Formula/Conversion Table
Water Treatment, Distribution, & Water Laboratory Exams

ABC Association of Boards of Certification | PO PROFESSIONAL OPERATOR

Alkalinity, mg/L as $CaCO_3$ = $\frac{\text{(Titrant Volume, mL)(Acid Normality)(50,000)}}{\text{Sample Volume, mL}}$

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

Area of Circle* = (0.785)(Diameter^2)

Area of Circle = (3.14)(Radius^2)

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

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

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

Where SA = surface area

Area of Rectangle* = (Length)(Width)

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

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

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

Blending = $(V_1)(C_1) + (V_2)(C_2) = (V_3)(C_3)$ ***Where V = volume or flow, C = concentration or percent solution***

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

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

Chemical Feed Pump Setting, mL/min =

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

Circumference of Circle = (3.14)(Diameter)

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

CT Calculation = (Disinfectant Residual Concentration, mg/L)(Time, min)

Degrees Celsius = $\frac{(°F - 32)}{1.8}$

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

Degrees Fahrenheit = (ºC)(1.8) + 32

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

Electromotive Force, volts* = (Current, amps)(Resistance, ohms)

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

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

Feed Rate (Fluoride), lb/day =

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

Feed Rate (Fluoride), kg/day =

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

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

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

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

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

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

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

Filter Loading Rate, gpm/ft² = $\frac{\text{Flow, gpm}}{\text{Filter area, } ft^2}$

Filter Loading Rate, L/sec/m² = $\frac{\text{Flow, L/sec}}{\text{Filter area, } m^2}$

Filter Yield, lb/hr/ft² = $\frac{\text{(Solids Loading, lb/day)(Recovery, \% expressed as a decimal)}}{\text{(Filter Operation, hr/day)(Area, } ft^2\text{)}}$

Filter Yield, kg/hr/m² = $\frac{\text{(Solids Concentration, \% expressed as a decimal)(Sludge Feed Rate, L/hr)(10)}}{\text{(Surface Area of Filter, } m^2\text{)}}$

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

Flow Rate, ft^3/sec* = (Area, ft^2)(Velocity, ft/sec)

Flow Rate, m^3/sec* = (Area, m^2)(Velocity, m/sec)

Force, lb* = (Pressure, psi)(Area, in^2)

Force, newtons* = (Pressure, pascals)(Area, m^2)

Hardness, as mg $CaCO_3$/L = $\dfrac{(\text{Titrant Volume, mL})(1{,}000)}{\text{Sample Volume, mL}}$ ***Only when the titration factor is 1.00 of EDTA***

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

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

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 = $\dfrac{(\text{Flow, gpm})(\text{Head, ft})}{3{,}960}$

Horsepower, Water, kW = (9.8)(Flow, m^3/sec)(Head, m)

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

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

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

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

Langelier Saturation Index = pH – pHs

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

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

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

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

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***

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

Two Normal Equation = $(C_1 \times V_1) = (C_2 \times V_2)$ ***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)(Diameter^2)(Height)

Volume of Cylinder* = (0.785)(Diameter^2)(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, % = $\frac{\text{(Flow, gpm)(Total Dynamic Head, ft)(0.746 kW/hp)(100\%)}}{\text{(3,960)(Electrical Demand, kW)}}$

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

Abbreviations

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

Conversion Factors

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

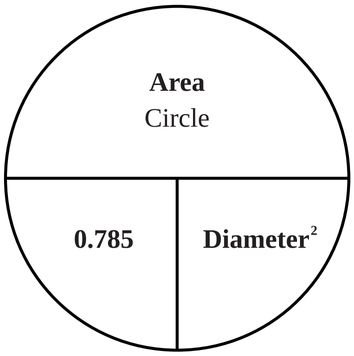
Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < ½T	0	2P	T – 2P
P = ½T	0	2P	0
P > ½T	2P – T	2(T – P)	0
P = T	T	0	0

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

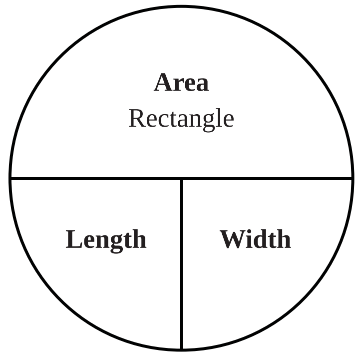
*Pie Wheels

- 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. (m^2).

