C2EP Certification Environmental Professionals, Collection, & Laboratory Exams					
Alkalinity, as mg CaCO ₃ /L = $\frac{(\text{Titrant Volume, mL})(\text{Acid Normality})(50,000)}{\text{Sample Volume, mL}}$					
$Amps = \frac{Volts}{Ohms}$					
*Area of Circle = $(.785)$ (Diameter ²)					
$= (\pi)$ (Radius ²)					
Area of Cone (lateral area) = (π) (Radius) $\sqrt{\text{Radius}^2 + \text{Height}^2}$					
Area of Cone (total surface area) = (π) (Radius) (Radius + $\sqrt{\text{Radius}^2 + \text{Height}^2})$					
Area of Cylinder (total exterior surface area) = [Surface Area of End #1] + [Surface Area of End #2] + $[(\pi)$ (Diameter) (Height or Depth)]					
*Area of Rectangle = (Length) (Width)					
*Area of a Right Triangle = $\frac{(Base)(Height)}{2}$					
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					
Biochemical Oxygen Demand (unseeded), $mg/L = \frac{[(Initial DO, mg/L) - (Final DO, mg/L)][300mL]}{Sample Volume, mL}$					
Chemical Feed Pump Setting, % Stroke = $\frac{\text{Desired Flow}}{\text{Maximum Flow}} \times 100\%$					
Chemical Feed Pump Setting, mL/min = $\frac{(Flow, MGD) (Dose, mg/L) (3.785 L/gal) (1,000,000 gal/MG)}{(Liquid, mg/mL) (24 hr/day) (60 min/hr)}$					
Circumference of Circle = (π) (Diameter)					
$= 2 (\pi)$ (Radius)					
Composite Sample Single Portion = $\frac{(\text{Instantaneous Flow})(\text{Total Sample Volume})}{(\text{Number of Portions})(\text{Average Flow})}$					
Cycle Time, min = <u>Storage Volume, gal</u> <u>Pump Capacity, gpm - Wet Well Inflow, gpm</u>					

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Degrees Celsius = (Degrees Fahrenheit - 32) (5/9) $= \frac{(^{\circ}\mathrm{F}-32)}{18}$ Degrees Fahrenheit = (Degrees Celsius) $(^{9}/_{5}) + 32$ = (Degrees Celsius) (1.8) + 32Detention Time = $\frac{\text{Volume}}{\text{Flow}}$ Units must be compatible Dose = Demand + Residual*Electromotive Force (EMF), volts = (Current, amps) (Resistance, ohms) or E = IR*Feed Rate, lbs/day = $\frac{(\text{Dosage,mg/L})(\text{Capacity,MGD})(8.34 \text{lbs/gal})}{\text{Purity,% expressed as a decimal}}$ $\frac{(\text{Backwash Rate, gpm/ft}^2)(12 \text{ in/ft})}{7.48 \text{ gal/ft}^3}$ Filter Backwash Rise Rate, in/min =Filter Flow Rate or Backwash Rate, $gpm/ft^2 = \frac{Flow, gpm}{Filter Area, ft^2}$ Filter Yield, $lbs/hr/ft^2 = \frac{(Solids Loading, lbs/day)(Recovery, % expressed as a decimal)}{(Filter Operation br/day)(Area <math>R^2$) (Filter Operation, hr/day) (Area, ft^2) *Flow Rate, $cfs = (Area, ft^2)$ (Velocity, ft/sec) or Q = AV Units must be compatible Food/Microorganism Ratio = $\frac{BOD_5, lbs/day}{MLVSS, lbs}$ *Force, lbs = (Pressure, psi) (Area, in^2) Gallons/Capita/Day = $\frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$ Hardness, as mg CaCO₃/L = $\frac{(\text{Titrant Volume, mL})(1,000)}{\text{Sample Volume, mL}}$ Only when the titration factor is 1.00 of EDTA Horsepower, Brake (bhp) = $\frac{(Flow, gpm)(Head, ft)}{(3,960)(Pump Efficiency, % expressed as a decimal)}$ Horsepower, Motor (mhp) =(Flow,gpm)(Head,ft) (3,960)(Pump Efficiency, % expressed as a decimal)(Motor Efficiency, % expressed as a decimal) *Horsepower, Water (whp) = $\frac{(Flow, gpm)(Head, ft)}{3,960}$

