

# Kinetics

- ①
- mass
  - pressure
  - temperature
  - color
  - pH
  - conductivity
  - concentration

②  $\text{mol/L}\cdot\text{s}$

③ a)  $\text{rate H}_2 = 3x$        $\text{rate N}_2 = x$

$$= 3(\text{rate N}_2)$$

$$\boxed{\text{rate H}_2 = 3 \times \text{rate N}_2}$$

b)  $\text{rate NH}_3 = 2x$        $\text{rate N}_2 = x$

$$= 2(\text{rate N}_2)$$

$$\boxed{\text{rate NH}_3 = 2 \times \text{rate N}_2}$$

④  $\text{rate B} = x = 0.30 \text{ mol/L}\cdot\text{s}$

a)  $\text{rate A} = 2x$

$$= 2(0.30)$$

$$\text{rate A} = \boxed{0.60 \text{ mol/L}\cdot\text{s}}$$

b)  $\text{rate C} = 3x$

$$= 3(0.30)$$

$$\text{rate C} = \boxed{0.90 \text{ mol/L}\cdot\text{s}}$$

$$\textcircled{5} \quad \text{rate } \text{N}_2\text{O}_5 = 2x = 2.5 \times 10^{-6} \text{ mol/L}\cdot\text{s}$$

$$x = \frac{2.5 \times 10^{-6}}{2} = 1.25 \times 10^{-6}$$

$$\text{rate } \text{NO}_2 = 4x$$

$$= 4(1.25 \times 10^{-6})$$

$$\text{rate } \text{NO}_2 = \boxed{5 \times 10^{-6} \text{ mol/L}\cdot\text{s}}$$

$$\text{rate } \text{O}_2 = x$$

$$\text{rate } \text{O}_2 = \boxed{1.25 \times 10^{-6} \text{ mol/L}\cdot\text{s}}$$

$$\textcircled{6} \quad \text{a) } \text{rate } \text{O}_2 = 3x$$

$$\text{rate } \text{O}_3 = 2x$$

$$= 3 \left( \frac{\text{rate } \text{O}_3}{2} \right)$$

$$x = \frac{\text{rate } \text{O}_3}{2}$$

$$\boxed{\text{rate } \text{O}_2 = \frac{3}{2} \cdot \text{rate } \text{O}_3}$$

$$\text{b) } \text{rate } \text{NH}_3 = 4x$$

$$\text{rate } \text{O}_2 = 5x$$

$$= 4 \left( \frac{\text{rate } \text{O}_2}{5} \right)$$

$$x = \frac{\text{rate } \text{O}_2}{5}$$

$$\text{rate } \text{NH}_3 = \frac{4}{5} \cdot \text{rate } \text{O}_2$$

$$\text{rate } \text{NH}_3 = 4x$$

$$\text{rate } \text{NO} = 4x$$

$$= 4 \left( \frac{\text{rate } \text{NO}}{4} \right)$$

$$x = \frac{\text{rate } \text{NO}}{4}$$

$$\text{rate } \text{NH}_3 = \text{rate } \text{NO}$$

⑥ continued

$$\text{rate NH}_3 = 4x$$

$$= 4 \left( \frac{\text{rate H}_2\text{O}}{6} \right)$$

$$\text{rate H}_2\text{O} = 6x$$

$$x = \frac{\text{rate H}_2\text{O}}{6}$$

$$\text{rate NH}_3 = \frac{2}{3} \text{ rate H}_2\text{O}$$

$$\boxed{\text{rate NH}_3 = \frac{4}{3} \text{ rate O}_2 = \text{rate NO} = \frac{2}{3} \text{ rate H}_2\text{O}}$$

c)  $\text{rate CH}_4 = x$

$$= \frac{\text{rate O}_2}{2}$$

$$\text{rate O}_2 = 2x$$

$$x = \frac{\text{rate O}_2}{2}$$

$$\text{rate CH}_4 = \frac{1}{2} \cdot \text{rate O}_2$$

$$\text{rate CH}_4 = x$$

$$\text{rate CO}_2 = x$$

$$\text{rate CH}_4 = \text{rate CO}_2$$

$$\text{rate CH}_4 = x$$

$$\text{rate H}_2\text{O} = 2x$$

$$= \frac{\text{rate H}_2\text{O}}{2}$$

$$x = \frac{\text{rate H}_2\text{O}}{2}$$

$$\text{rate CH}_4 = \frac{1}{2} \cdot \text{rate H}_2\text{O}$$

$$\boxed{\text{rate CH}_4 = \frac{1}{2} \text{ rate O}_2 = \text{rate CO}_2 = \frac{1}{2} \text{ rate H}_2\text{O}}$$

$$\textcircled{7} \text{ a) } [\text{CH}_4]_{\text{initial}} = \frac{8 \text{ mol}}{2 \text{ L}} = 4 \text{ mol/L}$$

$$\text{rate CH}_4 = \frac{0 - 4 \text{ mol/L}}{3.2 \text{ s}} = \boxed{-1.25 \text{ mol/L}\cdot\text{s}}$$

$$\text{b) rate CH}_4 = x = -1.25 \text{ mol/L}\cdot\text{s}$$

$$\begin{aligned} \text{rate O}_2 &= 2x \\ &= 2(-1.25) \end{aligned}$$

$$\text{rate O}_2 = \boxed{-2.5 \text{ mol/L}\cdot\text{s}}$$

$$\text{c) rate CO}_2 = x$$

$$= \boxed{1.25 \text{ mol/L}\cdot\text{s}} \quad (\text{positive b/c it is increasing})$$

$$\text{d) rate H}_2\text{O} = 2x$$

$$= 2(1.25)$$

$$\text{rate H}_2\text{O} = \boxed{2.5 \text{ mol/L}\cdot\text{s}}$$

$$\textcircled{8} \text{ rate O}_2 = x = 0.0042 \text{ mol/L}\cdot\text{s}$$

$$\text{a) rate I}_2 = 2x$$

$$= 2(0.0042)$$

$$\text{rate I}_2 = \boxed{0.0084 \text{ mol/L}\cdot\text{s}}$$

⑧ continued

$$\begin{aligned} \text{b) rate } \text{H}_2\text{O} &= 2x \\ &= 2(0.0042) \end{aligned}$$

$$\text{rate } \text{H}_2\text{O} = \boxed{0.0084 \text{ mol/L}\cdot\text{s}}$$

$$\begin{aligned} \text{c) rate } \text{HI} &= -4x \\ &= -4(0.0042) \end{aligned}$$

$$\text{rate } \text{HI} = \boxed{-0.0168 \text{ mol/L}\cdot\text{s}}$$

⑨ rate  $\text{O}_2 = x = 0.024 \text{ mol/L}\cdot\text{s}$

$$\begin{aligned} \text{a) rate } \text{N}_2\text{O}_5 &= 2x \\ &= 2(0.024) \end{aligned}$$

$$\text{rate } \text{N}_2\text{O}_5 = \boxed{0.048 \text{ mol/L}\cdot\text{s}}$$

$$\begin{aligned} \text{b) rate } \text{NO}_2 &= -4x \\ &= -4(0.024) \end{aligned}$$

$$\text{rate } \text{NO}_2 = \boxed{-0.096 \text{ mol/L}\cdot\text{s}}$$