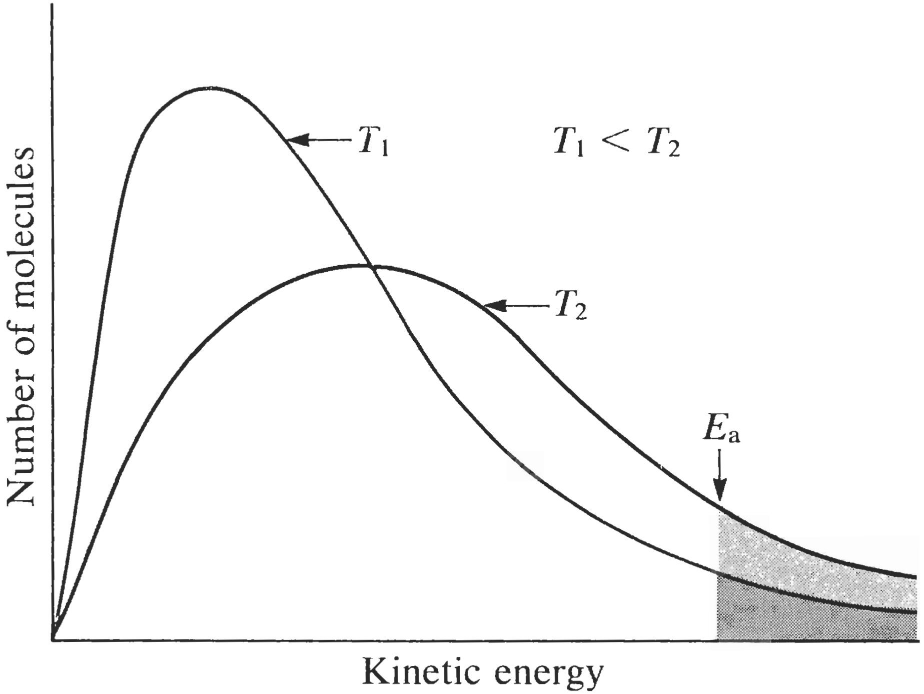
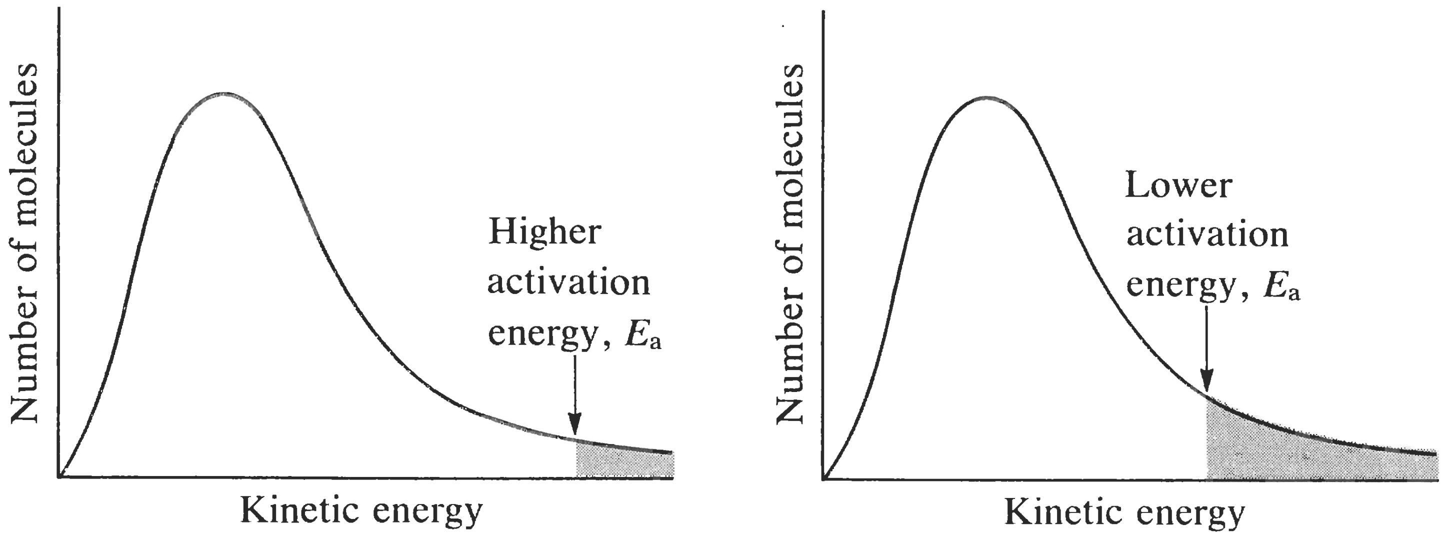
