CWEA

ECI MATH

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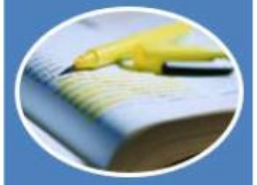
SENIOR INDUSTRIAL-WASTE INSPECTOR (RETIRED)

Agenda

- Introduction
- Presentation
- Time permitting, more “live” examples

Your Path to Certification



Explore & Learn

Read Your Candidate Handbook & Study Guide, Begin gathering your documentation

Assess Your Knowledge, Skills & Abilities

Review the KSAs and determine your areas of strength and weakness. Identify knowledge gaps you need to fill.

Identify Resources to Fill Your KSA Gaps

Books, workshops, local sections training, CWEA state training, youtube, community colleges

Attend a Cert Prep Session

Learn what to expect at the test site, resources to tap into and helpful hints/tools, take a sample test

Apply for Certification

Get your documentation ready and apply. You'll have 3 months to take your test once you are approved.

Continue Studying & Take Your Exam

Prepare, study, attend more trainings, read more books. Take the test.

Steps to help you be successful in getting CWEA certification for competency in your field

REFERENCES

- This presentation (as a PDF file)
- Applied Math for Wastewater System Operators, State of Tennessee [App. Math Wastewater]
- ECI Grade 1 Study Guide, CWEA [ECI 1 Study Guide]
- ECI Grade 3 Study Guide, CWEA [ECI 2 Study Guide]
- IWI Study Manual, CWEA
- Pretreatment Facility Inspection, OWP, CSUS [PFI]

All but the last (PFI) are available for download (https://cwea.app.box.com/s/nizgdiv19bt3cthuxtimj2cy8irlqnvt)

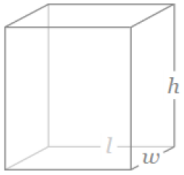
Equivalents & Formulas

Conversions

3.785 L/gal	453.6 g/lb	8.34 lb/gal	7.48 gal/ft^3
~~28.35 g/oz~~	~~43,560 ft^2/acre~~	$\pi = 3.14159$	

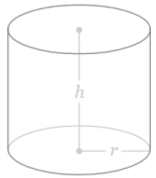
Volumes

Rectangular Solid



$V = lwh$

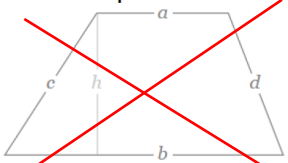
Right Cylinder



$V = \pi r^2 h$

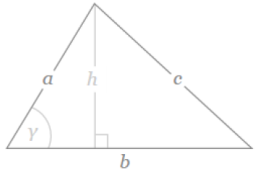
Areas

Trapezoid



$A = \frac{a+b}{2}h$

Triangle



$A = \frac{hb}{2}$

Formulas

Manning

$$Q = \frac{1.49\,AR^{2/3}S^{1/2}}{n}$$

Q= flow rate (CFS)
A = cross-sectional area of flow (ft^2)
R = hydraulic radius (ft)
S = slope of the hydraulic radius
n = Manning roughness coefficient

Counterflow Rinsing

$$R^n = \frac{C_p}{C_n}$$

R = rinse ratio (ratio of rinse water volumetric flow rate to the drag out volumetric flow rate)
C_p = plating bath metal concentration
C_n = metal concentration in the nth rinse tank
n = number of rinse tanks

Combined Waste Stream

$$C_T = \frac{[\sum_{i=1}^{N} C_i F_i][F_T - F_D]}{[\sum_{i=1}^{N} F_i][F_T]}$$

C_T = alternative concentration limit
C_i = concentration limit for stream i
F_i = average daily flow of stream i
F_T = F_i + F_D
F_D = average daily flow of dilute wastestream

PROBABLY NOT NEEDED ON THE GRADE 1 OR 2 TEST

KSA 101 math

- Recall how to calculate pH of an aqueous solution.
- Demonstrate how to balance chemical equations, identify acids and bases, and perform basic dilutions and neutralization calculations.

Basic dilutions

- $N = normality$
  - Can be replaced with concentration
- $V = volume\ or\ flow$

$$N_1 \times V_1 = N_2 \times V_2$$

OR

$$C_1 \times V_1 = C_2 \times V_2$$

- Normality is also a measure of concentration
- Units on both sides of eqn must be the same (N, mg/L, gpm, cfs, etc.)

