AP Chemistry Kinetics Practice

Use this key to check answers and read the explanations.

1. A simulation plots the concentration of reactant X against time as X becomes a product. Which feature shows that X is disappearing fastest in the first five seconds?

A. The line has its steepest downward slope then.
B. The concentration is highest then.
C. The line is horizontal then.
D. The line has its shallowest downward slope then.

Correct answer: A. The line has its steepest downward slope then.
For a reactant, the disappearance rate is the negative of its concentration-versus-time slope. The steepest downward segment has the largest magnitude.

2. The vertical axis of a concentration graph is in mol/L, and the horizontal axis is in seconds. Which units describe the slope?

A. mol·s/L
B. L/(mol·s)
C. mol/(L·s)
D. mol/L

Correct answer: C. mol/(L·s)
A slope is a concentration change divided by a time change, so the units are moles per liter per second.

3. Two otherwise identical particle simulations run at different temperatures. Which statement explains why the hotter model can reach a product faster?

A. Each reactant molecule is heavier.
B. A larger fraction of collisions has enough energy to cross the barrier.
C. There is a smaller fraction of high-energy collisions.
D. Heating removes the energy difference between reactants and products.

Correct answer: B. A larger fraction of collisions has enough energy to cross the barrier.
Higher temperature shifts the collision energy distribution upward. More collisions can meet or exceed the activation energy.

4. Two drawings show equal masses of an inert model solid. One drawing splits the solid into many smaller pieces. Which quantity is greater in that drawing?

A. Density of the solid
B. Mass of solid present
C. Average size of each piece
D. Surface area available for contact

Correct answer: D. Surface area available for contact
Breaking the model solid into pieces exposes surfaces that used to be inside it. More surface is available for contact.

5. Two energy profiles have the same reactant and product energies. One route has a lower highest barrier measured from the reactants. Which conclusion follows in the usual catalyst model?

A. The catalyst makes the products have higher energy.
B. The catalyst provides an alternative pathway.
C. The catalyst changes the overall energy difference.
D. The catalyst removes the products from the system.

Correct answer: B. The catalyst provides an alternative pathway.
A catalyst can provide a path with a lower activation energy. The two profiles can still begin and end at the same energies.

6. In a fictional run, [X] drops from 0.36 to 0.24 mol/L in 30 seconds. What is the positive average disappearance rate of X over that interval?

A. 0.0040 mol/(L·s)
B. 0.012 mol/(L·s)
C. 0.120 mol/(L·s)
D. 4.0 mol/(L·s)

Correct answer: A. 0.0040 mol/(L·s)
The concentration drops by 0.12 mol/L. Dividing by 30 s yields 0.0040 mol/(L·s).

7. For the model reaction 2 X → 3 Y, Y forms at 0.060 mol/(L·s). At what positive rate is X disappearing at that instant?

A. 0.090 mol/(L·s)
B. 0.020 mol/(L·s)
C. 0.060 mol/(L·s)
D. 0.040 mol/(L·s)

Correct answer: D. 0.040 mol/(L·s)
For every three units of Y produced, two units of X disappear. Multiply the Y rate by 2/3 to get 0.040 mol/(L·s).

8. A simulation follows rate = $k[X][Y]^2$. The researcher halves [X] and doubles [Y] while keeping k fixed. What happens to the initial rate?

A. It falls to half.
B. It stays the same.
C. It doubles.
D. It quadruples.

Correct answer: C. It doubles.
The respective factors are 1/2 and 2^2. Their product is 2, so the predicted rate doubles.

9. Three simulations plot [X], ln[X], and 1/[X] against time. Only 1/[X] produces a straight line. What order does that result support for a one-reactant model?

A. Second order
B. Zero order
C. First order
D. Third order

Correct answer: A. Second order
A second-order integrated rate law gives a linear plot of 1/[X] against time. The zero- and first-order plots use [X] and ln[X], respectively.

10. Model M starts at twice the concentration of model N. Both follow first-order decay with the same rate constant. How do their half-lives compare?

A. Their half-lives differ by the starting concentration.
B. M’s half-life is twice as long.
C. N’s half-life is twice as long.
D. They are equal.

Correct answer: D. They are equal.
First-order half-life is ln(2)/k. Starting concentration does not appear, so the half-lives match.

11. A model obeys rate = $k[X]^2[Y]$, with rate in mol/(L·s) and each concentration in mol/L. Which units must k have?

A. 1/s
B. L/(mol·s)
C. $L^2/(mol^2 \cdot s)$
D. $mol^2/(L^2 \cdot s)$

Correct answer: C. $L^2/(mol^2 \cdot s)$
Divide mol/(L·s) by $(mol/L)^3$. Cancel equal factors to obtain $L^2/(mol^2 \cdot s)$.

12. A diagram shows step 1, X + Y → I, and step 2, I + Y → Z. Which overall model and intermediate follow from those two steps?

A. X + Y → Z, with I as an intermediate
B. X + 2 Y → Z, with I as an intermediate
C. X + 2 Y → Z + I, with Y as an intermediate
D. X + 2 I → Z, with Y as an intermediate

Correct answer: B. X + 2 Y → Z, with I as an intermediate
Add the equations and cancel I, which is formed in step 1 and used in step 2. Both steps consume a unit of Y.

13. For a simulated first-order decay, [X] starts at 0.640 mol/L and the half-life is 8 minutes. If the model runs for 24 minutes, what concentration remains?

A. 0.320 mol/L
B. 0.160 mol/L
C. 0.240 mol/L
D. 0.080 mol/L

Correct answer: D. 0.080 mol/L
Twenty-four minutes gives three half-lives. Multiply 0.640 by $(1/2)^3$ to get 0.080 mol/L.

14. For a first-order model, ln[X] decreases from −1.00 to −1.60 over 20 seconds. What are the rate constant and approximate half-life?

A. 0.030 s^{-1} and 23 s
B. 0.030 s^{-1} and 46 s
C. 0.60 s^{-1} and 1.2 s
D. 0.60 s^{-1} and 23 s

Correct answer: A. 0.030 s^{-1} and 23 s
The slope equals −k, so k = 0.60/20 = 0.030 s^{-1}. The half-life is 0.693/0.030, approximately 23 s.

15. A fictional model has a fast equilibrium X + Y ⇌ I with K = [I]/([X][Y]), followed by slow I + Y → Z. Which initial-rate law results if the slow step controls the rate?

A. Rate = $k_2K[X][Y]$
B. Rate = $k_2K[X][Y]^2$
C. Rate = $k_2K[X][Y]^2$
D. Rate = $k_2[X]/(K[Y])$

Correct answer: C. Rate = $k_2K[X][Y]^2$
The elementary slow step has rate $k_2[I][Y]$. Substituting [I] = K[X][Y] gives $k_2K[X][Y]^2$.