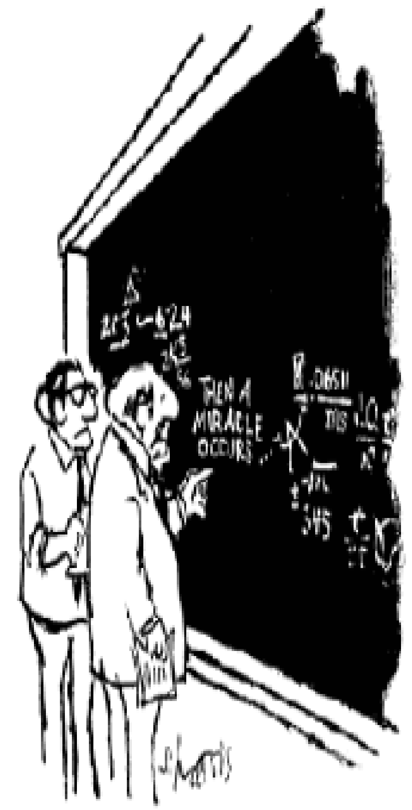
WATER TREATMENT MATH REVIEW

Kentucky Water Treatment System Operators



"I think you should be more explicit here in step two."

kentucky operator certification program

COMMONWEALTH OF KENTUCKY
ENERGY AND ENVIRONMENT CABINET
DIVISION OF COMPLIANCE ASSISTANCE
CERTIFICATION AND LICENSING BRANCH
OPERATOR CERTIFICATION PROGRAM

Kentucky Board of Certification of
Water Treatment and Distribution System Operators

certifying **Professionals**

This booklet is intended to be used in conjunction with the formula sheet given to students in certification class and the day of the exam. It is not intended to be a stand alone instructional book, but rather an attempt to allay the fears operators have relative to the math presented on the certification test.

Mathematical problem solving is essentially no different than any other type of problem solving. Determining where to start and following through with the necessary steps to complete the task are similar to any type of problem solving. A recommended and successful approach to solving problems on the certification test is as follows:

a) Determine WHAT the problem is asking.
b) Determine if there is an applicable formula needed to complete the problem.
c) Perform any necessary conversions to fulfill the requirements of the formula.
d) Plug the necessary converted numbers into the formula.
e) Make sure the answer is in the units necessary to satisfy the question.

MATHEMATICAL "RULES"

1) Always solve the calculations in the numerator before solving the calculations in the denominator.

$$\frac{\text{numerator}}{\text{denominator}}$$

EXAMPLE: If we see a problem similar to this one,

$$\frac{12 \times 12}{6} =$$

Do the calculation on the numerator first.

$$\frac{144}{6} =$$

$$24$$

If this calculation isn't done correctly in that the calculation in the numerator wasn't done first, one could conceivably arrive at this solution, which would be wrong.

$$\frac{12 \times 12}{6} =$$

$$\frac{2 \times 2}{1} =$$

$$4$$

2) Do any calculation in parenthesis first.

EXAMPLE: $$\frac{(24 \times 3) - 12}{(10 - 5)} =$$

$$\frac{72 - 12}{5} =$$

$$\frac{60}{5} =$$

$$12$$

3) Multiplication calculations can be indicated in several ways.

EXAMPLES:

a) 5 feet • 5 feet = 25 ft^2
b) [5 feet] [5 feet] = 25 ft^2
c) (5 feet) (5 feet) = 25 ft^2
d) 5 feet X 5 feet = 25 ft^2

4) The order by which numbers are multiplied have NO impact on the final answer.

EXAMPLES:

a) 5 X 10 X 20 X 30 = 30,000
b) (30) (20) (10) (5) = 30,000
c) 20 • 5 • 30 • 10 = 30,000

5) Division is the reverse operation of multiplication.

6) Division problems can be written in several ways.

EXAMPLES:

a) $\frac{\text{2778 gallons}}{\text{694.5 gallons}}$ = 4 MGD
b) 2778 gal/694.5 gal = 4 MGD
c) (2778 gal) ÷ (694.5 gal) = 4 MGD
d) 2778 gallons ÷ 694.5 gallons = 4 MGD

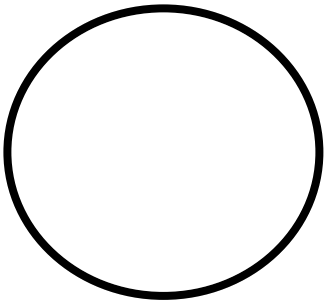
7) The order by which numbers are divided DOES have an impact on the final answer. The correct order must be maintained to derive the correct answer.

EXAMPLES: a) 41.7 lbs. ÷ 8.34 lbs = 5 gallons
b) 8.34 lbs ÷ 41.7 lbs = 0.2 gallons

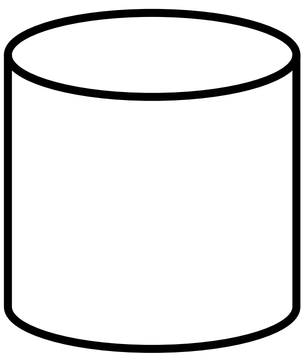
To turn a percentage into its decimal equivalent, divide by 100. 11% as a decimal is .11. 5.25% as a decimal is.0525

BASIC GEOMETRIC SHAPES and DEFINITIONS

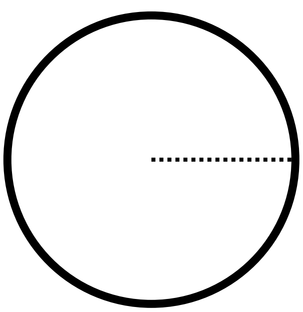
Rectangle – a two-dimensional geometric figure formed of four sides in which each angle is a right angle.