Basic dilutions, problem

An operator needs to make 10 gallons of a bleach dilution with a concentration 25 mg/L. The bleach on hand has a concentration of 100 mg/L. How many gallons of the concentrate must be used to achieve the dilution?

$$C_1 \times V_1 = C_2 \times V_2$$

Basic dilutions, problem

An operator needs to make 10 gallons of a bleach dilution with a concentration 25 mg/L. The bleach on hand has a concentration of 100 mg/L. How many gallons of the concentrate must be used to achieve the dilution?

$$C_1 \times V_1 = C_2 \times V_2$$

C_1 = 25 mg/L V_1 = 10 gal

C_2 = 100 mg/L V_2 = ?

Basic dilutions, answer

An operator needs to make 10 gallons of a bleach dilution with a concentration 25 mg/L. The bleach on hand has a concentration of 100 mg/L. How many gallons of the concentrate must be used to achieve the dilution?

C_1 = 25 mg/L V_1 = 10 gal

C_2 = 100 mg/L V_2 = ? $C_1 \times V_1 = C_2 \times V_2$

$$V_2 = \frac{C_1}{C_2} \times V_1 = \frac{25\ mg/L}{100\ mg/L} \times 10\ gal = 2.5\ gal$$

TRY THIS
Basic dilutions, problem

ECI 1
Study Guide 40

What is the normality of sodium hydroxide (NaOH) solution if 25 mL of a 0.01 N sulfuric acid solution neutralizes 100 mL of the NaOH solution?

Basic dilutions, answer

What is the normality of sodium hydroxide (NaOH) solution if 25 mL of a 0.01 N sulfuric acid solution neutralizes 100 mL of the NaOH solution?

$$N_1V_1 = N_2V_2$$

$$N_1 = \frac{V_2}{V_1} \times N_2 = \frac{25\ mL}{100\ mL} \times 0.01\ N = 0.0025\ N$$

KSA 112 math

- Calculate the density of liquids and which values to report, gallons that are discharged per day, and flow rate.
- Understand how to convert liquid measurements.

KSA 116 math

- Calculate volume unit conversions.

Density

Density — The density is the mass of a substance per unit volume. A related quantity is the specific gravity which is the density relative to water, which weights 1.0 grams/ml. A solution with a specific gravity of 1.5 would weight 1.5 grams/ml.

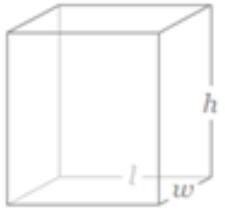
Units of density are g/mL, mg/L, lb/gal, etc.

Equivalents & Formulas

Conversions			
3.785 L/gal	453.6 g/lb	8.34 lb/gal	7.48 gal/ft^3
~~28.35 g/oz~~	~~43,560 ft^2/acre~~	$\pi = 3.14159$	

Volumes

Rectangular Solid



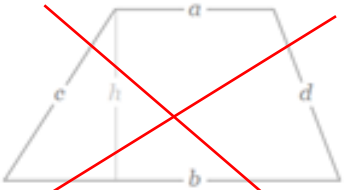
$V = lwh$

Right Cylinder

$V = \pi r^2 h$

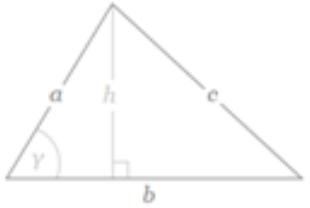
Areas

Trapezoid



$A = \frac{a+b}{2}h$

Triangle



$A = \frac{hb}{2}$

You should also know these:

365 d/y
24 h/d
60 s/min

52 w/y
60 min/h
3 ft/yd

SI PREFIXES

milli- (m): $10^{-3} = 1/1000$
centi- (c): $10^{-2} = 1/100$
kilo- (k): $10^{3} = 1000$

Conversions

Volume

- Volume is the capacity of a unit or how much it will hold

- Measured in
  - cubic units (ft^3, m^3, yd^3) or
  - liquid volume units (gallons, liters, million gallons)

Conversion, problem

Example 1

- Convert 1800 ft^3 into gallons.
- We need the conversion factor that connects the two units

1 cubic foot of water = 7.48 gal

- This is a ratio, so it can be written two different ways

$$\frac{1\ ft^3}{7.48\ gal} \quad \text{OR} \quad \frac{7.48\ gal}{1\ ft^3}$$

- We want to use the version that allows us to cancel out units and leave us in the units that we want

This conversion factor (7.48 gal/ft^3) is provided on the Equivalents & Formulas sheet

Conversion, answer

Convert 1800 ft^3 into gallons.