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

Copyright © 2013 by Association of Boards of Certification Leakage, $gpd = \frac{Volume, gallons}{Time days}$ *Mass, lbs = (Volume, MG) (Concentration, mg/L)(8.34 lbs/gal) *Mass Flux, lbs/day = (Flow, MGD) (Concentration, mg/L) (8.34 lbs/gal) $Mean Cell Residence Time (MCRT) or Solids Retention Time (SRT), days = \frac{Aeration Tank TSS, lbs + Clarifier TSS, lbs}{TSS Wasted, lbs/day + Effluent TSS, lb/day}$ Milliequivalent = (mL) (Normality) Molarity = $\frac{\text{Moles of Solute}}{\text{Liters of Solution}}$ Motor Efficiency, $\% = \frac{\text{Brake hp}}{\text{Motor hp}} \times 100 \%$ 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 = $\frac{\text{Total Weight}}{\text{Molecular Weight}}$ Organic Loading Rate, lbs BOD₅/day/ft³ = $\frac{\text{Organic Load, lbs BOD_5/day}}{\text{Volume, ft}^3}$ Organic Loading Rate-RBC, lbs BOD₅/day/1,000 ft² = $\frac{\text{Organic Load, lbs BOD}_5/\text{day}}{\text{Surface Area of Media, 1,000 ft}^2}$ Organic Loading Rate-Trickling Filter, lbs $BOD_5/day/1,000 \text{ ft}^3 = \frac{Organic Load, lbs BOD_5/day}{Organic Load, lbs BOD_5/day}$ Volume 1.000 ft^3 Oxygen Uptake Rate or Oxygen Consumption Rate, $mg/L/min = \frac{Oxygen Usage, mg/L}{Dxygen Usage, mg/L}$ Time, min Population Equivalent, Organic = $\frac{(Flow, MGD)(BOD, mg/L)(8.34 lbs/gal)}{BOD/dav/nerson lbs}$ Recirculation Ratio-Trickling Filter = $\frac{\text{Recirculated Flow}}{\text{Primary Effluent Flow}}$ Reduction in Flow, $\% = \left(\frac{\text{Original Flow} - \text{Reduced Flow}}{\text{Original Flow}}\right) \times 100\%$ Reduction of Volatile Solids, $\% = \left(\frac{\text{In} - \text{Out}}{\text{In} - (\text{In} \times \text{Out})}\right) \times 100\%$ All information (In and Out) must be in decimal form Removal, % = $\left(\frac{\text{In} - \text{Out}}{\text{In}}\right) \times 100\%$

Return Rate, $\% = \frac{\text{Return Flow Rate}}{\text{Influent Flow Rate}} \times 100\%$ (MLSS) (Flow Rate) Return Activated Sludge Suspended Solids – MLSS Return Sludge Rate-Solids Balance = Slope, $\% = \frac{\text{Drop or Rise}}{\text{Distance}} \times 100\%$ Sludge Density Index = $\frac{100}{SVI}$ Sludge Volume Index (SVI), mL/g = $\frac{(SSV_{30}, mL/L)(1,000 \text{ mg/g})}{MLSS, mg/L}$ Solids, mg/L = $\frac{(\text{Dry Solids, grams})(1,000,000)}{\text{Sample Volume, mL}}$ Solids Concentration, mg/L = $\frac{\text{Weight, mg}}{\text{Volume L}}$ Solids Loading Rate, $lbs/day/ft^2 = \frac{Solids Applied, lbs/day}{Surface Area, ft^2}$ Solids Retention Time (SRT): see Mean Cell Residence Time (MCRT) Specific Gravity = <u>Specific Weight of Substance, lbs/gal</u> Specific Weight of Water, lbs/gal Specific Oxygen Uptake Rate or Respiration Rate, $(mg/g)/hr = \frac{OUR, mg/L/min(60 min)}{MLVSS, g/L(1 hr)}$ Surface Loading Rate or Surface Overflow Rate, $gpd/ft^2 = \frac{Flow, gpd}{Area ft^2}$ 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 flowVelocity, ft/sec = $\frac{\text{Flow Rate, ft}^3 / \text{sec}}{\text{Area, ft}^2}$ or $\frac{\text{Distance, ft}}{\text{Time, sec}}$ Volatile Solids, % = $\left(\frac{\text{Dry Solids, g} - \text{Fixed Solids, g}}{\text{Dry Solids, g}}\right) \times 100\%$ *Volume of Cone = (1/3) (.785) (Diameter²) (Height) = (1/3) [(π) (Radius²) (Height)] *Volume of Cylinder = (.785) (Diameter²) (Height) $= (\pi)$ (Radius²) (Height) *Volume of Rectangular Tank = (Length) (Width) (Height)