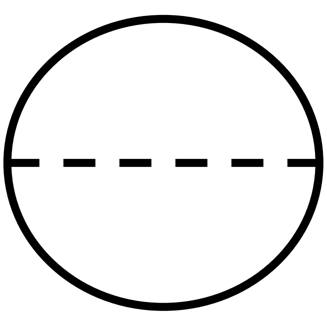
Circle – a two-dimensional geometric figure formed of a curved line surrounding a center point, every point of the line being an equal distance from the center point.



Cylinder – a three dimensional geometric form bounded by two equal parallel circles to a fixed straight line forming a hollow tube shape.



Radius – a straight line extending from the center of a circle to its edge.



Diameter – a straight line running from one side of a circle through the largest area of that circle to the other side. The width or thickness of something circular or cylindrical.

CONVERSIONS

Before we compute the area or the volume of a geometric form, we sometimes will have to convert units so they can be correctly used in the formulas.

EXAMPLES:

Find the area in square feet of a form 12 inches by 12 inches.

Area = 12 inches X 12 inches

If we don't convert Area = 144 ft^2 which is wrong!

The formula calls for Length in feet X Width in feet.

Now we would get Area = 12 inches X 12 inches

Area = 1 ft X 1 ft

Area = 1 ft^2

We use conversions every day. Four quarters is equivalent to a dollar as is ten dimes or twenty nickels.

Thirty six inches of a 2 X 4 will accomplish the same task as 3 feet of a 2 X 4. In order to satisfy the units demanded in the formulas, we have to convert in order to satisfy the equation.

If we travel 26,400 feet, we have traveled 5 miles or 26,400 feet.

1 psi	**=**	**2.31 ft of head**
1 ft of head	**=**	**.433 psi**
1 cu ft of water	**=**	**7.48 gallons**
1 cu ft of water	**=**	**62.4 lbs.**
1 gallon	**=**	**8.34 lbs.**
1 gallon	**=**	**3,785 ml (millimeters)**
1 Liter	**=**	**1,000 ml**
1 mg/L	**=**	**8.34 lbs/MG**
1 ppm	**=**	**1 mg/L**
1 pound	**=**	**453.6 grams**
1 pound	**=**	**7,000 grains**
1 kilogram	**=**	**1,000 grams**
1 cuft/sec	**=**	**448.8 gpm**
1 MGD	**=**	**1.55 cuft/sec (ft^3/sec)**
1 MGD	**=**	**694.5 gpm**
1 horsepower	**=**	**33,000 ft. lbs. /min**
1 horsepower	**=**	**.746 kilowatt**
1 mile	**=**	**5,280 feet**

You will notice that every unit in the left hand column has a numeric value of one and every unit in the right hand column (except for 1 mg/L) does not.

If you know the quantity of the units in the left hand column and are trying to determine the equivalent quantity of a unit in the right hand column you would *multiply*.

Examples:

10 psi = ____?___ ft of head
10 psi X 2.31 ft of head = 23.1 ft of head
5 ft^3/sec = __?___ gpm
5 ft^3/sec X 448.8 = 2244 gpm

If you know the quantity of the unit in the right hand column and are trying to determine the equivalent quantity of a unit in the left hand column you would *divide*.
Examples:

115.5 ft of head = ___?__ psi
115.5 ft of head ÷ 2.31 ft of head = 50 psi
3141.6 gpm = ___?___ ft^3/sec
3141.6 gpm ÷ 448.8 gpm = 7 ft^3/sec

In order to satisfy the unit requirement in our area and volume formulas, we have to convert the measurements to feet. Many of us use pipes and structures that are less than a foot or a foot and some extra area we denote as inches.

Examples:

What is the volume of an 8 inch pipe that is a mile long?
Our formula for a cylinder is: .785 X D' X D' X L'
If we don't convert from inches to feet we would arrive at this answer:
.785 X 8 X 8 X 5280 = 265267.2 ft^3
If we convert 8 inches to feet by dividing 8 by 12 we discover that 8 inches is .66 feet.
Now, .785 X .66' X .66' X 5280' = 1805.48 ft^3
Our answer comes out in cubic feet because we are multiplying feet X feet X feet or cubic feet.

I can't recall ever needing to know how many cubic feet of water was in something. So from our formula sheet we discover that each cubic foot of water is equivalent to 7.48 gallons of water.
So if we take the 1805.48 ft^3 and multiply it by 7.48 gallons we know that the 8 inch pipe could hold 13504.99 or 13505 gallons.

1805.48 ft^3 X 7.48 gallons = 13504.99 gallons

THERE WILL BE ONLY ONE LINE ON THE CONVERSION FORMULA PORTION OF THE FORMULA SHEET THAT HAS THE UNITS NEEDED FOR YOUR PROBLEM.

Determine:

1) 5 gallons	=	___?___	ml.
2) 30 psi	=	___?___	ft. of head
3) 41.7 lbs.	=	___?___	gallons
4) 3628.8 grams	=	___?___	lbs.
5) 15,840 feet	=	___?___	miles
6) 35 ft^3 of water	=	___?___	gallons
7) 2244 gpm	=	___?___	ft^3/sec of water
8) 8 MGD	=	___?___	gpm
9) 312 gallons of water	=	___?___	ft^3 of water
10) 161.7 ft. of head	=	___?___	psi
11) 5,000 gpm	=	___?___	MGD
12) 7 ft^3 of water	=	___?___	gpm
13) 5000 gallons of water	=	___?___	ft^3 of water
14) 6 miles	=	___?___	feet
15) 1 day	=	___?___	minutes

Answers are in the back of this booklet.

AREA

Area is a two – dimensional measurement usually notated in inches, feet, yards, or miles.

If we needed to determine how many square feet of roofing material you would need to cover your two outside sedimentation basins, one way to calculate this could be as listed below.

The two sedimentation basins each measure 15 feet wide by 30 feet in length. We want a two foot overhang on all four sides of each sedimentation basin. How many square feet would we need to accomplish this task?

