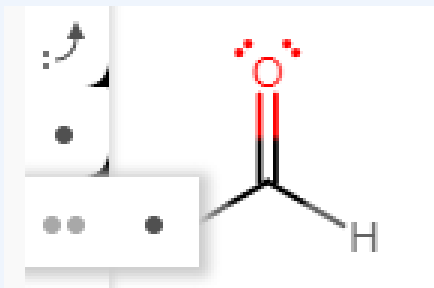
- Visible keyboard focus
- Associated alt text

Use a darker green to meet the required contrast of 4.5:1

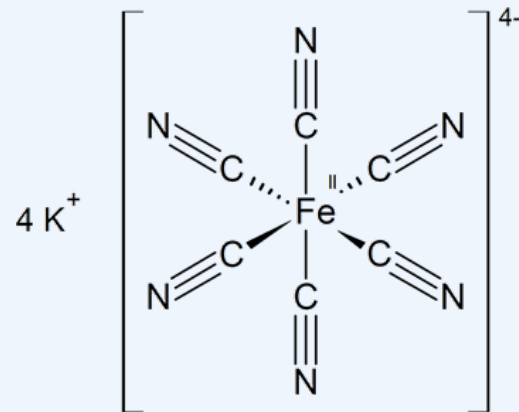
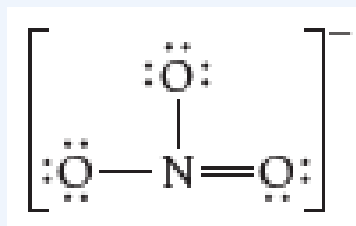


