Determining Rate Laws: \( \text{rate} = k [A]^m [B]^n \)

1) Find \( m \) and \( n \)
   a) \( \frac{\text{rate}_1}{\text{rate}_2} = \frac{k [A]^m [B]^n}{k [A]^m [B]^n} \) or \( \frac{\text{rate}_1}{\text{rate}_2} = \frac{k [A]^m [B]^n}{k [A]^m [B]^n} \)
   b) \( \frac{\text{rate}_2}{\text{rate}_2} = \left( \frac{[A]}{[B]} \right)^m \) or \( \frac{\text{rate}_2}{\text{rate}_2} = \left( \frac{[A]}{[B]} \right)^n \)

2) Find \( k \)
   a) \( \text{rate}_a = k [A]^m [B]^n \)

Clicker Question:
\( A(g) \rightarrow 2C(g) \)

1 unit of \( A \) makes 2 units of \( C \), so \( C \) is appearing 2x as fast as \( A \) is disappearing (or \( A \) is disappearing ½ as fast as \( C \) is appearing).

\( \frac{1}{2}(6.2 \times 10^{-2}) = 3.1 \times 10^{-2} \), therefore -3.1\( \times 10^{-2} \) is the answer (negative sign for disappearing)

Half-life: time it takes for ½ of the substance to react

1. time of ½ life only depends on the \( k \) value (rest are constants)
   a. \( [A_i] \) is going to become ½ \( [A_o] \)
      i. \( \frac{[A_{0,2}]}{[A_{0,1}]} = \frac{1}{2} \)
   b. \( \ln[A_i] = \ln[A_o] - k t \)
      i. \( kt = \ln \left( \frac{[A_0]}{[A_i]} \right) \)
      ii. \( K = \frac{t_{\text{half-life}} = \ln 2}{k} \)
   c. \( t_{\text{half-life}} = \frac{\ln 2}{k} \)

2. \( [A_i] = \frac{1}{2} \times \text{half-life} [A_o] \)

   a. \( \frac{1}{2} \times \text{half-life} \) # of half-lives
   b. \( t = \text{time elapsed} \)
   c. \( [A_{\text{end}}] = \frac{1}{2} \times \frac{t_{\text{end}}}{t_{\text{half-life}} [A_{\text{start}}]} \)
**Causes of Reaction Rates**

1. Concentration Rates
   a. \([A] \text{ and } [B]\)
      i. More collisions \(\rightarrow\) more reactions

2. Temperature
   a. \(T\)
      i. More collisions \(\rightarrow\) more reactions

3. Frequency Factor (% of collisions that happen at the right orientations of the reactants to create products)
   a. \(A\)
      i. Higher % \(\rightarrow\) more reactions

4. Activation Energy (Energy required to start off the reaction)
   a. \(E_a\)
      i. Lower \(E_a\) \(\rightarrow\) more reactions

Summed up by:

5. 
   \[ k = A \ e^{-\frac{E_a}{RT}} \]

Can be rewritten by:

6. 
   \[ (\ln k) = (\ln A) - \left(\frac{E_a}{R}\right) \times \left(\frac{1}{T}\right) \]

7. 
   \[ (y \text{ value}) = (y \text{ intercept}) - (slope) \times (x \text{ value}) \]

Therefore:

8. 
   \[ \frac{E_a}{R} = \frac{\Delta A}{\Delta T} \]