OBJECT	AREA ft^2	VOLUME ft^3
Rectangle	Length (ft) X Width (ft)	Length (ft) X Width (ft) X Length (ft)
Circle	.785 X Diameter (ft) X Diameter (ft)	
Triangle	½ (Base (ft) X Altitude (ft))	
Cylinder		.785 X D (ft) X D (ft) X Length (ft)
Sphere		.5236 X D (ft) X D (ft) X D (ft)

Diameter = 2 X radius **Circumference = 3.14 X D (ft)**

Perimeter = Sum of the Sides

D is diameter **L is Length**

The basin is a rectangle so the formula we need is:

Length (ft) X Width (ft)

Our width would be 15 feet plus a 2 foot overhang on each side for 19 feet.

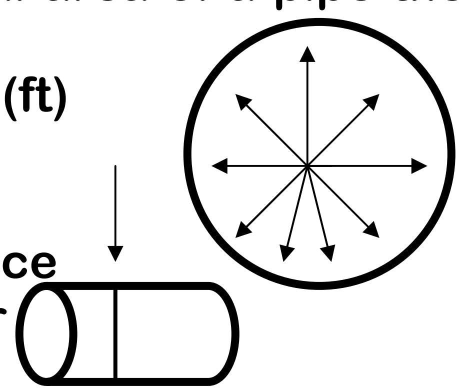
Our length would be 30 feet plus a 2 foot overhang on each side for 34 feet.

Area ft^2 = 19 ft X 34 ft
Area ft^2 = 646

When feet are multiplied by feet the answer will be in square feet. (ft^2)

When we need the cross-sectional area of pipe it is usually to determine velocity or flow past a stationary point in the pipe. To determine the cross=sectional area of a pipe the formula is:

.785 X Diameter (ft) X Diameter (ft)



We are not concerned with the length of the pipe for this formula, only one place on the pipe. Again, the formula calls for diameter in *feet*.

What is the cross-sectional area of a 10 inch pipe?

Area (ft^2) = .785 X D' X D'
Area (ft^2) = .785 X (10" ÷ 12") X (10" ÷ 12")
Area (ft^2) = .785 X .833' X .833'
Area (ft^2) = .544 ft^2

VOLUME

When calculating volume, the third dimension or measurement is figured into the equation. Volume by definition is a "three dimensional space enclosed within or occupied by an object."

These measurements are used by operators to determine how much water could be contained in a particular space. The formula to determine this calculation is:

Volume (ft^3) rectangular solid =

.785 X Diameter (ft) X Diameter (ft) X Length (ft)

What would the volume be in a standpipe that was 80 feet in height and 35 feet in diameter?

Volume (ft^3) = .785 X 35' X 35' X 80'
Volume (ft^3) = 76,930

How many gallons could this structure hold?

Each cubic foot of water is equivalent to 7.48 gallons.
So….. 76,930 ft^3 X 7.48 gallons
So….. 575,436.4 gallons

A trench measuring 3 ft, 6 inches in width, by 22 feet in length by 48 inches in depth could contain how many gallons?

Gallons = L (ft) X W (ft) X D (ft) X 7.48 gallons
Gallons = 22 ft X 3.5 ft X 4 ft X 7.48 gallons
Gallons = 2303.84 gallons

16) The mayor wants to cover the smoking area so you are not exposed to the elements because he cares about your welfare. If the smoking are is marked off at 7 feet by 9 feet, how many square feet of materials will you need for the roof of the smoking area?

17) Your flocculation basin measures 25 feet by 30 feet and it is 10 feet deep at the weir. How many gallons could this basin theoretically hold?

18) Because you are so much more intelligent than the distribution crew, you are responsible for disinfecting your new storage facility. If the storage facility measures 40 feet in height, and has a radius of 25 feet, how many gallons could this structure hold?

TEMPERATURE CONVERSIONS

$^{\circ}F = (^{\circ}C \times 1.8) + 32$	$^{\circ}C = \dfrac{(^{\circ}F - 32)}{1.8}$

19) If the thermostat on your porch reads 68º F what would be the equivalent temperature in Celsius?

20) The thermostat in your beer cooler reads 4.5 ºC. What is the equivalent temperature in Fahrenheit?

FLOW & VELOCITY

Flow is a measurement of volume over time. In our business we frequently use gallons per minute (gpm), cubic feet per second (ft^3/sec) or million gallons a day (MGD).

Velocity is the speed something travels over a certain distance. Usually in our business we express it as feet per second (fps). The state troopers usually notate it to me in miles per hour (mph). As long as it is the speed something travels over a particular distance it is velocity.

Area we have already discussed. In this case we can determine both the speed and volume of water of water in our systems by determining either the speed or flow passed a fixed point. For this calculation we use the cross-sectional, two dimensional measurement.

FLOW and VELOCITY

"Q" = FLOW, expressed in cubic feet per second (ft^3).
"V" = VELOCITY, expressed in feet per second (fps).
"A" = expressed in square feet (ft^2).

$$Q = A \times V$$
$$V = Q \div A$$
$$A = Q \div V$$

Q (flow) = A X V
Q (flow) = (.785 X (10" ÷ 12") X (10" ÷ 12")) X 2.8 fps
Q (flow) = .785 X .833’ X .833’ X 2.8 fps
Q (flow) = 1.525 ft^3/sec but the question asks what is the flow in gpm. So.....
If 1 cubic foot per second is equivalent to 448.8 gpm, would we multiply or divide?
If we divide 448.8 gpm by 1.525 ft^3/sec = 294.3 gpm
294.3 gpm is less than 448.8 or 1 ft^3/sec so it is <u>wrong</u>.
If we multiply 448.8 gpm X 1.525 ft^3/sec = 684.4 gpm. That makes sense. We have MORE than 1 ft^3/sec so our answer should be more than 448.8 gpm.

Water is flowing in an 18 inch pipe at a rate of 950 gpm. What is the velocity of this water?

