Chem 12 Hw set 9 - non-graded part

ch 15, 13. H_2 is lost at 3x the rate at which N_2 is lost; NH_3 is formed twice as fast as N_2 is lost; H_2 is lost 3/2 as fast as NH_3 is formed - i.e. $-\frac{d[H_2]}{dt} = \frac{3}{2}\frac{d[NH_3]}{dt}$

or $\frac{d[NH_3]}{dt} = -\frac{2}{3}\frac{d[H_2]}{dt}$

17. a. with [NO] constant, doubling $[Cl_2]$ doubles rxn rate; with $[Cl_2]$ const, doubling [NO] quadruples rxn rate

so rate $= k[Cl_2][NO]^2$

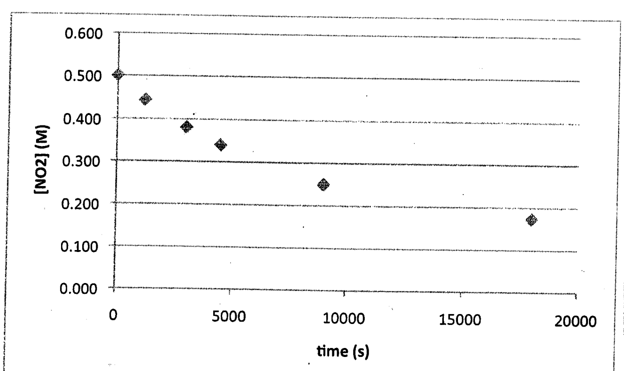
b. $k = \frac{\text{rate}}{[Cl_2][NO]^2}$ using each set of data, k = 180, 180, 181 ... let's say 180 $M^{-2}min^{-1}$

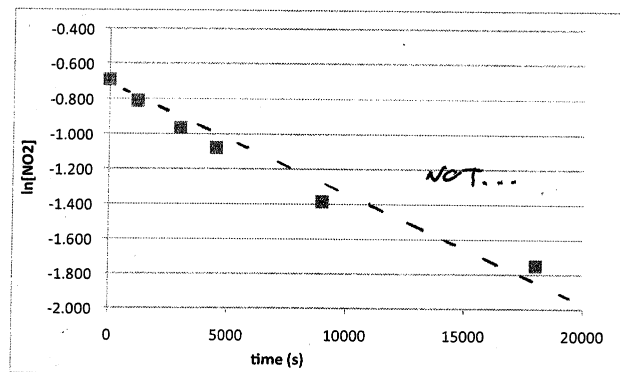
standard unit of time is seconds,

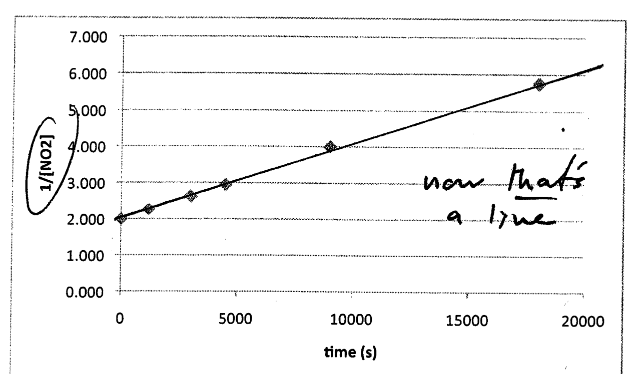
so $180\ M^{-2}min^{-1} \times \frac{1\ min}{60\ sec} = 3.0\ M^{-2}s^{-1}$

33.

time (sec)	[NO2] (M)	ln[NO2]	1/[NO2]
0	0.500	-0.693	2.000
1200	0.444	-0.812	2.252
3000	0.381	-0.965	2.625
4500	0.340	-1.079	2.941
9000	0.250	-1.386	4.000
18000	0.174	-1.749	5.747







cont'd

33. (cont'd) rate $= -\frac{d[NO_2]}{dt} = k[NO_2]^2$ since the rxn follows the integrated rate law $\frac{1}{[NO_2]} = kt + \frac{1}{[NO_2]_0}$ (i.e. $1/[NO_2]$ vs t plot is linear)

slope $= k = 2.08 \times 10^{-4}\ M^{-1}s^{-1}$
(using just the 1st + last points)

when $t = 2.70 \times 10^4$ s, $\frac{1}{[NO_2]} = 7.62$, so $[NO_2] = 0.131\ M$

39. $-\frac{d[PH_3]}{dt} = k[PH_3]$

$\Downarrow$

$\ln\left(\frac{[PH_3]_0}{[PH_3]}\right) = kt$

$t = 120$ s for $[PH_3] = [PH_3]_0/4$ (2 half-lives)

so $k = 0.0116\ s^{-1}$

for 2.00 M → 0.350 M,

$\ln\left(\frac{2.00}{0.350}\right) = (0.0116\ s^{-1})\,t$

$t = 150$ s

47. $3A + B + C \rightarrow$ prods

rate $= -\frac{1}{3}\frac{d[A]}{dt} = k[A]^2[B][C]$

[A]: 0.1 mM (1.0×10^{-4} M); [B]: 1 M, [C]: 1 M — large! so these are ~constant

— this is a pseudo-2nd-order rxn.

a. at $t = 180$ s, $[A] = 3.26 \times 10^{-5}$ M

$-\frac{d[A]}{dt} = \underbrace{3k[B][C]}_{k'}[A]^2 \Rightarrow \frac{1}{[A]} = \frac{1}{[A]_0} + k't$

plug in $[A]$, $[A]_0$, + t ⇒ $k' = 115\ M^{-1}s^{-1}$

so $k = 38.3\ M^{-3}s^{-1}$

b. "$t_{1/2}$" not meaningful for a 2nd-order rxn.

c. Plug 'n' chug - $[A] = 1.27 \times 10^{-5}$ M ; [B] ~ unchanged!