SELECTED MATH PROBLEMS FOR WASTEWATER

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Math Problem Solving Strategy

- 1. Read the question carefully and underline what they are asking you to find.
- 2. Write down the formula you need to solve the problem. Look in the front of the test booklet if necessary.
- 3. Fill in everything you know. Sometimes filling in what you know might require you to find something else first like area or volume.
- 4. Check your units! Make sure they are correct for the formula and agree with each other.
- 5. Convert units where needed.
- 6. Put the new units into the formula.
- 7. Solve.
- 8. Check the units of your answer. Are they what the question asked for?
- 9. Convert units if necessary.



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THE RULES FOR BASIC ALGEBRA

- 1. For Unit Conversions
 - a. Only tops and bottoms can cancel
 - b. Everything on the top gets multiplied
 - c. Everything on the bottom gets divided
- 2. You can rearrange any equation by following these simple rules:
 - a. Do anything you want.
 - b. Do the opposite.
 - c. Do it to both sides.
- 3. Simplify any equation correctly by following the Order of Operations. Whenever you CAN do things in this order, you MUST do them in this order.
 - a. Parenthesis, Powers or Exponents (x²), Multiply, Divide, Add, and Subtract
 - b. PMDAS or PEMDAS
 - c. Polly Makes Donuts After School
 - d. Please Excuse My Dear Aunt Sally

UNIT CONVERSIONS

- 1. Convert 6000 gallons to cubic feet.
- 2. Convert 4000 cubic feet to gallons.
- 3. Convert 7 days into seconds.
- 4. Convert 85 mph into feet per second
- 5. Convert 20 gpm to MGD.
- 6. Convert 300 gpm to cfs.
- 7. Convert 20 cfs to MGD.
- 8. Convert 400 psi into feet of head.
- 9. Convert 20 gallons per square foot per day.
- 10. A 30 HP pump runs for 80 hours. Electricity costs \$0.085 per Kwh. What will it cost to run the pump?

TANK GEOMETRY

1. It's a big night out for pizza, but you can't decide if you should order the 12-inch pizza for \$14.50 or spend a few more bucks and get the 16-inch pizza for \$18.00. What is the better deal? Find dollars spent per square inch of pizza.



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- 2. There is a 6-inch pipe and a 12-inch pipe. Assuming that the water is moving at the same speed through both AND both pipes are running full, how much more flow will the 12-inch pipe hold?
- 3. The diameter of a wet well is 15 feet. It is filled to a depth of 12 feet. How many gallons of water does it contain?
- 4. How many gallons of liquid can be held in a tank that is 120 feet long by 40 feet wide by 14 feet deep?
- 5. Approximately how many gallons would 450 feet of 6-inch diameter pipe hold?
- 6. A chemical storage tank is 15 feet in diameter and 10 feet deep. A pressure indicator at the bottom of the tank reads 3.8 psi. How many gallons of water are in it?
- 7. Find the perimeter or circumference of a tank that is 80 feet in diameter.
- 8. A covered cylindrical tank must be painted both inside and out. All surfaces, except the bottom of the tank, must be painted. If the tank is 25 feet tall and 50 feet in diameter, how many square feet must be painted?

HYDRAULIC RETENTION TIME

- 1. A tank holds 500 gallons. A pump is used to fill the tank at a rate of 25 gpm. How long will it take to fill the tank?
- 2. A sludge storage tank is being fed feed sludge at a rate of 300 gpm. At the same time, sludge is being taken out of the tank for land application at an average rate of 200 gpm. If the tank holds 1.2 MG, what is the hydraulic retention time in hours?
- 3. A wet well is 35 feet in diameter and 65 feet deep. With no water entering the tank, the water level dropped 14 feet in 5 hours. Find the average flow rate for water being pumped from the wet well in gpm.
- 4. A 250 gpm is able to completely empty an aeration basin in 6 hours and 15 minutes. How much MLSS was in the basin?

VELOCITY

- 1. A 42-inch diameter pipe transfers 35 cfs of water. Find the velocity in cfs if the pipe is running full.
- 2. A plastic float is dropped into a manhole. It appears in the downstream manhole, 450 feet away, after 68 seconds. Find the velocity of water in the sewer.
- 3. A wastewater plant has four grit basins that operate in parallel. Each grit basin is 2 feet wide, 10 feet long, and 1.5 feet deep. If the average influent flow is 3.5 MGD, what is the minimum number of grit basins to have on-line to achieve an average velocity through the grit basins of less than 1.0 fps?