V = Q ÷ A
V = (950 gpm ÷ 448.8 gpm) ÷ (.785 X 1.5’ X 1.5’)
V = 2.1 ft^3/sec ÷ 1.77 ft^2
V = 1.186 or 1.19 fps

21) It takes 2 seconds for water to travel in a channel that measures 2 feet wide by 4 feet long by 3 feet deep. What is the velocity of this water?

22) Water leaves your plant through a 12 inch pipe at 1050 gpm. What is the velocity of this water?

23) Water leaves your filters at a velocity of 1.8 fps through a 24 inch pipe. What is the flow in gpm?

24) Your flash mixing is accomplished by the source water cascading into a basin four feet below a channel that measures 3 feet wide by 4 foot deep by 10 feet long. The water enters the basin at 0.8 fps. What is the flow in gpm?

25) What is the velocity of water entering the sedimentation basin that measures 35 feet x 260 feet and has a flow of 20.5 cuft/sec?

Lbs. of chemical = $\frac{\text{ppm X 8.34 X MG}}{\text{\% purity}}$	**Specific Gravity = $\frac{\text{wt. of a particular chemical}}{\text{equivalent wt. of water}}$**
ppm = $\frac{\text{lbs. of chemical X \% purity}}{\text{8.34 X MG}}$	**Strength of Solution = $\frac{\text{wt. of chemical}}{\text{wt. of solution}}$**
Cl_2 Dosage = Demand + Residual	

DOSAGES, ETC.

Lbs. of chemical is obviously important so that we treat our water with enough, but not too much, chemical to reach not only the regulatory requirements but also our own targets for clean, potable water.

EXAMPLE:

If we treat our water with 4.2 mg/L of liquid polymer, how many lbs. of polymer would we need to treat our daily pumping rate of 3.6 MGD?

lbs. of chemical = ppm X 8.34 X MG

We don't need to worry about % purity because we are using 100% polymer.

lbs of chemical = 4.2 ppm X 8.34 X 3.6 MG
lbs of chemical = 126.1

We don't always use 100 % purity chemicals, particularly when we disinfect our water now because so many of us are using calcium or sodium hypochlorite to accomplish our disinfection. We must account for this reduced purity to accurately determine the correct amount of chemical to add to the water.

If we treat disinfect our 11 MGD flow of water with 3.5 ppm of 11% sodium hypochlorite, how many lbs. would be needed? How many lbs. of 70 % calcium hypochlorite would be needed? How many lbs. of 100 % chlorine gas?

$$\text{lbs. of chemical} = \frac{\text{ppm X 8.34 X MG}}{\text{\% purity}}$$

$$\text{lbs. of chemical} = \frac{\text{3.5 X 8.34 X 11 MG}}{.11}$$

lbs. of chemical = 2929 of 11% sodium hypochlorite

$$\text{lbs. of chemical} = \frac{\text{3.5 X 8.34 X 11MG}}{.70}$$

lbs. of chemical = 458.7 of 70% calcium hypochlorite
lbs. of chemical = 3.5 X 8.34 X 11MG
lbs. of chemical = 321.09 of 100% chlorine gas

If we knew the amount of lbs. we added but didn't know the dosage we could determine it with this formula:

$$\text{ppm} = \frac{\text{lbs. of chemical X \% purity}}{8.34 \text{ X MG}}$$

The Bougenvilla Water Plant treats 6 MGD during their 24 hour a day operation. If a chlorine cylinder weighs 129 lbs. at the beginning of an 8 hour shift and 104 lbs. and the end of the shift, what is the dosage that operator added to the water?

$$\text{ppm} = \frac{\text{lbs. of chemical X \% purity}}{8.34 \text{ X MG}}$$

$$\text{ppm} = \frac{(129 \text{ lbs.} – 104 \text{ lbs.})}{8.34 \text{ X } 2 \text{ MG}}$$ * it's 100% chlorine

* 12 MGD/24 hrs means 4 MGD/8 hrs

$$\text{ppm} = \frac{25 \text{ lbs of } 100\% \text{ chlorine}}{16.68}$$

ppm = 1.49 or 1.5

DOSAGE, DEMAND, RESIDUAL

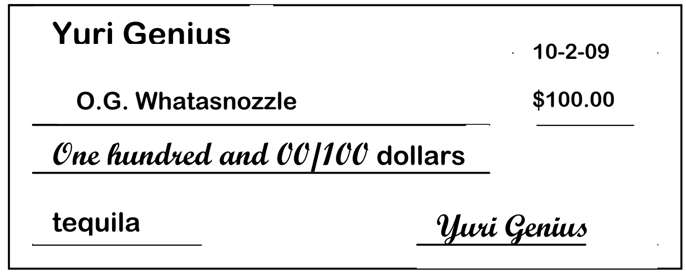
Dosage – The amount of disinfectant added to the water. In our business usually expressed in ppm, mg/L, lbs., etc.

Demand – the amount of disinfectant that has reacted with substances present in the water.

Residual – The amount of disinfectant that remains in the water after it has reacted with whatever substances are present.

An easy way to remember these terms was presented by Ruth Lancaster, formerly of DCA and now with Louisville Water Company. Most of us are familiar to some extent with a checking account.

a) Start by depositing $1000.00 into your new checking account.



b) You write checks to your creditors that total $750.00.

c) Your checkbook balance would be $250.00.

You can determine your dosage, demand and residual in much the same way.

$$Cl_2 \text{ Dosage} = \text{Demand} + \text{Residual}$$

How much you put into the water.	DOSAGE
How much is used up.	DEMAND
How much is left over.	RESIDUAL

If Mt. Airy treats their water with ***3.5 ppm*** of gaseous chlorine and it is determined that at the furthest point in their distribution system the ***residual is 1.1 ppm***. What is the ***demand***?

3.5 ppm
\- <u>1.1 ppm</u>
2.4 ppm

If Mayberry has determined that the chlorine ***demand*** in their system is ***1.8 ppm*** and their ***residual*** is ***0.8 ppm***, what is Mayberry's

1.8 ppm
<u>+0.8ppm</u>
2.6 ppm

dosage?

