Practice Questions Section 1.3

Calculating Reaction Rates

1. In the following decomposition reaction,

   $2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$

   oxygen gas is produced at the average rate of 9.1×10^{-4} mol · L^{-1}· s^{-1}. Over the same period, what is the average rate of the following:

   the production of nitrogen dioxide

   the loss of nitrogen pentoxide

2. Consider the following reaction:

   $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$

   If the rate of loss of hydrogen gas is 0.03 mol · L^{-1}· s^{-1}, what is the rate of production of ammonia?

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Calculating Reaction Rates Answers

1. In the following decomposition reaction,

   $2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$

   oxygen gas is produced at the average rate of $9.1 \times 10^{-4}\ mol \cdot L^{-1} \cdot s^{-1}$. Over the same period, what is the average rate of the following:

   the production of nitrogen dioxide

   the loss of nitrogen pentoxide

   Solution:

   From the equation we see that for every 1 mole of oxygen formed, four moles of nitrogen dioxide are produced.

   Thus, the rate of production of nitrogen dioxide is four times that of oxygen:

   $$\text{rate } NO_2 \text{ production} = 4 \times (9.1 \times 10^{-4}\ mol \cdot L^{-1} \cdot s^{-1})$$
   $$= 3.6 \times 10^{-3}\ mol \cdot L^{-1} \cdot s^{-1}$$

   Nitrogen pentoxide is consumed at twice the rate that oxygen is produced:

   $$\text{rate loss of } N_2O_5 = 2 \times (9.1 \times 10^{-4}\ mol \cdot L^{-1} \cdot s^{-1})$$
   $$= 1.8 \times 10^{-3}\ mol \cdot L^{-1} \cdot s^{-1}$$

2. Consider the following reaction:

   $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$

   If the rate of loss of hydrogen gas is $0.03\ mol \cdot L^{-1} \cdot s^{-1}$, what is the rate of production of ammonia?

   Solution:

   From the balanced equation we see that there are 2 moles NH_3 produced for every 3 moles H_2 used. Thus:

   $$\text{rate } NH_3 \text{ production} = \frac{2\ \text{mole}\ NH_3}{3\ \text{mol}\ H_2} \times \frac{0.03\ \text{mol} \cdot L^{-1} \cdot s^{-1}\ H_2}{1}$$
   $$= 0.02\ mol \cdot L^{-1} \cdot s^{-1}$$