

(a) When we compare the results of experiments 1 and 2, we see that when [NO] doubles, the rate quadruples, so the reaction is second order with respect to NO.

When we compare the results of experiments 1 and 3, we see that when [Br<sub>2</sub>] doubles, the rate doubles, so the reaction is first order with respect to Br<sub>2</sub>.

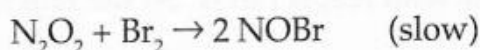
$$\text{Rate} = k[\text{NO}]^2[\text{Br}_2]$$

(b) Use the values from experiment 1, just because they look the simplest.

$$k = \frac{\text{rate}}{[\text{NO}]^2[\text{Br}_2]} = \frac{9.6 \times 10^{-2} \text{ M/sec}}{(0.02)^3 \text{ M}^3} = 1 \times 10^4 \text{ M}^{-2} \text{ sec}^{-1}$$

$$(c) \text{ rate of reaction} = \frac{1}{2} \times \frac{\Delta \text{NOBr}}{\Delta \text{time}} = \frac{1}{2} (9.6 \times 10^{-2} \text{ M/sec}) = 4.8 \times 10^{-2} \text{ M/sec}$$

(d) Choice (I) agrees with the rate law.



The slow step is the rate-determining step, with the following rate law:

$$\text{Rate} = k[\text{N}_2\text{O}_2][\text{Br}_2]$$

We can replace the intermediate (N<sub>2</sub>O<sub>2</sub>) by assuming that the first step reaches equilibrium instantaneously and remembering that at equilibrium, the rates of the forward and reverse reactions are equal.

$$k_f[\text{NO}]^2 = k_r[\text{N}_2\text{O}_2]$$

Now solve for [N<sub>2</sub>O<sub>2</sub>].

$$[\text{N}_2\text{O}_2] = \frac{k_f}{k_r} [\text{NO}]^2$$

Now we can substitute the rate law for the rate determining step.

$$\text{Rate} = k \frac{k_f}{k_r} [\text{NO}]^2 [\text{Br}_2]$$

This matches the experimentally determined rate law. By the way, the mechanism in choice (II) would have a rate law of Rate = k[Br<sub>2</sub>].