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Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction

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List of 14 Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction

Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction

1) Rate Constant for First Order Irreversible Reaction

Open Calculator

fx $$K_{1st\ order} = -\frac{\ln(1 - X_A)}{t}$$

ex $$0.223533s^{-1} = -\frac{\ln(1 - 0.8)}{7.2s}$$

2) Rate Constant for First Order Irreversible Reaction using log10

Open Calculator

fx $$K_{1st\ order} = -2.303 \cdot \frac{\log 10(1 - X_A)}{t}$$

ex $$0.223573s^{-1} = -2.303 \cdot \frac{\log 10(1 - 0.8)}{7.2s}$$

3) Rate Constant of Second Order Irreversible Reaction

Open Calculator

$$k_2 = \frac{r}{C_A \cdot C_B}$$

$$0.001885\text{m}^3/(\text{mol*s}) = \frac{0.017\text{mol/m}^3\text{*s}}{1.1\text{mol/m}^3 \cdot 8.2\text{mol/m}^3}$$

4) Rate Constant of Second Order Irreversible Reaction with Equal Reactant Concentrations

Open Calculator

$$k_2 = \frac{r}{(C_A)^2}$$

$$0.01405\text{m}^3/(\text{mol*s}) = \frac{0.017\text{mol/m}^3\text{*s}}{(1.1\text{mol/m}^3)^2}$$

5) Rate Constant of Third Order Irreversible Reaction

Open Calculator

$$k_3 = \frac{r}{C_A \cdot C_B \cdot C_D}$$

$$0.000157\text{m}^6/(\text{mol}^2\text{*s}) = \frac{0.017\text{mol/m}^3\text{*s}}{1.1\text{mol/m}^3 \cdot 8.2\text{mol/m}^3 \cdot 12\text{mol/m}^3}$$

6) Rate Constant of Third Order Irreversible Reaction with Two Equal Reactant Concentrations

Open Calculator

$$k_3 = \frac{r}{C_A \cdot (C_B)^2}$$

$$0.00023\text{m}^6/(\text{mol}^2*\text{s}) = \frac{0.017\text{mol/m}^3*\text{s}}{1.1\text{mol/m}^3 \cdot (8.2\text{mol/m}^3)^2}$$

7) Reactant Concentration of Second Order Irreversible Reaction

Open Calculator

$$C_A = \frac{r}{C_B \cdot k_2}$$

$$1.036585\text{mol/m}^3 = \frac{0.017\text{mol/m}^3*\text{s}}{8.2\text{mol/m}^3 \cdot 0.002\text{m}^3/(\text{mol}*\text{s})}$$

8) Reactant Concentration of Second Order Irreversible Reaction with Equal Reactant Concentrations

Open Calculator

$$C_A = \left(\frac{r}{k_2}\right)^{0.5}$$

$$2.915476\text{mol/m}^3 = \left(\frac{0.017\text{mol/m}^3*\text{s}}{0.002\text{m}^3/(\text{mol}*\text{s})}\right)^{0.5}$$

9) Reactant Concentration of Third Order Irreversible Reaction

Open Calculator

$$C_A = \frac{r}{k_3 \cdot C_B \cdot C_D}$$

$$0.863821\text{mol/m}^3 = \frac{0.017\text{mol/m}^3\text{*s}}{0.0002\text{m}^6/(\text{mol}^2\text{*s}) \cdot 8.2\text{mol/m}^3 \cdot 12\text{mol/m}^3}$$

10) Reaction Rate of Second Order Irreversible Reaction

Open Calculator

$$r = k_2 \cdot C_A \cdot C_B$$

$$0.01804\text{mol/m}^3\text{*s} = 0.002\text{m}^3/(\text{mol*s}) \cdot 1.1\text{mol/m}^3 \cdot 8.2\text{mol/m}^3$$

11) Reaction Rate of Second Order Irreversible Reaction with Equal Reactant Concentrations

Open Calculator

$$r = k_2 \cdot (C_A)^2$$

$$0.00242\text{mol/m}^3\text{*s} = 0.002\text{m}^3/(\text{mol*s}) \cdot (1.1\text{mol/m}^3)^2$$

12) Reaction Rate of Third Order Irreversible Reaction with Two Equal Reactant Concentrations

Open Calculator

$$r = k_3 \cdot C_A \cdot (C_B)^2$$

$$0.014793\text{mol/m}^3\text{*s} = 0.0002\text{m}^6/(\text{mol}^2\text{*s}) \cdot 1.1\text{mol/m}^3 \cdot (8.2\text{mol/m}^3)^2$$

13) Reaction Time for First Order Irreversible Reaction

Open Calculator

fx $$t = -\frac{\ln(1 - X_A)}{K_{1st\ order}}$$

ex $$107.2959s = -\frac{\ln(1 - 0.8)}{0.015s^{-1}}$$

14) Reaction Time for First Order Irreversible Reaction using log10

Open Calculator

fx $$t = -2.303 \cdot \frac{\log 10(1 - X_A)}{K_{1st\ order}}$$

ex $$107.3152s = -2.303 \cdot \frac{\log 10(1 - 0.8)}{0.015s^{-1}}$$

Variables Used

- C_A Concentration of Reactant A *(Mole per Cubic Meter)*
- C_B Concentration of Reactant B *(Mole per Cubic Meter)*
- C_D Concentration of Reactant D *(Mole per Cubic Meter)*
- $K_{1st\ order}$ Rate Constant for First Order Reaction *(1 Per Second)*
- k_2 Rate Constant for Second Order Reaction *(Cubic Meter per Mole Second)*
- k_3 Rate Constant for Third Order Reaction *(Square Cubic Meter per square Mole per Second)*
- **r** Reaction Rate *(Mole per Cubic Meter Second)*
- **t** Reaction Time *(Second)*
- X_A Reactant Conversion

Constants, Functions, Measurements used

- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Function: **log10**, log10(Number)
  Common logarithm function (base 10)
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Molar Concentration** in Mole per Cubic Meter (mol/m³)
  Molar Concentration Unit Conversion
- Measurement: **Reaction Rate** in Mole per Cubic Meter Second (mol/m³*s)
  Reaction Rate Unit Conversion
- Measurement: **First Order Reaction Rate Constant** in 1 Per Second (s^{-1})
  First Order Reaction Rate Constant Unit Conversion
- Measurement: **Second Order Reaction Rate Constant** in Cubic Meter per Mole Second (m³/(mol*s))
  Second Order Reaction Rate Constant Unit Conversion
- Measurement: **Third Order Reaction Rate Constant** in Square Cubic Meter per square Mole per Second (m⁶/(mol²*s))
  Third Order Reaction Rate Constant Unit Conversion

Check other formula lists

- Basics of Chemical Reaction Engineering Formulas
- Basics of Parallel & Single Reactions Formulas
- Basics of Reactor Design and Temperature Dependency from Arrhenius Law Formulas
- Forms of Reaction Rate Formulas
- Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate
- Important Formulas in Constant and Variable Volume Batch Reactor
- Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction
- Important Formulas in Design of Reactors & Recycle Reactors for Single Reactions
- Important Formulas in Potpourri of Multiple Reactions
- Reactor Performance Equations for Constant Volume Reactions Formulas
- Reactor Performance Equations for Variable Volume Reactions Formulas

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