7.48 gal/ft^3

$$1800\ ft^3 \times \frac{7.48\ gal}{ft^3} = 13{,}464\ gal$$

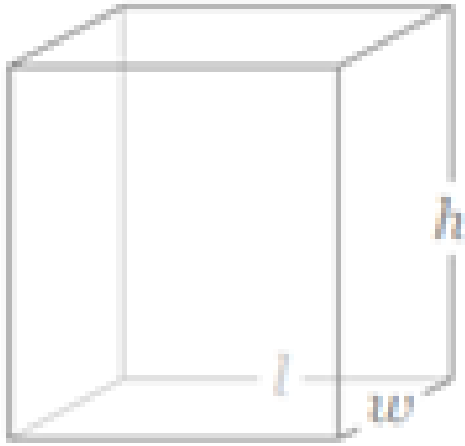
TRY THIS
Conversions, problem

Calculate the volume (in gallons) for a basin that measures 22 feet by 11 feet by 5 feet.

Volumes

$V = L \times W \times H$

Rectangular Solid



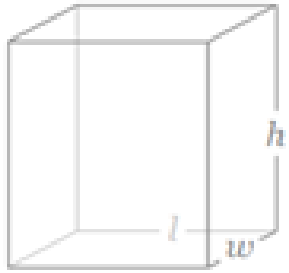
$V = lwh$

Conversions, answer

Calculate the volume (in gallons) for a basin that measures 22 feet by 11 feet by 5 feet.

Volumes

Rectangular Solid



$V = lwh$

$V = L \times W \times H = (22\ ft)(11\ ft)(5\ ft)$

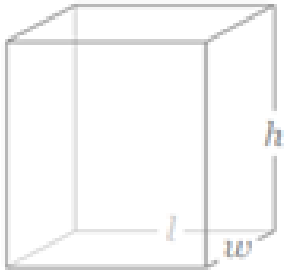
$= 1210\ ft^3$

Conversions, answer

Calculate the volume (in gallons) for a basin that measures 22 feet by 11 feet by 5 feet.

Volumes

Rectangular Solid



$V = lwh$

$$V = L \times W \times H = (22\ ft)(11\ ft)(5\ ft)$$

$$= 1210\ ft^3$$

$$1210\ ft^3 \times \frac{7.48\ gal}{ft^3} = 9050.8\ gal$$

KSA 106 math

- Calculate detention time, and minimum size of an interceptor using a set of given parameters.

KSA 201 math

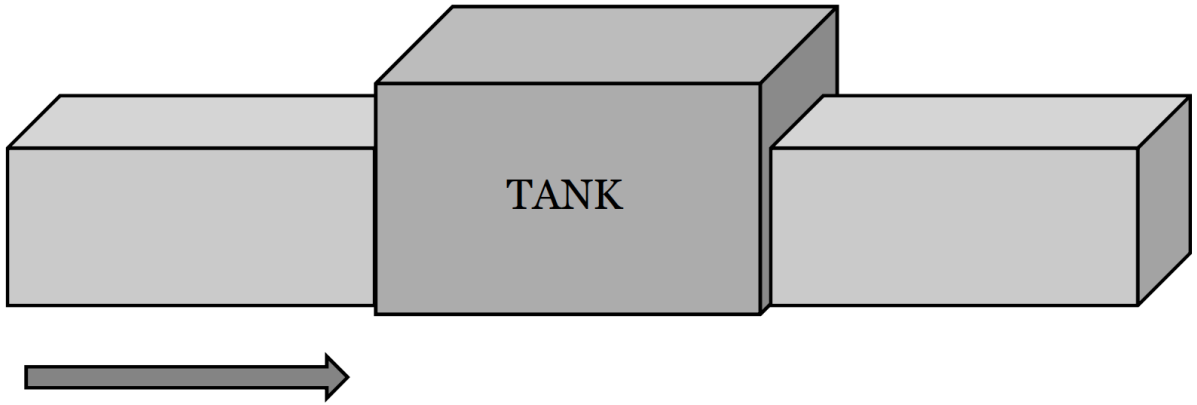
- Calculate size requirements of basin/containment structures.

