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Basic Water Math

Wednesday July 22, 2025

Guam & CNMI Water Operator Certification Series



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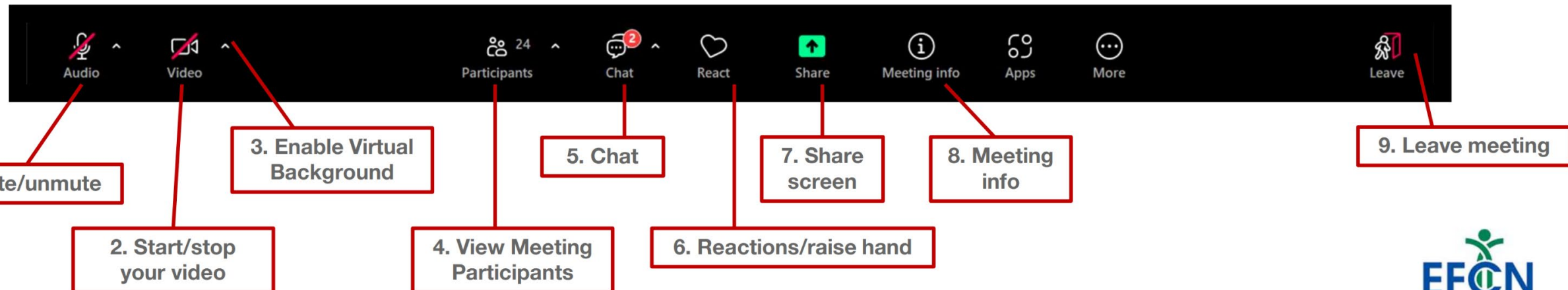
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This training series is funded by the EPA

Attendee Meeting Controls

- Locate your control bar
- All attendees will see a black horizontal bar on their screen
- If your control bar is not visible, it may be hidden
 - Move your cursor to the screen's bottom (or top) to reveal this control bar.



WPI/ABC Operator Certification

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Q Search ...

Standardized Wastewater Treatment Operator Exams

Wastewater Treatment Operator Need-to-Know Criteria

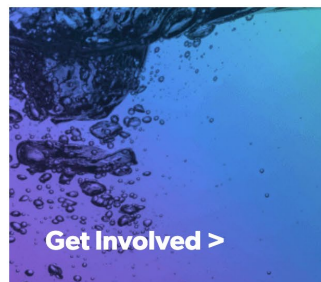
Need-to-Know Criteria outline the content that will be covered on WPI's standardized examinations provided through [ABC Testing](#), a WPI service.

- [Wastewater Treatment Operator Class I](#)
- [Wastewater Treatment Operator Class II](#)
- [Wastewater Treatment Operator Class III](#)
- [Wastewater Treatment Operator Class IV](#)

Wastewater Treatment Operator Formula/Conversion Table

WPI standardized exams are administered with a Formula/Conversion Table containing mathematical formulas and common abbreviations that may be present on the exam.

- [Wastewater Treatment Operator Formula/Conversion Table](#)



Schedule for 2025:

Date	Topic
6/25/25	Program Overview, Test Format, Study & Test Tips
7/9/25	Drinking Water System Overview - (Source, Treatment, & Distribution)
7/23/25	Basic Operator Math (+, -, /, x, Exponents and basic algebra)
8/6/25	Applied Operator Math (e.g. Areas, Volume, Flow Rates, Detention Time, Pressure/Hydraulic Head)
8/20/25	Drinking Water Regulations
9/3/25	Source Water Characteristics
9/17/25	Surface Water Intake Components, Well Components, and O&M
10/1/25	Disinfection 1: Chloramines, UV, Chlorine Dioxide, Chlorine
10/15/25	Disinfection 2: Chlorine Disinfection Application for Sodium Hypochlorite and Gas Chlorine (including storage and safety)
10/29/25	Disinfection 3: Distribution System Application, Residual Measurement, Evaluation & Adjustment,
11/12/25	Disinfection 4: Chlorine Disinfection Math
12/3/25	Surface Water Treatment 1: Coagulation, Flocculation, Sedimentation (including chemistry, process controls, operations)
12/17/25	Surface Water Treatment 2: Filtration

<https://swefc.unm.edu/home/op-cert-trainings/>



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This page is a repository of Wastewater and Drinking Water Operator Certification (Op Cert) Training Webinars offered by the SW EFC for systems in the Pacific Territories. Below you will find the **training webinar schedules (wastewater, then drinking water)** followed by a **training webinar recordings library**.

[Jump to Wastewater Trainings](#) [↓](#)

[Jump to Drinking Water Trainings](#) [↓](#)

Wastewater Training Schedule

Please note all times are local to CNMI and Guam. The times in American Samoa are one day earlier at 11 am.

Session	Date	Training Topic & Link to Recording (click to view)	Supporting Materials (click to download)
1	6/25/2025	Program Overview, Test Format, Study & Test Tips	PPT slides
2	7/9/2025	Treatment Overview	
3	7/23/2025	WW Math Part 1 (Areas & Volumes)	
4	8/6/2025	WW Math Part 2 (Flow Rates & Detention Times)	
5	8/20/2025	Collection Systems – Gravity systems	
6	9/3/2025	Collection Systems – Pumping & Force Mains	
7	9/17/2025	Collection System Maintenance	
8	10/1/2025	Operator Safety/OSHA/Chemical Safety & Inventory	

Sign in for every session to ensure you get credit for attending



US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet

Session Title: _____
Session Date: _____
Training Location: _____

Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____
Signature: _____
Title: _____
Date: _____

Why is it important for water operators to have a good understanding of math?

