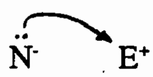
Casey/Nelsen

Electron Pushing Practice

Reich



Types of Arrows:

indicates movement of a pair of electrons. An arrow can **never** start from H^+, which has no electrons. An arrow can **never** go into a second row element with an octet of electrons without another arrow going out.

A ⟷ B means that A and B are resonance forms.

A ⇌ B means that A and B are in equilibrium.

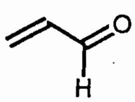
Use of these kinds of arrows should be carefully distingushed.

I. Writing resonance forms:

Give the major resonance contributors for the following structures, showing all lone pairs on N and O, as well as formal charges. Underline the major resonance contributor, and use curved arrows to indicate the movement of electrons necessary to convert each resonance form to the next one. **NOTE**: A molecule does not oscillate back and forth between resonance structures. It exists as a "hybrid", with geometry intermediate between that predicted for the resonance forms.

Example: $CH_3CO\text{-}CH_3$

1.



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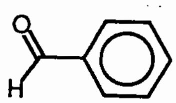

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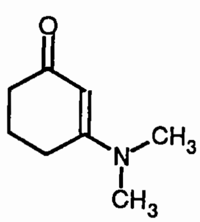
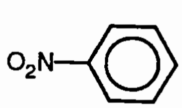
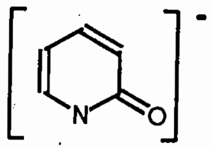
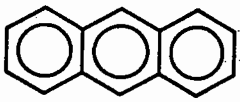


4. $[CH_3COCHCOCH_3]^-$

5.



6. 

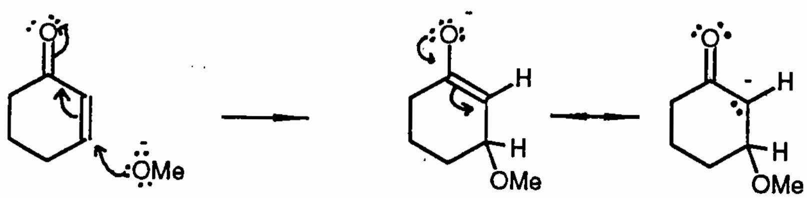
7. 

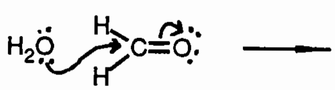
8. $Me_2N-C\equiv C-C(=O)-H$

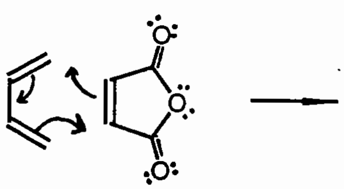
II. Results of Pushing Arrows:

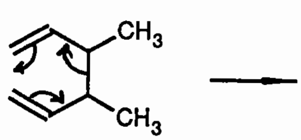
Reactions may also be represented by pushing electrons, using a curved arrow to show movement of an electron pair. (Some people argue that using electron pushing arrows to get between resonance structures is incorrect, because the electrons do not really move. These people only use electron pushing arrows to show new bonds being made and broken).

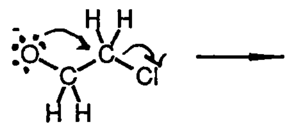
A. For the reactions shown, give the products, again showing any other important resonance structures present for the products.

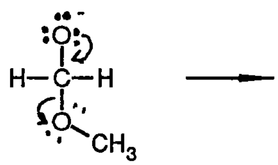
Example: 

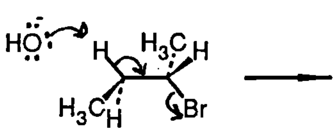
1. 

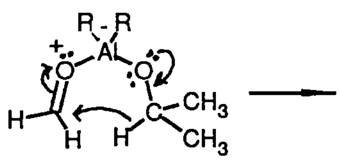
2. 

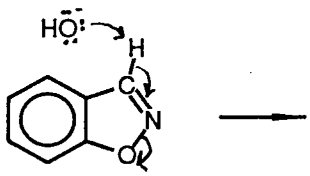
3. 

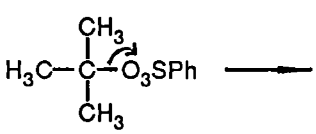
4. 

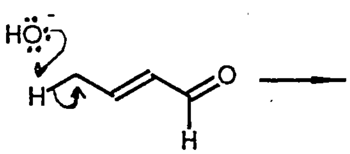
5. 

6. 

7. 

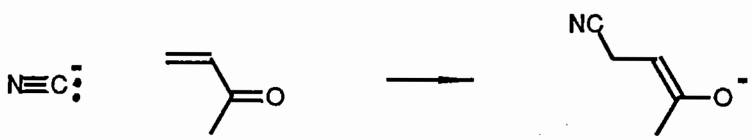
8. 