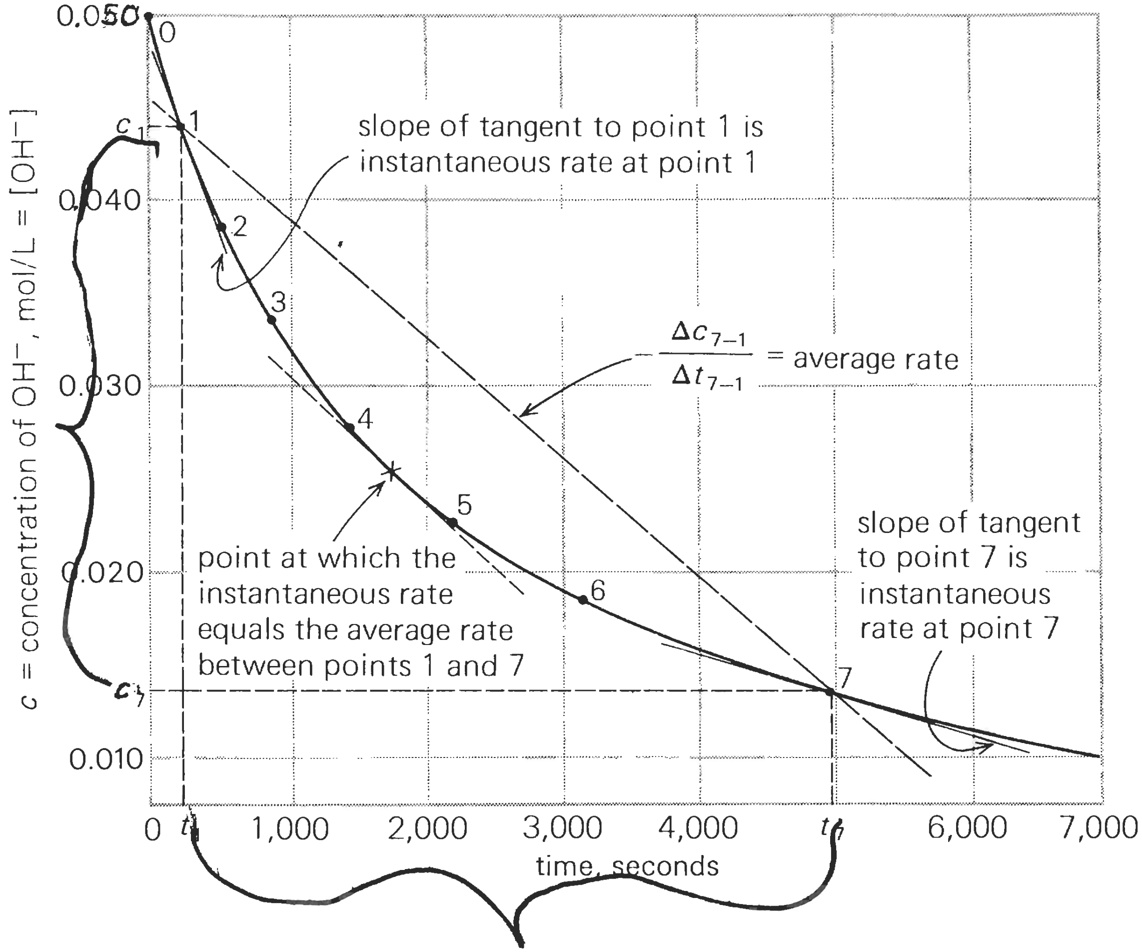