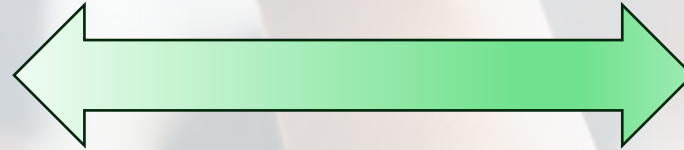
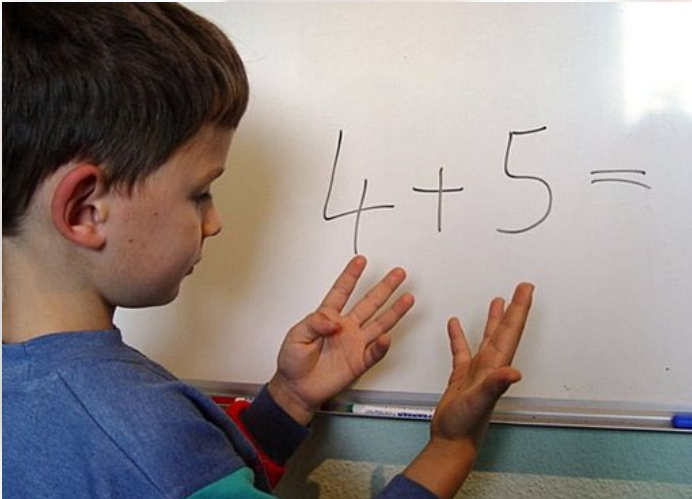
- Water usage
- Storage capacity
- Flow and retention rates
- Chemical usage and dosage
- Rate setting and budgeting

But first, we need to go over some math
fundamentals

Today's math topics

- All About Equations:
 - Order of Operations
 - Rearranging Equations and Solving For The Unknown
- Percentages
- Units
- Conversions

What would you say is your water math proficiency?



$$\begin{aligned} & \sin\left(3t_2 + \frac{\pi}{6}\right) = A \sin\left(3t_2 + \frac{\pi}{6}\right); \\ & = \frac{1}{2} k y_2^2; E_c = E - E_p = \frac{1}{2} k(A^2 - y_2^2) \\ & = \frac{1}{2} k(A^2 - y_2^2) \Rightarrow y_2 = A \sqrt{\frac{2}{3}} = \frac{4}{3} \cdot 10^{-1} \text{ V} \\ & E_p = E_{p_{\max}} \Rightarrow \sin^2\left(3t_p + \frac{\pi}{3}\right) = 1 \Rightarrow \sin \\ & = \sin\left(\frac{\pi}{2} + n\pi\right); n = 0, 1, 2, \dots \\ & y) \cdot z = \left[\frac{1}{2}(x + y - xy + 1)\right] \cdot z = \\ & + xy - xyz + z + 1 = \frac{1}{2}\left[\frac{1}{2}(x + y \right. \\ & y \cdot z) = x \cdot \left[\frac{1}{2}(y + z - yz + 1)\right] = \\ & x(y + z - yz + 1) + 1 = (x \cdot y) \cdot \\ & x \cdot y = \frac{1}{2}(x + y - xy + 1) \\ & = \int_{-a}^0 x^2 e^{ax} dx = \frac{1}{a} (x^2 e^{ax}) \Big|_{-a}^0 - \frac{2}{a} \int_{-a}^0 \\ & -a^2 - \frac{2}{a} \left[\frac{1}{a} (x e^{ax}) \Big|_{-a}^0 - \frac{1}{a} \int_{-a}^0 e^{ax} dx\right] \\ & + \frac{2}{a^2} \left[\frac{1}{a} (e^{ax}) \Big|_{-a}^0\right] = -a e^{-a^2} - \frac{2}{a} e^{-a^2} \\ & = \frac{1}{a^3 e^{a^2}} [2e^{a^2} - 2 - 2a^2 - a^4] \\ & Q_{\text{total}} = Q_1 + Q_2 = 3\epsilon_0 \frac{S}{d_1} U_0 \\ & C_1 = C_2 = \epsilon_0 \frac{S}{d_1} = 8,85 \text{ pF} \end{aligned}$$
$$\begin{aligned} & \frac{1 - \left(-\frac{1}{n+2}\right)^{n+1}}{1 + \frac{1}{n+2}} + \frac{1}{n+1} \cdot \frac{1 - \left(-\frac{1}{n+1}\right)^{n+1}}{1 + \frac{1}{n+1}} \\ & = \frac{1 - \left(-\frac{1}{n+1}\right)^{n+1}}{n+2} - \frac{1 - \left(-\frac{1}{n+2}\right)^{n+1}}{n+3} \\ & (-1)^{n+1} \frac{1}{(n+2)^n} + (-1)^n \cdot \frac{n+3}{n+1} \cdot \frac{1}{n} \\ & I_R = \frac{U}{R} = \frac{220}{17,32} = 12,7 \text{ A}, \\ & \frac{I_R}{\frac{1}{R_R} + \frac{1}{R_L}} = \frac{R}{\sqrt{R^2 + L^2 \omega^2}} = \frac{17,32}{34,64} = \frac{1}{2}, \varphi = \\ & \omega_0 = \frac{1}{C \omega_0} \Rightarrow v_0 = \frac{1}{2\pi \sqrt{LC}} = \frac{1}{2\pi \sqrt{X_L C}} = E_c = E_{c_{\max}} \Rightarrow \cos^2\left(3t_c + \frac{\pi}{3}\right) = 1 \Rightarrow \cos\left(3 \right. \\ & \cdot (x + t) I_2 + (x - y) I_2 = 0, \\ & \begin{pmatrix} x & y \\ z & t \end{pmatrix} \cdot \begin{pmatrix} x + t & 0 \\ 0 & x + t \end{pmatrix} = \begin{pmatrix} -t & y \\ z & -z \end{pmatrix}, \\ & y \begin{vmatrix} -t & y \\ z & -x \end{vmatrix} = \begin{pmatrix} yz - xt & 0 \\ 0 & yz - tx \end{pmatrix} = \\ & yz - xt) I_2 = -(xt - yz) I_2, \\ & = p_2 V_2 \Rightarrow \frac{V_2}{V_1} = \frac{P_1}{P_2} \Rightarrow \frac{V_2}{V_1} = \frac{P_1}{P_2} \left(\frac{V_1}{V_2}\right)^{\gamma} \\ & = p_2 V_2^{\gamma} \Rightarrow p_2 = p_1 \left(\frac{V_2}{V_1}\right)^{\gamma} \\ & = T_2 V_2^{\gamma-1} \Rightarrow \left(\frac{V_2}{V_1}\right)^{\gamma-1} = \frac{T_2}{T_1} \Rightarrow \frac{V_2}{V_1} = \left(\frac{T_2}{T_1}\right)^{\frac{1}{\gamma-1}} \\ & Q_{41} = \nu C T_1 (1 - \epsilon^{1/2}) + \nu C_V T_1 (\mathcal{K} - 1), \\ & Q_{34} = \nu C_V T_2 (\mathcal{K} - 1) + \nu C T_2 (1 - \epsilon^{1/2}), \\ & 1/\alpha, \frac{T_2}{T_1} = \mathcal{K}, \frac{T_2}{T_1} = \epsilon^{1/2}, \frac{T_1}{T_1} = \mathcal{K}_l \end{aligned}$$

