Factors Affecting Reaction Rate

Essential Question

What makes a reaction go faster?

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Reaction Rate

- Reaction rate: how fast reactants become products
- Rusting: years; cooking: minutes; fireworks: under a second
- Kinetics: the study of reaction rates

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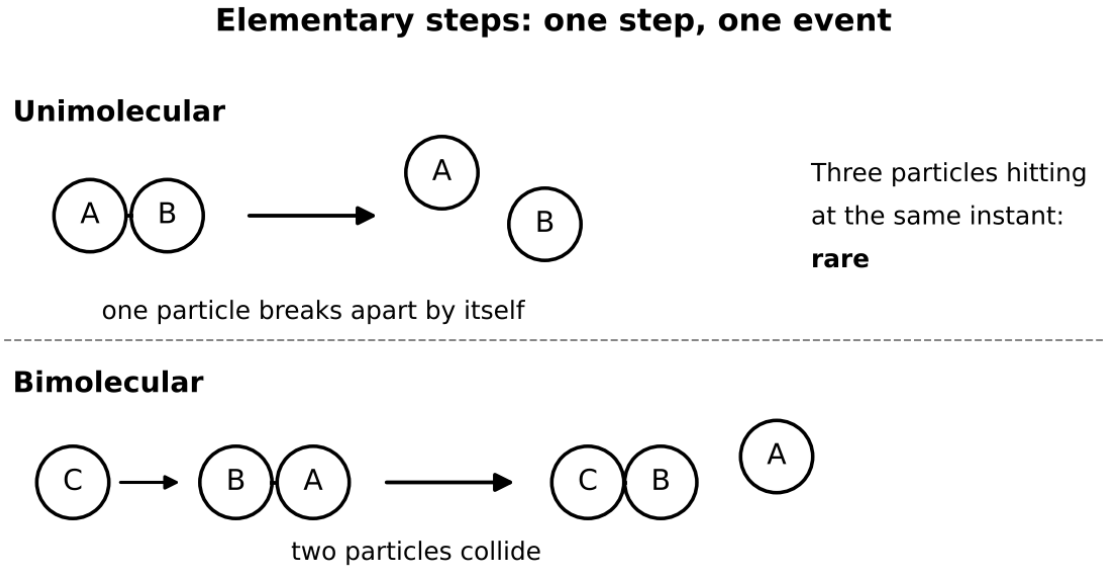
Collision Theory

- Particles must collide
- With enough energy
- In the right orientation
- Effective collision: one that makes products

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Elementary Reactions

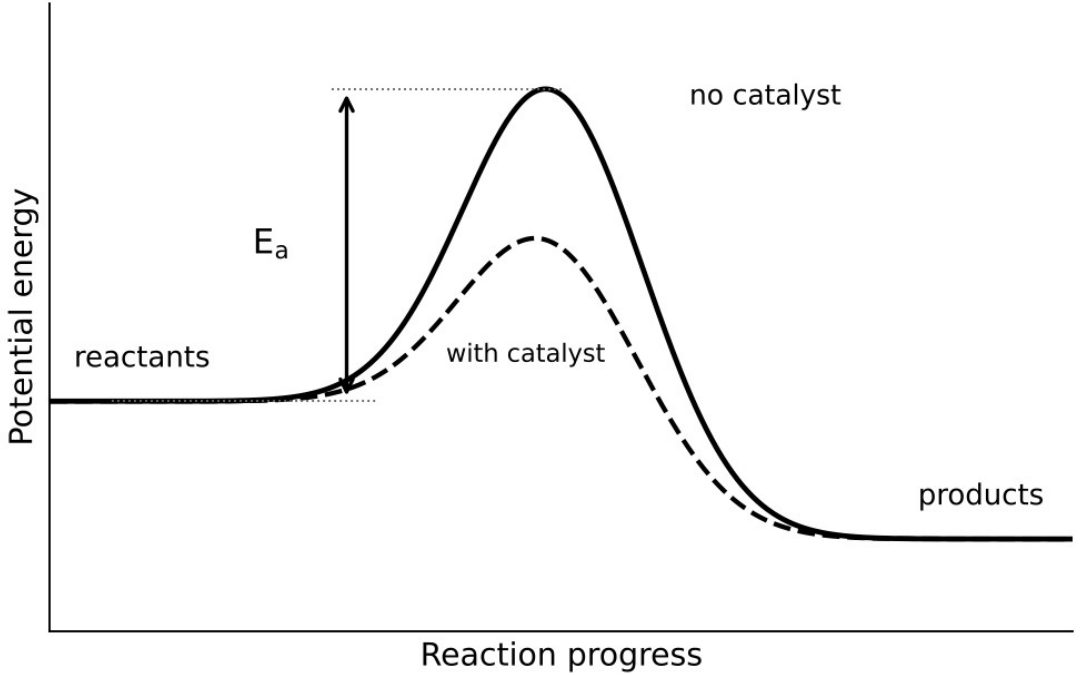
- Elementary reaction: one step
- Unimolecular: one particle breaks apart
- Bimolecular: two particles collide
- Three at once: rare



