# The Arrhenius Eqn Worksheet Answers

① 

| $K$ | $T$ (K) |
|---|---|
| $x$ | 273 |
| $7x$ | 300 |

$$\ln\left(\frac{K_2}{K_1}\right) = \frac{-E_A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{7x}{x}\right) = \frac{-E_A}{8.314\ \text{J/mol K}}\left(\frac{1}{300\text{ K}} - \frac{1}{273\text{ K}}\right)$$

$$1.946 = -E_A\left(-3.97\times10^{-5}\right)$$

$$E_A = 49074\ \text{J/mol}$$

$$= 4.90\ \text{kJ/mol}$$

② $E_A = 420$ kJ/mol

$= 420\,000$ J/mol

$= 4.2\times10^5$ J/mol

$R = 8.314\ \frac{\text{J}}{\text{mol K}}$

| $t_{1/2}$ (s) | T(°C) | T(K) | K |
|---|---|---|---|
| 120 | 50 | 323 | y |
| x | 37 | 310 | z |

$$t_{1/2} = \frac{\ln 2}{K}$$

← determine K @ 50°C

$$K = \frac{\ln 2}{t_{1/2}}$$

$$= \frac{\ln 2}{120}$$

$$= 5.78\times10^{-3}\ \text{s}^{-1}$$

determine K at 37°C

$$\ln\left(\frac{K_2}{K_1}\right) = \frac{-E_A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{5.78\times10^{-3}}{K_1}\right) = \frac{-4.2\times10^5\ \frac{\text{J}}{\text{mol}}}{8.314\ \frac{\text{J}}{\text{mol K}}}\left(\frac{1}{323} - \frac{1}{310}\right)$$

$$\ln\left(\frac{5.78\times10^{-3}}{K_1}\right) = 6.558$$

$$\frac{5.78\times10^{-3}}{K} = 705.4$$

$$K = 8.17\times10^{-6}\ \text{s}^{-1}$$

determine half life at 37°C

$$t_{1/2} = \frac{\ln 2}{K}$$

$$= \frac{\ln 2}{8.17\times10^{-6}\ \text{s}^{-1}}$$

$$= 8.49\times10^4\ \text{s}$$

$$= 23.6\ \text{hr}$$

3. $\ln\left(\frac{k_2}{k_1}\right) = -\frac{E_A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$$\ln\left(\frac{0.6000}{0.1050}\right) = \frac{-E_A}{8.314\ J/mol\,K}\left(\frac{1}{800\,K} - \frac{1}{700\,K}\right)$$

$$1.743 = -E_A\left(-2.15\times10^{-5}\right)$$

$$E_A = 81151\ J/mol$$

$$= 81.2\ kJ/mol$$

4. $E_A = 84\ kJ/mol$

$= 84\,000\ J/mol$

$R = 8.314\ J/mol\,K$

| T (K) | k |
|---|---|
| 300 | $1.2\times10^{-2}$ |
| 500 | $k_2$ |

$$\ln\left(\frac{k_2}{k_1}\right) = -\frac{E_A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{k_2}{1.2\times10^{-2}}\right) = -\left(\frac{84\,000\ J/mol}{8.314\ \frac{J}{mol\,K}}\right)\left(\frac{1}{500\,K} - \frac{1}{300\,K}\right)$$

$$\ln \frac{k_2}{1.2\times10^{-2}} = 13.47$$

$$\frac{k}{1.2\times10^{-2}} = 7.09\times10^{5}$$

$$k = 8504$$

$$= 8.50\times10^{3}\ L/mol\cdot s$$

d. $k = 2.50 \times 10^{-8}\ s^{-1}$

$$\ln k = -22400\left(\frac{1}{T}\right) + 25.3$$

$$\ln(2.50 \times 10^{-8}) - 25.3 = -22400\ \frac{1}{T}$$

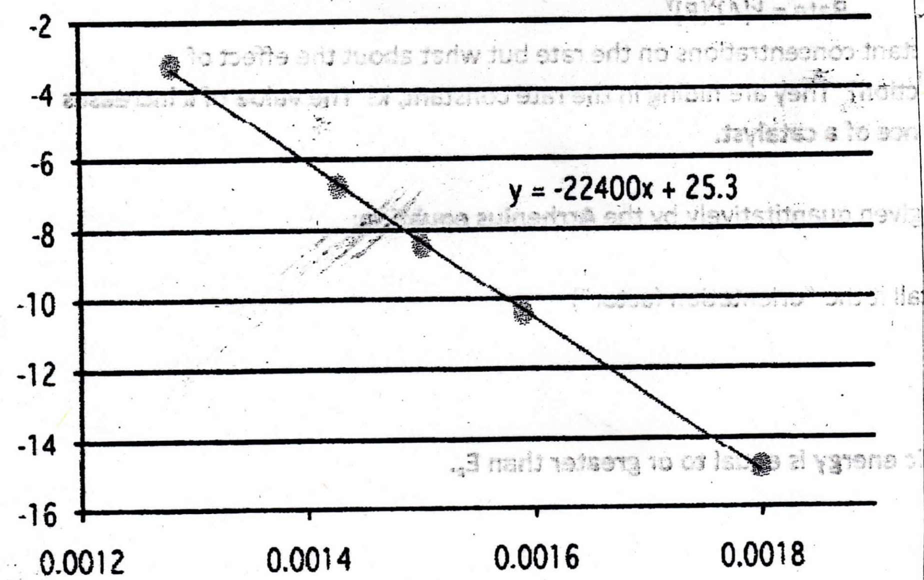
$$-22400\ \frac{1}{T} = -40.50$$

$$T = 553\ K.$$

5. The rate law constant data for the decomposition of hydrogen iodide (a first order reaction),

$$2\,HI_{(g)} \rightarrow H_{2\,(g)} + I_{2\,(g)},$$

have been plotted below according to the Arrhenius equation:




$1/T$

b. slope $= -22400 = -\frac{EA}{R}$

$EA = -22400^{k} \times -8.314$ J/mol·k

$= 186233.6$

$= 1.86 \times 10^{5}$ J/mol

$= 1.86 \times 10^{2}$ kJ/mol

c. $T = 400k$ $\qquad \frac{1}{T} = 2.5 \times 10^{-3}$ $\qquad y = -22400x + 25.3$

$\ln k = -22400 \frac{1}{T} + 25.3$

$\ln k = -22400\left(\frac{1}{400}\right) + 25.3$

$\ln k = \cancel{\phantom{xx}} -30.7$

$k = 4.65 \times 10^{-14}$