What is an Equation?

A technique for answering a question about how much, how long, or how fast

Equations are balanced math sentences

Left Side = Right Side



Order of Operations

Please (Parentheses)



Excuse (Exponents)



My Dear (Multiply and/or Divide)



Aunt Sally (Add and/or Subtract)

“PEMDAS”

Example

(Please Excuse My Dear Aunt Sally)

$$(4)(2) + (6 \times 5)^2 - 16 = ?$$

Parentheses

$$(4)(2) + (30)^2 - 16 = ?$$

Exponents

$$(4)(2) + 900 - 16 = ?$$

Multiply/Divide

$$8 + 900 - 16 = ?$$

Add/Subtract

$$8 + 900 - 16 = 892$$

Equations are balanced math sentences

Left Side = Right Side



**Rearranging equations makes them easier
to handle before inserting known numbers
and helps keep track of units**

Solving for the Unknown and Rearranging Equations, aka Algebra

- The unknown is the part of the equation that we are trying to find or solve for
- Sometimes represented by a letter such as d, t, or x (variable)
- When solving for an unknown, the variable/unknown must be by itself on one side of the equation

$$46 + x = 98$$

Solving for x

Addition and Subtraction

1. To get x alone, you have to move other numbers across the equal sign (=)
2. Remember an equation must be balanced
3. When a number crosses the equal sign, it does the opposite of what it was doing on the other side
4. If a number is positive on one side, it will be subtracted from both sides
5. If a number is negative from one side, it will added to both sides

Example

$$46 + x = 98$$

$$46 - 46 + x = 98 - 46$$

$$x = 52$$

Example

$$x - 12 = 25$$

$$x - 12 + 12 = 25 + 12$$

$$x = 37$$



Solving for x

Addition and Subtraction Practice

Solve for x

$$2 + 15 - 8 + x = 50 + 8$$

$$x = 50 + 8 - 2 - 15 + 8$$

$$\mathbf{x = 49}$$

Solve for x

$$8 + 6 - x + 5 + 2 = 29$$

$$-x = 29 - 8 - 6 - 5 - 2$$

$$-x = 8$$

$$\mathbf{x = -8}$$

Solving for x

Multiplication and Division

1. To get x alone other numbers must cross the equal sign (=)
2. Remember an equation must be balanced
3. When a number crosses the equal sign, it does the opposite of what it was doing on the other side
4. If a number is multiplied on one side, it will be divided from both sides
5. If a number is divided on one side, it will be multiplied on both sides