If Mt. Pilot treats their water with *2.9 ppm* (*dosage*) and the chlorine *demand* has been shown to be *2.3 ppm*, what is the chlorine residual?	**2.9 ppm** **- 2.3 ppm** **0.6 ppm**

SPECIFIC GRAVITY

Specific gravity is nothing more than the weight of a substance in comparison to the weight of water. Water has a specific gravity of 1.0 which means it weighs 8.34 lbs./gallon. Kerosene has a specific gravity of 0.8 which means it weighs (0.8 X 8.34 lbs.) 6.67 lbs per gallon. A particular polymer could have a specific gravity of 1.8. If it does then the polymer would weigh (1.8 X 8.34 lbs.) 15.01 lbs./gal.

Again, since our dosage formulas are based on the weight of water then the difference in weight of any substance that doesn't weigh the same as water has to be accounted for to obtain correct dosage numbers.

EXAMPLE:

You are adding Hydrofluosilicic Acid to the water that has a specific gravity of 1.5. What would this acid weigh per gallon?

SG = 8.34 lbs. X 1.5
SG = 12.5 lbs. /gal

STRENGTH of SOLUTION

Strength of solution compares the weight of a chemical you add to water as compared to the weight of the water that you put the chemical in plus the weight of the chemical.

$$\text{Strength of Solution} = \frac{\text{weight of chemical}}{\text{weight of solution}}$$

EXAMPLE:

You are adding 12 lbs. of lime to 100 gallons of water. What is the strength of solution?

$$\text{SOS} = \frac{\text{wt. of chemical}}{\text{wt. of solution}}$$

$$\text{SOS} = \frac{\text{12 lbs. of lime}}{(100 \text{ X } 8.34 \text{ lbs.}) + \text{12 lbs. of lime}}$$

$$\text{SOS} = \frac{\text{12 lbs of lime}}{\text{846 lbs of solution (834 lbs/water + 12 lbs/lime)}}$$

SOS = 0.014 or turned into a percentage by multiplying it by 100.

SOS = 1.4 %

26) Tucumcari treats 14.2 MGD and operates 18 hours a day. The five operators, three male and two female, treat their water with 3.8 mg/L cationic polymer, 1.2

mg/L of lime, and 2.8 mg/L of chlorine. The Cl_2 demand has been determined to be 1.9 mg/L. What is the chlorine residual in Tucumcari?

27) Pasadena uses 227 lbs of Cl_2 to treat 8.5 MGD. The residual in their system has been measured at 1.3 ppm. What is the Cl_2 demand?

FILTRATION RATE	=	Flow (gpm) ÷ Surface Area (sqft)
BACKWASH RATE	=	Flow (gpm) ÷ Surface Area (sqft)
SURFACE OVERFLOW RATE	=	Flow (gpm) ÷ Area (sqft)
DETENTION TIME	=	Volume (gallons) ÷ Flow (gpm)
WEIR OVERFLOW RATE	=	Flow (gpm) ÷ Feet of weir
SPECIFIC CAPACITY	=	Well Yield (gpm Drawdown (feet)

FILTRATION RATE: for every 1.6 in./min. of rise or fall = 1 gpm/ft²

FILTRATION RATE BACKWASH RATE
SURFACE OVERFLOW RATE
DETENTION TIME
WEIR OVERFLOW RATE
SPECIFIC CAPACITY
FILTRATION RATE #2

Obviously, determining filtration, backwash, weir overflow and other rates of flow are important when optimizing the processes we use to treat water.

FILTRATION RATE, BACKWASH RATE

These two use the same formula to determine the rate of flow through your filters. Both are based on flow in gpm and area in square feet.

EXAMPLE:

The treatment facility has four filters, each one measuring twenty five feet square. The flow rate at the plant is 7000 gpm. What is the filtration rate?

FR = Flow (gpm) ÷ Area (ft^2)
FR = 7000 gpm ÷ (25' X 25' X 4)
FR = 7000 gpm ÷ 2500 ft^2
FR = 2.8 gpm/ft^2

Another way to determine the filtration rate is to measure the rise or fall of the water level in your filters.

For every 1.6 inches/minute of rise or fall = 1 gpm/ft^2

EXAMPLE:

During a recent filter run, Clayton observed that the water level had dropped 6.4 inches every minute the filter was in operation. What was the filtration rate?

Every 1.6 inches/minute ↕ = 1 gpm/ft^2
FR = 6.4 inches/minute ÷ 1.6 inches/ minute
FR = 4 gpm/ft^2

Detention time is the amount of time water remains in an enclosure, such as a basin. To determine detention time we would use this formula.

Detention Time = Volume/gallons ÷ Flow/gallons per minute

EXAMPLE:

A tank has a volume of 4.5 MG and the flow from the tank is 5.25 MGD. What is the detention time in hours?

> **DT = Volume (gals) ÷ Flow (gpm)**
> **DT = 4,500,000 gallons ÷ (5.25 X 694.5 * gpm)**
> **DT = 4,500,000 gallons ÷ 3646.13 gpm**
> **DT = 1234.19 minutes**
> **DT = 1234.19 minutes ÷ 60 minutes/hr**
> **DT = 20.57 hours (actually 20.569833 rounded up)**

*** The conversion sheet tell us that 1 MGD = 694.5 gpm**

A basin that measures 40 feet by 120 feet and has a water depth of 12 feet is flowing at a rate of 720 gallons per minute. What is the detention time of this basin in hours?

> **DT = Volume (gals) ÷ Flow (gpm)**
> **DT = (40' X 120' X 12' X 7.48 gallons) ÷ 720 gpm**
> **DT = 430848 gallons ÷ 720 gpm**
> **DT = 598.4 minutes**
> **DT = 598.4 minutes ÷ 60 minutes/hour**
> **DT = 10 hours (actually 9.97333 hours)**

WEIR OVERFLOW RATE

Weir overflow rate is a measurement of the volume of water flowing over each unit length of weir per day/hour.