DISINFECTION AND CHEMICAL DOSING

- 1. Find the chlorinator setting in pounds per day for a wastewater plant disinfecting with gaseous chlorine when the influent flow is 2.5 MGD. The desired dose is 5 mg/L.
- 2. A wastewater plant treating 3.5 MGD uses seven 150 pound chlorine cylinders each week. What was the average chlorine dose in mg/L?
- 3. The chlorine dose at the beginning of the chlorine contact chamber was 5.2 mg/L. The measured total chlorine result at the end of the chlorine contact chamber was 0.5 mg/L. What was the demand?
- 4. A wastewater plant disinfects with a sodium hypochlorite solution that contains 15% available chlorine. If the effluent flow rate is 600 gpm, how many gallons of sodium hypochlorite solution will be needed each day at a dose of 4.5 mg/L?
- 5. From experience, the operator knows that the chlorine demand will be about 1.2 mg/L in the treated effluent. She would like to maintain a total chlorine residual of 3.0 mg/L for disinfection. If the plant is treating 800 gpm and is using HTH tablets for disinfection (70% available chlorine), how many pounds of HTH tablets will be needed each day?

PUMPS

- 1. Water is being pumped from a wet well through a force main to the next gravity line which is 225 feet higher at the top of the ridge. Find the pump size required to transfer the wastewater at a rate of 80 gpm. The pump is 85% efficient and the motor is 90% efficient.
- 2. A 25 HP pump is being used for a dewatering operation. If the pump runs for 8 hours a day, 7 days a week, how much will it cost to run the pump for one week? Assume energy costs of \$0.085 a Kwh.
- 3. A chemical feed pump with a 6-inch bore and a 6-inch stroke pumps at 75 cycles per minute. What is the pumping rate in gpm?
- 4. A pump station with two pumps (lead and lag) is pushing wastewater uphill 50 feet at a rate of 150 gpm. The pumps are consuming 1.865 Kwh of electricity each hour of run time. How efficient is this pump and motor combination overall?

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	7 days / 24 hrs / 60 min / 60 sec/ _ 604, 800 sec
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	5. 20 gal 1440 min 1 MG - 0.0288 mgd LINE - min 1 day 1,000,000 gd GALLONS "PER" MINUTE
20	GALLONS "PER" MINUTE
	4. 300-gal / cf / min / 0.67 cf/s min / 7.48-gal / 60 sec /
	min 17.48-20/ 60 sec
	* early was 20 cfs / 1 MGD = 12.9 MGD
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say that there are 0.433 psi for every foot a depth, we mean feet of weight the same and weight the same as water: 8.34 lbs/gal
Hame we work - 0.34 105/ggl

	9. Convert to gal/min.sf
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And the second s	20 sal 1 day - 0.0138 gelfd.st St. day 1440 min
	10. 30 HP 0.746 kw \$ 0.085 80 has = \$ 152.18
	1 HP 1 kwh 1 e power 15 sold in kw. hrs
	so, we need kilowalls and we
	need total hours of run time
	GEOMETRY
	Geomerag
	1. Find the price per square inch of pizza
	$A = 0.785 d^2$ $A = 0.785 d^2$
***************************************	$A = (0.785) (2in) (12in)$ $A = (0.785) (16in) (16in)$ $A = 113.04 in^{2}$ $A = 200.96 in^{2}$
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	much pizza! (i)
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PRESENTATION OF THE PROPERTY O	113.04 = (4) WHEN YOU DOUBLE THE DIAMETER; AREA GOES	
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tarian periodi di salah sa	=(0.785 \ 15 f+\ \ 15 f+\ \ 12 f+)	jaga.
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erskeidymos/itelikultikultikultusympis	4. VOLUME = (LENGTH YWIDTH Y HEIGT OF DEPTH)	_
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	67,200 ft3 7.48 zel = 502,656 gallons	-
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	- Re so 1 1 - all the inite and to as to the	-
	5. Be careful - all the units need to go together. 6 inches / 1 ft / = 0.5 ft	-
	12:0	-
	1 10-116	-
	Volume = 0.185 dh	-
ACCORDINATION AC	Volume = (0.785 YO.5 ft YD.5 ft Y 4504)	-
	Volume = (0.785 10.5 ft 10.5 ft 1450ft) Volume = 88.3125 ft3	Ĭ