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Weir Overflow Rate, gpd/ft = $\frac{Flow, gpd}{Weir Length, ft}$ Wire-to-Water Efficiency, % = $\frac{(Flow, gpm)(Total Dynamic Head, ft) (0.746 kW/hp)}{Power Input, hp or Motor hp} \times 100%Wire-to-Water Efficiency, % = \frac{(Flow, gpm)(Total Dynamic Head, ft) (0.746 kW/hp)}{(3.960)(Electrical Demand, kW)} \times 100%Abbreviations:RODBODbiochemical oxygen demandCODCODchemical oxygen demandCODchemical oxygen demandCODchemical oxygen demandCODchemical oxygen demandDOdissolved oxygenftfeetF/M ratiogpdgalons per daygpdgpmgallons per daygpmgpmgpmgnd gallons per daygpmgpmgnd gallons per daygpmgpmgnd gallons per daygpmgpmgnd gallons per daymkmkmkMCRTmean cell residence timeMGDMLSSmixed liquor volatilesuspended solidMCXSMCXSMCXSmixed liquor volatilesuspended solidMCXSMCXMLSSmixed liquor volatilesuspended solidMCXMCXMLSSmixed liquor volatilesuspended solidMCXM$	Watts (AC circuit) = (Volts) (Amps) (Power Factor) Watts (DC circuit) = (Volts) (Amps)					
Power Input, hp or Motor hpWire-to-Water Efficiency, $\% = \frac{(Flow, gpm)(Total Dynamic Head, ft) (0.746 kW/hp)}{(3.960) (Electrical Demand, kW)} \times 100%Abbreviations:BOD biochemical oxygen demandCBOD carbonaceous biochemicaloxygen demandCDD chemical oxygen demandDO dissolved oxygenft feetAbbreviations(continued):RAS return activated sludgeRBC rotating biological contactorSDI sludge density indexCDD chemical oxygen demandCDD dissolved oxygenft feetAbbreviations(continued):RAS return activated sludgeCDD dissolved oxygen demandft feetSSV subject on timeSSV subject of the sludge volume 30 minuteTOC total organic carbonTS total solidsgpg gramsgpg grains per gallongpm gallons per daymg/L milligrams per litermL millititerConversion Factors:1 core = 43,560 square feet1 acre foot = 326,000 gallons1 cubic foot per second = 0.646 MGD1 foot e 0.305 metersMCRT mean cell residence timemLmL millilitermLmLVSS mixed liquor volatilesuspended solidsConversion Factors:1 cubic foot per second = 0.646 MGD1 foot e 0.305 meters1 foot of water = 0.433 psi1 gallon = 3.79 liters= 8.34 pounds1 grain per gallon = 17.1 mg/L1 horsepower = 0.746 kW= 746 watts= 33,000 foot lbs/min1 mile = 5,280 feet1 pound = 0.454 kilograms= 0.454 kilograms= 0.454 kilograms= 0.400 pounds= 2.31 feet of water= 1.55 cubic feet per second (cfs)1 pound per square inch = 2.31 feet of water= 1.0000 mg/L\pi or pi = 3.14159$	Weig Overflow Rate $\operatorname{red}(\theta) = \operatorname{Flow}, \operatorname{gpd}$					
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IntInfinitedMLSSmixed liquor suspended solidsMLVSSmixed liquor volatile suspended solidOCRoxygen consumption rateORPoxidation reduction potentialOURoxygen uptake rateppbparts per billionppmparts per millionpsipounds per square inchPEpopulation equivalent1grain per gallon = 17.1 mg/L1grain per gallon = 0.746 kW = 33,000 foot lbs/min1mized liquor volatile suspended solid0oxygen consumption rate010oxygen uptake rate1million gallons per day = 694 gallons per minute = 1.55 cubic feet per second (cfs)1pound = 0.454 kilograms1pound per square inch = 2,000 pounds1m = 2,000 pounds1% = 10,000 mg/L π or pi = 3.14159	min	minute	-			
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MLVSSmixed liquor volatile suspended solid $= 746$ watts $= 33,000$ foot lbs/minOCRoxygen consumption rate1 mile = 5,280 feetORPoxidation reduction potential1 mile = 5,280 feetOURoxygen uptake rate pb $= 1.55$ cubic feet per second (cfs)ppbparts per billion ppm1 pound = 0.454 kilograms 1 pound per square inch = 2.31 feet of water 1 ton = 2,000 poundspEpopulation equivalent π or pi = 3.14159	MLSS	mixed liquor suspended solids				
suspended solid $= 33,000$ foot lbs/minOCRoxygen consumption rate $1 \text{ mile} = 5,280$ feetORPoxidation reduction potential $1 \text{ mile} = 5,280$ feetOURoxygen uptake rate $1 \text{ million gallons per day} = 694$ gallons per minuteppbparts per billion $1 \text{ pound} = 0.454 \text{ kilograms}$ ppmparts per million $1 \text{ pound per square inch} = 2.31 \text{ feet of water}$ psipopulation equivalent $1\% = 10,000 \text{ mg/L}$ $\pi \text{ or pi} = 3.14159$ $\pi \text{ or pi} = 3.14159$	MLVSS	mixed liquor volatile	*			
OCRoxygen consumption rate1 mile = $5,280$ feetORPoxidation reduction potential1 mile = $5,280$ feetOURoxygen uptake rate1 million gallons per day = 694 gallons per minuteppbparts per billion1 pound = 0.454 kilogramsppmparts per million1 pound per square inch = 2.31 feet of waterpsipopulation equivalent $1\% = 10,000 \text{ mg/L}$ PEpopulation equivalent π or pi = 3.14159		suspended solid				
OURoxygen uptake rate ppb= 1.55 cubic feet per second (cfs)ppbparts per billion ppm1 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	OCR	oxygen consumption rate				
potential product and the product of the product	ORP	oxidation reduction potential				
ppbparts per officialppmparts per millionpsipounds per square inchPEpopulation equivalent π or pi = 3.14159	OUR	oxygen uptake rate	•			
ppmparts per million $1 \text{ ton} = 2,000 \text{ pounds}$ psipounds per square inch $1\% = 10,000 \text{ mg/L}$ PEpopulation equivalent $\pi \text{ or pi} = 3.14159$	ppb	parts per billion	· ·			
psipounds per square inch $1\% = 10,000 \text{ mg/L}$ PEpopulation equivalent $\pi \text{ or pi} = 3.14159$	ppm	parts per million				
PE population equivalent π or pi = 3.14159	psi	pounds per square inch	· 1			
	PE	population equivalent		-		

