

## Chapter 4. Alkenes

### Learning objectives:

1. Describe the three-dimensional structure of an alkene and reason the structure with the overlapping of hybridized and non-hybridized atomic orbitals of carbons.
2. Name alkenes including *cis-trans* and/or E-Z assignments when necessary.
3. Identify the followings from a potential energy diagram when applicable: endothermic or exothermic reactions, activation energy, heat of reaction, locations of transition states, locations of intermediates, and rate-limiting step.
4. Identify electrophiles and nucleophiles

### Sections to be covered (in the order of delivery):

- 4.1 Molecular formula
- 4.2 The nomenclature of alkenes
- 4.3 The structure of alkenes
- 4.4 Alkenes can have *cis-trans* isomers
- 4.5 Naming alkenes using the *E,Z* system
- 4.6 The relative stabilities of alkenes
- 4.7 How alkenes react: curved arrows show the bonds that break and the bonds that form
- 4.8 A reaction coordinate diagram describes the energy changes that takes place during a reaction

### Recommended additional problems

19, 21, 22, 24, 26, 29, 37

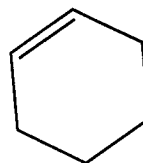
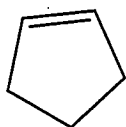
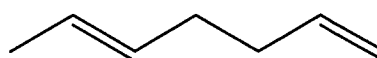
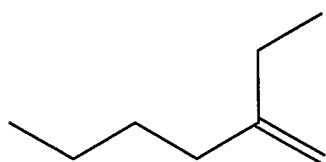
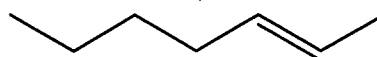
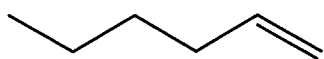
## 4.1 Molecular formula

General formula of alkenes:  $C_nH_{2n}$

General formula of cycloalkenes:  $C_nH_{2n-2}$

## 4.2 The nomenclature of alkenes

### A. IUPAC Names

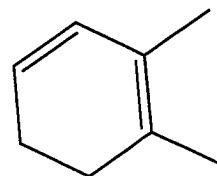
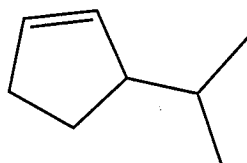
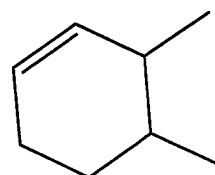
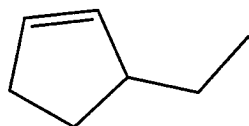
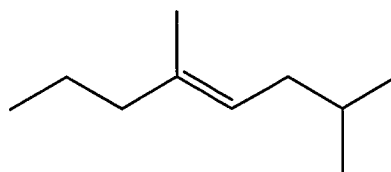
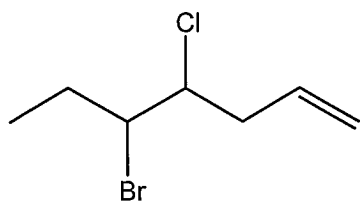


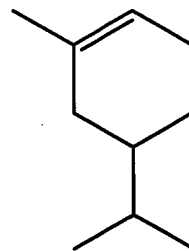
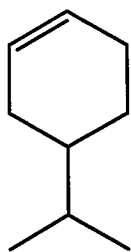
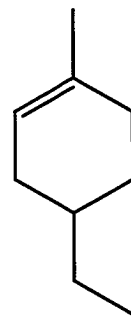
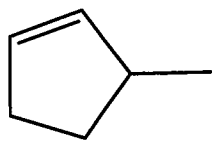
B. Common Names

ethylene

propylene

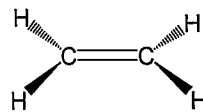
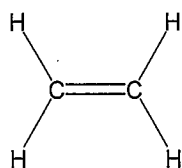
C. More examples



