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

12. 3 A + B -----> C + 2 D

Mixt #	Initial [A](M)		Initial [B] (M)		Initial rate of formation of D (M/s)	
1	0.300	×1.5	0.100	×2	0.001157	×1.5
2	0.200		0.100		0.000771	
3	0.450		0.200		0.00694	

×1.5

$\frac{.00694}{.001157} = 5.998 \approx 6$

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.

$\frac{6}{1.5} = 4$, 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.

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

(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)

$.001157\ M/s = k(.300\ M)(.100\ M)^2$ $\quad k = 0.38567 \rightarrow$ 0.386 $M^{-2}s^{-1}$

$.000771\ M/s = k(.200\ M)(.100\ M)^2$ $\quad k = 0.3855 \rightarrow$ 0.386 $M^{-2}s^{-1}$

$.00694\ M/s = k(.450\ M)(.200\ M)^2$ $\quad k = 0.3855 \rightarrow$ 0.386 $M^{-2}s^{-1}$

13. C3PO + R2D2 -----> BB8 + K2SO

Mix #	Initial [C3PO](M)	Initial [R2D2] (M)	Initial rate of formation of BB8(M/min)
1	0.100	0.100	0.013
2	0.900	0.200	0.078
3	0.400	0.100	0.026

×9 ×4 ×2 ×6 ×2

In Mixtures 1 and 3, [R2D2] is constant, [C3PO] 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 [C3PO] causes a factor of 2 $(4^{1/2})$ increase in the rate, the rxn must be $(\frac{1}{2})$ order wrt [C3PO].

In Mixtures 1 and 2, [C3PO] increases by a factor of 9 while [R2D2] increases by a factor of 2 and the rate increases by a factor of 6.

When C3PO 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~~ a ~~other~~ factor of 2 increase in the rate must be explained by [R2D2] increasing by a factor of 2. So rxn is 1st order wrt R2D2

$$\boxed{r = k[C3PO]^{1/2}[R2D2]^{1}}$$

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

$\boxed{k = 0.41\ M^{-1/2}\,min^{-1}}$ or $0.41\ \frac{l^{1/2}}{mol \cdot min}$

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

14. 2X + Y ----> Bees?

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

×2 ×3 ×2 ×9 ×4

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

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 <u>2nd</u> 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 ~~fact~~ rate is entirely explained by [X] tripling, which means that [Y]'s twofold increase doesn't affect the rate at all!

So it is <u>zeroeth</u> order wrt [Y].

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

or $\boxed{r = k[X]^2}$

$0.114\ M/s = k(.150\ M)^2$

$k = 5.0666 \rightarrow \boxed{5.07\ M^{-1}s^{-1}}$

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