

Here's a little guidance on the old exam problems...

1. $k = 2.48 \times 10^{-11} \text{ sec}^{-1}$; $t_{1/2} = 886$ years; to reach 99% completion requires 59 centuries.
2. Isn't this a text problem (or close)? $d[\text{tBuCl}]/dt = (k_1^{1/2}k_2k_3/k_{-1}^{1/2}k_{-2})[\text{HtBu}][\text{Cl}_2]^{3/2}/[\text{HCl}]$
3. The first 3 parts are essentially what you did in lab Exp 7. $m = 2$, $n = 1$ in this case.
4. With a large concentration of NO, the loss of chlorine gas is (pseudo-)1st-order; with a large concentration of Cl_2 , the loss of NO is (pseudo-)2nd-order. The actual rate constant can be extracted from the apparent rate constant in each case. $k = 3.0 \text{ M}^{-2}\text{sec}^{-1}$.
5. Now that's definitely a text problem. Don't get confused on the implications of one step or the other being rate-limiting — if the first step is rate-limiting, i.e. *slower* than the second, then $k_2[\text{NO}] \gg k_{-1}$. Of course the rate law implied by assuming the second step is rate-limiting is the one that fits the experimental data.
6. (a) This is important. If you do it correctly, you'll find that (b) the activation energy (enthalpy) for the reverse rxn must be 28.0 kJ/mol. At 53K, the process happens on a 12.3-minute timescale; at room temp the timescale is 45.5 ps (picoseconds). You can figure out the k s and half-lives from that info.
7. Sorry, I neglected to include the plots... no biggie — they were plots of various appropriate, inappropriate things — some were linear, some were curveed. Of course, the one we wanted, based on the Arrhenius equation, was the $\ln(k)$ vs $1/T$ plot, with k in sec^{-1} and T in Kelvin (which was linear and came with the equation of the best linear fit to the data points, $y = -18704x + 34.098$). $E_a = 156 \text{ kJ/mol}$, and $A = 10^{14.8}$ (or 6.4×10^{14}). (b) calculate k , then plug 'n' chug to find a temperature of 270°C.