

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

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

$$\begin{aligned} \text{*Area of Circle} &= (.785) (\text{Diameter}^2) \\ &= (\pi) (\text{Radius}^2) \end{aligned}$$

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

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

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

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

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

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

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

$$\text{Chemical Dry Feeder Calibration, lbs/day} = \frac{(\text{Dry Chemical Collected, grams}) (60 \text{ min/hr}) (24 \text{ hr/day})}{(454 \text{ grams/lb}) (\text{Time, min})}$$

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

$$\text{Chemical Feed Pump Setting, mL/min} = \frac{(\text{Flow, MGD}) (\text{Dose, mg/L}) (3.785 \text{ L/gal}) (1,000,000 \text{ gal/MG})}{(\text{Liquid, mg/mL}) (24 \text{ hr/day}) (60 \text{ min/hr})}$$

$$\begin{aligned} \text{Circumference of Circle} &= (\pi) (\text{Diameter}) \\ &= 2 (\pi) (\text{Radius}) \end{aligned}$$

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

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

$$\begin{aligned} \text{Degrees Celsius} &= (\text{Degrees Fahrenheit} - 32) (\frac{5}{9}) \\ &= \frac{(\text{°F} - 32)}{1.8} \end{aligned}$$

$$\begin{aligned} \text{Degrees Fahrenheit} &= (\text{Degrees Celsius}) \left(\frac{9}{5}\right) + 32 \\ &= (\text{Degrees Celsius}) (1.8) + 32 \end{aligned}$$

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

$$\text{*Electromotive Force (EMF), volts} = (\text{Current, amps}) (\text{Resistance, ohms}) \quad \text{or} \quad E = IR$$

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

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

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

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

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

$$\text{Filter Flow Rate or Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter Area, ft}^2}$$

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

$$\text{*Flow Rate, cfs} = (\text{Area, ft}^2) (\text{Velocity, ft/sec}) \quad \text{or} \quad Q = AV \quad \text{Units must be compatible}$$

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

$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

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

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

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

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

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

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

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

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

$$\text{*Mass Flux, lbs/day} = (\text{Flow, MGD})(\text{Concentration, mg/L})(8.34 \text{ lbs/gal})$$

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

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

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

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

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

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

$$\text{Removal, \%} = \left(\frac{\text{In} - \text{Out}}{\text{In}} \right) \times 100\%$$

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

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

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

$$\text{Specific Gravity} = \frac{\text{Specific Weight of Substance, lbs/gal}}{\text{Specific Weight of Water, lbs/gal}}$$

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

$$\text{Three Normal Equation} = (N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3) \quad \text{Where } V_1 + V_2 = V_3$$

$$\text{Two Normal Equation} = N_1 \times V_1 = N_2 \times V_2 \quad \text{Where } N = \text{normality, } V = \text{volume or flow}$$

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

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

$$\begin{aligned} \text{*Volume of Cone} &= (1/3)(.785)(\text{Diameter}^2)(\text{Height}) \\ &= (1/3)[(\pi)(\text{Radius}^2)(\text{Height})] \end{aligned}$$

$$\text{*Volume of Cylinder} = (.785) (\text{Diameter}^2) (\text{Height})$$

$$= (\pi) (\text{Radius}^2) (\text{Height})$$

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

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

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

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

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

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

Abbreviations:

cfs	cubic feet per second
DO	dissolved oxygen
ft	feet
g	grams
gpd	gallons per day
gpg	grains per gallon
gpm	gallons per minute
hp	horsepower
hr	hour
in	inches
kW	kilowatt
lbs	pounds
mg/L	milligrams per liter
MGD	million gallons per day
mL	milliliter
min	minute
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
Q	flow
SS	settleable solids
TTHM	total trihalomethanes
TOC	total organic carbon
TSS	total suspended solids
VS	volatile solids

Conversion Factors:

1 acre	= 43,560 square feet
1 acre foot	= 326,000 gallons
1 cubic foot	= 7.48 gallons
	= 62.4 pounds
1 cubic foot per second	= 0.646 MGD
1 foot	= 0.305 meters
1 foot of water	= 0.433 psi
1 gallon	= 3.79 liters
	= 8.34 pounds
1 grain per gallon	= 17.1 mg/L
1 horsepower	= 0.746 kW
	= 746 watts
	= 33,000 ft lbs/min
1 mile	= 5,280 feet
1 million gallons per day	= 694 gallons per minute
	= 1.55 cubic feet per second (cfs)
1 pound	= 0.454 kilograms
1 pound per square inch	= 2.31 feet of water
1 ton	= 2,000 pounds
1%	= 10,000 mg/L
π or pi	= 3.14159

Alkalinity Relationships:

All Alkalinity expressed as mg/L as CaCO₃

Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < 1/2 T	0	2P	T - 2P
P = 1/2 T	0	2P	0
P > 1/2 T	2P - T	2(T - P)	0
P = T	T	0	0

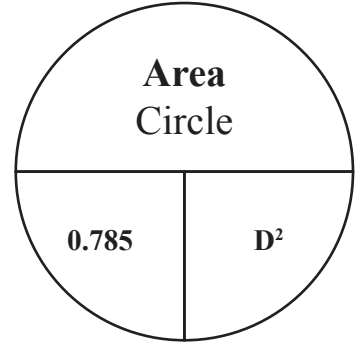
Key: P – phenolphthalein alkalinity T – total alkalinity

***Pie Wheels:**

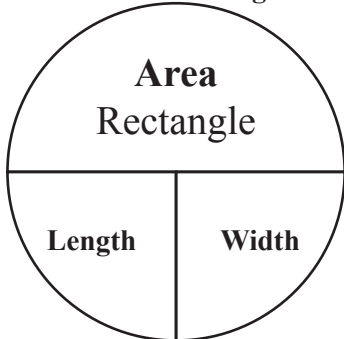
- To find the quantity above the horizontal line: multiply the pie wedges below the line together.
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge, then divide the remaining pie wedge(s) into the quantity above the horizontal line.

