

Exercise walk-through

5.7

Introduction to Reaction Mechanisms

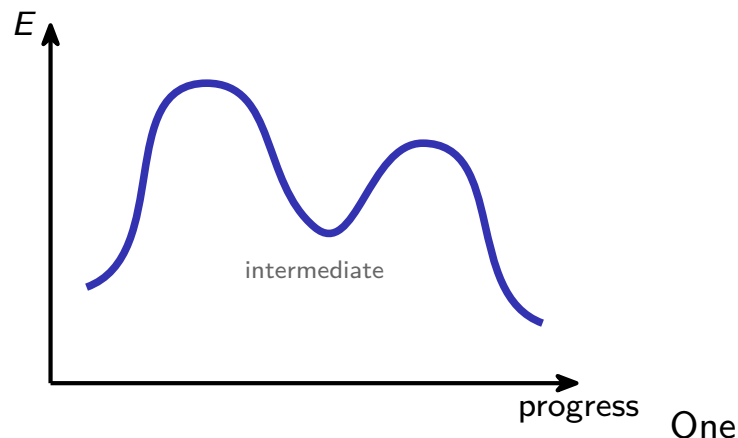
AP Chemistry

Reaction mechanisms

A **mechanism** is the ordered list of **elementary steps**.

- an **intermediate** is made, then used up
- steps must add to the overall equation
- for an elementary step, the rate law comes from its stoichiometry

The slow **rate-determining step** sets the overall rate.



peak per step; a valley is the intermediate.

Exercises 2.1·2.3

2.1 What is the rate-determining step?

[1]

2.2 Step 1 is slow, step 2 is fast. Which sets the overall rate?

[1]

2.3 If you speed up only the fast step, does the overall rate change much?

[1]

Exercises 2.1-2.3

2.1 What is the rate-determining step? [1]

2.1

- The slowest step in the mechanism, which sets the overall rate
-

2.2 Step 1 is slow, step 2 is fast. Which sets the overall rate? [1]

2.2

- Step 1 (the slow step)
-

2.3 If you speed up only the fast step, does the overall rate change much? [1]

2.3

- No – it is limited by the slow step

Exercise 3.1

3.1 The overall rate of a multi-step reaction is controlled by the

[1]

☐

A fastest step

B slowest step

C first step always

D last step always

Exercise 3.1

3.1 The overall rate of a multi-step reaction is controlled by the

[1]

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A fastest step

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C first step always

D last step always

3.1 B

- the slowest step

Exercise 3.2 (a)

3.2 A mechanism is: Step 1 (slow) $\text{NO}_2 + \text{NO}_2 \rightarrow \text{NO}_3 + \text{NO}$; Step 2 (fast) $\text{NO}_3 + \text{CO} \rightarrow \text{NO}_2 + \text{CO}_2$.

(a) Which step is rate-determining?

[1]

Exercise 3.2 (a)

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(a) Which step is rate-determining?

[1]

(a)

- Step 1

Exercise 3.2 (b)

3.2 A mechanism is: Step 1 (slow) $\text{NO}_2 + \text{NO}_2 \rightarrow \text{NO}_3 + \text{NO}$; Step 2 (fast) $\text{NO}_3 + \text{CO} \rightarrow \text{NO}_2 + \text{CO}_2$.

(b) Write the rate law from that step.

[2]

Exercise 3.2 (b)

3.2 A mechanism is: Step 1 (slow) $\text{NO}_2 + \text{NO}_2 \rightarrow \text{NO}_3 + \text{NO}$; Step 2 (fast) $\text{NO}_3 + \text{CO} \rightarrow \text{NO}_2 + \text{CO}_2$.

(b) Write the rate law from that step.

[2]

(b)

- $\text{rate} = k[\text{NO}_2]^2$ (from the slow elementary step)

Exercise 3.3

3.3 Explain, with the highway analogy or otherwise, why speeding up a fast step does not speed up the overall reaction if another step is slow. [2]

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3.3

- The overall reaction can only proceed as fast as its slowest bottleneck; a faster fast-step just waits on the slow step, so the total time barely changes