

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

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

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

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

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

$$\text{Blending or Three Normal Equation} = (C_1 \times V_1) + (C_2 \times V_2) = (C_3 \times V_3)$$

Where $V_1 + V_2 = V_3$; C = concentration,
V = volume or flow; Concentration units must match; Volume units must match

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

$$\text{Chemical Feed Pump Setting, mL/min} =$$

$$\frac{(\text{Flow, MGD})(\text{Dose, mg/L})(3.785 \text{ L/gal})(1,000,000 \text{ gal/MG})}{(\text{Feed Chemical Density, mg/mL})(\text{Active Chemical, \% expressed as a decimal})(1,440 \text{ min/day})}$$

$$\text{Chemical Feed Pump Setting, mL/min} =$$

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

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

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

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

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

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

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

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

$$\text{Dilution or Two Normal Equation} = (C_1 \times V_1) = (C_2 \times V_2) \quad \text{Where } C = \text{Concentration, } V = \text{volume or flow;}$$

Concentration units must match;
Volume units must match

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\text{Force, lb}^* = (\text{Pressure, psi})(\text{Area, in}^2)$$

$$\text{Force, newtons}^* = (\text{Pressure, pascals})(\text{Area, m}^2)$$

$$\text{Hardness, as mg CaCO}_3/\text{L} = \frac{(\text{Titrant Volume, mL})(1,000)}{\text{Sample Volume, mL}} \quad \text{Only when the titration factor is 1.00 of EDTA}$$

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

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

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

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

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

$$\text{Horsepower, Water, kW} = (9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})$$

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

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

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

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

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

$$\text{Langelier Saturation Index} = \text{pH} - \text{pHs}$$

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

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

$$\text{Loading Rate, lb/day}^* = (\text{Flow, MGD})(\text{Concentration, mg/L})(8.34 \text{ lb/gal})$$

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

$$\text{Mass, lb}^* = (\text{Volume, MG})(\text{Concentration, mg/L})(8.34 \text{ lb/gal})$$

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

$$\text{Milliequivalent} = (\text{mL})(\text{Normality})$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\text{Volume of Cone}^* = (1/3)(0.785)(\text{Diameter}^2)(\text{Height})$$

$$\text{Volume of Cylinder}^* = (0.785)(\text{Diameter}^2)(\text{Height})$$

$$\text{Volume of Rectangular Tank}^* = (\text{Length})(\text{Width})(\text{Height})$$

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

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

$$\text{Watts (AC circuit)} = (\text{Volts})(\text{Amps})(\text{Power Factor})$$

$$\text{Watts (DC circuit)} = (\text{Volts})(\text{Amps})$$

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

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

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

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

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

Abbreviations

C	Celsius	Lpm	liters per minute
cfs	cubic feet per second	LSI	Langelier Saturation Index
cm	centimeters	m	meters
DO	dissolved oxygen	mg	milligrams
EMF	electromotive force	MG	million gallons
F	Fahrenheit	MGD	million US gallons per day
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	settleable 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	year
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

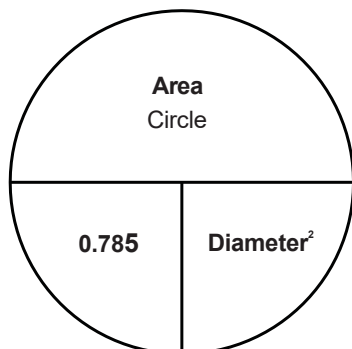
Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < ½T	0	2P	T – 2P
P = ½T	0	2P	0
P > ½T	2P – T	2(T – P)	0
P = T	T	0	0

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

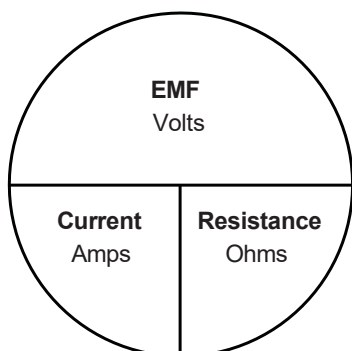
*Pie Wheels

- 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. (m²).

