Catalysts and Graphical Rate Reasoning

Student Worksheet | g10_u03_w11

I can: use concentration-time and relative-energy evidence to explain how a catalyst can change rate without changing the net thermodynamic state difference.
Classroom model: for the same reaction under otherwise matched conditions, a catalyst can provide a pathway with a lower activation barrier and can increase the observed forward and reverse rates. It does not change the net ΔH, ΔG at a specified state, or the equilibrium constant/position for the same conditions. A concentration-time slope describes rate over a named interval; a graph alone does not prove a detailed mechanism. All prompts are supplied data-card analyses; no catalyst handling or live reaction is requested.

Time (s)	[R] without catalyst (M)	[R] with catalyst (M)
0	0.800	0.800
20.0	0.680	0.560
40.0	0.580	0.400
60.0	0.500	0.300

Graph/energy card: Both pathways start at relative energy 40 kJ/mol and end at 10 kJ/mol. The uncatalyzed peak is 120 kJ/mol; the catalyzed peak is 80 kJ/mol. Treat this as a relative-energy model, not measured molecular detail.

1. Distinguish a rate claim from a thermodynamic claim about ΔH, ΔG, or equilibrium.

2. In this packet's model, what does a catalyst change? Name two things it does not change for the same initial/final states and conditions.

3. On a relative-energy diagram, what features must remain the same if the catalyzed and uncatalyzed drawings represent the same net reaction?

4. What graph feature on a concentration-time plot represents an average rate over a stated interval? How does a steeper reactant line compare with a less-steep one?

5. Calculate the uncatalyzed average disappearance rate from 0 to 20.0 s.

6. Calculate the catalyzed average disappearance rate from 0 to 20.0 s.

7. Calculate the initial-interval rate factor (catalyzed/uncatalyzed). State the conclusion under the table's stated comparison.

8. Calculate both average disappearance rates from 20.0 to 40.0 s.

9. Calculate the 20.0–40.0 s rate factor (catalyzed/uncatalyzed). Why does a changed factor across intervals not by itself reveal a mechanism?

10. Describe how the two reactant curves would look if plotted on the same concentration-time axes. Identify which direct graphical observation supports a faster catalyzed rate.

11. Why are the rates in items 5–9 interval averages rather than automatically instantaneous rates? What additional graphical/data feature would support an instantaneous-rate estimate?

12. From the energy card, calculate the uncatalyzed and catalyzed forward activation-barrier heights.

13. From the same energy card, calculate ΔH for both pathways. Explain why the two values must agree in this model.

14. A learner says, "The catalyst makes products more stable because the peak is lower." Correct the claim using the energy card.

15. A learner says, "The catalyst makes ΔG more negative." Correct the claim, including the phrase "at the same specified state/conditions."

16. In a reversible system at the same conditions, how can a catalyst help a system reach equilibrium sooner without changing the equilibrium position?

17. A catalyst data card shows a larger rate in one trial. List three conditions or measurements that should be matched before crediting the catalyst for the difference.

18. A trial with a catalyst also has a higher temperature than the comparison trial. Why is a catalyst-only conclusion not supported? Write a fair-test revision.

19. A concentration-time graph has only measurements at 0 and 60.0 s. State one rate quantity it supports and one claim it cannot support about how the catalyst changed rate during the interval.

20. Write a cautious claim-evidence-reasoning statement that uses both the table and energy card. Include one rate result, one barrier result, and one limit on a mechanism or equilibrium claim.