

Objectives for Chapter 7 – Organic Reactions I

I. Introduction to chemical reactions

What a chemical reaction is

1. Describe what happens during a chemical reaction.

How to represent chemical reactions

2. Identify reactants and products of a reaction, as well as compounds commonly referred to as starting materials or reagents.
3. Explain how writing reactions is often modified when writing organic reactions.
4. Explain what it means to say a reaction is reversible, and how we show this when we write out the reaction.

Energy Diagrams for chemical reactions

4. Explain what an energy diagram tells us about a reaction.
5. Explain what the transition state is and where it is located on the energy diagram, and why its energy is higher than the energy of either the reactants or products.
6. Explain what the activation energy is, and where it can be seen on an energy diagram.
7. Explain what the enthalpy of a reaction is, and where it can be seen on an energy diagram.
8. Explain the difference between an exothermic and an endothermic reaction, including how their energy diagrams differ, whether their enthalpy is positive or negative, and what causes a reaction to be endothermic or exothermic.
9. Explain the relationship between ΔG , ΔH , and ΔS .

II. Kinetics of Reactions

1. Explain what kinetics tells us about a reaction, and why it is important.
2. Explain why two molecules must collide with the correct orientation and sufficient energy in order to react.
3. Explain how and why activation energy, the probability factor, concentration, and temperature affect the reaction rate.
4. Explain which of the above can be changed for a reaction, and which are always the same.

5. Write the general form for a rate law, and explain what all of the variables are.
6. Explain how the rate law for a one step reaction is written.
7. Explain why it is important to determine the rate-limiting step for a multi-step reaction, and how the rate law is written using this information.
8. Explain why concentration of products never appear in the rate law of a forward reaction.

III. Thermodynamics of Reactions

What thermodynamics tells you

1. Explain what thermodynamics of a reaction tells us, and why this is important.

What equilibrium is

2. Explain what is happening to the rates of the reactions and the concentrations of the reactants in both reactions when the reaction is at equilibrium.

The Equilibrium Constant

3. Give the equation for the equilibrium constant, and explain what a large or small K_{eq} means.

Independence of rate and equilibrium constant

4. Give some examples showing that the rate of the reaction and the equilibrium constant are independent.

Relationship between equilibrium constant and change in free energy

5. Explain the relationship between the equilibrium constant and difference in the free energy of the products and reactants.

How concentration and activation energy combine to give equal rates

6. Explain how activation energy and concentrations of reactants and products combine to allow systems with different initial and final energies to come to equilibrium.

How systems reach and maintain equilibrium

7. Explain how a system with initially all reactants (or all products) can achieve equilibrium.
8. Explain how Le Chatelier's principle predicts what will happen to the concentrations of the other compounds and to the rates of the forward and backward reactions of a system at equilibrium if a reactant or product is added or removed.
9. Explain how a large excess of one reactant can cause the other to be (nearly) used up in order to reach equilibrium.

III. Nucleophiles and Electrophiles

1. Give the definitions of Lewis acids and bases and Bronsted-Lowry acids and bases, and explain the relationship between these definitions.
2. Explain happens in an association, dissociation, and displacement reaction, and correctly label reactions as one of these.
3. Identify the nucleophile and electrophile in an association or displacement reaction.
4. Draw arrows representing the movement of electrons when given the products and reactants.
5. Draw the products of a reaction (including correct charges) when give the reactants and the arrows representing the movement of electrons.
6. Explain what lone electron pairs and electron pairs in bonds can do in a reaction.
7. Use arrows to show how to convert one resonance structure to another.
8. Explain 4 ways to judge the strength of a nucleophile, and choose the stronger nucleophile of a pair using these guidelines.
9. Explain 4 ways to judge the strength of an electrophile, and choose the stronger electrophile of a pair using these guidelines.

V. Bronsted-Lowry Acids and Bases

Introduction to acids and bases

1. Identify acids, bases, conjugate acids, and conjugate bases in a reaction.
2. Explain what an amphoteric compound is, and how to recognize compounds that are amphoteric.
3. Put the individual steps of a reaction together to form a mechanism.

Using pKa's to determine acid and base strength

4. Explain where the pKa of an acid comes from, and how it can be used to compare the strength of two acids.
5. Explain how the strength of an acid and its conjugate base is related, and how to use pKa's of the conjugate acid to determine base strength.

Using pKa's to predict whether an acid/base reaction will be favorable

6. Use the pKa's of the two acids in a reaction to determine the equilibrium constant and whether a particular acid/base reaction will be favorable.

Predicting relative acid and base strength

7. List 5 characteristics of acids that make them stronger, explain why they have the effect that they do, and use these to judge the relative strength of acids.
8. Explain why these characteristics also make bases weaker, and use them to judge the relative strength of bases.