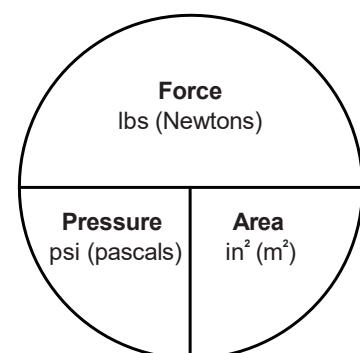
Area of Circle



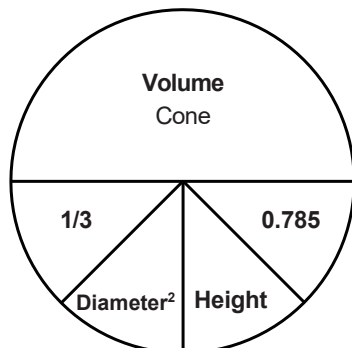
Electromotive Force (EMF), Volts



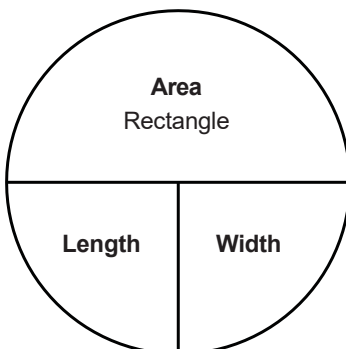
Force, lbs (Newtons)



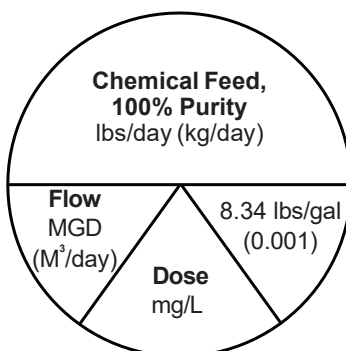
Volume of Cone



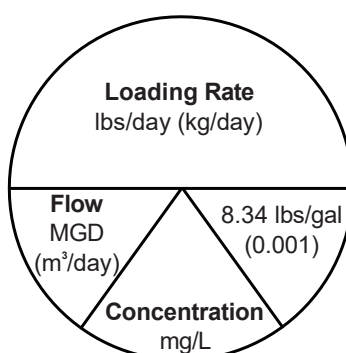
Area of Rectangle



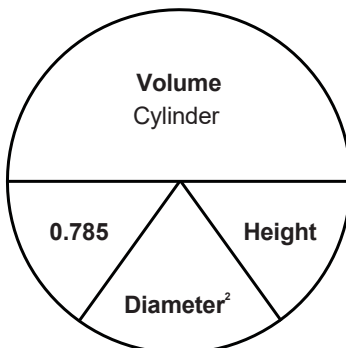
Feed Rate, lbs/day (kg/day)



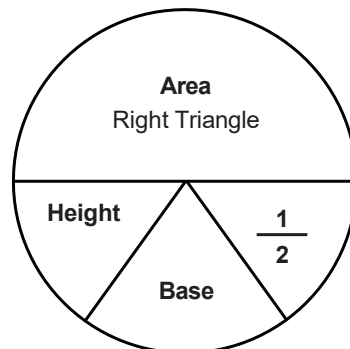
Loading Rate, lbs/day (kg/day)



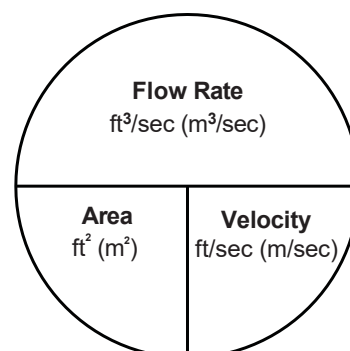
Volume of Cylinder



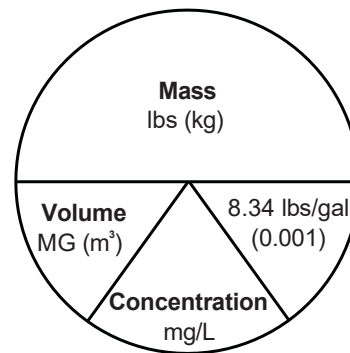
Area of Right Triangle



Flow Rate, ft³/sec (m³/sec)



Mass, lbs (kg)



Volume of Rectangular Tank

