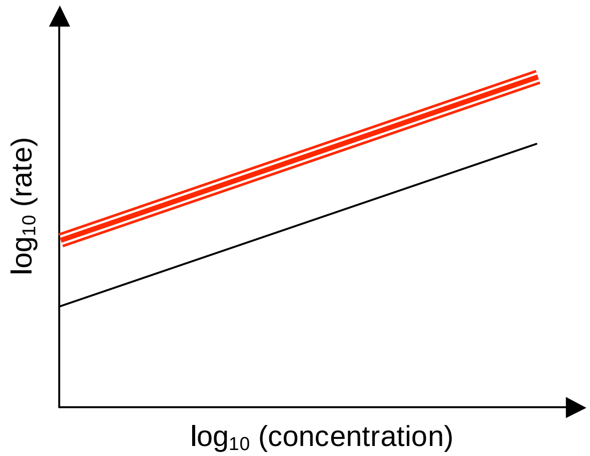
Self-Assessment: Reactions & Kinetics

Weekly Homework Quiz – Solution Outlines

1. Urbium (Ur) is an upscale element found in big cities. Its oxide (UrO_2) is not very stable and decomposes readily at temperatures exceeding 666ºC. The figure below shows how the rate of reaction varies with the concentration of UrO_2 at 777ºC. The rate, *r*, is in units of M/s and the concentration of UrO_2, *c*, is in units of M (mole/L). The slope has a value of 1.77 and the intercept has a value of 1.46.



(a) What is the order of reaction? The order is the slope: 1.77

(b) Calculate the value of the rate constant. Pay strict attention to the units.

$r = kc^n \rightarrow \log r = \log k + n \log c$; when $c = 1$, $r = k = 10^{1.46} = 28.8$
Units of $k = r/c^n = (\text{M/s})/(\text{M}^{1.77}) = \text{M}^{-0.77}/\text{s} \rightarrow k = 28.8\ \text{M}^{-0.77}/\text{s}$

(c) On the graph above, draw the line showing how the rate of reaction varies with the concentration of UrO_2 at 888ºC. No calculation necessary. Pay attention to relative values and slopes.

The upper line on the graph represents the isotherm at 888ºC. Note same slope as 777ºC but greater value of *r*-intercept.

2. Show by a calculation that the diffusion length of boron (B) in germanium (Ge) is less than 1.0 μm at a temperature of 1200 K for a diffusion time of 30 minutes. The diffusion coefficient of B in Ge at 1200 K, D_B, has the value of 2.0 x 10^{-17} m^2/s.

The diffusion length is approximated by the relationship $x = \sqrt{Dt}$ or $x = 2\sqrt{Dt}$

$$\therefore \sqrt{Dt} = \sqrt{2.0\times10^{-17}\frac{m^2}{s}\cdot 30\,\text{min}\cdot 60\frac{s}{\text{min}}} = 1.90\times10^{-7}\,m < 1.0\,\mu m$$