# Concentration and Temperature Effects on Rate

Student Worksheet | `g10_u03_w10`

**I can:** read concentration-time evidence, calculate interval average rates, and make a careful collision-theory interpretation of concentration and temperature trends.
**Data-card model:** for a one-to-one modeled change R → P, use $-\Delta[\mathrm{R}]/\Delta t$ for reactant disappearance and $\Delta[\mathrm{P}]/\Delta t$ for product appearance. Plot time on the horizontal axis and concentration on the vertical axis. A steeper concentration-time slope means a greater magnitude of average rate over that interval. All values are supplied data; no live reaction, heating, or chemical handling is requested.

| Time (s) | Trial C | | Trial T | |
|---|---|---|---|---|
| | [R] (M) | [P] (M) | [R] (M) | [P] (M) |
| 0 | 0.800 | 0.000 | 0.800 | 0.000 |
| 20.0 | 0.680 | 0.120 | 0.620 | 0.180 |
| 40.0 | 0.560 | 0.240 | 0.480 | 0.320 |
| 60.0 | 0.460 | 0.340 | 0.380 | 0.420 |

**Condition note:** Trials C and T are labeled separately because their complete condition cards are not identical. Use the table to calculate and compare rates; do not attribute their difference to a single cause without the listed controls.

1. Distinguish a concentration-time graph from an energy diagram. What does each graph's vertical axis represent?

2. On a concentration-time graph, which axis should show time? What units belong on each axis for the table above?

3. For a reactant curve, explain why the concentration slope is negative while the reported disappearance rate is positive.

4. For a product curve, explain why the concentration slope and reported appearance rate are positive.

5. Calculate Trial C's average disappearance rate for R from 0 to 20.0 s.

6. Calculate Trial C's average disappearance rate from 20.0 to 40.0 s.

7. Calculate Trial C's average disappearance rate from 0 to 40.0 s. Why is this an interval average rather than automatically an instantaneous rate?

8. Calculate Trial C's average appearance rate for P from 0 to 40.0 s. Compare it with item 7 using the stated one-to-one model.

9. Calculate Trial T's average disappearance rate for R from 0 to 20.0 s.

10. Calculate Trial T's average appearance rate for P from 0 to 20.0 s.

11. If you plotted Trial C [R] and [P], describe the direction of each line. Which interval appears to have the larger magnitude of reactant slope: 0–20.0 s or 40.0–60.0 s? Show evidence.

12. Find Trial C's average disappearance rate from 40.0 to 60.0 s. Write one cautious conclusion about how the interval rates change.

13. Matched concentration cards report: Low, $[A]_0 = 0.400$ M, [A] falls to 0.320 M in 20.0 s; High, $[A]_0 = 0.800$ M, [A] falls to 0.560 M in 20.0 s. Calculate both average disappearance rates.

14. Calculate the rate factor High/Low for item 13. State the observed proportional pattern without naming a reaction order or mechanism.

15. Give a collision-theory explanation that is consistent with item 14, including one condition that must be matched. Why does this explanation not prove every collision is productive?

16. Matched temperature cards report 0.00400 $\mathrm{M\,s^{-1}}$ at 293 K and 0.0100 $\mathrm{M\,s^{-1}}$ at 313 K. Calculate the rate factor.

17. Give a collision-model interpretation of item 16 that refers to an energy distribution. State one conclusion the two cards cannot establish about an exact temperature law or mechanism.

18. Correct this claim: "A steeper concentration-time line means the products are more stable and the reaction is more spontaneous."

19. A graph has only two measured points, at 0 and 60.0 s. What rate quantity can you calculate directly? What cannot be claimed about the curve between the points without additional data?

20. Draft a data-only claim-evidence-reasoning statement comparing the High and Low cards. Include the numerical evidence, at least two controlled conditions, and one mechanism limitation.