Example

$$5x = 55$$

$$\begin{array}{r} \cancel{5} x = \cancel{5} 5 \\ \hline 5 \quad 5 \end{array}$$

$$x = \underline{55}$$

5

$$\mathbf{x = 11}$$



Solving for x

Multiplication and Division Practice

Solve for x

$$\frac{x}{(8.34)(5)} = 15$$

$$\frac{x}{41.7} = 15$$

$$x = 625.5$$

Solve for x

$$x(7.2)(8.34) = 2550$$

$$x(60.048) = 2550$$

$$x = 42.47$$

Formula/Conversion Table

Water Treatment, Distribution, & Water Laboratory Exams



$$\text{Alkalinity, mg/L as CaCO}_3 = \frac{(\text{Titrant Volume, mL})(\text{Acid Normality})(50,000)}{\text{Sample Volume, mL}}$$

$$\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}$$

$$\text{Area of Circle}^* = (0.785)(\text{Diameter}^2)$$

$$\text{Area of Circle} = (3.14)(\text{Radius}^2)$$

$$\text{Area of Cone (lateral area)} = (3.14)(\text{Radius})\sqrt{\text{Radius}^2 + \text{Height}^2}$$

$$\text{Area of Cone (total surface area)} = (3.14)(\text{Radius})(\text{Radius} + \sqrt{\text{Radius}^2 + \text{Height}^2})$$

$$\text{Area of Cylinder (total exterior surface area)} = [\text{End \#1 SA}] + [\text{End \#2 SA}] + [(3.14)(\text{Diameter})(\text{Height or Depth})]$$

Where SA = surface area

$$\text{Area of Rectangle}^* = (\text{Length})(\text{Width})$$

$$\text{Area of Right Triangle}^* = \frac{(\text{Base})(\text{Height})}{2}$$

$$\text{Average (arithmetic mean)} = \frac{\text{Sum of All Terms}}{\text{Number of Terms}}$$

$$\text{Average (geometric mean)} = [(X_1)(X_2)(X_3)(X_4)(X_n)]^{1/n} \quad \text{The } n\text{th root of the product of } n \text{ numbers}$$

$$\text{Blending} = (V_1)(C_1) + (V_2)(C_2) = (V_3)(C_3) \quad \text{Where } V = \text{volume or flow, } C = \text{concentration or percent solution}$$

$$\text{Chemical Feed Pump Setting, \% Stroke} = \frac{\text{Desired Flow}}{\text{Maximum Flow}} \times 100\%$$

$$\text{Chemical Feed Pump Setting, mL/min} = \frac{(\text{Flow, MGD})(\text{Dose, mg/L})(3.785 \text{ L/gal})(1,000,000 \text{ gal/MG})}{(\text{Feed Chemical Density, mg/mL})(1,440 \text{ min/day})}$$

$$\text{Chemical Feed Pump Setting, mL/min} = \frac{(\text{Flow, m}^3/\text{day})(\text{Dose, mg/L})}{(\text{Feed Chemical Density, g/cm}^3)(\text{Active Chemical, \% expressed as a decimal})(1,440 \text{ min/day})}$$

$$\text{Circumference of Circle} = (3.14)(\text{Diameter})$$

$$\text{Composite Sample Single Portion} = \frac{(\text{Instantaneous Flow})(\text{Total Sample Volume})}{(\text{Number of Portions})(\text{Average Flow})}$$

$$\text{CT Calculation} = (\text{Disinfectant Residual Concentration, mg/L})(\text{Time, min})$$

$$\text{Degrees Celsius} = \frac{(^{\circ}\text{F} - 32)}{1.8}$$

$$\text{Degrees Fahrenheit} = (^{\circ}\text{C})(1.8) + 32$$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}} \quad \text{Units must be compatible}$$

$$\text{Electromotive Force, volts}^* = (\text{Current, amps})(\text{Resistance, ohms})$$

$$\text{Feed Rate, lb/day}^* = \frac{(\text{Dosage, mg/L})(\text{Flow, MGD})(8.34 \text{ lb/gal})}{\text{Purity, \% expressed as a decimal}}$$

$$\text{Feed Rate, kg/day}^* = \frac{(\text{Dosage, mg/L})(\text{Flow Rate, m}^3/\text{day})}{(\text{Purity, \% expressed as a decimal})(1,000)}$$

$$\text{Feed Rate (Fluoride), lb/day} = \frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34 \text{ lb/gal})}{(\text{Available Fluoride Ion, \% expressed as a decimal})(\text{Purity, \% expressed as a decimal})}$$

$$\text{Feed Rate (Fluoride), kg/day} = \frac{(\text{Dosage, mg/L})(\text{Capacity, m}^3/\text{day})}{(\text{Available Fluoride Ion, \% expressed as a decimal})(\text{Purity, \% expressed as a decimal})(1,000)}$$

$$\text{Feed Rate (Fluoride Saturator), gpm} = \frac{(\text{Plant capacity, gpm})(\text{Dosage, mg/L})}{18,000 \text{ mg/L}}$$

$$\text{Feed Rate (Fluoride Saturator), Lpm} = \frac{(\text{Plant capacity, Lpm})(\text{Dosage, mg/L})}{18,000 \text{ mg/L}}$$

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(\text{Backwash Rate, gpm/ft}^2)(12 \text{ in/ft})}{7.48 \text{ gal/ft}^3}$$

$$\text{Filter Backwash Rise Rate, cm/min} = \frac{\text{Water Rise, cm}}{\text{Time, min}}$$

$$\text{Filter Drop Test Velocity, ft/min} = \frac{\text{Water Drop, ft}}{\text{Time of Drop, min}}$$

$$\text{Filter Drop Test Velocity, m/min} = \frac{\text{Water Drop, m}}{\text{Time of Drop, min}}$$

$$\text{Filter Loading Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

$$\text{Filter Loading Rate, L/sec/m}^2 = \frac{\text{Flow, L/sec}}{\text{Filter area, m}^2}$$

$$\text{Filter Yield, lb/hr/ft}^2 = \frac{(\text{Solids Loading, lb/day})(\text{Recovery, \% expressed as a decimal})}{(\text{Filter Operation, hr/day})(\text{Area, ft}^2)}$$

$$\text{Filter Yield, kg/hr/m}^2 = \frac{(\text{Solids Concentration, \% expressed as a decimal})(\text{Sludge Feed Rate, L/hr})(10)}{(\text{Surface Area of Filter, m}^2)}$$

