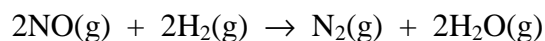


- Hydrogenation of nitric oxide to nitrogen and water is a potential means of reducing smog-forming NO_x gases:



The initial rates of this reaction at constant temperature were determined at the following combination of initial pressures (P_0).

Run	$P_0(\text{H}_2)$ / kPa	$P_0(\text{NO})$ / kPa	Rate / kPa s^{-1}
1	53.3	40.0	0.137
2	53.3	20.3	0.033
3	38.5	53.3	0.213
4	19.6	53.3	0.105

Derive an expression for the rate law for this reaction.

Between Run 1 and 2, $P_0(\text{H}_2)$ is constant and $P_0(\text{NO})$ is halved. This causes the rate to be reduced by a factor of four. The rate is second order with respect to NO.

Between Run 3 and 4, $P_0(\text{H}_2)$ is halved and $P_0(\text{NO})$ is constant. This causes the rate to be reduced by a factor of two. The rate is first order with respect to H_2 .

Overall,

$$\text{rate} = k \times P(\text{H}_2) \times P^2(\text{NO})$$

Answer: **$\text{rate} = k \times P(\text{H}_2) \times P^2(\text{NO})$**

Calculate the value of the rate constant.

Using Run 1, rate = 0.137 kPa s^{-1} when $P(\text{H}_2) = 53.3 \text{ kPa}$ and $P(\text{NO}) = 40.0 \text{ kPa}$:

$$0.137 \text{ kPa s}^{-1} = k \times 53.3 \text{ kPa} \times (40.0 \text{ kPa})^2$$

$$k = 1.61 \times 10^{-6} \text{ kPa}^{-2} \text{ s}^{-1}$$

Answer: **$k = 1.61 \times 10^{-6} \text{ kPa}^{-2} \text{ s}^{-1}$**

What is the order of the reaction?

1 (H_2) + 2 (NO) = 3 (third order)