

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**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
$\pi$ or pi	= 3.14159

**Alkalinity Relationships:**

All Alkalinity expressed as mg/L as CaCO<sub>3</sub>

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

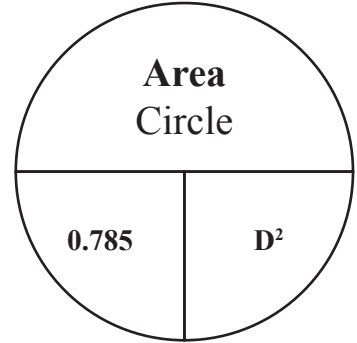
Key: P – phenolphthalein alkalinity T – total alkalinity

**\*Pie Wheels:**

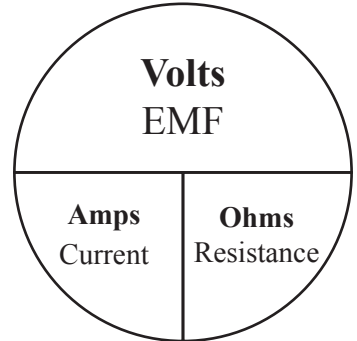
- To find the quantity above the horizontal line: multiply the pie wedges below the line together.
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge, then divide the remaining pie wedge(s) into the quantity above the horizontal line.

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

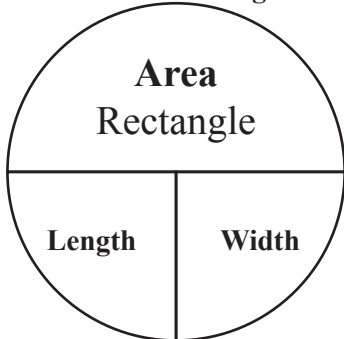
**Area of Circle**



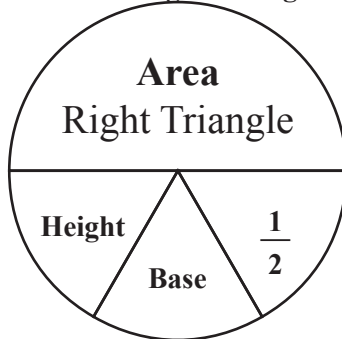
**Electromotive Force (EMF), volts**



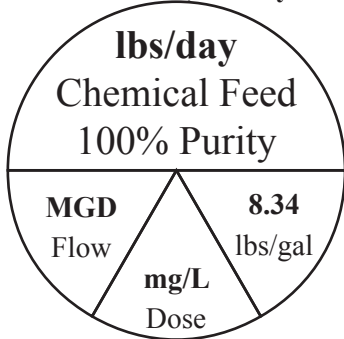
**Area of Rectangle**



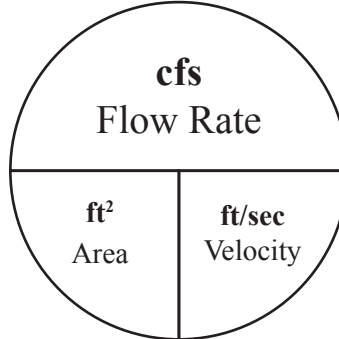
**Area of Right Triangle**



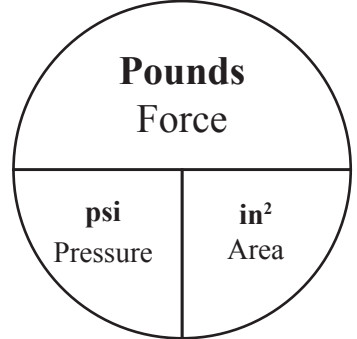
**Feed Rate, lbs/day**



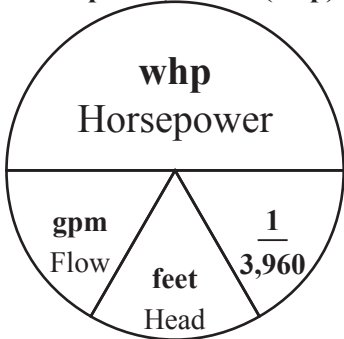
**Flow Rate, cfs**



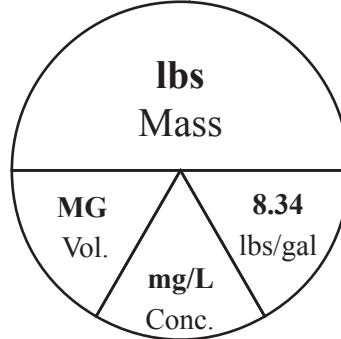
**Force, pounds**



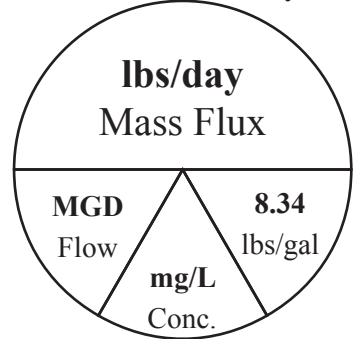
**Horsepower, Water (whp)**



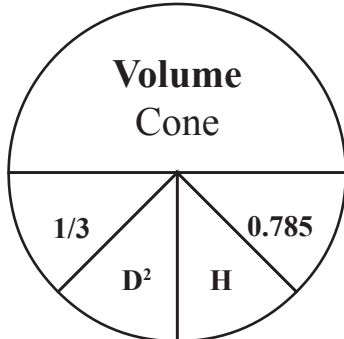
**Mass, lbs**



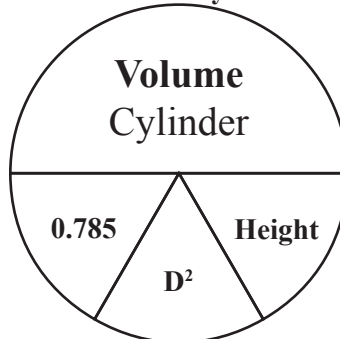
**Mass Flux, lbs/day**



**Volume of Cone**



**Volume of Cylinder**



**Volume of Rectangular Tank**

