For each of the following reactions, determine a possible mechanism based on the overall reaction and the experimental rate law. Also, identify the rate-limiting step of your mechanism.

A) **Overall Reaction: $NO_2\ (g) + CO\ (g) \rightarrow NO\ (g) + CO_2\ (g)$ Rate = $k[NO_2]^2$**

$$2\ NO_2\ (g) \rightarrow NO\ (g) + \cancel{NO_3\ (g)} \quad \text{Slow}$$

$$\cancel{NO_3\ (g)} + CO\ (g) \rightarrow CO_2\ (g) + NO_2\ (g) \quad \text{Fast}$$

$$NO_2\ (g) + CO\ (g) \rightarrow NO\ (g) + CO_2\ (g)$$

B) **Overall Reaction: $NO\ (g) + O_3\ (g) \rightarrow NO_2\ (g) + O_2\ (g)$ Rate = $k[O_3]$**

$$O_3\ (g) \rightarrow O_2\ (g) + \cancel{O\ (g)} \quad \text{Slow}$$

$$\cancel{O\ (g)} + NO\ (g) \rightarrow NO_2\ (g) \quad \text{Fast}$$

$$NO\ (g) + O_3\ (g) \rightarrow NO_2\ (g) + O_2\ (g)$$

C) **Overall Reaction: $2\ NO\ (g) + 2\ H_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$ Rate = $k[NO]^2[H_2]$**

$$2\ NO\ (g) + H_2\ (g) \rightarrow \cancel{N_2O\ (g)} + H_2O\ (g) \quad \text{Slow}$$

$$\cancel{N_2O\ (g)} + H_2\ (g) \rightarrow N_2\ (g) + H_2O\ (g) \quad \text{Fast}$$

$$2\ NO\ (g) + 2\ H_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$$

D) Overall Reaction: $2\ NO_2\ (g) + F_2\ (g) \rightarrow 2\ NO_2F\ (g)$ Rate = $k[NO_2][F_2]$

$$NO_2\ (g) + F_2\ (g) \rightarrow NO_2F\ (g) + \cancel{F\ (g)} \quad \text{Slow}$$

$$NO_2\ (g) + \cancel{F\ (g)} \rightarrow NO_2F\ (g) \quad \text{Fast}$$

$$2\ NO_2\ (g) + F_2\ (g) \rightarrow 2\ NO_2\ F\ (g)$$

E) Overall Reaction: $2\ NO_2\ (g) + O_3\ (g) \rightarrow N_2O_5\ (g) + O_2\ (g)$ Rate = $k[NO_2]\ [O_3]$

$$NO_2\ (g) + O_3\ (g) \rightarrow \cancel{NO_3\ (g)} + O_2\ (g) \quad \text{Slow}$$

$$\cancel{NO_3\ (g)} + NO_2\ (g) \rightarrow N_2O_5\ (g) \quad \text{Fast}$$

$$2\ NO_2\ (g) + O_3\ (g) \rightarrow N_2O_5\ (g) + O_2\ (g)$$

F) Overall Reaction: $2\ NO\ (g) + Cl_2\ (g) \rightarrow 2\ NOCl\ (g)$ Rate = $k[NO][Cl_2]$

$$NO\ (g) + Cl_2\ (g) \rightarrow NOCl\ (g) + \cancel{Cl\ (g)} \quad \text{Slow}$$

$$\cancel{Cl\ (g)} + NO\ (g) \rightarrow NOCl\ (g) \quad \text{Fast}$$

$$2\ NO\ (g) + Cl_2\ (g) \rightarrow 2\ NOCl\ (g)$$