	5. (cont.) 88. 3125 ft3 7.48 sel - 660 gallons
	6. WHEN IN DOUBT, DRAW A PICTURE.
102	CONVERT TO SFE TO FIND DEPTH OF LIQUID
	DEPTIOF TANK; NOT LIQUID 3.8 psi 1ft 8.78 ft 0.433psi
	VOLUME = 0.785 d h. VOLUME = (0.785X 15 F+X 15F+X 8.78F+) VOLUME = 1550.7675 cf
	1550.7675 cf 7.48 gal = 11600 gallons
	#. CIRCUMFERENCE = T.d. = (3.14)(80 ft) = 251.2 ft
	8. STEP ONE IS TO DREN THE TANK WITO SIMPLER SHAPES
	RECTANGE DEPTH OF THANK BOTTOM THIS LENGTH IS THE
	CUT UP THE SAME AS THE SIDE PERIMETER OR CIRCUMFERNICE OF OUR CIRCLE

AREA OF RECTANGLE = (LENGTH YWIDTH) AREA OF RECTANGLE = (Td) (WIDTH) CIRCUMFERENCE ARLA OF RECTANGLE = (3.14) 50 PTY 25 FT) = 3925 A2 BUT, I NEED THE INSIDE + THE OUTSIDE, SO MULTIPLY BY 2 = 7850 Ft2 APLA OF CIPCLE = 0.785 d2 = (0.785) 50 FT Y 50 FT) = XXXX F12 This should be 1962.5 ft2. BUT, I NEED THE INSIDE + OUTSIDE OF THE TOP AND THE WSIDE OF THE BOTTOM, SO Last, add the pieces together. 7850 ft2 + 28XXXX F12 HYDRAULIC RETENTION TIME t = Volume t = 500 gallons t = 20 minutes 200 spm here, detention time withdrawal is the average time spent in the tank. USE THE DIFFERENCE; 100 gpm

-	·
	2. time = Volume
	Flow
Management and the	time = 1.2 mg - UNITS DON'T MATCH
	6:mc = 1,200,000 gallons
	100 apm
	bime = 12000 minutes - THEY ASKED FOR HOURS
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and the second second	12000 minutes 1bx - 200 Hours
	60 min
	1 WO MIN!
	35f4
	3. dropped 14 ft in 5 lus. 14ft 165ft This is the volume we
	are interested in.
	Volume = 0.785 d2h
	Volume = (0.785 X 35 F+ X.35 F+ X H F+)
	Volume = 13462.75 cf
	6me = volume
	flow we want flow
1	ine needs in apm, so volume
to	be in minutes needs to be in gallons
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	13462.75 ft3 7.48 sal - 100,701.37 gallons
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	5 les 60 min = 300 minutes
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		plus the ex	tra 15 min	= 375 min
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	1 & Stelocity	Acea ft2		
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	1 & Stelocity	Acea ft2	3.5 ft-	

18. (cont) AREA = 0.785 d2	
= (0.785 X 3.5 A	(V = C)
1	
= 9.61625 A	
velocity = flow area	
	* note: you end up
= 35 cfs	with cfs on top
9.61625 F12	and ft ² on the
= 3.64 H/second	bottom. Here is
	what happens to the
	units.
these_	
concel to	- f+.f+.f+/sec
leave f	F4. F+
2. Velocity = DISTANCE	then dillerent
2. Velocity = DISTANCE TIME	formulas for velocity
Velocity = 450 ft	0
Velocity = 450 ft 68 sec	
Velacity - 1/1 ft/1	•
Velocity = 6.6 ft/s	
3. The englished to this	andem is to
3. The easy way to do this pour throw	de 1 wit bosin
per all the flow fillow	J Julia.
la and	Dieu Carre
1.5 10ft	THEN; CONVERT
2.84	MGD TO CFS
WE NEED THE CROSS-SECTIONAL	
ALEA SO:	3.5 mgp 1.55 cfs = 5.425 cfs
	/ /MGD /
AREA = (LENGTH X WIDTH)	
ALEA = (2 PTX IS FT)	
18/1- OH-	

