

Zero Order Reactions

Concept Deconstruction 6 – Section 3.3.1

Chip 1

Zero Order Reaction



The rate of the reaction is directly proportional to the zero power of the concentration of reactants.

$$\text{Rate} \propto [R]^0$$

(Reaction rate is entirely independent of reactant concentration).

Chip 2

Integrated Rate Law



A mathematical equation that integrates the differential rate to a form that directly link measured experimental data (concentrations at different times) to the rate constant.

Chip

01 | THE RULE

$$\text{Rate} = \frac{-d[R]}{dt}$$
$$= k[R]^0 = k$$

Rate is a constant value (k).

Chip

02 | THE EQUATION

$$[R] = -kt + [R]_0$$

Structured identically to a straight line: $y = mx + c$.

Chip

03 | THE CONSTANT

$$k = \frac{([R]_0 - [R])}{t}$$

Rearranged to solve for the rate constant.



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$$E=mc^2$$



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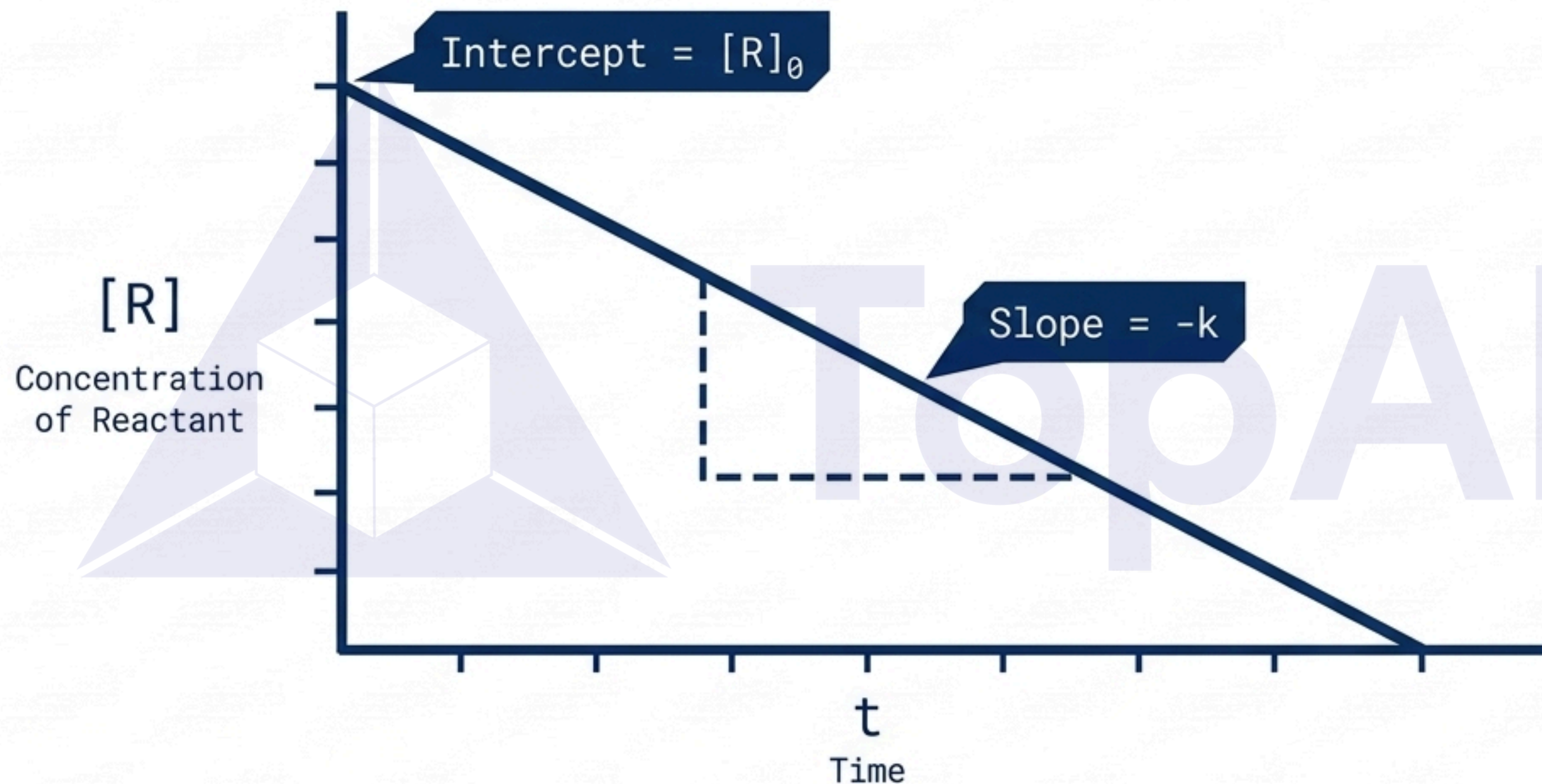
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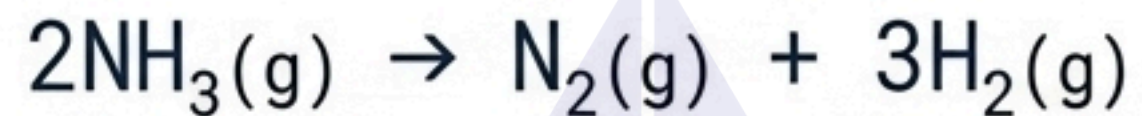
GRAPHICAL SIGNATURE: ZERO ORDER REACTION



The graphical signature of a zero order reaction: a perfect straight line for $[R]$ vs t .



