ABC & C₂EP Formula/Conversion Table for Water Treatment, Distribution, & Laboratory Exams

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

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

$$*\text{Area of Circle} = (.785)\,(\text{Diameter}^2)$$
$$= (\pi)\,(\text{Radius}^2)$$

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

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

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

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

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

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

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

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

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

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

$$\text{Circumference of Circle} = (\pi)\,(\text{Diameter})$$
$$= 2\,(\pi)\,(\text{Radius})$$

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

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

$$\text{Degrees Celsius} = (\text{Degrees Fahrenheit - 32})\,(5/9)$$
$$= \frac{(°F - 32)}{1.8}$$

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

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Water Treatment, Distribution, Laboratory
Formula/Conversion Table

Degrees Fahrenheit $= $ (Degrees Celsius) $(^9/_5) + 32$

$\qquad\qquad\quad = $ (Degrees Celsius) $(1.8) + 32$

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

*Electromotive Force (EMF), volts $=$ (Current, amps) (Resistance, ohms)   *or* $E = IR$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Milliequivalent $=$ (mL) (Normality)

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

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

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

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

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

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

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

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

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

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

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

Three Normal Equation $= (N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3)$ *Where $V_1 + V_2 = V_3$*

Two Normal Equation $= N_1 \times V_1 = N_2 \times V_2$ *Where N = normality, V = volume or flow*

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

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

*Volume of Cone $=$ (1/3) (.785) (Diameter^2) (Height)

$=$ (1/3) [(π) (Radius^2) (Height)]

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

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Water Treatment, Distribution, Laboratory
Formula/Conversion Table

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

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

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

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

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

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

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

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

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
$\qquad\qquad = 62.4$ 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
$\qquad\quad = 8.34$ pounds
1 grain per gallon $= 17.1$ mg/L
1 horsepower $= 0.746$ kW
$\qquad\qquad\quad = 746$ watts
$\qquad\qquad\quad = 33{,}000$ ft lbs/min
1 mile $= 5{,}280$ feet
1 million gallons per day $= 694$ gallons per minute
$\qquad\qquad\qquad\qquad\quad = 1.55$ 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 $CaCO_3$

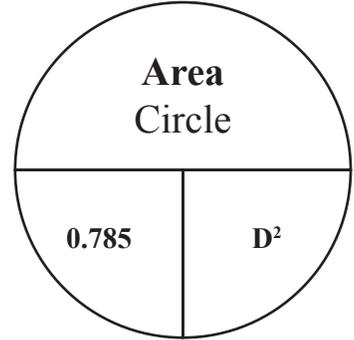| Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < ½T	0	2P	T − 2P
P = ½T	0	2P	0
P > ½T	2P − T	2(T − P)	0
P = T	T	0	0

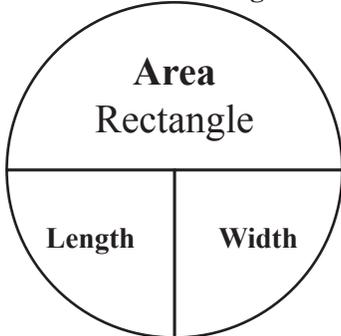Key: P – phenolphthalein alkalinity   T – total alkalinity

- 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.

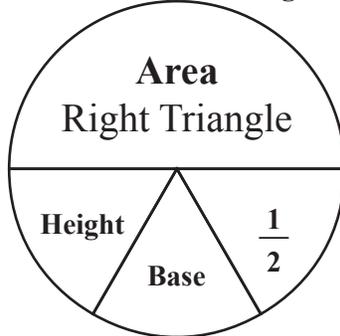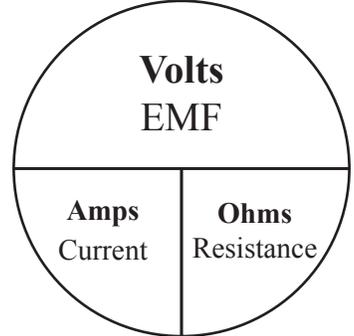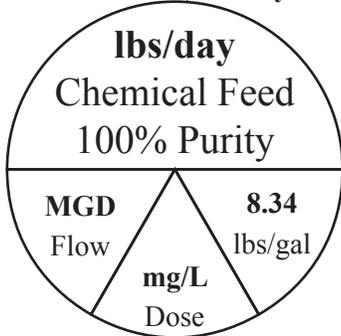*Given units must match the units shown in the pie wheel.*

