

# Chemistry 225 Semester 01-2012

## Homework for Submission #2

Answer the following questions and submit them for marking on or before 1:50 pm on Tuesday 7<sup>th</sup> February 2012 in the chemistry drop box. Only answers showing full working can attract full marks. Careless and sloppy work will be penalised. Express your answer to the correct number of significant figures. *Answers showing evidence of copying will attract zero marks.*

The decomposition of dinitrogen oxide ( $\text{N}_2\text{O}$ ) to oxygen and nitrogen is first order with a rate constant of  $0.167\text{ s}^{-1}$  at  $737^\circ\text{C}$  and  $25.4\text{ s}^{-1}$  at  $947^\circ\text{C}$ .

- Write a balanced chemical equation, and the rate equation, for the reaction.
- Calculate the activation energy for the reaction.
- Calculate the Arrhenius constant for the reaction at  $737^\circ\text{C}$ . (Note: its units are the same as those of  $k$ .)
- Calculate the rate of the reaction in  $\text{Ms}^{-1}$  if the partial pressure of  $\text{N}_2\text{O}$  is  $1.00\text{ atm}$  at  $737^\circ\text{C}$ . (Hint: determine the molarity of the gas.)
- Draw a fully-labelled energy profile diagram for the reaction assuming it occurs in a single step. Include the overall energy change for the reaction,  $\Delta E$ . (Make your graph big enough to accommodate your answer to (h) below.) If the activation energy for the back reaction is  $327\text{ kJ mol}^{-1}$ , what is the value of  $\Delta H$  for the forward reaction?
- Gold catalyses this reaction. Assuming that the Arrhenius constant remains the same for the catalysed and uncatalysed reactions, derive the expression

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{(E_2 - E_1)}{RT}$$

from the logarithmic form of the Arrhenius equation,

$$\ln(k) = \ln(A) - \frac{E_a}{RT}$$

where  $k_1$  and  $k_2$  represent the rate constants for the catalysed and uncatalysed reactions respectively,  $E_1$  and  $E_2$  the respective activation energies, and  $T$  is constant.

- The rate constant for the reaction in the presence of gold is 2.61 million times greater than that for the uncatalysed reaction at  $737^\circ\text{C}$ . Calculate the activation energy for this catalysed reaction.
- On the sketch graph that you drew in answer to (e) sketch in a line showing the energy profile for the catalysed reaction, assuming it occurs in 2 steps, the first being rate-limiting. Indicate the reactive intermediate.