

## 20.1 Types of Organic Reactions

### Understandings:

#### *Nucleophilic Substitution Reactions:*

- $S_N1$  represents a nucleophilic unimolecular substitution reaction and  $S_N2$  represents a nucleophilic bimolecular substitution reaction.  $S_N1$  involves a carbocation intermediate.  $S_N2$  involves a concerted reaction with a transition state.
- For tertiary halogenoalkanes the predominant mechanism is  $S_N1$  and for primary halogenoalkanes it is  $S_N2$ . Both mechanisms occur for secondary halogenoalkanes.
- The rate determining step (slow step) in an  $S_N1$  reaction depends only on the concentration of the halogenoalkane, rate =  $k[\text{halogenoalkane}]$ . For  $S_N2$ , rate =  $k[\text{halogenoalkane}][\text{nucleophile}]$ .  $S_N2$  is stereospecific with an inversion of configuration at the carbon.
- $S_N2$  reactions are best conducted using aprotic, polar solvents and  $S_N1$  reactions are best conducted using protic, polar solvents.

#### *Electrophilic Addition Reactions:*

- An electrophile is an electron-deficient species that can accept electron pairs from a nucleophile. Electrophiles are Lewis acids.
- Markovnikov's rule can be applied to predict the major product in electrophilic addition reactions of unsymmetrical alkenes with hydrogen halides and interhalogens. The formation of the major product can be explained in terms of the relative stability of possible carbocations in the reaction mechanism.

#### *Electrophilic Substitution Reactions:*

- Benzene is the simplest aromatic hydrocarbon compound (or arene) and has a delocalized structure of  $\pi$  bonds around its ring. Each carbon to carbon bond has a bond order of 1.5. Benzene is susceptible to attack by electrophiles.

#### *Reduction Reactions:*

- Carboxylic acids can be reduced to primary alcohols (via the aldehyde). Ketones can be reduced to secondary alcohols. Typical reducing agents are lithium aluminium hydride (used to reduce carboxylic acids) and sodium borohydride.

## **Applications and skills:**

### *Nucleophilic Substitution Reactions:*

- Explanation of why hydroxide is a better nucleophile than water.
- Deduction of the mechanism of the nucleophilic substitution reactions of halogenoalkanes with aqueous sodium hydroxide in terms of  $S_N1$  and  $S_N2$  mechanisms. Explanation of how the rate depends on the identity of the halogen (ie the leaving group), whether the halogenoalkane is primary, secondary or tertiary and the choice of solvent.
- Outline of the difference between protic and aprotic solvents.

### *Electrophilic Addition Reactions:*

- Deduction of the mechanism of the electrophilic addition reactions of alkenes with halogens/interhalogens and hydrogen halides.

### *Electrophilic Substitution Reactions:*

- Deduction of the mechanism of the nitration (electrophilic substitution) reaction of benzene (using a mixture of concentrated nitric acid and sulfuric acid).

### *Reduction Reactions:*

- Writing reduction reactions of carbonyl containing compounds: aldehydes and ketones to primary and secondary alcohols and carboxylic acids to aldehydes, using suitable reducing agents.
- Conversion of nitrobenzene to phenylamine via a two-stage reaction.