At a higher temperature, T_2, more molecules have an energy greater than E_a, as shown by the yellow shaded area.

Information taken from *College Chemistry with Qualitative Analysis**, Holtzclaw, Robinson, 8th edition, Heath and Company, 1988.*



Information taken from College Chemistry with Qualitative Analysis, Holtzclaw, Robinson, 8th edition, Heath and Company, 1988.



Plot of $[OH^-]$ versus time for the basic hydrolysis of ethyl acetate. The instantaneous rates of reaction at points 1 and 7 are described by the slopes of the colored lines, which are the tangents at these two points. The average rate between points 1 and 7 is equal to the slope of the dashed black line connecting these two points. A tangent whose slope is equal to the slope of this average rate line is shown by the dashed colored line; the point at which it is tangent is shown by the colored *x*.

Information taken from General College Chemistry with Qualitative Analysis, *Keenan, Kleinfelter, Wood, 6th edition, Harper & Row Publishers, 1980.*

also be second order. It is not, but instead it has a more complex rate equation.

Consider the general reaction $2A + B_2 \rightarrow 2AB$ and the following experimental data:

experiment	[A]	$[B_2]$	rate, $mol \cdot L^{-1} \cdot s^{-1}$
1	0.50	0.50	1.6×10^{-4}
2	0.50	1.00	3.2×10^{-4}
3	1.00	1.00	3.2×10^{-4}

Write the most probable rate equation for this reaction.

• Solution • Comparing the data in experiment 2 with those in experiment 1, we note that when the concentration of B_2 is doubled, the rate is doubled. Hence the reaction is first order in B_2. Comparing the data in experiment 3 with those in experiment 2, we note that when the concentration of A is doubled, the rate is unchanged. Hence the reaction is zero order in A. The most probable rate equation is

$$\text{rate} = k[A]^0[B_2] \quad \text{or} \quad \text{rate} = k[B_2]$$

Information taken from <u>General College Chemistry with Qualitative Analysis</u>, Keenan, Kleinfelter, Wood, 6th edition, Harper & Row Publishers, 1980.

Examples of reactions of different orders	
First-Order Reactions	Rate
$2N_2O_5 \longrightarrow 4NO_2 + O_2$	$k[N_2O_5]$
$2H_2O_2 \longrightarrow 2H_2O + O_2$	$k[H_2O_2]$
$SO_2Cl_2 \longrightarrow SO_2 + Cl_2$	$k[SO_2Cl_2]$
$C_2H_5Cl \longrightarrow C_2H_4 + HCl$	$k[C_2H_5Cl]$
Second-Order Reactions	
$NO + O_3 \longrightarrow NO_2 + O_2$	$k[NO][O_3]$
$2NO_2 \longrightarrow 2NO + O_2$	$k[NO_2]^2$
$NO_2 + CO \longrightarrow NO + CO_2$	$k[NO_2][CO]$
$H_2 + I_2 \longrightarrow 2HI$	$k[H_2][I_2]$
$C_2H_4Br_2 + 3KI \longrightarrow C_2H_4 + 2KBr + KI_3$	$k[C_2H_4Br_2][KI]$
$CH_3CO_2C_2H_5 + OH^- \longrightarrow CH_3CO_2^- + C_2H_5OH$	$k[CH_3CO_2C_2H_5][OH^-]$
Third-Order Reactions	
$2NO + O_2 \longrightarrow 2NO_2$	$k[NO]^2[O_2]$
$2NO + Cl_2 \longrightarrow 2NOCl$	$k[NO]^2[Cl_2]$
$2NO + Br_2 \longrightarrow 2NOBr$	$k[NO]^2[Br_2]$
$2NO + 2H_2 \longrightarrow N_2 + 2H_2O$	$k[NO]^2[H_2]$
Fractional-Order Reactions	
$CO + Cl_2 \longrightarrow COCl_2$	$k[CO][Cl_2]^{3/2}$
$COCl_2 \longrightarrow CO + Cl_2$	$k[COCl_2][Cl_2]^{1/2}$

Information taken from <u>General College Chemistry with Qualitative Analysis</u>*, Keenan, Kleinfelter, Wood, 6th edition, Harper & Row Publishers, 1980.*

[NO], mol L^{-1}	[O_3], mol L^{-1}	$\frac{\Delta[NO_2]}{\Delta t}$, mol L^{-1} s^{-1}
1.00×10^{-6}	3.00×10^{-6}	0.660×10^{-4}
1.00×10^{-6}	6.00×10^{-6}	1.32×10^{-4}
1.00×10^{-6}	9.00×10^{-6}	1.98×10^{-4}
2.00×10^{-6}	9.00×10^{-6}	3.96×10^{-4}
3.00×10^{-6}	9.00×10^{-6}	5.94×10^{-4}

Information taken from College Chemistry with Qualitative Analysis, Holtzclaw, Robinson, 8th edition, Heath and Company, 1988.

The variation in the rate of decomposition of H_2O_2 at 40°C				
Time, s	$[H_2O_2]$, mol L^{-1}	$\Delta[H_2O_2]$, mol L^{-1}	Δt, s	Rate, mol L^{-1} s^{-1}
0	1.000			
		−0.500	2.16×10^4	2.31×10^{-5}
2.16×10^4	0.500			
		−0.250	2.16×10^4	1.16×10^{-5}
4.32×10^4	0.250			
		−0.125	2.16×10^4	0.579×10^{-5}
6.48×10^4	0.125			
		−0.062	2.16×10^4	0.29×10^{-5}
8.64×10^4	0.0625			

Information taken from College Chemistry with Qualitative Analysis, Holtzclaw, Robinson, 8th edition, Heath and Company, 1988.