CHEM1612 Problem Sheet 9 (Week 11)

**Work through the ChemCAL modules "*Reaction Rates and Chemical Kinetics 1*" and "*Reaction Rates and Chemical Kinetics 2*"**

1. One of the key reactions in the formation of acid rain and in the industrial production of nitric acid is the reaction of nitric oxide with oxygen:

$$O_2(g) + 2NO(g) \rightarrow 2NO_2(g)$$

The following data were obtained at constant temperature.

| experiment number | initial concentrations (mol $L^{-1}$) $[O_2]$ | $[NO]$ | initial reaction rate (mol $L^{-1}$ $s^{-1}$) |
|---|---|---|---|
| 1 | $1.10 \times 10^{-2}$ | $1.30 \times 10^{-2}$ | $3.20 \times 10^{-3}$ |
| 2 | $2.20 \times 10^{-2}$ | $1.30 \times 10^{-2}$ | $6.40 \times 10^{-3}$ |
| 3 | $1.10 \times 10^{-2}$ | $2.60 \times 10^{-2}$ | $12.8 \times 10^{-3}$ |
| 4 | $3.30 \times 10^{-2}$ | $1.30 \times 10^{-2}$ | $9.60 \times 10^{-3}$ |

(a) Deduce the rate equation for this reaction and find the value of the rate constant.

(b) If the initial rate of consumption of oxygen was $1 \times 10^{-3}$ mol $L^{-1}$ $s^{-1}$, what is the initial rate of formation of $NO_2(g)$?

2. The half life at 20 °C for the first order decomposition of $N_2O_5(g)$ is $6.00 \times 10^4$ s. Calculate the rate constant at this temperature.

3. Using the data below for the hydrolysis of an antibiotic in a patient, calculate the activation energy, $E_a$, and the "$A$" factor for the hydrolysis of an antibiotic.

| Temperature / °C | Rate constant, $k$ / L $mol^{-1}$ $s^{-1}$ |
|---|---|
| 37 | 0.208 |
| 40 | 0.248 |

4. For the reaction $2O_3 \rightarrow 3O_2$ a suggested mechanism is:

$$O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O \qquad \text{fast}$$

$$O_3 + O \xrightarrow{k_2} 2O_2 \qquad \text{slow}$$

(a) On the basis of this mechanism, write the rate equation for this reaction

(b) What is the molecularity of the rate determining step?