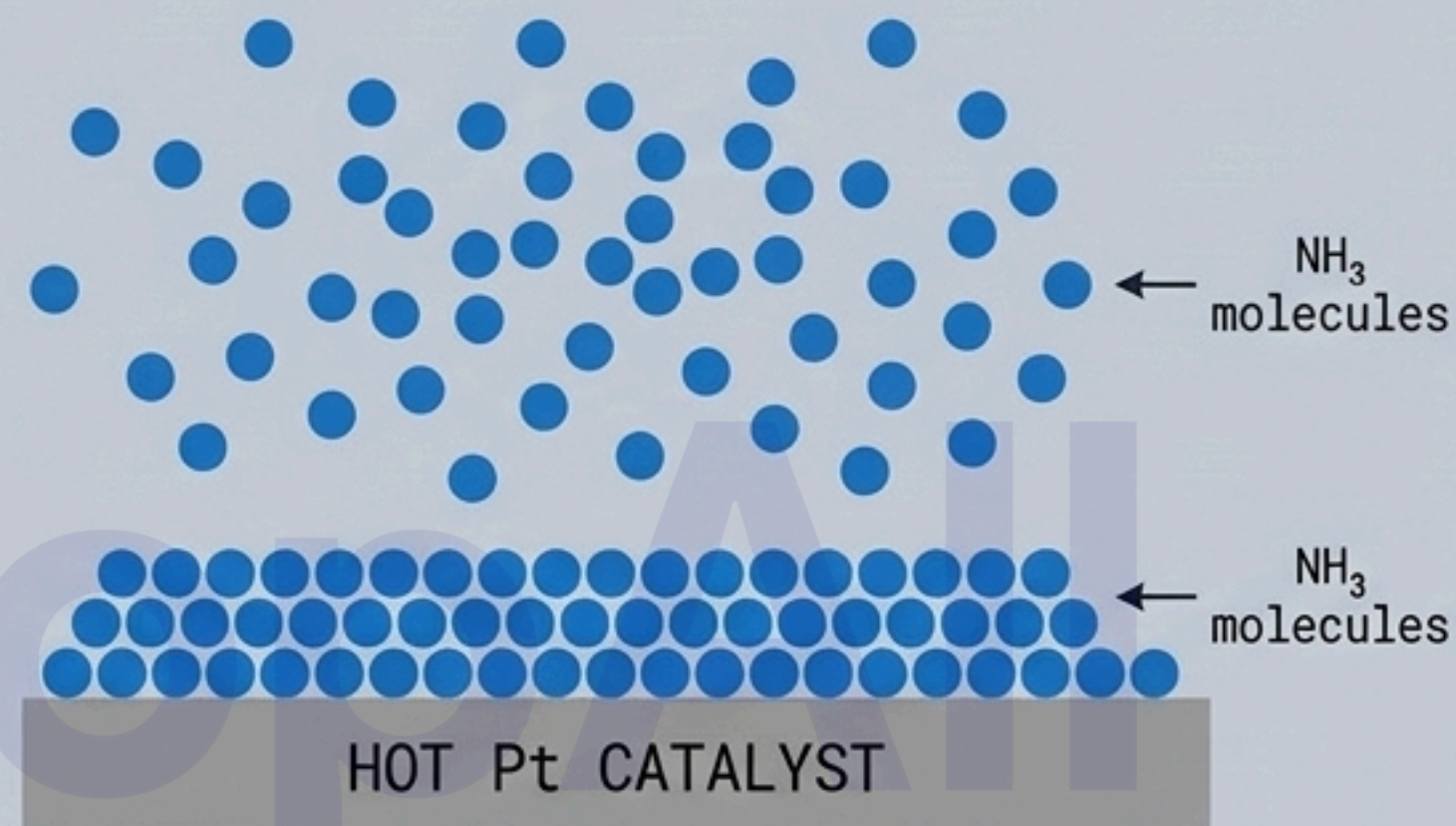
WORKED EXAMPLE



CONDITIONS: 1130K, Hot Platinum (Pt)
Catalyst, High Pressure

RESULT: $\text{Rate} = k[\text{NH}_3]^0 = k$

SATURATION MODEL



CATALYST SATURATION.

At high pressure, the metal surface is fully occupied. Adding more NH_3 above it cannot speed up the reaction because there is no room on the catalyst. Thus, rate becomes independent of concentration.

