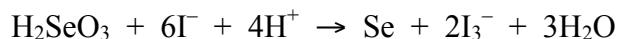


- The following reaction is run from 4 different starting positions.



Experiment	Initial $[\text{H}_2\text{SeO}_3]$ (mol L <sup>-1</sup> )	Initial $[\text{I}^-]$ (mol L <sup>-1</sup> )	Initial $[\text{H}^+]$ (mol L <sup>-1</sup> )	Initial rate of increase of $[\text{I}_3^-]$ (mol L <sup>-1</sup> s <sup>-1</sup> )
1	0.100	0.100	0.100	1.000
2	0.100	0.075	0.100	0.422
3	0.075	0.100	0.100	0.750
4	0.100	0.075	0.075	0.237

**Marks**  
**4**

Determine the rate law for the reaction.

**The rate law is of the form:**

$$\text{rate} = k[\text{H}_2\text{SeO}_3]^x[\text{I}^-]^y[\text{H}^+]^z$$

Between experiments (1) and (3),  $[\text{I}^-]$  and  $[\text{H}^+]$  are both constant. The change in rate is due to the change in  $[\text{H}_2\text{SeO}_3]$ :

$$\frac{\text{rate (3)}}{\text{rate (1)}} = \frac{k(0.075)^x(0.100)^y(0.100)^z}{k(0.100)^x(0.100)^y(0.100)^z} = \frac{(0.075)^x}{(0.100)^x} = \frac{0.750}{1.000} \quad \text{so } x = 1$$

Between experiments (1) and (2),  $[\text{H}_2\text{SeO}_3]$  and  $[\text{H}^+]$  are both constant. The change in rate is due to the change in  $[\text{I}^-]$ :

$$\frac{\text{rate (2)}}{\text{rate (1)}} = \frac{k(0.100)^x(0.075)^y(0.100)^z}{k(0.100)^x(0.100)^y(0.100)^z} = \frac{(0.075)^y}{(0.100)^y} = \frac{0.422}{1.000} \quad \text{so } y = 3$$

Between experiments (2) and (4),  $[\text{H}_2\text{SeO}_3]$  and  $[\text{I}^-]$  are both constant. The change in rate is due to the change in  $[\text{H}^+]$ :

$$\frac{\text{rate (4)}}{\text{rate (2)}} = \frac{k(0.100)^x(0.075)^y(0.075)^z}{k(0.100)^x(0.075)^y(0.100)^z} = \frac{(0.075)^z}{(0.100)^z} = \frac{0.237}{0.422} \quad \text{so } z = 2$$

**Overall:**

$$\text{rate} = k[\text{H}_2\text{SeO}_3][\text{I}^-]^3[\text{H}^+]^2$$

What is the value of the rate constant?

Using, for example, experiment (1), the initial rate of increase of  $[\text{I}_3^-] = 1.000 \text{ mol L}^{-1} \text{ s}^{-1}$ . As  $2\text{I}_3^-$  are produced in the reaction:

$$\text{rate of reaction} = \frac{1}{2} \times \text{rate of increase of } \text{I}_3^- = 0.5000 \text{ mol L}^{-1} \text{ s}^{-1}$$

**ANSWER CONTINUES ON THE NEXT PAGE**

$$\begin{aligned} \text{rate} &= k[\text{H}_2\text{SeO}_3][\text{I}^-]^3[\text{H}^+]^2 \\ &= k (0.100 \text{ mol L}^{-1})(0.100 \text{ mol L}^{-1})^3(0.100 \text{ mol}^{-1})^2 = 0.5000 \text{ mol L}^{-1} \text{ s}^{-1} \end{aligned}$$

**Hence:**

$$k = (0.5000 \text{ mol L}^{-1} \text{ s}^{-1}) / (1.00 \times 10^{-6} \text{ mol}^6 \text{ L}^{-6}) = 5.00 \times 10^5 \text{ L}^5 \text{ mol}^{-5} \text{ s}^{-1}$$

Answer:  $5.00 \times 10^5 \text{ L}^5 \text{ mol}^{-5} \text{ s}^{-1}$