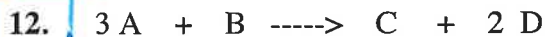


For #12, 13, and 14, determine the rate law, the value and units of k, and the overall order of the reaction.



Mixt #	Initial [A](M)	Initial [B] (M)	Initial rate of formation of D (M/s)
①	0.300	0.100	0.001157
②	0.200	0.100	0.000771
③	0.450	0.200	0.00694

(Annotations:
 - Between ① and ②: [A] increases by 1.5, rate increases by 1.5.
 - Between ② and ③: [B] doubles (x2), [A] increases by 1.5, rate increases by 6.
 - Calculation: $\frac{0.00694}{0.001157} = 5.998 \approx 6$

In mixtures 1 and 2, B is constant, and when [A] increases by a factor of 1.5, the rate also increases by a factor of 1.5. Since the concentration and rate increase by the same factor, the rxn is 1st order for A.

In mixtures ① and ③, [B] doubles, [A] increases by a factor of 1.5, and the rate increases by a factor of 6. We know that the rxn is 1st order for A, so when A increases by a factor of 1.5, this alone would cause the rate to increase by a factor of 1.5.

$$\frac{6}{1.5} = 4, \text{ so the remaining factor of 4 increase}$$

in the rate must be caused by [B] doubling.

so the rxn is 2nd order with respect to B.

$$\text{So } r = k[A]^1[B]^2$$

$$.001157 \text{ M/s} = k(.300 \text{ M})(.100 \text{ M})^2$$

$$.000771 \text{ M/s} = k(.200 \text{ M})(.100 \text{ M})^2$$

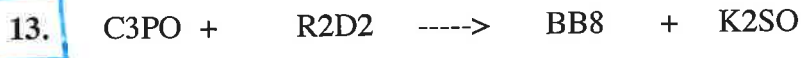
$$.00694 \text{ M/s} = k(.450 \text{ M})(.200 \text{ M})^2$$

(you can just use 1 trial, but if you do all 3, it helps to confirm your rate law is correct if k = same for each)

$$k = 0.38567 \rightarrow 0.386 \text{ M}^{-2}\text{s}^{-1}$$

$$k = 0.3855 \rightarrow 0.386 \text{ M}^{-2}\text{s}^{-1}$$

$$k = 0.3855 \rightarrow 0.386 \text{ M}^{-2}\text{s}^{-1}$$



Mix #	Initial $[C_3PO]$ (M)	Initial $[R_2D_2]$ (M)	Initial rate of formation of BB_8 (M/min)
①	0.100	0.100	0.013
②	0.900	0.200	0.078
③	0.400	0.100	0.026

In Mixtures ① and ③, $[R_2D_2]$ is constant, $[C_3PO]$ increases by a factor of 4, and the rate increases by a factor of 2, or $\sqrt{4}$, or $(4)^{1/2}$. Since the factor of 4 increase in $[C_3PO]$ causes a factor of 2 ($4^{1/2}$) increase in the rate, the rxn must be $(\frac{1}{2})$ order wrt $[C_3PO]$.

In Mixtures ① and ②, $[C_3PO]$ increases by a factor of 9 while $[R_2D_2]$ increases by a factor of 2 and the rate increases by a factor of 6.

When C_3PO increases by a factor of 9, this alone should cause the rate to increase by a factor of 3, since $(9)^{1/2} = 3$. But the rate increased by a factor of 6. $\frac{6}{3} = 2$, so the ~~rate~~ factor of 2 increase in the rate must be explained by $[R_2D_2]$ increasing by a factor of 2. So rxn is 1st order wrt R_2D_2 .

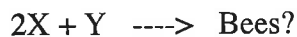
$$r = k [C_3PO]^{1/2} [R_2D_2]^1$$

$$.013 \text{ M/min} = k (0.100 \text{ M})^{1/2} (0.100 \text{ M})^1$$

$$k = 0.41 \text{ M}^{-1/2} \text{ min}^{-1} \text{ or } 0.41 \frac{\text{L}^{1/2}}{\text{mol} \cdot \text{min}}$$

(I also got the same "k" for mixtures 2 and 3)

14.



Mixt #	Initial [X](M)	Initial [Y] (M)	Initial rate of formation of Bees? (M/s)
①	0.150	0.100	0.114
② $\times 2$	0.300	0.100	0.456
③ $\times 3$	0.450	0.200	1.026

$\frac{1.026}{.114} = 9$

In mixtures ① and ②, [Y] is constant. When [X] increases by a factor of 2, the rate increases by a factor of 4, or $(2)^2$. So the rxn is 2nd order wrt X.

In mixtures ① and ③, [X] increases by a factor of 3, [Y] increases by a factor of 2, and the rate increases by a factor of 9. Since the rxn is 2nd order with respect to [X], the factor of 3 increase in [X] should (by itself) cause the rate to increase by a factor of $(3)^2$ or 9. So the ninefold increase in the ~~rate~~ rate is entirely explained by [X] tripling, which means that [Y]'s twofold increase doesn't affect the rate at all!

So it is zeroeth order wrt [Y].

$$r = k [X]^2 [Y]^0$$

or $r = k [X]^2$

$$0.114 \text{ M/s} = k (0.150 \text{ M})^2$$

$$k = 5.066\bar{6} \rightarrow 5.07 \text{ M}^{-1}\text{s}^{-1}$$

(I got the same k for all 3 mixtures) $5.07 \frac{\text{l}}{\text{mol}\cdot\text{s}}$