*Pie Wheel Format for this equation is available at the end of this document

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Flow Rate, ft³/sec* = (Area, ft²)(Velocity, ft/sec)

Flow Rate, m³/sec* = (Area, m²)(Velocity, m/sec)

Force, lb* = (Pressure, psi)(Area, in²)

Force, newtons* = (Pressure, pascals)(Area, m²)

Hardness, as mg CaCO₃/L =
$$\frac{(\text{Titration Volume, mL})(1,000)}{\text{Sample Volume, mL}}$$
 Only when the titration factor is 1.00 of EDTA

Horsepower, Brake, hp =
$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3,960)(\text{Pump Efficiency, \% expressed as a decimal})}$$

Horsepower, Brake, kW =
$$\frac{(9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})}{(\text{Pump Efficiency, \% expressed as a decimal})}$$

Horsepower, Motor, hp =
$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3,960)(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

Horsepower, Motor, kW =
$$\frac{(9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})}{(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

Horsepower, Water, hp =
$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{3,960}$$

Horsepower, Water, kW = (9.8)(Flow, m³/sec)(Head, m)

Hydraulic Loading Rate, gpd/ft² =
$$\frac{\text{Total Flow Applied, gpd}}{\text{Area, ft}^2}$$

Hydraulic Loading Rate, m³/day/m² =
$$\frac{\text{Total Flow Applied, m}^3/\text{day}}{\text{Area, m}^2}$$

Hypochlorite Strength, % =
$$\frac{\text{Chlorine Required, lb}}{(\text{Hypochlorite Solution Needed, gal})(8.34 \text{ lb/gal})} \times 100\%$$

Hypochlorite Strength, % =
$$\frac{(\text{Chlorine Required, kg})(100)}{(\text{Hypochlorite Solution Needed, kg})}$$

Langelier Saturation Index = pH – pH_s

Leakage, gpd =
$$\frac{\text{Volume, gal}}{\text{Time, days}}$$

Leakage, Lpd =
$$\frac{\text{Volume, L}}{\text{Time, days}}$$

Loading Rate, lb/day* = (Flow, MGD)(Concentration, mg/L)(8.34 lb/gal)

Loading Rate, kg/day* =
$$\frac{(\text{Volume, m}^3/\text{day})(\text{Concentration, mg/L})}{1,000}$$

Mass, lb* = (Volume, MG)(Concentration, mg/L)(8.34 lb/gal)

Mass, kg* =
$$\frac{(\text{Volume, m}^3)(\text{Concentration, mg/L})}{1,000}$$

Milliequivalent = (mL)(Normality)

Molarity =
$$\frac{\text{Moles of Solute}}{\text{Liters of Solution}}$$

Normality =
$$\frac{\text{Number of Equivalent Weights of Solute}}{\text{Liters of Solution}}$$

Number of Equivalent Weights =
$$\frac{\text{Total Weight}}{\text{Equivalent Weight}}$$

Number of Moles =
$$\frac{\text{Total Weight}}{\text{Molecular Weight}}$$

Power, kW =
$$\frac{(\text{Flow, L/sec})(\text{Head, m})(9.8)}{1,000}$$

Reduction in Flow, % =
$$\frac{(\text{Original Flow} - \text{Reduced Flow})(100\%)}{\text{Original Flow}}$$

Removal, % =
$$\frac{\text{In} - \text{Out}}{\text{In}} \times 100\%$$

Slope, % =
$$\frac{\text{Drop or Rise}}{\text{Distance}} \times 100\%$$

Solids, mg/L =
$$\frac{(\text{Dry Solids, g})(1,000,000)}{\text{Sample Volume, mL}}$$

Solids Concentration, mg/L =
$$\frac{\text{Weight, mg}}{\text{Volume, L}}$$

Specific Gravity =
$$\frac{\text{Specific Weight of Substance, lb/gal}}{8.34 \text{ lb/gal}}$$

Specific Gravity =
$$\frac{\text{Specific Weight of Substance, kg/L}}{1.0, \text{ kg/L}}$$

Surface Loading Rate or Surface Overflow Rate, gpd/ft² =
$$\frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

Surface Loading Rate or Surface Overflow Rate, Lpd/m² =
$$\frac{\text{Flow, Lpd}}{\text{Area, m}^2}$$

*Pie Wheel Format for this equation is available at the end of this document

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Three Normal Equation = (C₁ x V₁) + (C₂ x V₂) = (C₃ x V₃) *Where V₁ + V₂ = V₃; C = concentration, V = volume or flow; Concentration units must match; Volume units must match*

Threshold Odor Number = $\frac{A+B}{A}$ *Where A = volume of odor causing sample, B = volume of odor free water*

Two Normal Equation = (C₁ x V₁) = (C₂ x V₂) *Where C = Concentration, V = volume or flow; Concentration units must match; Volume units must match*

Velocity, ft/sec = $\frac{\text{Flow Rate, ft}^3/\text{sec}}{\text{Area, ft}^2}$

Velocity, ft/sec = $\frac{\text{Distance, ft}}{\text{Time, sec}}$

Velocity, m/sec = $\frac{\text{Flow Rate, m}^3/\text{sec}}{\text{Area, m}^2}$

Velocity, m/sec = $\frac{\text{Distance, m}}{\text{Time, sec}}$

Volume of Cone* = (1/3)(0.785)(Diameter²)(Height)