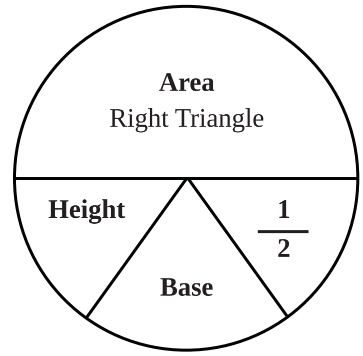
Area of Circle



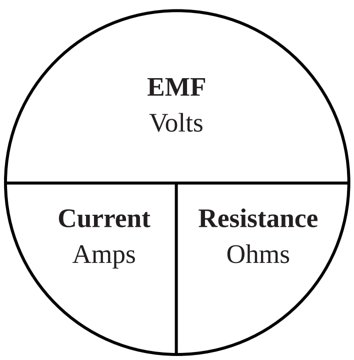
Area of Rectangle



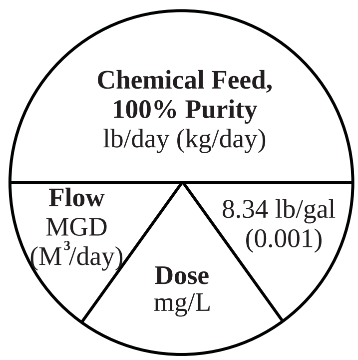
Area of Right Triangle



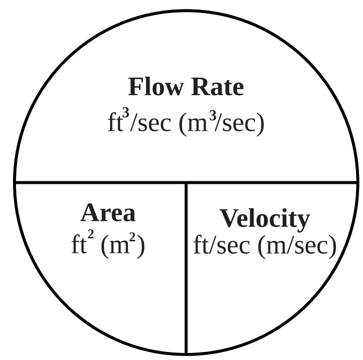
Electromotive Force (EMF), Volts



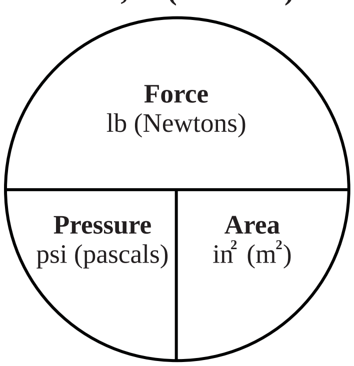
Feed Rate, lb/day (kg/day)



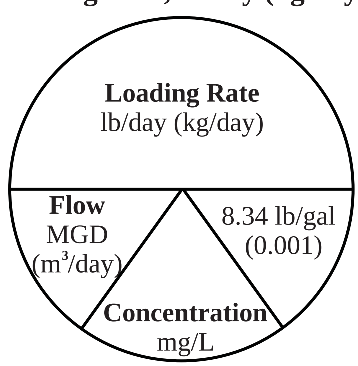
Flow Rate, ft^3/sec (m^3/sec)



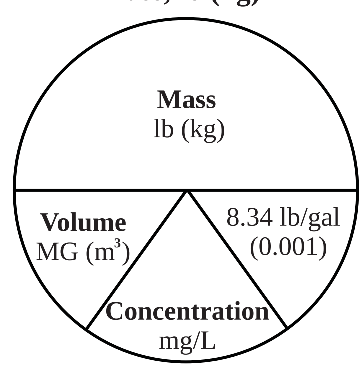
Force, lb (Newtons)



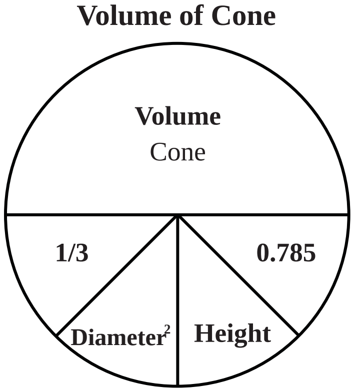
Loading Rate, lb/day (kg/day)



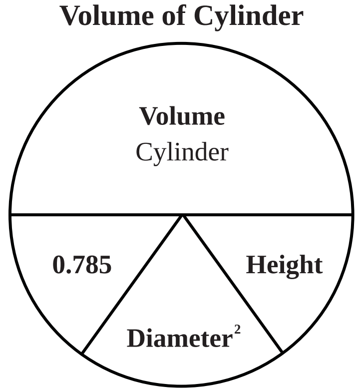
Mass, lb (kg)



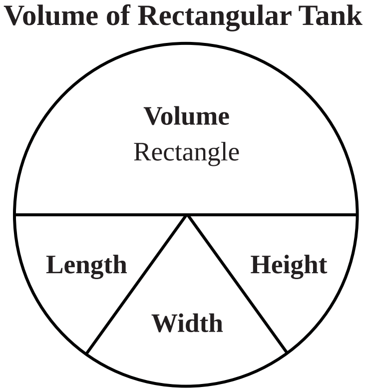
Volume of Cone



Volume of Cylinder



Volume of Rectangular Tank



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