# Improvements: Lewis drawing

1 Unpaired and lone-pairs of electrons manually added and graded



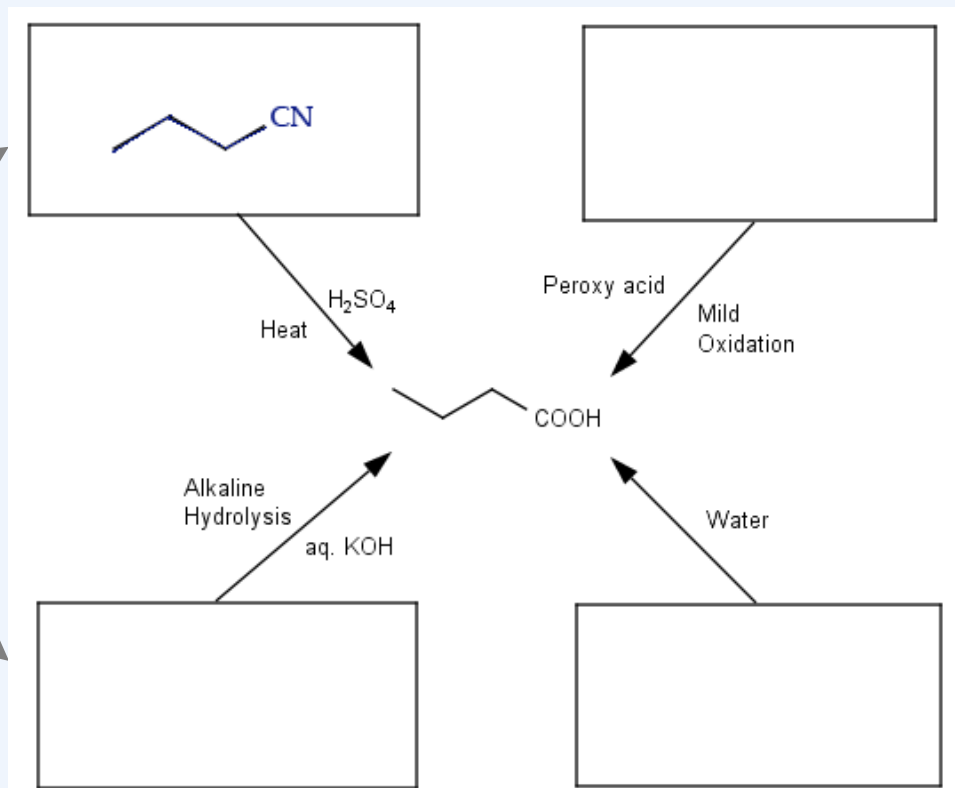
2 Brackets available for ionic species



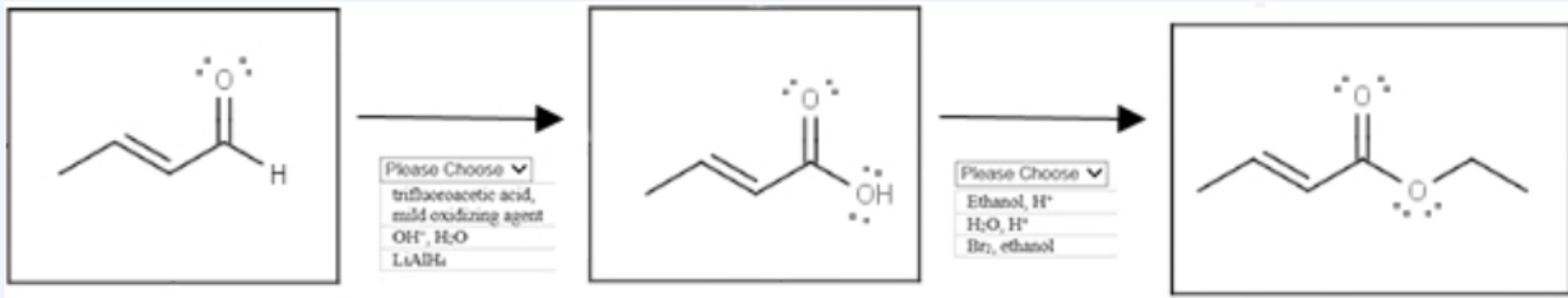
*Extend use of MarvinJS to all answer types in MasteringChemistry.*

# Mastering Today: Synthesis maps

Students add precursors

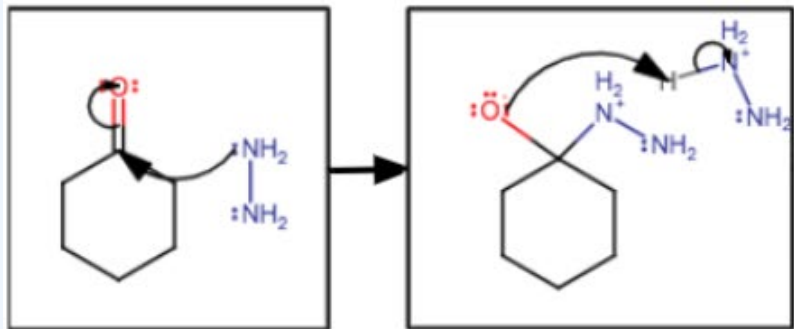


# Mastering Tomorrow: Reagent Dropdown Menu

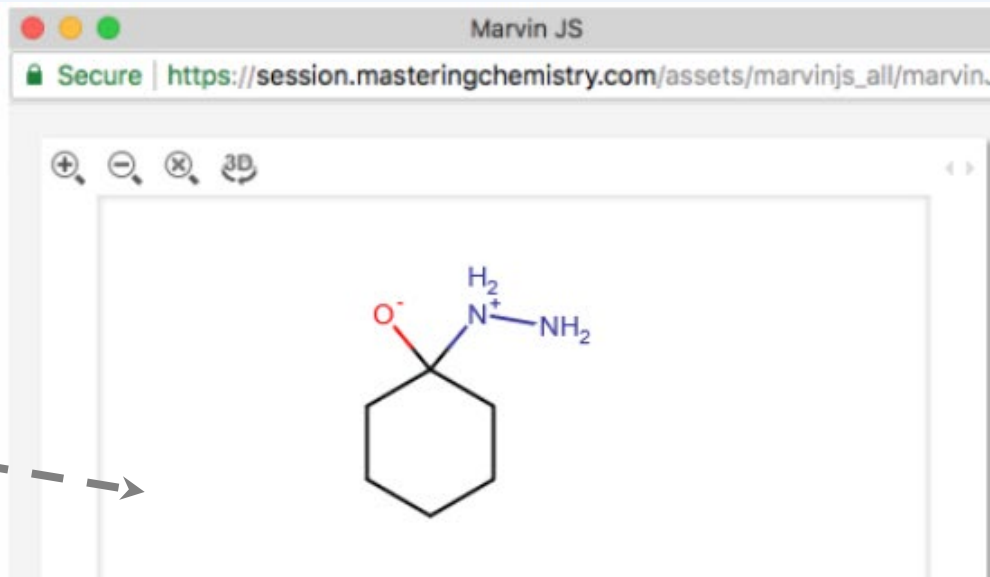


*This answer type would enhance use in 2nd semester Organic Chemistry.*

# Mastering Tomorrow: Predictive Mechanism



Check Answer



Check steps as move through mechanism

*This answer type would enhance use in 2nd semester Organic Chemistry.*

# Marvin for JavaScript

For more information, please contact  
[chris.hess@pearson.com](mailto:chris.hess@pearson.com)