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Activation Energy

- E_a: the minimum energy to react
- Energy profile: energy along the reaction pathway
- Low E_a: usually fast



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Temperature

- Faster particles collide more often
- More collisions reach E_a
- Why the refrigerator slows spoiling

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Concentration

- More particles in the same space
- More collisions every second
- Measured in molarity (M)

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Surface Area

- Only surface particles can be hit
- 2 cm cube: 24 square units
- Eight 1 cm cubes: 48 square units
- Powders react faster than chunks

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Pressure (Gases)

- Same gas in a smaller volume
- Reacting particles meet more often
- Really a concentration change

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Nature of Reactants

- Some substances are more reactive
- Sodium fizzes in seconds; iron rusts over weeks
- Ions in solution react quickly
- You can't adjust this one

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Catalysts

- New pathway (mechanism) with a lower E_a
- Not used up
- Enzymes: the body's catalysts

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Example: Which Is Faster?

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$. Setup A uses a 1.0 g lump of zinc and Setup B uses 1.0 g of zinc powder, both with 1.0 M HCl at 25 °C. Which reacts faster? Explain using collision theory.

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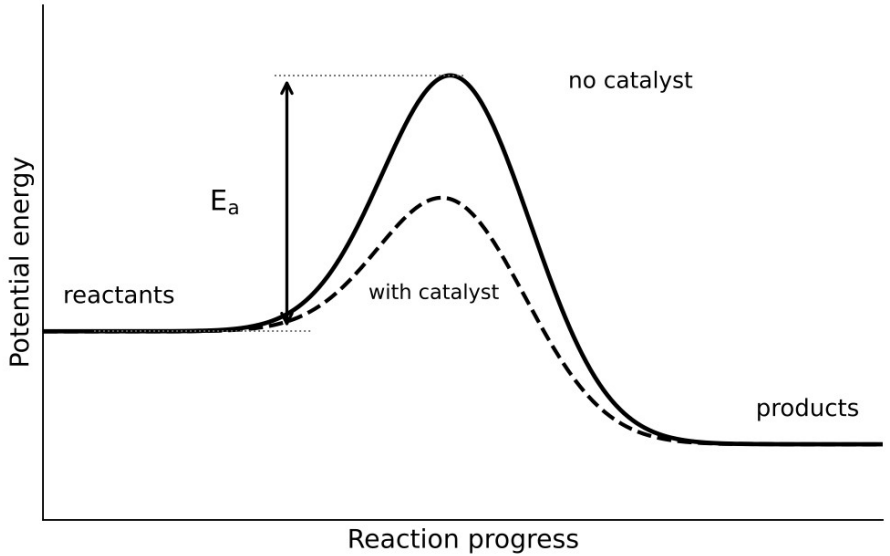
Example: The Refrigerator

Milk spoils in about a day on the counter (25 °C) but lasts about a week in the refrigerator (4 °C). Which factor explains this? Use collision theory to explain.

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Example: Adding a Catalyst

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$ is slow. A pinch of MnO_2 makes it fizz quickly, and the MnO_2 is unchanged at the end. Explain why.



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Factors Affecting Reaction Rate

Big Ideas

- Reactions need effective collisions
- More collisions, faster reaction
- Higher temperature: more collisions reach E_a
- Catalysts lower E_a and are not used up
- Elementary step: one event, uni- or bimolecular

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