KSA 224 math

- Understand all aspects of a grease Interceptor, sizing requirements and clarifier calculations.

Detention time

Detention Time is Flow-Through Time

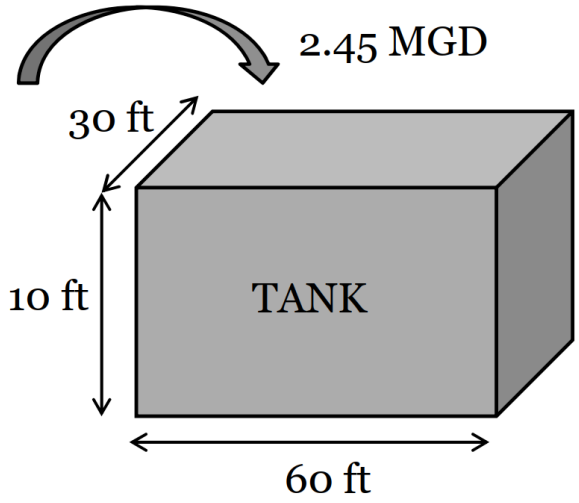


$$\text{Detention Time, hrs} = \frac{Volume\ of\ Tank, gal}{Flow, gph}$$

Be sure your time and volume units match!

Detention time, problem

The flow to a sedimentation tank 60 ft long, 30 ft wide, and 10 ft deep is 2.45 MGD. What is the detention time in the tank, in hours?



Tank Volume:

Volume (ft^3) = (L,ft)(W,ft)(d,ft)
Vol. = (60ft)(30ft)(10ft) = 18000 ft^3
Vol. = (18000 $\cancel{ft^3}$)(7.48 gal/ $\cancel{ft^3}$) = 134640 gal

Flow Rate:

Flow = MGD ➔ gph
= (2.45 $\cancel{MG}$/$\cancel{day}$)(1 $\cancel{day}$/24 hrs)(1000000 gal/1 $\cancel{MG}$)
= 102083.3333 gph

$$\text{Detention Time, hrs} = \frac{Volume\ of\ Tank, gal}{Flow, gph}$$

Detention time, answer

Volume = 134,640 gal

Flow ≈ 102,083 gph

$$\text{Detention Time, hrs} = \frac{Volume\ of\ Tank, gal}{Flow, gph}$$

$$t = \frac{V}{q} = \frac{134{,}640\ gal}{102{,}083\ gal/hr} \approx 1.32\ hr$$

Detention time

You could be asked to solve for any of the three variables:

$$t = \frac{V}{q}$$

$$q = \frac{V}{t}$$

$$V = q\ t$$

TRY THIS
Detention time, problem

The flow to a circular clarifier is 3,940,000 gpd. If the clarifier is 75 ft in diameter and 12 feet deep, what is the clarifier detention time in hours?

q = 3,940,000 gpd

d = 75 ft

h = 12 ft

$V = \pi r^2 h$

Detention time, answer

q = 3,940,000 gal/d x d/24 hr ≈ 164,167 gal/hr

d = 75 ft

h = 12 ft

$V = \pi r^2 h$

$$V = \pi r^2 h = \pi \left(\frac{d}{2}\right)^2 h = (3.14159)\left(\frac{75\ ft}{2}\right)^2 (12\ ft) \approx 53{,}014\ ft^3$$

$$53{,}014\ ft^3 \times \frac{7.48\ gal}{ft^3} \approx 396{,}548\ gal$$

$$t = \frac{V}{q} = \frac{396{,}548\ gal}{164{,}167\ gal/hr} \approx 2.42\ hr$$

TRY THIS
Containment, problem

PFI 718

A company is required to construct an outdoor spill containment system. This containment area rnust be capable of holding double the volume of the following tanks:

a. Square Tank 6 ft wide, 6 ft long and 6 ft high,

b. Rectangular Tank 4 ft wide, 20 ft long and 3 ft high,

c. Cylindrical Tank 8 ft in diameter and 9 ft high, and

d. A 12-inch rainfall during a 24-hour period.

The company is proposing to construct a 200 foot by 200 foot level containment pad surrounded by a 15-inch wall. Will the containment system be adequate?

