Chemistry 4000/5000/7001, Fall 2012, Assignment 1

Due: Friday, September 14, 4:00 p.m.
Total marks: 17

1. The gas-phase reaction $NO_3 + NO \rightarrow 2NO_2$ is known to be elementary.

   (a) According to the law of mass-action, what should the rate of reaction be? What is the order of the reaction with respect to $[NO_3]$? What is the overall order of the reaction? [3 marks]

   (b) What is the predicted relationship between the rate of change of the concentration of NO_2 and the reactant concentrations? [1 mark]

   (c) In gas-phase reactions, concentrations are often given in molecules per cubic centimetre (molecules cm^{-3}). Suppose that we use those units for the concentration and measure time in seconds. What are the units of the rate of reaction? What are the units of the rate constant? [2 marks]

   (d) Another option is to use pressures instead of concentrations.

      i. Using the ideal gas law, show that pressures and concentrations are proportional to each other (neglecting non-ideal behavior) at fixed temperature. [2 marks]

      ii. Give the units of the rate and rate constant if reactant and product pressures are measured in bar. [2 marks]

   Bonus: Draw Lewis structures of all reactants and products. Explain why it is plausible that this reaction is elementary.

2. (a) An often-heard rule of thumb suggests that the rate of reaction typically doubles for every 10-degree increase in the temperature. What value of the activation energy does this rule imply? [4 marks]

   (b) By what factor would the rate of reaction increase for a 10-degree increase in temperature if the activation energy was half as large as that calculated in part (a)? [2 marks]

   (c) What if the activation energy was twice as large as in part (a)? [1 mark]