Volume of Cylinder* = (0.785)(Diameter²)(Height)

Volume of Rectangular Tank* = (Length)(Width)(Height)

Water Use, gpcd = $\frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$

Water Use, Lpcd = $\frac{\text{Volume of Water Produced, Lpd}}{\text{Population}}$

Watts (AC circuit) = (Volts)(Amps)(Power Factor)

Watts (DC circuit) = (Volts)(Amps)

Weir Overflow Rate, gpd/ft = $\frac{\text{Flow, gpd}}{\text{Weir Length, ft}}$

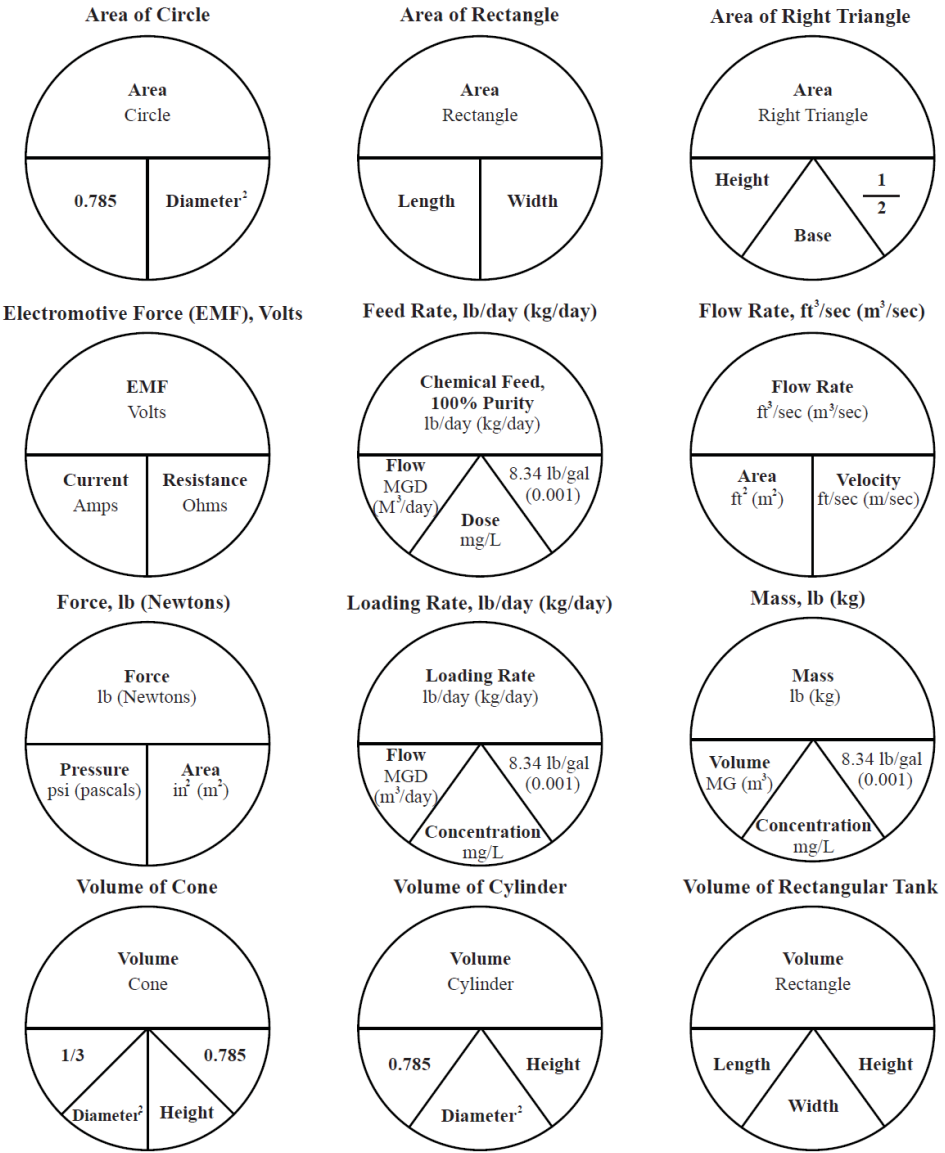
Weir Overflow Rate, Lpd/m = $\frac{\text{Flow, Lpd}}{\text{Weir Length, m}}$

Wire-to-Water Efficiency, % = $\frac{\text{Water hp}}{\text{Motor hp}} \times 100\%$

Wire-to-Water Efficiency, % = $\frac{(\text{Flow, gpm})(\text{Total Dynamic Head, ft})(0.746 \text{ kW/hp})(100\%)}{(3,960)(\text{Electrical Demand, kW})}$

*** Pie Wheels**

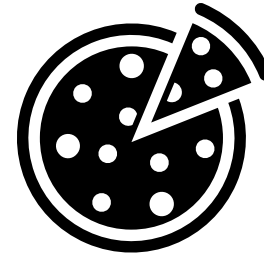
- To find the quantity above the horizontal line: multiply the pie wedges below the line together.
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge, then divide the remaining pie wedge(s) into the quantity above the horizontal line.
- Given units must match the units shown in the pie wheel.
- When US and metric units or values differ, the metric is shown in parentheses, e.g. (m³).