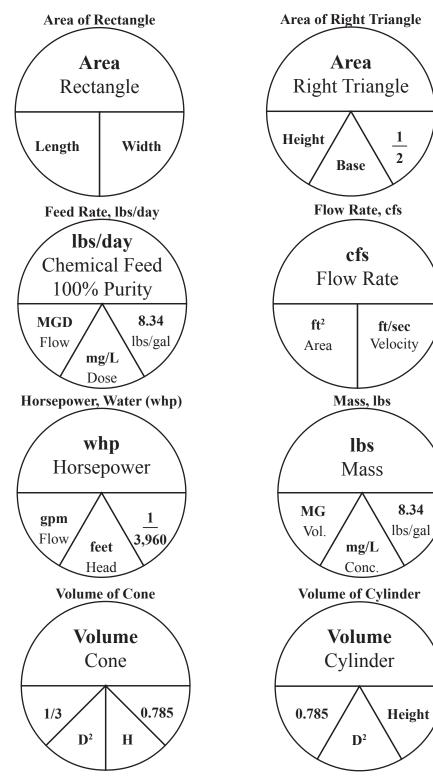
*Pie Wheel format for this equation is available at the end of this document.

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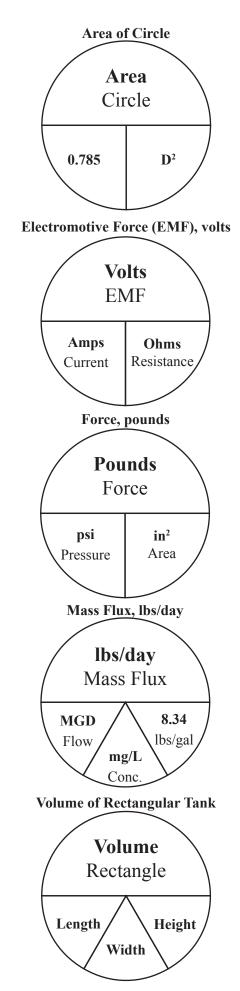
*Pie Wheels:

- 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.



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