1. A reactant drops from 0.9 M to 0.6 M in 5 s. What is its average disappearance rate in M/s?

   _____ M/s

2. For rate $= k[A]^2$, doubling $[A]$ multiplies the rate by...

   ☐ 2

   ☐ 8

   ☐ 4

3. If a plot of $\ln[A]$ versus time is a straight line, the reaction is...

   ☐ first order

   ☐ zero order

   ☐ second order

4. An intermediate is a species that is...

   ☐ present at the start and end

   ☐ never involved in the reaction

   ☐ made in one step and used up in a later one

5. Select **both** conditions a collision needs to cause a reaction.

   ☐ correct orientation

   ☐ a colour change

   ☐ enough energy

   Tick every correct option.

6. Reactants at 40 kJ, peak at 100 kJ. The activation energy (in kJ)?

   _____ kJ

7. The rate-determining step is the...

   ☐ slowest elementary step

   ☐ last step

   ☐ fastest elementary step

8. If the slow first step is $NO_2 + NO_2 \rightarrow$ products, the rate law is...

   ☐ rate $= k[NO_2]$

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   ☐ rate $= k$

9. An intermediate is allowed to remain in the final rate law.

   ☐ True ☐ False

10. A catalyst is consumed (used up) by the reaction.

    ☐ True ☐ False

1. **0.06 M/s**

   Average disappearance rate is $-\Delta[A]/\Delta t = -(0.6 - 0.9)/5 = 0.06$ M/s. The minus sign makes disappearance positive; a normalized reaction rate would also divide by the reactant coefficient.

2. **4**

   Second order means $2^2 = 4$ times the rate.

3. **first order**

   A linear $\ln[A]$-versus-time plot indicates first order.

4. **made in one step and used up in a later one**

   An intermediate forms then is consumed, so it cancels overall.

5. **correct orientation; enough energy**

   A successful collision needs both sufficient energy and the right orientation.

6. **60 kJ**

   Use $E_a = H_{\text{peak}} - H_{\text{reactants}}$. Thus $E_a = 100 - 40 = 60$ kJ; the zero of the vertical axis is irrelevant.

7. **slowest elementary step**

   The slowest step is the bottleneck controlling the overall rate.

8. **rate** $= k[\mathbf{NO_2}]^2$

   Two NO_2 react in the slow step, so it is second order.

9. **False**

   Eliminate it using a justified relation; here the fast pre-equilibrium supplies that relation.

10. **False**

    A catalyst is regenerated, not used up.

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