JEE/NEET TRAP ALERT

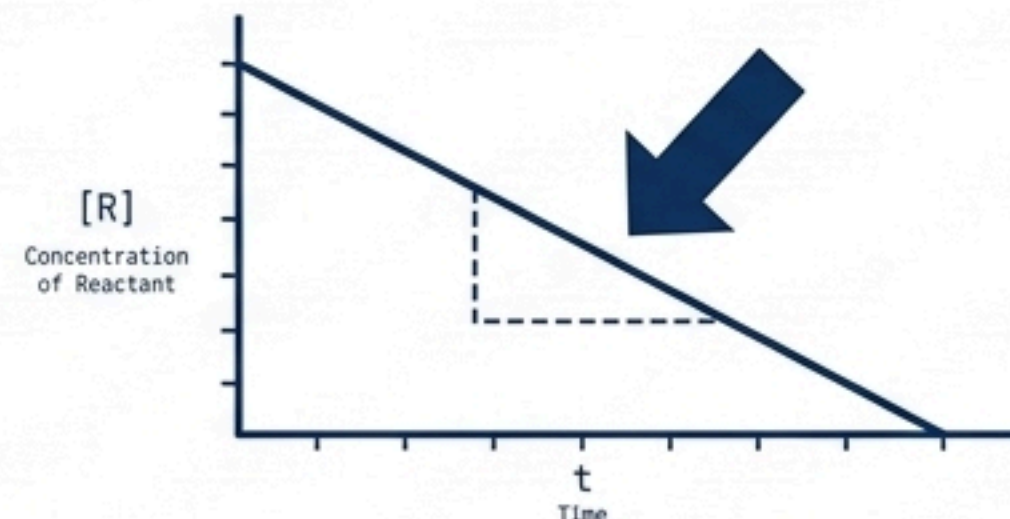
The Intuition Trap

Assuming rate **must** slow down as reactant concentration drops.

ZERO ORDER means the reaction ticks at a completely constant, absolute speed until it suddenly stops (reactant depleted).
It does NOT decelerate.

The Sign Trap

Misreading the graph's slope.



The slope is $-k$, not k . Because the rate constant (k) must be a positive value, the negative slope mathematically requires the minus sign. Don't forget the negative!

For a hypothetical reaction $R \rightarrow P$, plotting the concentration of $[R]$ against time (t) yields a straight line with a downward trajectory. What is the order of this reaction, and what does the slope of this line represent, respectively?

A) First order, slope = $-k$

B) Zero order, slope = k

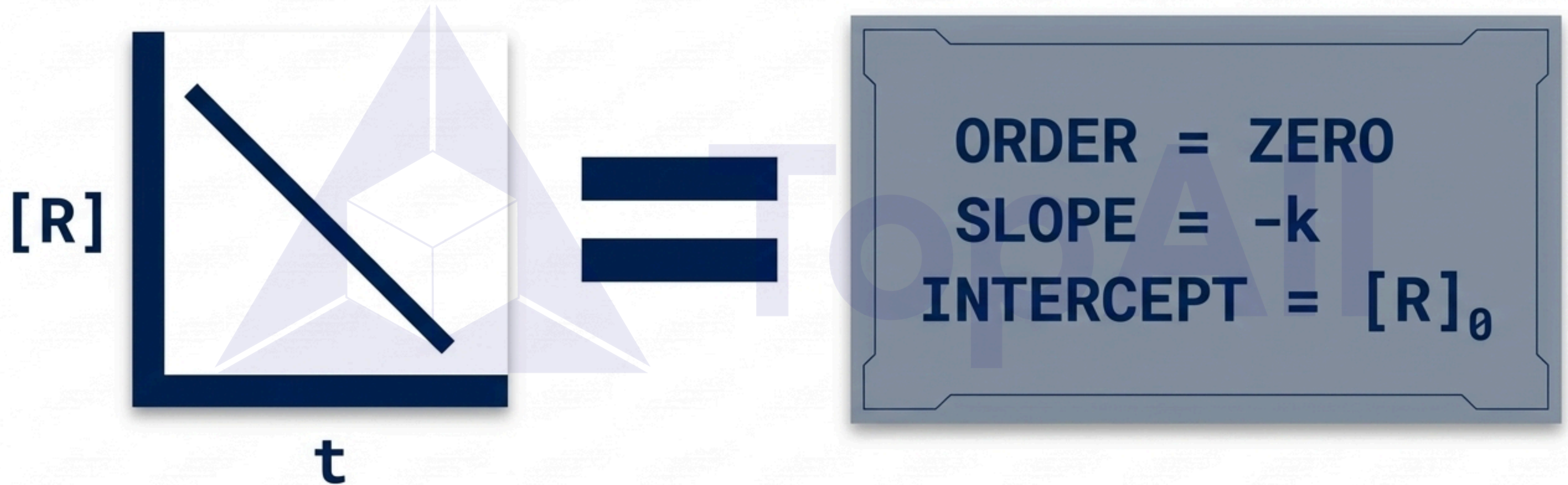
C) Zero order, slope = $-k$



D) First order, slope = k

Straight line in $[R]$ vs t indicates zero order. Equation $[R] = -kt + [R]_0$ matches $y = mx + c$, making slope = $-k$.

The Ultimate Visual Truth



If the line is straight for $[R]$ vs time, the rate is entirely independent of concentration.



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