Ignore the “footprints” of the tanks.

Containment, answer

Square tank: $V_1 = 6 \times 6 \times 6 = 216\ ft^3$

Rectangular tank: $V_2 = 4 \times 20 \times 3 = 240\ ft^3$

Cylindrical tank: $V_3 = \pi r^2 h = \pi(d/2)^2 h = \pi(8/2)^2(9) \approx 452\ ft^3$

$2 \times (V_1 + V_2 + V_3) = 2(216 + 240 + 452) = 1817\ ft^3$

Rainfall: 12 in. = 1 ft, $1 \times 200 \times 200 = 40{,}000\ ft^3$

Total = $1817 + 40{,}000 = 41{,}817\ ft^3$

Proposed volume: 15 in. = $15\ in. \times \frac{ft}{12\ in.}$ = 1.25 ft

$1.25 \times 200 \times 200 = 50{,}000\ ft^3 > 41{,}817\ ft^3$ ✓

KSA 117 math

- Understand how to measure and calculate sewer use fees.

KSA 203 math

- Calculate Production-Based and Mass-Based limits.

KSA 223 math

- Ability to calculate penalties for exceeding discharge limitations

KSA 224 math

- Calculate annual sewer service fees, organic loading and wastewater strength.

THE DAVIDSON PIE

Davidson Pie

lb/d = (mg/L)(8.34)(mgd)

The pie can be thought of as a fraction:

$$\frac{lb/d}{mg/L \bullet 8.34 \bullet mgd}$$

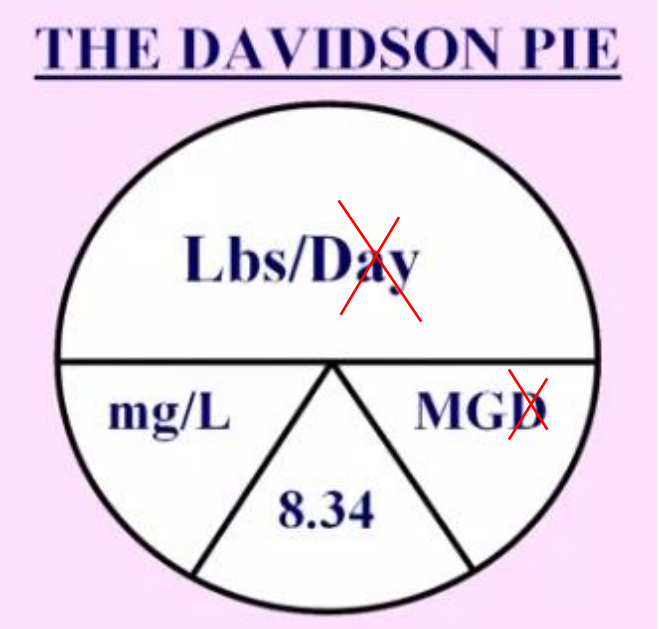
Given any two of the three unknowns, you can solve for the third.

Quantities in the same half of the pie are multiplied together; those on opposite sides are divided.

Davidson Pie, problem

- Lab results for MLSS = 3000 mg/L
- How many pounds of Mixed Liquor Suspended Solids are in the aeration basin if the basin volume is 2 million gallons?

$$lb = (mg/L)(8.34)(MG)$$



Davidson Pie, answer

- Lab results for MLSS = 3000 mg/L
- How many pounds of Mixed Liquor Suspended Solids are in the aeration basin if the basin volume is 2 million gallons?

lb = (mg/L)(8.34)(MG)

$$lb = \left(3000\frac{mg}{L}\right)(8.34)(2\ MG) = 50{,}040\ lb$$

TRY THIS
Davidson Pie, problem

- Lab results for TSS = 25 mg/L
- How many pounds of Total Suspended Solids are being discharged to the receiving stream if your flow is 10 MGD?

$$lb/d = (mg/L)(8.34)(MGD)$$

Davidson Pie, answer

- Lab results for TSS = 25 mg/L
- How many pounds of Total Suspended Solids are being discharged to the receiving stream if your flow is 10 MGD?

lb/d = (mg/L)(8.34)(mgd)

$$\frac{lb}{d} = \left(25\frac{mg}{L}\right)(8.34)(10\ MGD) = 2085\ lb/d$$

Sewer-use fees, problem

A meat packing plant discharges a waste flow of 45,000 GPD with a BOD of 3,500 mg/*L* and suspended solids of 1,300 mg/*L*. If the local POTW agency assesses the following charges, what would be the company's annual sewer service fee if the company works 260 days per year?

