Marks 6

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

$$H_2SeO_3 + 6I^- + 4H^+ \rightarrow Se + 2I_3^- + 3H_2O$$

Experiment Number	Initial $[H_2SeO_3]$ (mol L^{-1})	Initial $[I^-]$ (mol L^{-1})	Initial $[H^+]$ (mol L^{-1})	Initial rate of increase of $[I_3^-]$ (mol L^{-1} s^{-1})
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

Determine the rate law for the reaction.

The rate law has the form:

rate = $k[H_2SeO_3]^x[I^-]^y[H^+]^z$

Between experiments (1) and (2), only $[I^-]$ is varied:

$$\frac{\text{rate}_{(1)}}{\text{rate}_{(2)}} = \frac{([I^-]_{(1)})^y}{([I^-]_{(2)})^y} \quad \text{so} \quad \frac{1.000}{0.422} = \left(\frac{0.100}{0.075}\right)^y$$

Solving this gives $y = 3$.

Between experiments (1) and (3), only $[H_2SeO_3]$ is varied:

$$\frac{\text{rate}_{(1)}}{\text{rate}_{(3)}} = \frac{([H_2SeO_3]_{(1)})^x}{([H_2SeO_3]_{(3)})^x} \quad \text{so} \quad \frac{1.000}{0.750} = \left(\frac{0.100}{0.075}\right)^x$$

Solving this gives $x = 1$.

Between experiments (2) and (4), only $[H^+]$ is varied:

$$\frac{\text{rate}_{(2)}}{\text{rate}_{(4)}} = \frac{([H^+]_{(2)})^z}{([H^+]_{(4)})^z} \quad \text{so} \quad \frac{0.422}{0.237} = \left(\frac{0.100}{0.075}\right)^z$$

Solving this gives $z = 2$.

Rate law: **rate = $k[H_2SeO_3][I^-]^3[H^+]^2$**

ANSWER CONTINUES ON THE NEXT PAGE

Calculate the value of the rate constant.

Using experiment (1):

$$(1.000\ \text{mol L}^{-1}\ \text{s}^{-1}) = k \times (0.100\ \text{mol L}^{-1}) \times (0.100\ \text{mol L}^{-1})^3 \times (0.100\ \text{mol L}^{-1})^2$$

$$k = 1.00 \times 10^6\ \text{mol}^{-5}\ \text{L}^5\ \text{s}^{-1}$$

Answer: $k = 1.00 \times 10^6\ \text{mol}^{-5}\ \text{L}^5\ \text{s}^{-1}$