Assignment 12

Due on 2020-04-30, 23:59:59 ET

1. On your sheet of paper, write down the answer to the following question:

What is the half-life of a radioactive isotope with a decay constant of 0.05 per minute?

2. The half-life of a radioactive isotope is related to its nuclear properties by the following equation:

\[ t_{1/2} = \frac{\ln 2}{\lambda} \]

where \( t_{1/2} \) is the half-life and \( \lambda \) is the decay constant. Calculate the half-life of an isotope with a decay constant of 0.1 per minute.

3. The rate constant for a first-order reaction is given by the Arrhenius equation:

\[ k = Ae^{-\frac{E_a}{RT}} \]

where \( A \) is the pre-exponential factor, \( E_a \) is the activation energy, \( R \) is the gas constant, and \( T \) is the temperature in Kelvin. If the rate constant for a certain reaction at 300 K is 0.1 s\(^{-1}\) and the activation energy is 100 kJ mol\(^{-1}\), calculate the rate constant at 400 K.

4. The rate of a second-order reaction is given by the rate law:

\[ \text{Rate} = k[A]^2 \]

where \( [A] \) is the concentration of reactant A. If the rate law of a reaction is \( \text{Rate} = 0.01 \text{ M s}^{-1} [A]^2 \) and the concentration of A is 0.5 M, calculate the rate of the reaction.

5. The rate of a reaction is given by the integrated rate law for a first-order reaction:

\[ \frac{1}{[A]} = kt + \frac{1}{[A]_0} \]

where \( [A] \) is the concentration of reactant A at time \( t \), \( [A]_0 \) is the initial concentration of A, and \( k \) is the rate constant. If the initial concentration of A is 0.1 M and the concentration at time \( t \) is 0.05 M, calculate the rate constant if the reaction order is 1.

6. The rate of a reaction is given by the integrated rate law for a second-order reaction:

\[ \frac{1}{[A]} = 2kt + \frac{1}{[A]_0} \]

where \( [A] \) is the concentration of reactant A at time \( t \), \( [A]_0 \) is the initial concentration of A, and \( k \) is the rate constant. If the initial concentration of A is 0.01 M and the concentration at time \( t \) is 0.005 M, calculate the rate constant if the reaction order is 2.

7. The rate of a reaction is given by the integrated rate law for a third-order reaction:

\[ \frac{1}{[A]^3} = 3kt + \frac{1}{[A]_0^3} \]

where \( [A] \) is the concentration of reactant A at time \( t \), \( [A]_0 \) is the initial concentration of A, and \( k \) is the rate constant. If the initial concentration of A is 0.001 M and the concentration at time \( t \) is 0.0005 M, calculate the rate constant if the reaction order is 3.

8. The rate of a reaction is given by the integrated rate law for a fourth-order reaction:

\[ \frac{1}{[A]^4} = 4kt + \frac{1}{[A]_0^4} \]

where \( [A] \) is the concentration of reactant A at time \( t \), \( [A]_0 \) is the initial concentration of A, and \( k \) is the rate constant. If the initial concentration of A is 0.0001 M and the concentration at time \( t \) is 0.00005 M, calculate the rate constant if the reaction order is 4.