Weir Overflow Rate = Flow (gpm) ÷ Feet of weir

EXAMPLE:

A circular basin has a diameter of 65 feet and a flow of 2.2 MGD. What is the weir overflow rate?

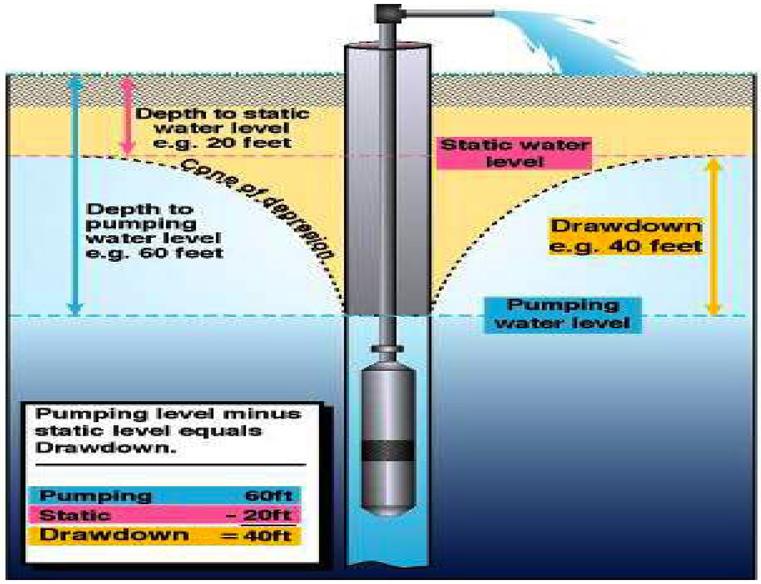
WOR = Flow (gpm) ÷ Feet of weir
WOR = (2.2 X 694.5 gpm) ÷ (3.14 X 65 ft)*
WOR = 1527.9 gpm ÷ 204.1 feet
WOR = 7.486 or 7.5 gpm/ft of weir
*** This is a circular structure so we need to determine the circumference of the unit. 3.14 X Diameter (ft)**

A weir has a length of 32 feet and a flow of 0.5 MGD. What is the weir overflow rate?

WOR = Flow ÷ Feet of weir
WOR = (0.5 X 694.5 gpm) ÷ 32 ft
WOR = 347.25 gpm ÷ 32 ft
WOR = 10.85 gpm/ft of weir

SPECIFIC CAPACITY

A calculation used in groundwater applications to help determine the yield of a particular well.



Specific Capacity = Well yield (gpm) ÷ Drawdown (feet)

EXAMPLE:

In this particular illustration above, if the well yield was 150 gpm, what would the specific capacity be?

SC = Well Yield (gpm) ÷ Drawdown (feet)
SC = 150 gpm ÷ 40 feet
SC = 3.75 gpm/ft

28) If your plant uses six filters, each measuring 30 feet by 20 feet, and you treat 12.2 MGD, what is the filtration rate?

29) You notated that your filter is dropping at a rate of 9.6 inches per minute. What is your filtration rate?

30) You are backwashing the filter in one of your 15 feet by 20 feet filters. The flow during your backwash is 470 gpm. What is your backwash rate?

31) If the water during your backwash cycle rises at a rate of 4.8 inches per minute, what is your backwash rate?

32) What is the surface overflow rate if the area measures 10 feet by 12 feet and the flow rate is 1.5ft^3/sec?

33) Determine the detention time of a basin that measures 12 feet deep, 20 feet wide and 35 feet long and has a flow of 3.1 MGD.

34) Calculate the detention time in hours for a clarifier that has a diameter of 180 feet and a water depth of 12.75 feet, if the flow rate is 4.7 MGD.

35) What is the weir overflow rate of a weir that is 19 feet in diameter and a flow of 1.3 ft^3/sec?

36) If 3.5 MGD flows over 71 feet of weir, what is the weir overflow rate?

37) If the pumping level of your well is 90 feet and the static water level is 35 feet and the well delivers 1.2 MGD, what is the specific capacity?

38) The Oshkosh Treatment Plant is adding 358 grams/min of caustic soda to its water. If the plant is producing water at 13 MGD, what is the caustic soda usage in lbs. per day?

39) Your system has a tank that is 60 feet in diameter and 40 feet tall. If there are 676,431 gallons of water in the tank, what is the psi at the bottom of the tank?

40) A conventional treatment plant uses 190 ml/minute of polymer as it produces 2500 gpm of water on average over a 30 day period. How many gallons will be used over that 30 day period?

41) Approximately how many lbs. of iron will be removed in a years time if the plant treats 6.8 MGD, the iron concentration is 0.07 ppm and the removal rate is 91%?

42) What is the chlorine dosage in mg/L if the plant uses 519 lbs. /day and treats 29.2 MGD?

43) A channel that is 6 feet wide has water flowing through it at a depth of 4 feet and a velocity of 1.9 fps. What is the flow rate in gpm?

44) What is the specific gravity of a solution that weighs 14.2 lbs/gallon?

45) The Whatasnozzle Treatment Facility uses 800 lbs. of chlorine a day. If the chlorine demand is 2.1mg/L and the chlorine residual is 0.8 mg/L, how many million gallons a day are being treated?

Snapshots at jasonlove.com

"Of students surveyed, 64% prefer English and 32% prefer math. The fact that these numbers do not add up to 100 may help explain why."

46) Determine the detention time in hours for the following water treatment plant:3

- **6 filters, each measuring 35 feet by 18 feet and an average depth of 9 feet and a flow of 15 MGD**
- **1 sedimentation basin that measures 475 feet long, 60 feet wide, with a water depth of 11 feet**
- **2 flocculation basins measuring 30 feet by 15 feet that average 10 feet in water depth**

47) If a pump discharges 15,750 gallons in 2 and ½ hours, how many gpm is this pump discharging?

