The Arrhenius Equations Questions

1. The decomposition of N_2O_5 at 308K has a rate constant of $1.35 \times 10^{-4}\ s^{-1}$. The Arrhenius constant for this reaction is $4.79 \times 10^{13}\ s^{-1}$. Calculate the activation energy of this reaction. ($R = 8.31\ JK^{-1}mol^{-1}$)

(Rearrange steps →) $k = Ae^{\left(\frac{-Ea}{RT}\right)}$ $\quad \ln k = \ln A - \frac{Ea}{RT}$ $\quad Ea = (\ln A - \ln k) \times RT$

$Ea = (\ln 4.79 \times 10^{13} - \ln 1.35 \times 10^{-4}) \times 8.31 \times 308$

$Ea = 103429.54\ J mol^{-1}$ or $103.4\ kJ mol^{-1}$

2. The same reaction is set up at a different temperature, and the rate constant is found to have a value of $2.4 \times 10\text{-}3 s^{-1}$. Given that the Arrhenius constant for this reaction is $6.22 \times 10^{13}\ s^{-1}$, but all other conditions remain the same, calculate the temperature at which this reaction occurs.

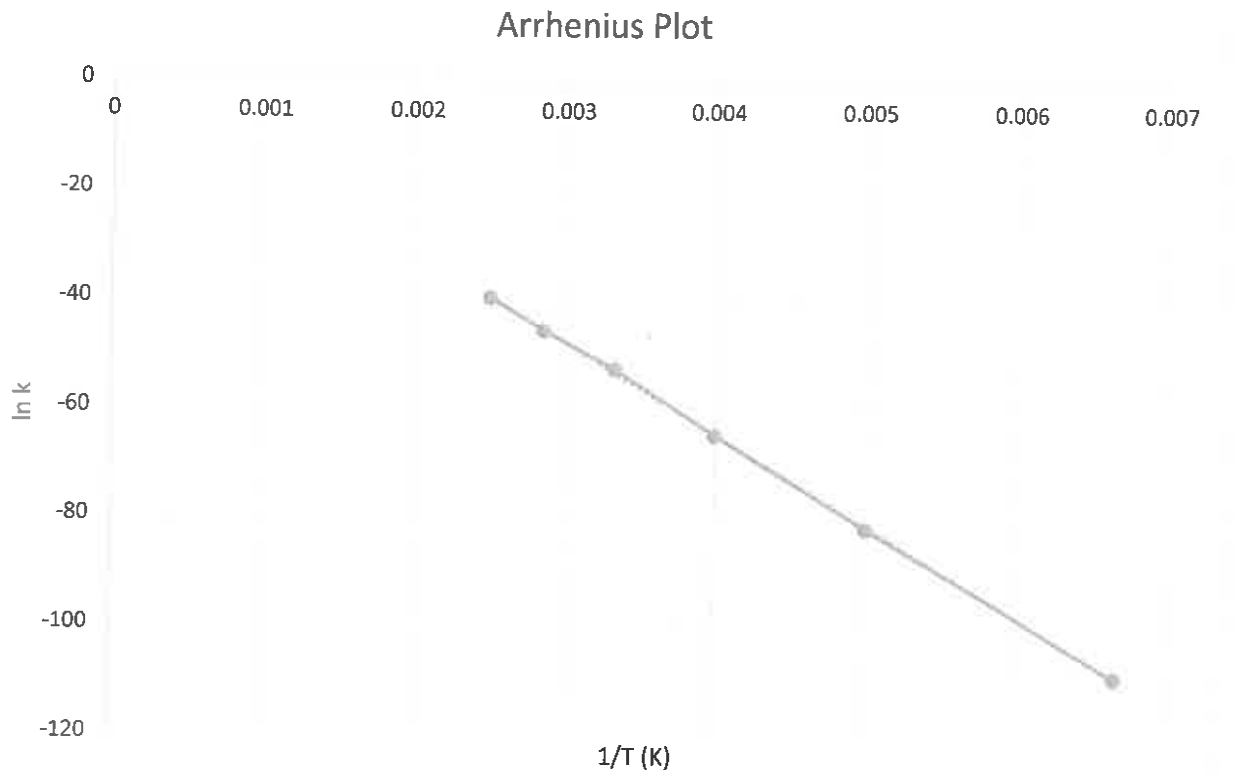
(Rearrange steps →) $k = Ae^{\left(\frac{-Ea}{RT}\right)}$ $\quad \ln k = \ln A - \frac{Ea}{RT}$ $\quad T = \frac{Ea}{R \times (\ln A - \ln k)}$

$$T = \frac{103429.54}{8.31 \times (\ln 6.22 \times 10^{13} - \ln 2.4 \times 10^{-3})}$$

$T = 329\ K$

3.

T / K	k / s-1	1/T	lnk
150	4.59E-48	0.006667	-109
200	2.44E-36	0.005	-82.0011
250	5.90E-29	0.004	-65
300	9.60E-24	0.003333	-53.0003
350	1.05E-20	0.002857	-46.0029
400	4.25E-18	0.0025	-39.9996



Y intercept =	1.737901	= ln A
Gradient =	-16645.3	= -Ea/RT
Ea =	-138322	

To find out A you will need to choose a temp and k value from the table, for example @ 150k.

$$A = \frac{k}{e^{-Ea/RT}} \qquad A = \frac{4.59 \times 10^{-48}}{e^{(-137910.6/8.31 \times 150)}}$$

$$A = 5.1\,s^{-1}$$