that the reaction rate is directly proportional to the *square* of the reactant. An order of *zero* means that the rate does not depend on the concentration of the reactant, *as long as some of the reactant is present.* The sum of all of the reactant orders is called the *order of the reaction,* or *overall order.* The overall order of the reaction is equal to the sum of the reactant orders, or $n + m$. Some examples of observed rate laws that have been derived experimentally are shown below. Some of these reactions involve nitrogen oxides, which are highly reactive gases that contribute to the formation of smog that can blanket an entire city, as shown in **Figure 10.**

$3NO(g) \longrightarrow N_2O(g) + NO_2(g)$	$R = k[NO]^2$ second order in NO, second order overall
$NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$	$R = k[NO_2]^2$ second order in NO_2, zero order in CO, second order overall
$2NO_2(g) \longrightarrow 2NO(g) + O_2(g)$	$R = k[NO_2]^2$ second order in NO_2, second order overall
$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$	$R = k[H_2O_2]$ first order in H_2O_2, first order overall

It is important to understand that the orders in the rate law *may* or *may not* match the coefficients in the balanced equation. These orders must be determined from experimental data.

FIGURE 10 A cloud of polluted air, commonly known as smog, settles over a city. Smog is common in industrialized areas, where highly reactive gases and particulate matter are released into the air.

Specific Rate Constant

The *specific rate constant* (k) is the proportionality constant relating the rate of the reaction to the concentrations of reactants. It is important to remember the following about the value of k:

1. Once the reaction orders (powers) are known, the value of k must be determined from experimental data.
2. The value of k is for a *specific reaction;* k has a different value for other reactions, even at the same conditions.
3. The units of k depend on the *overall order of the reaction.*
4. The value of k *does not change* for different concentrations of reactants or products. So, the value of k for a reaction remains the same throughout the reaction and does not change with time.
5. The value of k is for the reaction *at a specific temperature*; if we increase the temperature of the reaction, the value of k increases.
6. The value of k changes (becomes larger) if a *catalyst* is present.