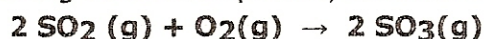


Chapter 12 Chemical Kinetics

1) Given the following balanced equation, determine the rate of reaction with respect to $[\text{SO}_2]$.

A) $\text{Rate} = -\frac{1}{2} \frac{\Delta[\text{SO}_2]}{\Delta t}$

B) $\text{Rate} = +\frac{1}{2} \frac{\Delta[\text{SO}_2]}{\Delta t}$

C) $\text{Rate} = -\frac{\Delta[\text{SO}_2]}{\Delta t}$

D) $\text{Rate} = +\frac{2\Delta[\text{SO}_2]}{\Delta t}$

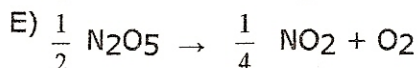
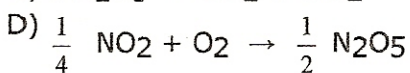
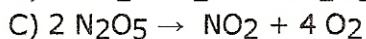
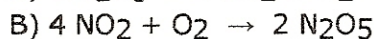
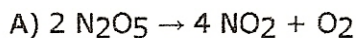
E) It is not possible to determine without more information

My answer is letter

A

2) Which balanced reaction describes the following rate relationships.

$$\text{Rate} = -\frac{1}{2} \frac{\Delta[\text{N}_2\text{O}_5]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t} = \frac{\Delta[\text{O}_2]}{\Delta t}$$



My answer is letter

A3) Given the following balanced equation, determine the rate of reaction with respect to $[\text{NOCl}]$.If the rate of Cl_2 loss is $4.84 \times 10^{-2} \text{ M/s}$, what is the rate of formation of NOCl ?

A) $4.84 \times 10^{-2} \text{ M/s}$

B) $2.42 \times 10^{-2} \text{ M/s}$

C) $1.45 \times 10^{-1} \text{ M/s}$

D) $9.68 \times 10^{-2} \text{ M/s}$

E) $1.61 \times 10^{-2} \text{ M/s}$

My answer is letter

D

rate of change for NOCl
is twice that of Cl_2

$$2 \times 4.84 \times 10^{-2} \text{ M/s} = 9.68 \times 10^{-2} \text{ M/s}$$

- 4) What is the overall order of the following reaction, given the rate law?



- A) 1st order
 B) 2nd order
 C) 3rd order
 D) $1\frac{1}{2}$ order
 E) 0th order

1st order for NO
 1st order for O₃

 2nd order overall
 1 + 1 = 2

My answer is letter

B

- 5) i. Given the rate law, $\text{Rate} = k[\text{X}][\text{Y}]^2$, how does the rate of reaction change if the concentration of **Y** is doubled?
 ii. For this same rate law, how does the rate of reaction change if the concentration of **X** is doubled?

- A) The rate of reaction will increase by a factor of 2.
 B) The rate of reaction will increase by a factor of 4.
 C) The rate of reaction will increase by a factor of 5.
 D) The rate of reaction will decrease by a factor of 2.
 E) The rate of reaction will remain unchanged

My answer is letter

i. Bii. AFor the first order integrated rate law: $\ln[A]_t = -kt + \ln[A]_0$

- 6) The first-order decomposition of cyclopropane has a rate constant of
- $6.7 \times 10^{-4} \text{ s}^{-1}$
- . If the initial concentration of cyclopropane is 1.33 M, what is the concentration of cyclopropane after 644 s?

- A) 0.43 M
 B) 0.15 M
 C) 0.94 M
 D) 0.86 M
 E) 0.67 M

$$[\text{cyclopropane}]_0 = 1.33 \text{ M}$$

$$k = 6.7 \times 10^{-4} \text{ s}^{-1}$$

$$t = 644 \text{ s}$$

My answer is letter

D

$$\ln[\text{cyclopropane}]_{t=644\text{s}} = (-6.7 \times 10^{-4} \text{ s}^{-1})(644 \text{ s}) + \ln 1.33 \text{ M}$$

$$\ln [C_P] = -.146 \quad [C_P] = e^{-.146}$$

$$[C_P]_{t=644\text{s}} = 0.86 \text{ M}$$

- 7) The first-order decay of radon has a half-life of 3.823 days. How many grams of radon remain after 7.646 days if the sample initially weighs 250.0 grams?