48) What is the velocity of the water in a 10 inch pipe that has a flow of 120 gpm?

49) A positive displacement pump is used to put a chemical solution into the water supply. The pump speed can be adjusted accurately between 10 and 50 strokes per minute. At 25 strokes per minute the pump delivers 45 gallons per minute. What does the pump deliver at 15 and 45 strokes per minute?

50) A sedimentation basin is 300 feet by 75 feet with a water depth of 14 feet. If the maximum flow in the sedimentation basin is 1450 gpm, how long will it take to drain the basin?

51) A chlorine cylinder weighs 149 lbs. at the beginning of Ralph's eight hour shift and 117 lbs. at the end of his shift. The plant operates 24 hours a day and treats 9.6MGD. What was the chlorine dosage during Ralph's shift?

52) Raleigh treats 27.4 MGD and desires a dosage of 2.6 mg/L. How many lbs. of 11% sodium hypochlorite will be needed to obtain the desired dosage?

53) You need to disinfect a new 18 inch waterline that is 1.5 miles long with 65% available calcium hypochlorite. Each tablet weighs 0.5 lbs. How many tablets will be needed to complete this task?

54) You are adding 50 lbs of orthophosphate to 400 gallons of water. What is the strength of solution?

55) You have drawn lines on your day tank and divided it into 50 equal volumes. If your tank is 48 inches in diameter and 60 inches tall, theoretically how many gallons would be contained between each set of marks?

56) Your plant treated 91,276,981 during the month of September, 2009. The amount of water billed for at City Hall was 79,950,354 gallons. What is the percent of your unaccounted for water or water loss?

57) If you are adding 757 ml of caustic to your flow of 6944.5 gpm daily, how many gallons of caustic would be used after 30 days if the plant operated 24 hrs/day?

58) Your high service pump uses 41.03 kilowatts. How many horsepower pump are you using?

59) If your standpipe is 95 feet tall and 35 feet in diameter, what would a pressure gauge read if the gauge was 5 feet above grade?

60) Convert 3.7 ft^3/sec to MGD.

61) Padonka treats 1.2 MGD with 8.5% sodium hypochlorite that has a specific gravity of 1.4 to obtain a dosage of 2.8 mg/L. How many gallons of sodium hypochlorite will be Podunka need each week?

62) A hypochlorinator feeds 45 ml/min of a solution composed of 30 lbs of HTH (65% available) in 120 gallons of water. The specific gravity of the solution is 1.2 and the plant operates 12 hours a day. How many lbs of solution are fed each day?

63) A hypochlorinator feeds 30 ml/min of a solution composed of 20 lbs of HTH (70% available) in 200 gallons of water. We fed 10.5 gallons, which is what percent of the solution and how many lbs of chlorine?

PROBLEM SOLUTIONS

1) 5 gallons = ? ml
   5 gallons = (5 gallons X 3785 ml)

   1 gallon = 3,785 ml

   5 gallons = 18,925 ml

2) 30 psi = ? ft of head
   30 psi = (30 psi X 2.31 ft of head)

   1 psi = 2.31 ft of head

   30 psi = 69.3 ft of head

3) **41.7 lbs. = ? gallons**
41.7 lbs. = (41.7 ÷ 8.34 lbs/gal)

1 gallon = 8.34 lbs.

41.7 lbs. = 5 gallons

4) **3628.8 grams = ? lbs**
3628.8 grams = (3628.8 grams ÷ 453.6 grams)

1 pound = 453.6 grams

3628.8 grams = 8 lbs.

5) **15,840 ft = ? miles**
15,840 = 15,840 ft ÷ 5,280 ft)

1 mile = 5,280 feet

15,840 ft = 3 miles

6) **35 ft^3 of water = ? gallons**
35 ft^3 of water = (35 X 7.48 gallons)

1 cuft of water = 7.48 gallons

35 ft^3 of water = 261.8 gallons

7) **2244 gpm = ? ft^3/sec of water**
2244 gpm = (2244 gpm ÷ 448.8 gpm)

1 ft^3/sec = 448.8 gpm

2244 gpm = 5 ft^3/sec

8) 8 MGD = ? gpm

8 MGD = (8 X 694.5 gpm)

1 MGD = 694.5 gpm

8 MGD = 5556 gpm

9) 312 gallons of water = ? ft^3 of water

312 gallons of water = (312 ÷ 7.48 gallons)

1 cuft of water = 7.48 gallons

312 gallons of water = 41.7 ft^3 of water

10) 161.7 ft of head = ? psi

161.7 ft of head = (161.7 ft/head X.433 psi)

1 ft of head = .433 psi

161.7 ft of head = 70 psi

11) 5,000 gpm = ? MGD

5,000 gpm = (5,000 ÷ 694.5 gpm)

1 MGD = 694.5 gpm

5,000 gpm = 7.2 MGD

12) 7 ft^3 of water = ? gpm

7 ft^3 of water = (7 X 448.8 gpm)

1 cu ft = 448.8 gpm

7 ft^3 of water = 3141.6 gpm

13) 5000 gallons = ? ft^3
5000 gallons = 5000 gal ÷ 7.48 gallons

7.48 gallons = 1 ft^3 of water

5000 gallons = 668.45 ft^3

14) 6 miles = ? feet
6 miles = (6 X 5,280 ft)

1 mile = 5,280 ft

6 miles = 31,680 ft

15) 1 day = ? minutes
1 day = (24 hr/day) X (60 min/hr)
1 day = 1440 minutes

16) 7 feet X 9 feet =
63 ft^2

17) Basin measures 25' X 30' X 10'
Volume of a rectangle = Length' X Width' X Height"
Volume of a rectangle = 25' X 30' X 10'
Volume of a rectangle = 7500 ft^3
Convert ft^3 to gallons
Volume of a rectangle = 7500 ft^3 X 7.48 gallons
Volume of rectangle/gals = 56,100 gallons

