

Enzymes • Lowering Activation Energy

Learning objective 3.1.A Explain how enzymes catalyze reactions by lowering the activation energy, and what that does and does not change.

Name: _____

Date: _____

Period: _____

Use the tool **Lowering the Hill**. Work on the **The energy profile** tab for Parts 1 to 3, **Same yield, less time** for Part 4, and **True or false** for Part 5. Most of this topic is knowing what an enzyme does **not** change, so read the unchanged readouts as carefully as the changing one.

Part 1 • Add the enzyme and watch the readouts

Start on the **exergonic** reaction with no enzyme. Record all four readouts, then press **Add the enzyme** and record them again.

	Activation energy	Reactant level	Product level	ΔG
Without enzyme				
With enzyme				
Changed?				

1. One readout changed and three did not. Name them.

2. Define activation energy, and state where it is measured from on the energy profile.

Part 2 · Why a lower barrier is faster

Open **Why a lower barrier means a faster reaction** and read the table of activation energies.

Activation energy	Share of collisions with enough energy	Relative rate
70		
45		
15		

3. Explain how lowering the activation energy makes a reaction go faster. Refer to collisions in your answer.

4. A student says the enzyme gives the substrate molecules more energy. Explain why that is not what happens.

Part 3 · Both kinds of reaction

Switch to the **endergonic** reaction and add the enzyme.

Reaction	ΔG without enzyme	ΔG with enzyme	Ea falls?
Exergonic			
Endergonic			

5. State what happened to ΔG when you added the enzyme to the endergonic reaction, and explain what that shows.

6. Explain why a reaction being spontaneous does not mean it happens quickly.

Part 4 · Same yield, less time

Switch to **Same yield, less time**. Both flasks start with 100 units of substrate. **Write your prediction in the table before you press run.**

	Final product (predict)	Final product (actual)	Steps to finish
No enzyme			
With enzyme			

7. Describe how the two curves differ, and describe how they are the same.

8. Explain what this result shows about the difference between the rate of a reaction and its yield.

Part 5 · Judge the claims

Work all six cards on the **True or false** tab, then answer these in complete sentences.

9. State three things an enzyme does not change about a reaction.

10. A student claims an enzyme can make an endergonic reaction release energy. Evaluate that claim.

11. A reaction is catalyzed by an enzyme. Predict what would happen to the final amount of product, and to the time taken, if you doubled the amount of enzyme. Justify both predictions.

What the model simplifies

Energy is in arbitrary units. Real activation energies and free energy changes are measured in kilojoules per mole, and the numbers here are chosen so the diagram reads clearly rather than to match any particular reaction.

The share of collisions with enough energy is calculated with a Boltzmann-style exponential. That gives the right shape — a small drop in the barrier producing a large rise in rate — without pretending to real temperatures or real units.

The energy profile is drawn as a single smooth hump. Real reactions often pass through several intermediates and have several humps.

Both flasks react at a rate proportional to how much substrate is left, so both curves flatten as they approach completion. Real enzyme kinetics also saturate as substrate concentration rises, which Topic 3.2 covers.