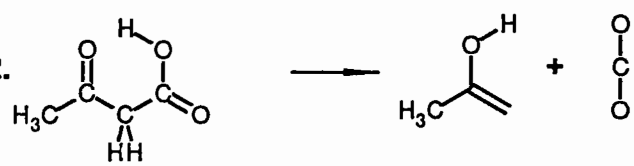
9. 

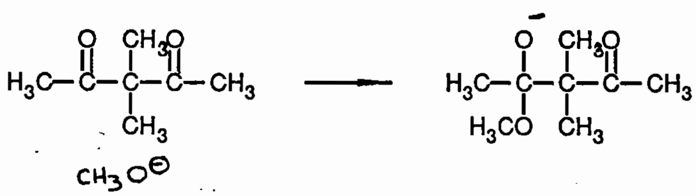
10. 

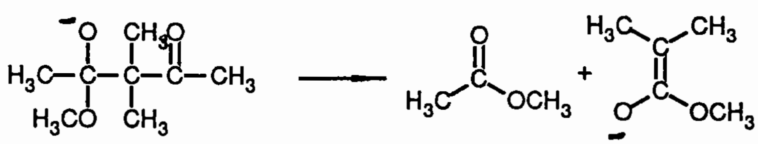
B: For the reactions shown, put in the necessary arrows:

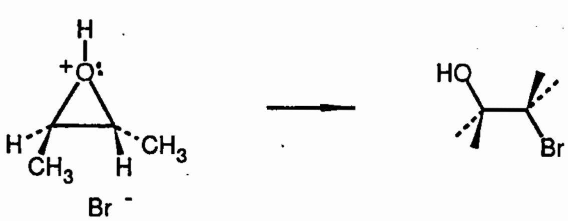
Example:

1. 

2.  (finish CO_2 structure)

3. 

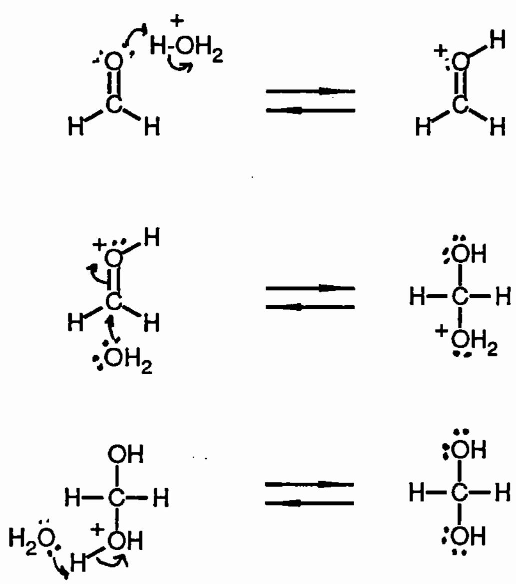
4. 

5.  (put stereochem. in properly)

III. Reaction Pathways. Give reasonable arrow-pushing pathways from starting materials to product, showing reaction intermediates.

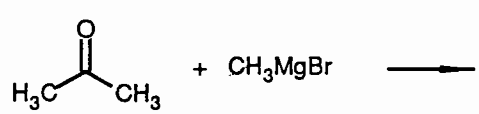
Example

$$H_2C{=}O + H_2O \xrightarrow{H^+} H_2C(OH)_2$$

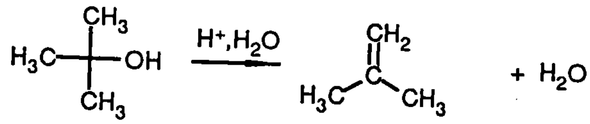


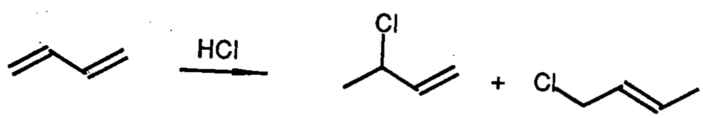
+ H_2O

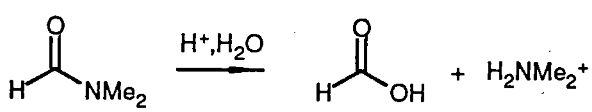
Note: no reason to draw all resonance forms in an arrow-pushing mechanism

1. 

$$\xrightarrow[H^+]{H_2O} (CH_3)_3COH$$

2. 
CH3
H3C
OH
CH3
H+,H2O
CH2
C
H3C
CH3
+ H2O

3. 
HCl
Cl
+
Cl

4. 
O
H
NMe2
H+,H2O
O
H
OH
+ H2NMe2+