Given units must match the units shown in the pie wheel.

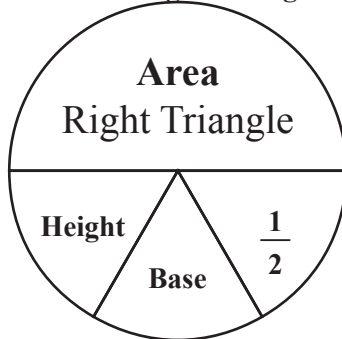
Area of Circle



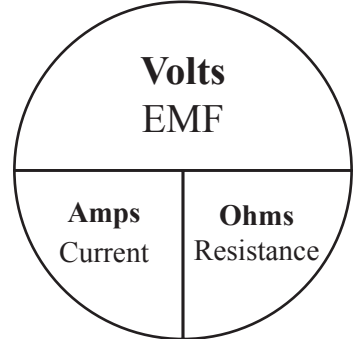
Area of Rectangle



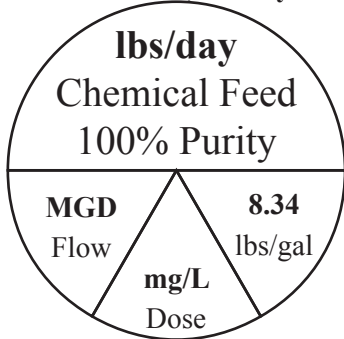
Area of Right Triangle



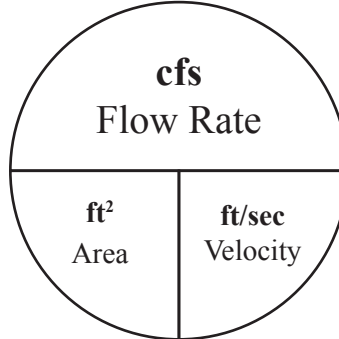
Electromotive Force (EMF), volts



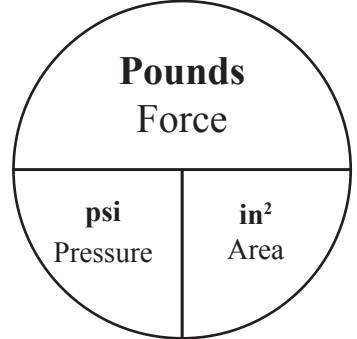
Feed Rate, lbs/day



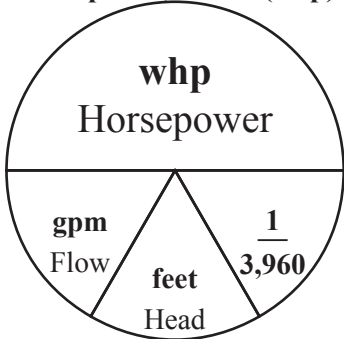
Flow Rate, cfs



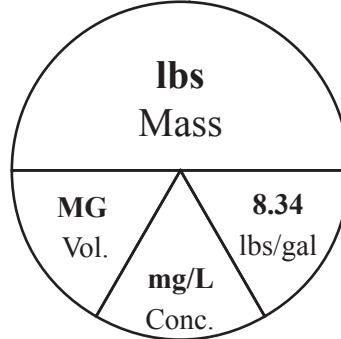
Force, pounds



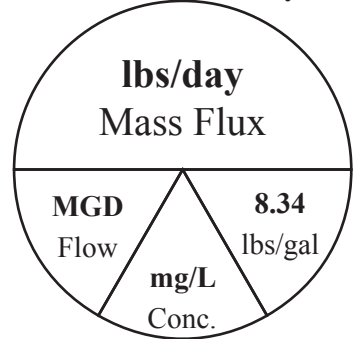
Horsepower, Water (whp)



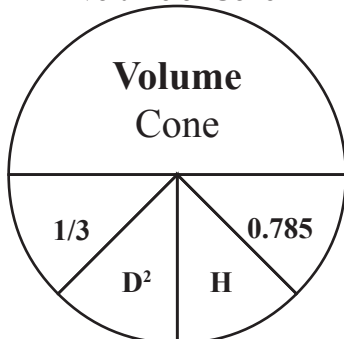
Mass, lbs



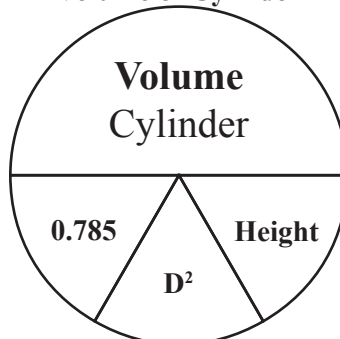
Mass Flux, lbs/day



Volume of Cone



Volume of Cylinder



Volume of Rectangular Tank