BOD	=	$68.00 / lb BOD
SS	=	$59.00 / lb SS
Flow	=	$218.00 / MG

TRY TO FIND SS FEE

PFI 722

Sewer-use fees, answer

q = 45,000 gpd = 0.045 MGD
BOD = 3500 mg/L
SS = 1300 mg/L
260 d/y

BOD	=	$68.00 / lb BOD
SS	=	$59.00 / lb SS
Flow	=	$218.00 / MG

lb/d = (mg/L)(8.34)(mgd)

fee = lb/d x d/y x $/lb

$$BOD = (3500)(8.34)(0.045)\frac{lb}{d} = 1313.55\ lb/\mathrm{d}$$

SS = ?
Flow = ?
Annual fee = ?

TRY TO FIND FLOW FEE

PFI 722

Sewer-use fees, answer

q = 45,000 gpd = 0.045 MGD
BOD = 3500 mg/L
SS = 1300 mg/L
260 d/y

BOD	=	$68.00 / lb BOD
SS	=	$59.00 / lb SS
Flow	=	$218.00 / MG

lb/d = (mg/L)(8.34)(mgd)

fee = lb/d x d/y x $/lb

$$BOD = (3500)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$68}{lb} = \$23{,}223{,}564.00$$

$$SS = (1300)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$59}{lb} = \$7{,}484{,}232.60$$

Flow = ?

Sewer-use fees, answer

q = 45,000 gpd = 0.045 MGD
BOD = 3500 mg/L
SS = 1300 mg/L
260 d/y

BOD	=	$68.00 / lb BOD
SS	=	$59.00 / lb SS
Flow	=	$218.00 / MG

lb/d = (mg/L)(8.34)(mgd)

fee = lb/d x d/y x $/lb

$$BOD = (3500)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$68}{lb} = \$23{,}223{,}564.00$$

$$SS = (1300)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$59}{lb} = \$7{,}484{,}232.60$$

$$Flow = (0.045\ MGD) \times \frac{260\ d}{y} \times \frac{\$218}{MG} = \$2550.60$$

Sewer-use fees, answer

PFI 723

q = 45,000 gpd = 0.045 MGD
BOD = 3500 mg/L
SS = 1300 mg/L
260 d/y

BOD	=	\$68.00 / lb BOD
SS	=	\$59.00 / lb SS
Flow	=	\$218.00 / MG

lb/d = (mg/L)(8.34)(mgd)

fee = lb/d x d/y x \$/lb

$$BOD = (3500)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$68}{lb} = \$23{,}223{,}564.00$$

$$SS = (1300)(8.34)(0.045)\frac{lb}{d} \times \frac{260\ d}{y} \times \frac{\$59}{lb} = \$7{,}484{,}232.60$$

$$Flow = (0.045\ MGD) \times \frac{260\ d}{y} \times \frac{\$218}{MG} = \$2550.60$$

Total = \$23,223,564 + \$7,484,233 + \$2551 = \$30,710,347

Discharge penalty, problem

A metal finisher has the following discharge limitations: copper, 3.0 mg/*L*; lead, 0.7 mg/*L*; chromium, 2.7 mg/*L*; and nickel, 3.3 mg/*L*. The metal finisher had the following metal concentrations in a recent 24-hour discharge sample collected and analyzed for sewer-use fees: Cu, 15.0 mg/*L*; Pb, 3.2 mg/*L*; Cr, 18.3 mg/*L*; and Ni, 6.3 mg/*L*. The metal finisher discharges a flow of 30,000 gallons per day (0.03 MGD). The sewer-use penalties in dollars per pound discharged over the limitations are: Cu, $225/lb; Pb, $325/lb; Cr, $250/lb; and Ni $375/lb. What would be the metal finisher's daily monetary penalty for exceeding the discharge limitations?