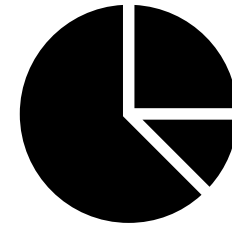
*Pie Wheel Format for this equation is available at the end of this document

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Fractions and Decimals



Used to represent parts of a whole



Converting...

Fraction to decimals: divide the numerator by the denominator

$$\text{Ex. } \frac{1}{2} = 1 \div 2 = 0.5$$

Decimals to Fraction: write the decimal as a fraction, multiply the numerator and denominator by 100, simplify using the lowest common denominator.

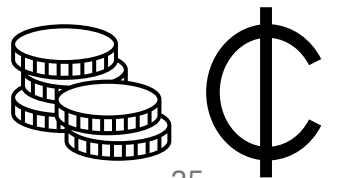
$$\text{Ex. } 2.75 = \frac{2.75 \times 100}{1 \times 100} = \frac{275 \div 25}{100 \div 25} = \frac{11}{4}$$

% Percentage: just another fraction

Per cent; parts per hundred

- *Fractions with 100 in the denominator*
- *Can be converted to a fraction or a decimal*

$$\mathbf{30\ percent = 30\% = \frac{30}{100} = 0.3}$$



Converting Percents into Decimals

65%

= 65/100

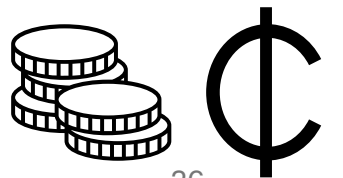
= 0.65

- Drop the percent sign
- Divide the number by 100
(Move decimal left two places)

65%



= 0.65



Converting Decimals into Percents

0.65

= 0.65×100

= 65%

- Multiply the number by 100
(Move decimal right two places)
- Add the percent sign

0.65


= 65%





Changing Between Percents and Decimals Practice

Change the Percents into decimals

$$3\% = \mathbf{.03}$$

$$25\% = \mathbf{.25}$$

$$0.05\% = \mathbf{.0005}$$

$$135\% = \mathbf{1.35}$$

Change the decimals into Percents

$$10.5 = \mathbf{1050\%}$$

$$0.01 = \mathbf{1\%}$$

$$0.36 = \mathbf{36\%}$$

$$0.263 = \mathbf{26.3\%}$$

Rounding

The temperature of a digester that operates in the mesophilic range is measured to be 37°C. What is this temperature in degrees Fahrenheit?

- A. 55
- B. 80
- C. 99
- D. 107

$$\begin{aligned}\text{Degrees Fahrenheit} &= (^\circ\text{C})(1.8) + 32 \\ &= (37)(1.8) + 32 \\ &= 66.6 + 32 \\ &= 98.6^\circ\text{F}\end{aligned}$$

Round up if the last digit is between **5 and 9**
Round down if the last digit is between **1 and 4**

Units

- Temperature
 - °F, °C, K
- Distance/length
 - Inches, feet, meters, miles, kilometers
- Area
 - inches², feet², meters², miles²
- Volume
 - ft³, m³, gallons, liters, acre-feet
- Mass
 - lbs; grams, kilograms, tons
- Rate
 - CFS, GPM



Rate measurements are a unit (e.g., volume, distance) divided by what variable/dimension?

- A. Height
- B. Weight
- C. Time
- D. Volume

Metric System

	Meter (Length)	Liter (Volume)	Gram (Mass)
Milli-	1 m = 1000 mm	1 L = 1000 mL	1 g = 1000 mg
Centi-	1 m = 100 cm	1 L = 100 cL	1 g = 100 cg
Deci-	1 m = 10 dm	1 L = 10 dL	1 g = 10 dg
Base	1 m = 1 m	1 L = 1 L	1 g = 1 g
Deca-	1 m = 0.1 dam	1 L = 0.1 daL	1 g = 0.1 dag
Hecto-	1 m = 0.01 hm	1 L = 0.01 hL	1 g = 0.01 hg
Kilo-	1 m = 0.001 km	1 L = 0.001 kL	1 g = 0.001 kg

Metric System

	Meter (Length)	Liter (Volume)	Gram (Mass)
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Kilo-	1 m = 0.001 km	1 L = 0.001 kL	1 g = 0.001 kg

Conversions

Common Conversion Factors

1 acre	=	43,560 ft ²
1 acre-foot	=	326,00 gallons
1 cubic foot	=	7.48 gallons
1 cubic foot	=	62.4 pounds
1 cfs	=	0.646 MGD
1 foot	=	0.305 meters
1 ft of water	=	0.433 psi
1 gallon	=	3.79 liters
1 gallon	=	8.34 pounds
1 mile	=	5,280 feet
1 MGD	=	1.55 cfs
1 pound	=	0.454 kg
1 psi	=	2.31 feet of water
1 ton	=	2,000 pounds
1 year	=	365 days

