13.10

$0^{th}$ order

rate = $k [A]$

rate = $k$ units for $k = \frac{M}{s}$

$1^{st}$ order

rate = $k [A]$ units for $k = \frac{1}{s}$ or M$^{-1}$s$^{-1}$

$2^{nd}$ order

rate = $k [A]^2$

$k = \frac{\text{rate}}{[A]^2} = \frac{\frac{M}{s}}{M^2} \Rightarrow \frac{M}{Ms^2} = \frac{1}{Ms}$

units for $k = \frac{1}{Ms}$ or M$^{-1}$s$^{-1}$

3.11

rate law: rate = $k [A]^0$

units for $k$: M/s

\[ \text{rate (M/s)} \]

\[ [A] \text{ (M)} \]
13.12

**Temperature**

13.13

_Given:_  

\[
\text{rate} = k [\text{NH}_4^+] [\text{NO}_2^-] \\
k = 3.0 \times 10^{-4} \text{ 1/} \text{Ms} \\
[\text{NH}_4^+] = 0.26 \text{ M} \\
[\text{NO}_2^-] = 0.080 \text{ M}
\]

\[
\text{rate} = (3.0 \times 10^{-4} \text{ 1/} \text{Ms})(0.26 \text{ M})(0.080 \text{ M})
\]

\[
\text{rate} = 6.2 \times 10^{-6} \text{ M/s}
\]

13.14

\[
\text{rate} = k [\text{F}_2] [\text{ClO}_2] \\
k = 1.2 \text{ 1/} \text{Ms} \\
[\text{F}_2] = 0.010 \text{ M} \\
[\text{ClO}_2] = 0.020 \text{ M}
\]

\[
\text{rate} = (1.2 \text{ 1/} \text{Ms})(0.010 \text{ M})(0.020 \text{ M})
\]

\[
\text{rate} = 2.4 \times 10^{-4} \text{ M/s}
\]

13.15

\[
\text{rate} = k [\text{A}] [\text{B}]^{1}
\]

- Compare 1\text{st} and 3\text{rd} data, doubling [A] doubles rate  
  \[\therefore \text{1\text{st} order in} \text{ A}\]

- Compare 1\text{st} and 2\text{nd} data, change in [B] doesn't affect rate  
  \[\therefore \text{O\text{th} order in} \text{ B}\]

Using 1\text{st} data:  

\[320 \times 10^{-1} \text{ M/s} = k (1.50 \text{ M}) \]

\[k = 0.213 \text{ S}^{-1}\]

1\text{st order overall}
13.16 a) \( \text{use } \exp a \# 5; [x] \text{ doubles } \uparrow \text{ rate quadruples} \)
\[ \therefore \text{ 2nd order in } x \]
\[ \text{compare } \exp a \# 4; \text{ doubling } [y], \text{ rate doubles} \]
\[ \therefore \text{ 1st order in } y \]
\[ \text{rxn order } = 2 + 1 = 3 \]
\[ \text{3rd order overall} \]

b) \( \text{given: } [x] = 0.30 \text{M } \# [y] = 0.40 \text{M} \)
\( \text{determine rate} \)
\[ \text{first find } k \text{ using any dataset (1st)} \]
\[ k = \frac{\text{rate}}{[(x)]^2[y]} = \frac{0.053 \text{ M/s}}{(0.10 \text{M})^2 (0.50 \text{M})} = 10.6 \frac{1}{\text{M}^2 \text{s}} \]
\[ \text{rate} = (10.6 \frac{1}{\text{M}^2 \text{s}}) (0.30 \text{M})^2 (0.40 \text{M}) \]
\[ \text{rate} = 0.38 \text{ M/s} \]

13.17
\( \text{a) 2nd order overall } \)
\( \text{b) 0 order overall } \)
\( \text{c) 1.5 order overall } \)
\( \text{d) 3rd order overall } \)

13.18 \( \text{skeleton rate law } \Rightarrow \text{ rate} = k [A]^x \)
\( \text{if } [A] = 0.35 \text{M then rate} = 1.6 \times 10^{-2} \text{M/s} \)
\( \text{a) if 1st order in } A, \text{ calc } k \)
\[ \text{rate} = k [A] \]
\[ 1.6 \times 10^{-2} \text{M/s} = k (0.35 \text{M}) \]
\[ k = 0.046 \text{M}^{-1} \text{s} \]
\( \text{b) if 2nd order in } A \)
\[ \text{rate} = k [A]^2 \]
\[ 1.6 \times 10^{-2} \text{M/s} = k (0.35 \text{M})^2 \]
\[ k = 0.13 \text{M}^{-1} \text{s} \]