84.122-204
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Quiz 13

Name KEY
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Integrated Rate Laws: $\ln [A] = -kt + \ln[A]_o$

$1/[A] = kt + 1/[A]_o$

First-order Half-life: $k=0.693/t_{1/2}$

$k = Ae^{-(Ea/RT)}$ $\ln [k_1/k_2] = E_a/R\,[1/T_2 - 1/T_1]$ $R=8.314$ J/mol-K

1. The first-order decay of radon has a half-life of 3.823 days. How many grams of radon remain after 8.50 days if the sample initially weighs 250.0 grams? Show your work. (10 pts)

$\ln [A] = -kt + \ln [A]_o$ $\quad k = \frac{.693}{3.823 \text{ days}} = 1.813 \times 10^{-1}\ d^{-1}$

$\ln [A] = -(1.813 \times 10^{-1} d^{-1})(8.50 d) + \ln [250.0]$

$= -1.541 + 5.5215 = 3.980$

$[A] = e^{3.980} = 53.5$ grams

2. How does the presence of a catalyst affect the activation energy of a reaction? (Circle your choice.) (8 pts)

a) A catalyst increases the activation energy of a reaction.
(b) A catalyst decreases the activation energy of a reaction.
c) A catalyst does not affect the activation energy of a reaction.
d) It depends on whether you are talking about the forward or the reverse reaction.

3. The first-order rearrangement of CH_3NC is measured to have a rate constant of $3.61 \times 10^{-15}\ s^{-1}$ at 298 K and a rate constant of $8.66 \times 10^{-7}\ s^{-1}$ at 425 K. Determine the activation energy for this reaction. Show your work. (8 pts)

$$\ln\left[\frac{k_1}{k_2}\right] = \frac{E_a}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

$$\ln \frac{3.61 \times 10^{-15}\ s^{-1}}{8.66 \times 10^{-7}\ s^{-1}} = \frac{E_a}{8.314\ J/mol \cdot K}\left[\frac{1}{425\ K} - \frac{1}{298\ K}\right]$$

$$\ln(4.17 \times 10^{-9}) = \frac{E_a}{8.314\ J/mol \cdot K}\underbrace{\left[2.35 \times 10^{-3} - 3.36 \times 10^{-3}\right]}_{-1.006 \times 10^{-3}\ K^{-1}}$$

$$-19.30$$

$$\frac{(-19.30)(8.314\ J/mol\ K)}{-1.006 \times 10^{-3}\ K^{-1}} = E_a$$

$$\frac{-19.30(8.314\ J/mol\ K)}{-1.006 \times 10^{-3}\ K^{-1}} = 1.60 \times 10^{5}\ \frac{J}{mol} = 160.\ \frac{kJ}{mol}$$

4 Given the following proposed mechanism, predict the rate law for the overall reaction. (8 pts)

Overall Reaction: $2NO_2 + Cl_2 \rightarrow 2NO_2Cl$

Mechanism

Step 1: $NO_2 + Cl_2 \rightarrow NO_2Cl + Cl$ (slow)

Step 2: $NO_2 + Cl \rightarrow NO_2Cl$ (fast)

(a) Rate = $k[NO_2][Cl_2]$

b) Rate = $k[NO_2]^2[Cl_2]$

c) Rate = $k[NO_2][Cl]$

d) Rate = $k[NO_2Cl][Cl]$

e) Rate = $k[NO_2Cl]^2$

5. In the reaction mechanism provided in question 4, Cl is: (circle your choice) (6 pts)

a) a catalyst

(b) a reaction intermediate

c) a reaction inhibitor

d) a reaction product

e) a reaction accelerator