Discharge penalty, problem

Cu = 15 mg/L limit = 3 mg/L Cu
Pb = 3.2 mg/L limit = 0.7 mg/L Pb
Cr = 18.3 mg/L limit = 2.7 mg/L Cr
Ni = 6.3 mg/L limit = 3.3 mg/L Ni

Q = 30,000 GPD =0.03 MGD

Penalties over limit

- $225/lb Cu
- $325/lb Pb
- $250/lb Cr
- $375/lb Ni

TRY THE OTHERS

PFI 723

Discharge penalty, answer

Cu = 15 mg/L
Pb = 3.2 mg/L
Cr = 18.3 mg/L
Ni = 6.3 mg/L
Q = 0.03 MGD

limit = 3 mg/L Cu
limit = 0.7 mg/L Pb
limit = 2.7 mg/L Cr
limit = 3.3 mg/L Ni

Penalties over limit

- $225/lb Cu
- $325/lb Pb
- $250/lb Cr
- $375/lb Ni

Cu: (15 – 3)(8.34)(0.03) x $225 = $675.54

Pb ?
Cr ?
Ni ?

PFI 723

Discharge penalty, answer

Cu = 15 mg/L
Pb = 3.2 mg/L
Cr = 18.3 mg/L
Ni = 6.3 mg/L
Q = 30,000 MGD

limit = 3 mg/L Cu
limit = 0.7 mg/L Pb
limit = 2.7 mg/L Cr
limit = 3.3 mg/L Ni

Penalties over limit

- $225/lb Cu
- $325/lb Pb
- $250/lb Cr
- $375/lb Ni

Cu: (15 – 3)(8.34)(0.03) x $225 = $675.54
8.34 x 0.03 = 0.2502
Pb: (3.2 – 0.7)(0.2502) x $325 = $203.29
Cr: (18.3 – 2.7)(0.2502) x $250 = $975.78
Ni: (6.3 – 3.3)(0.2502) x $375 = $281.48

Total = $2136.08

KSA 209 math

- Understand how to calculate flow rate, and Open Channel Flow Measurement devices.

Velocity

- The speed at which something is moving
- Measured in
  - $ft/_{min}$ $ft/_{sec}$ $miles/_{hr}$ etc

$$Velocity = \frac{distance}{time}$$

This equation is NOT on the Equivalents & Formulas sheet; you should memorize it.

TRY THIS
Velocity, problem

Blue dye is placed in a sewer line at a manhole. Three (3) minutes later, the dye appears in a manhole 125 feet down stream. What is the velocity of the flow in ft/min?

$$Velocity = \frac{distance}{time}$$

Velocity, answer

Blue dye is placed in a sewer line at a manhole. Three (3) minutes later, the dye appears in a manhole 125 feet down stream. What is the velocity of the flow in ft/min?

$$Velocity = \frac{distance}{time}$$

$$Vel = \frac{125\ ft}{3\ min}$$

$$Vel = 41.67\ {}^{ft}/_{min}$$

Flow

- The volume of water that flows over a period of time
- Measured in
  - $ft^3/_{sec}$ $ft^3/_{min}$ $gal/_{day}$ $MG/_D$

$$Flow = (Area)(Velocity)$$

$$Q = AV$$

This equation is NOT on the Equivalents & Formulas sheet; you should memorize it.

TRY THIS
Flow, problem

Water is flowing at velocity 3 ft/sec through a channel that is 2 feet wide and 1.5 feet deep. What is the flow in cubic feet per second?

$$Q = AV$$

Flow, answer

Water is flowing at velocity 3 ft/sec through a channel that is 2 feet wide and 1.5 feet deep. What is the flow in cubic feet per second?

$$Q = AV$$

$$Q = (l)(w)(velocity)$$

$$Q = (2ft)(1.5ft)\left(3\ {}^{ft}/_{sec}\right)$$

$$Q = 9\ {}^{ft^3}/_{sec}$$

The equation for the area of a rectangle (L x W)is NOT on the Equivalents & Formulas sheet; you should memorize it.

KSA 210 math

- Calculate and understand how to identify an illicit discharge in the sanitary sewer.