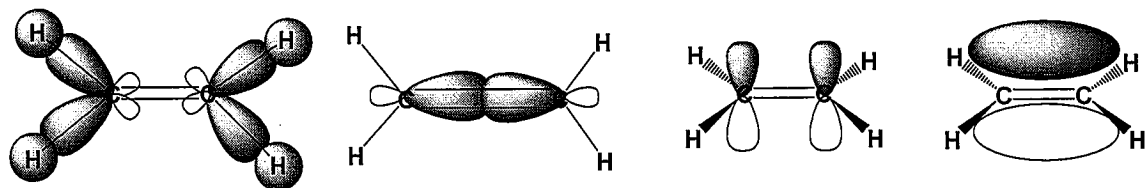


### 4.3 The structure of alkenes

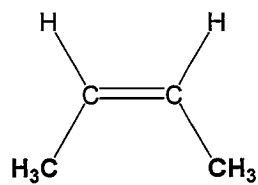
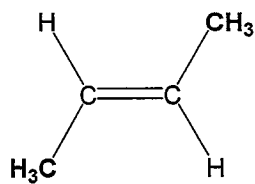
#### A. Shapes of Alkenes



## B. Orbital Overlap Model of a Carbon-Carbon Double Bond

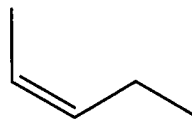
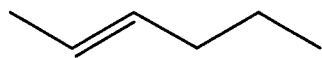


### 4.4 Alkenes can have cis-trans isomers



### 4.5 Naming alkenes using the *E,Z* system

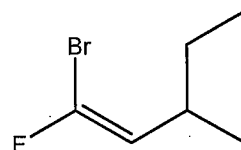
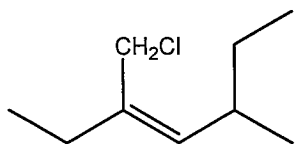
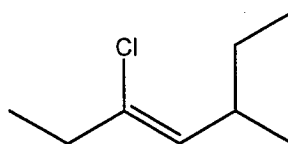
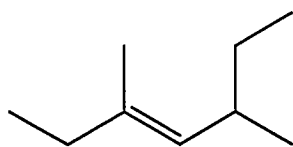
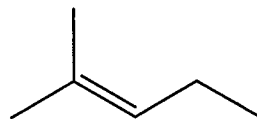
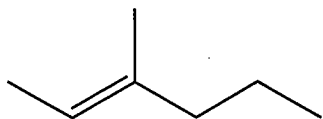
#### A. The Cis-Trans System



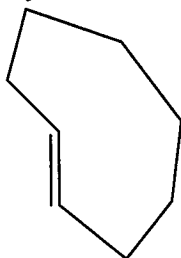
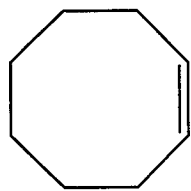
## B. The E,Z system

- higher atomic number, higher priority
- first difference in priority

Examples:

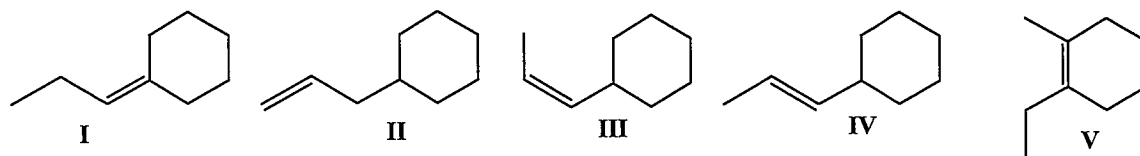


## C. Cis-Trans Isomerism in Cycloalkenes





#### 4.6 The relative stabilities of alkenes

*More substituted (alkyl group) alkenes, higher stability*



#### 4.7 How alkenes react: curved arrows show the bonds that break and the bonds that form

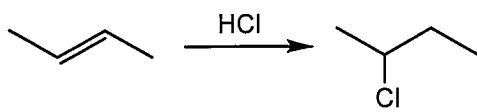
Use  to represent two electrons movement.

Use  to represent one electron movement.

**Identify electrophiles and nucleophile.**

**Recognize electron-rich and electron-deficient atoms.**

Example



**4.8 A reaction coordinate diagram describes the energy changes that takes place during a reaction**

**Important Terminologies:** starting materials, products, reaction mechanism, energy diagram, reaction coordinate, heat of reaction ( $\Delta H$ ), exothermic reaction, endothermic reaction, activation energy ( $E_a$ ) or free energy of activation ( $\Delta G^\ddagger$ ), reaction intermediate, rate-determining step (rate-limiting step) and transition state ( $TS^\ddagger$ ).