A) 4.21 g
B) 183 g
C) 54.8 g
D) 76.3 g
E) 62.5

$$\begin{array}{l} 250\text{g} \xrightarrow{1^{\text{st}} \text{ half-life}} 125\text{g} \text{ in } 3.823 \text{ days} \\ 125\text{g} \xrightarrow{2^{\text{nd}} \text{ half-life}} 62.5\text{g} \text{ in } 3.823 \text{ days} \\ \hline \text{OR} \\ 7.646 \text{ days} \end{array}$$

My answer is letter

E

$$\ln \frac{N_t}{N_0} = -kt \quad \text{where } k = 0.693/t_{1/2} \quad 3.823 = 0.693/k \quad k = 0.181$$

$$\ln \frac{N_t}{250} = -0.181(7.646 \text{ days}) \quad \therefore \ln N = 4.1355 \quad N = e^{4.1355} = 62.5\text{g}$$

For the **SECOND** order half life expression: $t_{1/2} = 1/[A]_0 k$

- 8) The half-life for the second-order decomposition of HI is 15.4 s when the initial concentration of HI is 0.67 M. What is the rate constant for this reaction?

A) $1.0 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$
B) $4.5 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$
C) $9.7 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$
D) $2.2 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$
E) $3.8 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$

$$t_{1/2} = 15.4 \text{ s}$$

$$[HI]_0 = 0.67 \text{ M}$$

$$15.4 \text{ s} = 1 / 0.67 \text{ M } k$$

$$k = 1 / 0.67 \text{ M} \times 15.4 \text{ s} = 9.7 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$$

My answer is letter

C

$$\text{Given: } \ln(k_2/k_1) = -E_a/R \left(1/T_2 - 1/T_1 \right) = (E_a/R) \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

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

A) 160. kJ/mol
B) 240. kJ/mol
C) 417 kJ/mol
D) 127 kJ/mol
E) 338 kJ/mol

$$t_1 = 298^\circ\text{K} \quad k_1 = 3.61 \times 10^{-15} \text{ s}^{-1}$$

$$t_2 = 425^\circ\text{K} \quad k_2 = 8.66 \times 10^{-7} \text{ s}^{-1}$$

My answer is letter

A

$$\ln(8.66 \times 10^{-7} \text{ s}^{-1} / 3.61 \times 10^{-15} \text{ s}^{-1}) = (+E_a / 8.314 \text{ J/mol K}) \left(\frac{1}{298 \text{ K}} - \frac{1}{425 \text{ K}} \right)$$

$$\ln(2.4 \times 10^8) = \frac{E_a}{8.314 \text{ J/mol K} (0.001 \text{ K})}$$

$$\frac{(8.314 \text{ J/mol K}) 19.3}{0.001} = E_a = 160 \text{ kJ/mol}$$

- 10) A reaction is found to have an activation energy of 108 kJ/mol. If the rate constant for this reaction is $4.60 \times 10^{-6} \text{ s}^{-1}$ at 275 K, what is the rate constant at 366 K?

- A) 11.7 s^{-1}
B) 1.72 s^{-1}
C) 0.580 s^{-1}
D) $5.40 \times 10^{-5} \text{ s}^{-1}$
E) $1.85 \times 10^{-4} \text{ s}^{-1}$

$$T_1 = 275 \text{ K} \quad k_1 = 4.60 \times 10^{-6} \text{ s}^{-1}$$
$$T_2 = 366 \text{ K} \quad k_2 = ?$$

My answer is letter

C

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

$$\ln k_2 = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right) + \ln k_1 = \frac{108000 \text{ J/mol}}{8.314 \text{ J/mol K}} \left(\frac{1}{275 \text{ K}} - \frac{1}{366 \text{ K}} \right) - \ln 4.60 \times 10^{-6} \text{ s}^{-1}$$

$$\ln k_2 = -0.5495 \quad k_2 = e^{-0.5495} = 0.58 \text{ s}^{-1}$$

- 11) Match the following.

Write your letter answer below:

i) k

E

A) reaction order

ii) $t_{1/2}$

D

B) activation energy

iii) E_a

B

C) frequency factor

iv) A

C

D) half-life

v) n , in Rate = $k[A]^n$

A

E) rate constant