Chem 2 AP Homework #13-1: The Rate of a Reaction
Problems pg 575 #1, 6, 7, 8; Extra Problem A

13.1 What is meant by the rate of a chemical reaction? What are the units for a rate of reaction?

13.6 For the following reaction, write expressions for the rates of reaction of O_2, NO, H_2O, and the overall reaction as functions of the rate of reaction of NH_3.

$$4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (g)$$

13.7 For the reaction: $2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$, if the rate of reaction of NO is 0.066 *M*/s:

$$\text{rate}_{NO} = \frac{\Delta[NO]}{\Delta t} = -0.066\ M/s$$

(a) At what rate is NO_2 being formed?

(b) At what rate is molecular oxygen reacting?

13.8 For the reaction: $N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$, consider that molecular hydrogen is reacting at 0.074 *M*/s:

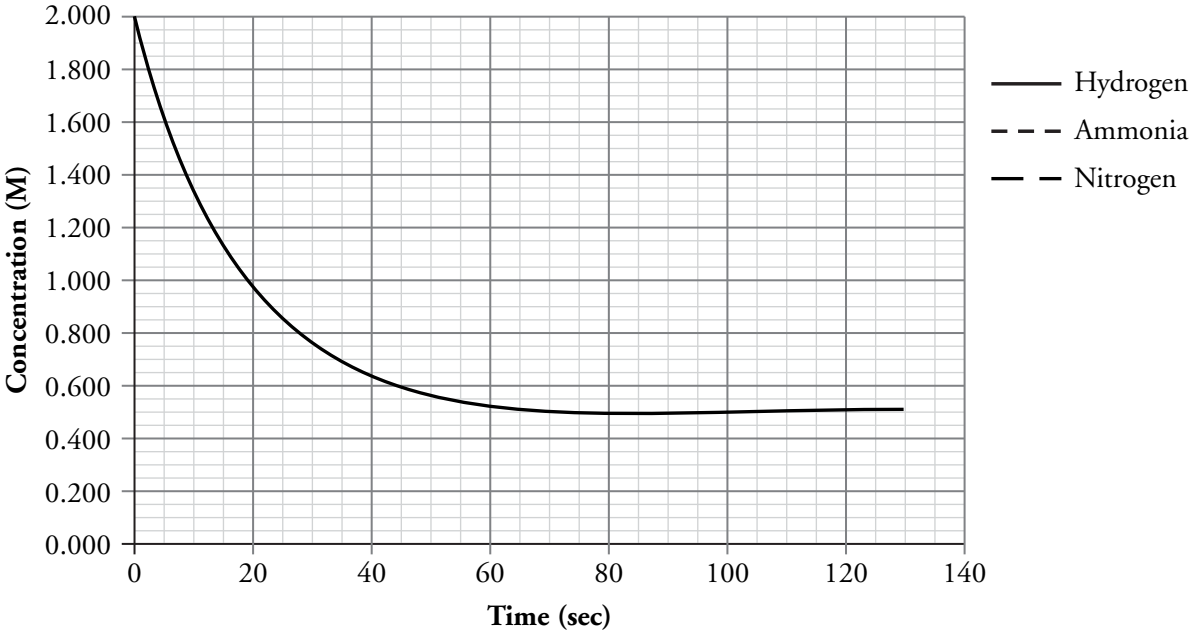
$$\text{rate}_{H_2} = \frac{\Delta[H_2]}{\Delta t} = -0.074\ M/s$$

(a) What is the rate at which ammonia is being formed?

(b) What is the rate at which nitrogen is reacting?

A. The graph below shows the rate of change for hydrogen in the following reaction. The initial concentration of nitrogen is 0.500 M. There is no presence of ammonia initially.

N_2 (g) + 3 H_2 (g) → 2 NH_3 (g)



1. **Sketch the rate curves for nitrogen and ammonia. Be certain that they reflect the correct stoichiometry.** *Hint: The reaction is definitely over at 100 secs (how do you know?). Thus, use an ICF chart to determine final concentrations of nitrogen and ammonia at 100 secs. Put in these final concentrations and the given initial concentrations into the graph. Now, use stoichiometry to get the right relative concentrations of nitrogen and ammonia at 20 secs. Now, draw smooth curves for nitrogen and ammonia.*

   (100s) N_2 (g) + 3 H_2 (g) → 2 NH_3 (g) (20 s) N_2 (g) + 3 H_2 (g) → 2 NH_3 (g)

   Initial:

   Change:

   Final:

2. **Draw the tangent to the H_2 concentration curve at t = 0 s. Use this line to determine the instantaneous initial rate of reaction for H_2. Calculate the rates of reaction for N_2 and for NH_3 from this rate.**

3. **Draw the lines and determine (a) the instantaneous rate of reaction for H_2 at t = 20 s and (b) the average rate of reaction for H_2 using the changes in concentration from 15 s to 25 s. From these calculations, is the average rate based on surrounding data points an accurate representation of the instantaneous reaction rate?**

Answers: 13.7a) 0.066 M s^{-1}; 13.7b) −0.033 M s^{-1}; 13.8a) 0.049 M s^{-1}; 13.8b) −0.025 M s^{-1}; A2) [these are approximate and depend on how you read the graph] −0.0863 M s^{-1}, −0.0288 M s^{-1}, 0.0575 M s^{-1}; A3) [these are also approximate] both rates ~−0.027 M s^{-1}