ABC Formula Sheet

Abbreviations and

Conversion factors

Abbreviations

C	Celsius	Lpm	liters per minute
cfs	cubic feet per second	LSI	Langelier Saturation Index
cm	centimeters	m	meters
DO	dissolved oxygen	MG	million gallons
EMF	electromotive force	MGD	million US gallons per day
F	Fahrenheit	mg/L	milligrams per liter
ft	feet	min	minutes
ft lb	foot-pound	mL	milliliters
g	grams	ML	million liters
gal	US gallons	MLD	million liters per day
gfd	US gallons flux per day	ORP	oxidation reduction potential
gpcd	US gallons per capita per day	ppb	parts per billion
gpd	US gallons per day	ppm	parts per million
gpg	grains per US gallon	psi	pounds per square inch
gpm	US gallons per minute	Q	flow
hp	horsepower	RPM	revolutions per minute
hr	hours	SDI	sludge density index
in	inches	sec	second
kg	kilograms	SS	settleeable solids
km	kilometers	TOC	total organic carbon
kPa	kilopascals	TSS	total suspended solids
kW	kilowatts	TTHM	total trihalomethanes
kWh	kilowatt-hours	VS	volatile solids
L	liters	W	watts
lb	pounds	yd	yards
Lpcd	liters per capita per day	yr	years
Lpd	liters per day		

Conversion Factors

1 acre	= 43,560 ft ² = 4,046.9 m ²	1 inch	= 2.54 cm
1 acre foot of water	= 326,000 gal	1 liter per second	= 0.0864 MLD
1 cubic foot of water	= 7.48 gal = 62.4 lb	1 meter of water	= 9.8 kPa
1 cubic foot per second	= 0.646 MGD = 448.8 gpm	1 metric ton	= 2,205 lb = 1,000 kg
1 cubic meter of water	= 1,000 kg = 1,000 L = 264 gal	1 mile	= 5,280 ft = 1.61 km
1 foot	= 0.305 m	1 million US gallons per day	= 694 gpm = 1.55 ft ³ /sec
1 foot of water	= 0.433 psi	1 pound	= 0.454 kg
1 gallon (US)	= 3.785 L = 8.34 lb of water	1 pound per square inch	= 2.31 ft of water = 6.89 kPa
1 grain per US gallon	= 17.1 mg/L	1 square meter	= 1.19 yd ²
1 hectare	= 10,000 m ²	1 ton	= 2,000 lb
1 horsepower	= 0.746 kW = 746 W = 33,000 ft lb/min	1%	= 10,000 mg/L
		π or pi	= 3.14

Alkalinity Relationships

All Alkalinity expressed as mg/L as CaCO₃ • P – phenolphthalein alkalinity • T – total alkalinity

Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < ½T	0	2P	T – 2P
P = ½T	0	2P	0
P > ½T	2P – T	2(T – P)	0
P = T	T	0	0

*Pie Wheel Format for this equation
is available at the end of this document

How do we use conversion factors?

Multiply or divide your measurement by the conversion factor

What you're really doing:

1. Turning the conversion factor into a fraction
2. Multiplying by one

$$1 \text{ gal} = 3.79 \text{ Liters} \quad \left(\frac{1 \text{ gal}}{3.79 \text{ L}} \right) = 1 \quad \left(\frac{3.79 \text{ L}}{1 \text{ gal}} \right) = 1$$

You can multiply anything by 1 and not change its quantity, only change the units.

Example of unit conversion

Your Sodium Hypochlorite tank holds 40 gallons, but the store sells it by the liter. How many liters of Sodium Hypochlorite do you need to fill up your 40 gallon tank?

1 gal = 3.79 liters

$$40 \cancel{\text{gal}} * \left(\frac{3.79\text{L}}{1\cancel{\text{gal}}} \right) = \sim 150 \text{ L}$$

$$\frac{40 \cancel{\text{gal}} \mid 3.79\text{L}}{1 \mid 1 \cancel{\text{gal}}} = \sim 150 \text{ L}$$



Your turn: Unit Conversion

To figure out the volume of your clarifier, you measure it with your tape measure and determine it holds 46 cubic feet of water. How many gallons does your clarifier hold? $1 \text{ ft}^3 = 7.48 \text{ gal}$

- A. 6.1 gal
- B. 53 gal
- C. 344 gal
- D. 466 gal

$$\frac{46 \cancel{\text{ft}^3} \mid 7.48 \text{ gal}}{1 \mid 1 \cancel{\text{ft}^3}} = 344 \text{ gal}$$



Your turn: Order of Operations

To calculate your CT, you want to determine the volume of water after treatment and before your first customer, including water in mains that have a 1 ft diameter and are 860 ft long and a box shaped storage tank. You determine the below equation for calculating this. What is the volume in ft³?

$$\pi (1\text{ft}/2)^2 (860\text{ft}) + (20\text{ft})(15\text{ft})(25\text{ft})$$

A. 923 ft³

B. 8180 ft³

C. 11,740 ft³

D. 5,060,00 ft³

$$\begin{aligned}\pi (1\text{ft}/2)^2 (860\text{ft}) + (20\text{ft})(15\text{ft})(25\text{ft}) &= \\ \pi (0.5\text{ft})^2 (860\text{ft}) + (20\text{ft})(15\text{ft})(25\text{ft}) &= \\ \pi (0.25\text{ft}^2)(860\text{ft}) + (20\text{ft})(15\text{ft})(25\text{ft}) &= \\ (0.785 \text{ ft}^2) (860\text{ft}) + (300 \text{ ft}^2)(25\text{ft}) &= \\ 675 \text{ ft}^3 + 7500 \text{ ft}^3 &= 8180 \text{ ft}^3\end{aligned}$$

Questions?

Thanks for attending!



SOUTHWEST
ENVIRONMENTAL
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Next webinar in the series:

**Water Math pt. 2: Area, Volume,
Pressure**

August 6, 2025

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