Weighted average

Common example of weighted average is calculation of grade-point average:

$$GPA = \frac{\sum g_i u_i}{\sum u_i}$$

g_i are the grade points (A = 4, B = 3, etc.)

u_i are the number of units

Weighted average, example

$$GPA = \frac{\sum g_i u_i}{\sum u_i}$$

UNITS	GRADE	POINTS	GRADE POINT
3	F	0	
2	D	1	
5	B	3	
TOTAL =			TOTAL =

Weighted average, example

UNITS	GRADE	POINTS	GRADE POINT
3	F	0	0
2	D	1	2
5	B	3	15

Weighted average, example

UNITS	GRADE	POINTS	GRADE POINT
3	F	0	0
2	D	1	2
5	B	3	15
10	$= \Sigma u_i$	$\Sigma g_i u_i =$	17

Weighted average, example

UNITS	GRADE	POINTS	GRADE POINT
3	F	0	0
2	D	1	2
5	B	3	15
10	= u_i	g_i =	17

$$GPA = \frac{\sum g_i u_i}{\sum u_i} = \frac{17}{10} = 1.7\ (C-)$$

Illicit discharge, problem

A plating company has an underground hard chrome waste recirculation tank located close to an underground sewer. The company's wastestream flow is 25,000 gallons per day with a chromium content of 10.5 mg/*L*. During routine sewer monitoring upstream and downstream of this company, the following information was obtained:

	Upstream	**Downstream**
Flow, GPD	150,000 GPD	175,000 GPD
Chromium Conc, mg/*L*	0.85 mg/*L*	3.2 mg/*L*

Could the inspector suspect a leak in the underground chromium tank migrating into the sewer system?

Illicit discharge, answer

A plating company has an underground hard chrome waste recirculation tank located close to an underground sewer. The company's wastestream flow is 25,000 gallons per day with a chromium content of 10.5 mg/*L*. During routine sewer monitoring upstream and downstream of this company, the following information was obtained:

	Upstream	Downstream
Flow, GPD	150,000 GPD	175,000 GPD
Chromium Conc, mg/*L*	0.85 mg/*L*	3.2 mg/*L*

Could the inspector suspect a leak in the underground chromium tank migrating into the sewer system?

q_1 = 25,000 gpd

c_1 = 10.5 mg/L

q_2 = 150,000 gpd

c_2 = 0.85 mg/L

c = 3.2 mg/L

Illicit discharge, answer

q_1 = 25,000 gpd q_2 = 150,000 gpd

c_1 = 10.5 mg/L c_2 = 0.85 mg/L

c = 3.2 mg/L

$$c = \frac{\sum c_i q_i}{\sum q_i} = \frac{(10.5\ mg/L)(25{,}000\ gpd) + (0.85\ mg/L)(150{,}000\ gpd)}{(25{,}000 + 150{,}000)\ gpd}$$

$$= \frac{262{,}500 + 127{,}500}{25{,}000 + 150{,}000} = \frac{390{,}000}{175{,}000} = 2.23\ mg/L$$

3.2 > 2.23, so there does appear to be a leak

Weighted average, problem

The local municipal sewage treatment plant's effluent has a TDS averaging 600 mg/L. The flow averages 24 MGD. The maximum allowable discharge of TDS in the effluent is 750 mg/L. A new industry is proposing to locate in this town and to discharge 1.5 MGD to the sewer. The agency intends to keep the treatment plant's effluent TDS below 710 mg/L.

What is the maximum TDS concentration the new industry can discharge at the proposed 1.5 MGD flow rate?

$c_1 = 600$ mg/L $\qquad$ $c_2 = ?$

$q_1 = 24$ MGD $\qquad$ $q_2 = 1.5$ MGD

$c \leq 710$ mg/L

TRY THIS
Weighted average, answer

c_1 = 600 mg/L

c_2 = ?

q_1 = 24 MGD

q_2 = 1.5 MGD

c ≤ 710 mg/L

$$c = \frac{\sum c_i q_i}{\sum q_i} = \frac{c_1 q_1 + c_2 q_2}{q_1 + q_2}$$

Weighted average, answer

c_1 = 0 mg/L

c_2 = X

q_1 = 24 MGD

q_2 = 1.5 MGD

c ≤ 710 mg/L

$$c = \frac{\sum c_i q_i}{\sum q_i} = \frac{c_1 q_1 + c_2 q_2}{q_1 + q_2}$$

$$710 = \frac{(600)(24) + (X)(1.5)}{24 + 1.5}$$

SOLVE FOR X

Weighted average, answer

$$710 = \frac{(600)(24) + (X)(1.5)}{24 + 1.5}$$

$$1.5X + 14{,}400 = 710(24 + 1.5)$$

$$X = \frac{710(25.5) - 14{,}400}{1.5} = 2470\ mg/L$$

QUESTIONS?

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