Rate Law Proofs

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1 Zero Order

$$\boxed{A = -kt + A_0}$$

1.1 Half Life

$$\frac{1}{2}A_0 = -kt + A_0$$

$$\boxed{t = \frac{A_0}{2k}}$$

2 First Order

$$\text{Rate} = \frac{dA}{dt} = -kA$$

$$\frac{1}{A}dA = -kdT$$

$$\int \frac{1}{A}\, dA = \int -k\, dt$$

$$\ln(|A|) = -kt + C$$

$$e^{-kt+C} = A$$

At time t=0, A = A0, so $e^C = A_0$

$$\boxed{A = A_0 e^{-kt}}$$

2.1 Half Life

$$\frac{1}{2}A_0 = A_0 e^{-kt}$$

$$\boxed{t = -\frac{-\ln(\frac{1}{2})}{k}}$$

3   Second Order

$$\text{Rate} = \frac{dA}{dt} = -kA^2$$

$$\int \frac{1}{A^2} \, dA = \int -k \, dt$$

$$\frac{-1}{A} = -kt + C$$

$$\text{At time t=0, } \frac{-1}{A} = C = \frac{1}{A_0} \text{ so } C = \frac{-1}{A_0}$$

$$\boxed{\frac{1}{A} = kt + \frac{1}{A_0}}$$

3.1   Half Life

$$\frac{1}{\frac{1}{2}A_0} = kt + \frac{1}{A_0}$$

$$\boxed{t = \frac{1}{kA_0}}$$