

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

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

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

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

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

$$\text{Blending or Three Normal Equation} = (C_1 \times V_1) + (C_2 \times V_2) = (C_3 \times V_3) \quad \textit{Where } V_1 + V_2 = V_3; C = \textit{concentration, } V = \textit{volume or flow; Concentration units must match; Volume units must match}$$

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

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

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

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

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

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

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

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

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

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

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

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

$$\text{Dilution or Two Normal Equation} = (C_1 \times V_1) = (C_2 \times V_2) \quad \begin{array}{l} \text{Where } C = \text{Concentration, } V = \text{volume or flow;} \\ \text{Concentration units must match;} \\ \text{Volume units must match} \end{array}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*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

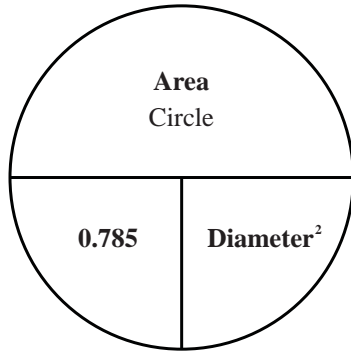
| Result of Titrations | Hydroxide Alkalinity | Carbonate Alkalinity | Bicarbonate Concentration |
|----------------------|----------------------|----------------------|---------------------------|
| P = 0 | 0 | 0 | T |
| P < ½T | 0 | 2P | T – 2P |
| P = ½T | 0 | 2P | 0 |
| P > ½T | 2P – T | 2(T – P)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

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

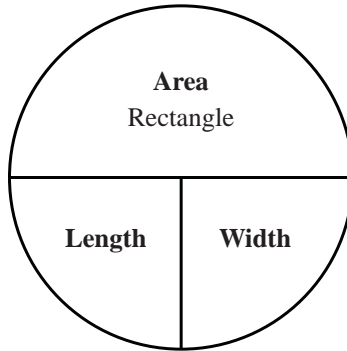
***Pie Wheels**

- 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).

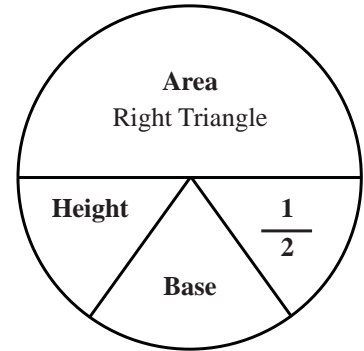
Area of Circle



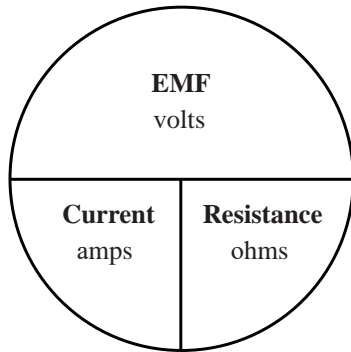
Area of Rectangle



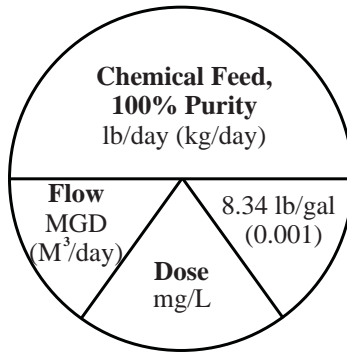
Area of Right Triangle



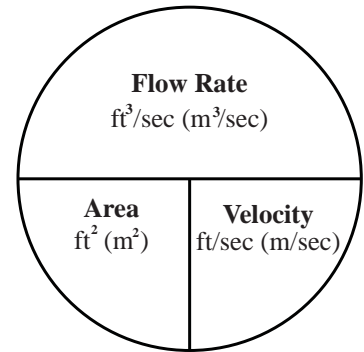
Electromotive Force (EMF), volts



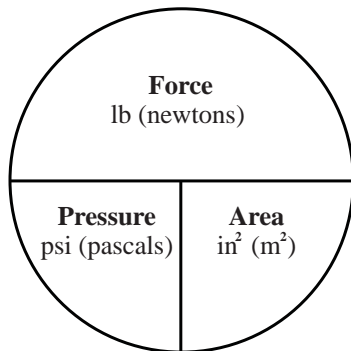
Feed Rate, lb/day (kg/day)



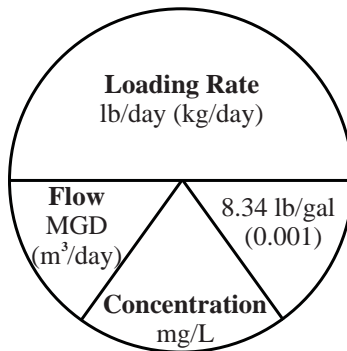
Flow Rate, ft³/sec (m³/sec)



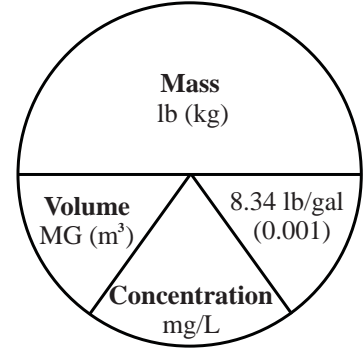
Force, lb (newtons)



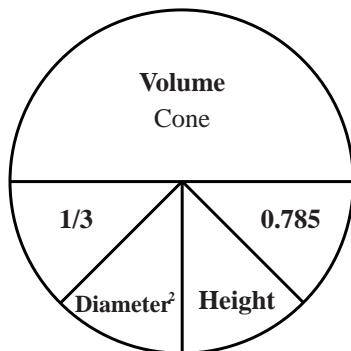
Loading Rate, lb/day (kg/day)



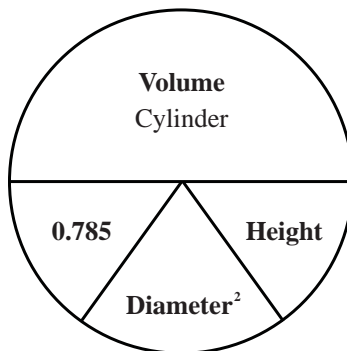
Mass, lb (kg)



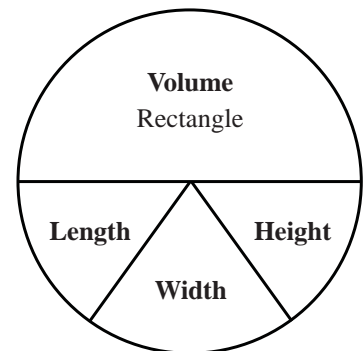
Volume of Cone



Volume of Cylinder



Volume of Rectangular Tank



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