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3. relogity = flow	the minutes of the second discount of months and disputing an appropriate segment over
area neloc	city with
wlocity = 5.425cfs /1 =	wit hasia
3 fts on-liv	grit basin ne, so we
velocity = 1.8 ft/s x need	0
7 2 27	(2)
DISINFECTION	
1. Ibld = (mo/L) MGD (8.34)	
15/d = (5 mole) 2.5 mon 8.34)	
2. 16/d = (m8/L) man (8.34)	
150 Ibld = (moll) 3.5 mad) 8.34)	O SIMPLIFY
150 /b/d = (M8/1 V 29 19)	@ move to SCT
29.19 29.19	MIL ALONE
5.14 = mell	
3. DOSE = DEMAND + RESIDUAL	
PUT IN OTHER WOEDS	
ADDED = USED + LEFT OVER	and the second second
5.2 mg/L = USED + 0.5 mg/L	* NOW, SUBTRAC
5.2 -0.5 = USED +0.5 -0.5	0.5 Mb/L FROM
4.7 mg/L = USED OR	BOTH SIDES
DEMAND	
4. MUST HAVE MGD, SO CONVERT F	TIRST.
600 gal / 1440 min / 1Mg / - 0.86	4 mgd
	U
min / (day / 1000000 gal)	
	Wholety = 5.425cfs 3 ft2 on-lin velocity = 1.8 ft/s need DISIALFECTION 1. Ib/d = (m8/L) MGDX8.34) Ib/d = (5 m8/L) 2.5 mGDX8.34) Ib/d = 104.25 2. Ib/d = (m8/L) MGDX8.34) 150 Ib/d = (m8/L) MGDX8.34) 150 Ib/d = (m8/L) 3.5 mgdX8.34) 150 Ib/d = (m8/L) 3.5 mgdX8.34) 29.19 29.19 29.19 5:14 = mg/L B. DOSE = DEMAND + RESIDUAL PUT IN OTHER WOEDS ADDED = USED + LEFT OVER 5.2 m8/L = USED + 0.5 m8/L 5.2 -0.5 = USED + 0.5 -0.5 4.7 m8/L = USED OR DEMAND

Concerns of the contract of th		AND THE RESIDENCE OF THE PARTY	W. T. Britania C. Charles Co. Marie Marie
V. (cont) 16/d =	[M8/L X MGD X 8.3	4)	
· ·	2. PURITY		
16/d = 1	4.5 mg/L X 0.864	(MGD) 8.34)	
	0.15		
16/d =	216.1728		
216.1728 lbs	1 gel =	26 gallons	
	1 8.341bs/	0	
5. @ DOSE = DEMAN		. 4	
	18/L + 3.0 mg/c		
DOSE = 4.2	78/		
@ 800 1 1 1440.	win 1 146 1	1150	
@ 800 gal 1440 min / 1 day	1/200000 1	1.132 Mga	
mirit i wat	7 70000000		
(a) thid = / mg	5/LY mad Y 8.34)		
	16 Mgd X 8.34)		
16/d = (4.	2 mg/L X 1.152 mg	18.34)	
	0.7		•
1b/d = 57.0	,	And an income and a second and a	5
Pumes			
	. · ·	Micien	uf
1. HP = Capr	DH. Ft)	To fell	w:2
(39	GDX Ep XEm)		
Herone - (BDg	1pm (225 ft)		
(39%	010.8510.90)		
Alparoe - 5.	17		
	in acartica	uldie vandel en	. d
Andre All College Charles to control to a release and injury and in account of the college and	- in practice,	this would en	
	up being a	1.3 PF TUMP	

TOTAL RUD TIME = (8 hrs X 7 days) = 56 hrs. per week. _ \$ 88.71 25 HP 10.746 km \$ 0.085 | 56 km | 3. This is a geometry problem in disquise. Find the volume of the piston cavity. Volume = 0.785d2h biaches = 0.5 ft Volume = (0.78510.5 F+ 10.5F+Y0.5F+) Volume - 0.098125 ft3 0.098125 ft3 7.48 gal | 75 cycles | 55 gal cycle | 1 ft3 | 1 min min 4. HPMORE = (gpm X TDH, Ft) (3960)(Ep X Em) 1.865kw 1HP = 2.5 25 HP = (150 gpm × 50 ft) (3960× Ep × Em) * simplify 25HP = 1893 (Ep.YEm) * rearrange 12.5 MPX Ep YED) = (1.893) Ep YED) LEASEN (2.540 XEDXEM) = 1.893 oreral/ officience (EDXEM) = 0.758