Area of Circle

Area
Circle

| 0.785 | D^2 |

Area of Rectangle

Area
Rectangle

| Length | Width |

Area of Right Triangle

Area
Right Triangle

Height | Base | $\dfrac{1}{2}$

Electromotive Force (EMF), volts

Volts
EMF

| Amps Current | Ohms Resistance |

Feed Rate, lbs/day

lbs/day
Chemical Feed
100% Purity

MGD Flow | mg/L Dose | 8.34 lbs/gal

Flow Rate, cfs

cfs
Flow Rate

| ft² Area | ft/sec Velocity |

Force, pounds

Pounds
Force

| psi Pressure | in² Area |

Horsepower, Water (whp)

whp
Horsepower

gpm Flow | feet Head | $\dfrac{1}{3{,}960}$

Mass, lbs

lbs
Mass

MG Vol. | mg/L Conc. | 8.34 lbs/gal

Mass Flux, lbs/day

lbs/day
Mass Flux

MGD Flow | mg/L Conc. | 8.34 lbs/gal
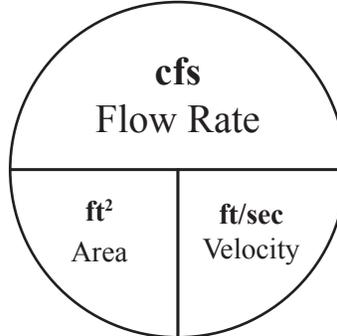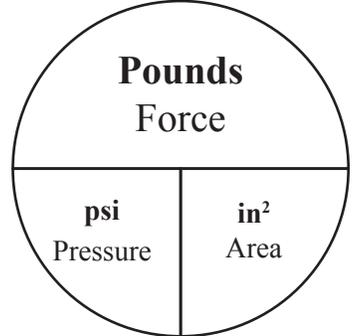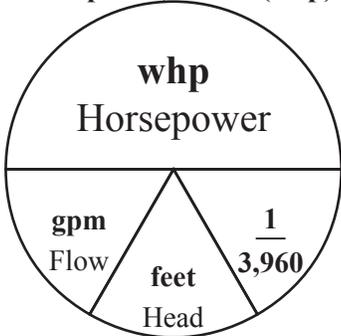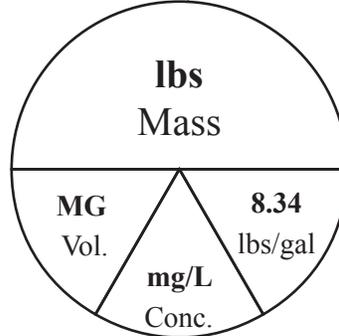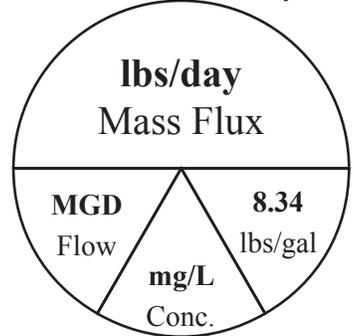
Volume of Cone

Volume
Cone

1/3 | D² | H | 0.785
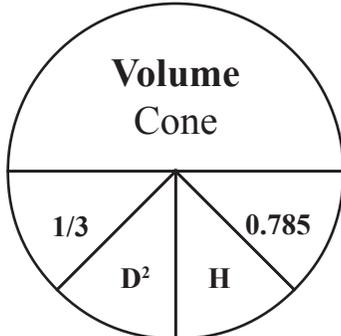
Volume of Cylinder

Volume
Cylinder

0.785 | D² | Height

Volume of Rectangular Tank

Volume
Rectangle

Length | Width | Height