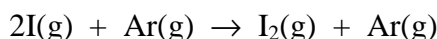


- The following data were obtained for the reaction of iodine atoms in the gas phase in the presence of argon.

**Marks**  
**4**



Experiment Number	Initial [I] (M)	Initial [Ar] (M)	Initial Reaction Rate $-\text{d}[\text{I}(\text{g})]/\text{dt}$ ( $\text{M s}^{-1}$ )
1	$1.0 \times 10^{-5}$	$1.0 \times 10^{-3}$	$8.70 \times 10^{-4}$
2	$2.0 \times 10^{-5}$	$1.0 \times 10^{-3}$	$3.48 \times 10^{-3}$
3	$2.0 \times 10^{-5}$	$5.0 \times 10^{-3}$	$1.74 \times 10^{-2}$

Derive an expression for the rate law for the formation of  $\text{I}_2(\text{g})$  and calculate the value of the rate constant for this reaction.

Between experiments (1) and (2), [Ar] is constant and [I] is doubled. This leads to the rate increasing by  $\frac{3.48 \times 10^{-3}}{8.70 \times 10^{-4}}$ : a factor of 4. The rate is proportional to  $[\text{I}]^2$ .

Between experiments (2) and (3), [I] is constant and [Ar] is increased by a factor of 5. This leads to the rate increasing by  $\frac{1.74 \times 10^{-2}}{3.48 \times 10^{-3}}$ : a factor of 5. The rate is proportional to  $[\text{Ar}]^1$ .

Overall:

$$-\text{d}[\text{I}(\text{g})]/\text{dt} = k[\text{I}]^2[\text{Ar}]$$

From experiment (1), rate =  $8.70 \times 10^{-4} \text{ M s}^{-1}$  when  $[\text{I}] = 1.0 \times 10^{-5} \text{ M}$  and  $[\text{Ar}] = 1.0 \times 10^{-3} \text{ M}$ . Hence:

$$8.70 \times 10^{-4} \text{ M s}^{-1} = k \times (1.0 \times 10^{-5} \text{ M})^2 \times (1.0 \times 10^{-3} \text{ M})$$

$$k = 8.70 \times 10^9 \text{ M}^{-2} \text{ s}^{-1}$$

Rate law:  $-\text{d}[\text{I}(\text{g})]/\text{dt} = k[\text{I}]^2[\text{Ar}]$

Rate constant:  $8.70 \times 10^9 \text{ M}^{-2} \text{ s}^{-1}$

Calculate the rate of appearance of  $\text{I}_2(\text{g})$  when  $[\text{I}(\text{g})] = 1.0 \times 10^{-3} \text{ M}$  and  $[\text{Ar}(\text{g})] = 1.0 \times 10^{-2} \text{ M}$ .

$$\begin{aligned} -\text{d}[\text{I}(\text{g})]/\text{dt} &= k[\text{I}]^2[\text{Ar}] \\ &= (8.70 \times 10^9 \text{ M}^{-2} \text{ s}^{-1}) \times (1.0 \times 10^{-3} \text{ M})^2 \times (1.0 \times 10^{-2} \text{ M}) = 87 \text{ M s}^{-1} \end{aligned}$$

From the chemical equation, two I are lost for every  $\text{I}_2$  produced. Hence:

$$\text{d}[\text{I}_2(\text{g})]/\text{dt} = \frac{1}{2} \times -\text{d}[\text{I}(\text{g})]/\text{dt} = \frac{1}{2} \times (87 \text{ M s}^{-1}) = 44 \text{ M s}^{-1}$$

Answer:  $44 \text{ M s}^{-1}$