18) Storage facility = 40 feet high X 25 foot radius
Volume of a cylinder = .785 X D' X D' X H'
Volume of a cylinder = .785 X (2 x 25') X 2 x 25') X 40'
Volume = .785 X 50' X 50' X 40'
Volume = 78,500 ft^3
Converted to gallons = 78,500 ft^3 X 7.48 gallons
Volume in gallons = 587,180

19) 68ºF = ?º C

$$ºC = \frac{(ºF – 32)}{1.8}$$

$$ºC = \frac{(68 -32)}{1.8}$$

ºC = 20

20) 4.5ºC = ?º F

ºF = (ºC X 1.8) + 32

ºF = (º4.5 X 1.8) + 32

ºF = 8.1 + 32

ºF = 40.1

21) Velocity (fps) = ?
Velocity (fps) = 4 feet in 2 seconds
Velocity (fps) = 2.0 fps

22) Velocity = Q ÷ A
Velocity = (1050 gpm ÷ 448.8 gpm) ÷ (.785X 1'X 1')
Velocity = 2.3 ft^3/sec ÷ .785 ft^2
Velocity = 2.93 fps

23) **Flow (gpm) = ?**

Flow = A X V

Flow = (.785 X (24”÷ 12”) X (24”÷ 12”)) X 1.8

Flow = (.785 X 2’ X 2’) X 1.8 fps

Flow = 3.14 ft^2 X 1.8 fps

Flow = 5.65 ft^3/sec

Flow = converted to gpm 5.65 ft^3/sec X 448.8 gpm

Flow (gpm) = 2535.7

24) **Flow = ?**

Flow = A X V

Flow = (3’ X 10’) X 0.8 fps

Flow = 30’ X 0.8 fps

Flow = 24 ft^3/sec X 448.8 gpm (remember 1 ft^3/sec = 448.8 gpm)

Flow = 10,771.2 gpm

25) **Velocity = ?**

Velocity = Q ÷ A

Velocity = 20.5 ft^3/sec ÷ (35’ X 260’)

Velocity = 20.5 ft^3/sec ÷ 9100 ft^2

Velocity = .002 fps

26) **Residual = ?**

Residual = Dosage – Demand

Residual = 2.8 mg/L Dosage – 1.9 mg/L Demand

Residual = 0.9 mg/L

27) **Demand = ?**

Demand = Dosage – Residual

$$\text{Demand} = \frac{227 \text{ lbs}}{8.34 \times 8.5} - 1.3 \text{ ppm}$$

$$\text{Demand} = \frac{227 \text{ lbs}}{70.9} - 1.3$$

Demand = 3.2 ppm – 1.3 ppm

Demand = 1.9 ppm

28) **Filtration Rate = ?**

Filtration Rate = Flow (gpm) ÷ Surface Area (sq ft)

Filtration Rate = (12.2 X 694.5 gpm) ÷ (30' X 20' X 6)

Filtration Rate = 8473 gpm ÷ 3600 ft^2

Filtration Rate = 2.35 gpm/ft^2

29) **Filtration Rate = ?**

Filtration Rate = for every 1.6 in/min = 1 gpm/ft^2

Filtration Rate = 9.6 in/min ÷ 1.6 in/min

Filtration Rate = 6 gpm/ft^2

30) **Backwash Rate = ?**

Backwash Rate = Flow (gpm) ÷ Surface Area (sqft)

Backwash Rate = 470 gpm ÷ (15' X 20')

Backwash Rate = 470 gpm ÷ 300 ft^2

Backwash Rate = 1.6 gpm/ft^2

31) **Backwash Rate = ?**

Backwash Rate = for every 1.6 in/min = 1 gpm/ft^2

Backwash Rate = 4.8 in/min ÷ 1.6 in/min

Backwash Rate = 3 gpm/ft^2

32) **Surface Overflow Rate = ?**

Surface Overflow Rate = Flow (gpm) ÷ Area (ft^2)

Surface Overflow Rate = $\dfrac{(1.5\ ft^3/sec \times 448.8\ gpm)}{(10' \times 12')}$

Surface Overflow Rate = 673.2 gpm ÷ 120 ft^2

Surface Overflow Rate = 5.61 gpm/ft^2

33) **Detention Time = ?**

Detention Time = Volume (gallons) ÷ Flow (gpm)

Detention Time = $\dfrac{(12' \times 20' \times 35' \times 7.48\ gallons)}{(3.1\ MGD \times 694.5\ gpm)}$

Detention Time = 62832 gallons ÷ 2152.95 gpm

Detention Time = 29.12 minutes or .485 hours

34) **Detention Time = ?**

Detention Time = Volume (gals) ÷ Flow (gpm)

Detention Time = $\dfrac{(.785 \times 180' \times 180' \times 12.75' \times 7.48\ gal)}{(4.7\ MGD \times 694.5)}$

Detention Time = 2425640.5 gallons ÷ 3264.15 gpm

Detention Time = 743.12 minutes or 12.38 hours

35) **Weir Overflow Rate = ?**

Weir Overflow Rate = Flow (gpm) ÷ Feet of Weir

Weir Overflow Rate = $\dfrac{(1.3\ ft^3/sec \times 448.8\ gpm)}{(3.14 \times 19')}$

Weir Overflow Rate = 583.44 gpm ÷ 59.66'

Weir Overflow Rate = 9.8 gal/ft of weir

36) **Weir Overflow Rate = ?**

Weir Overflow Rate = Flow (gpm) ÷ Feet of Weir

Weir Overflow Rate = (3.5 X 694.5 gpm) ÷ 71'

Weir Overflow Rate = 2430.75 gpm ÷ 71'

Weir Overflow Rate = 34.2 gal/ft of weir

37) Specific Capacity = $\frac{\text{Well Yield (gpm)}}{\text{Drawdown}}$

Specific Capacity = $\frac{(1.2 \text{ MGD X } 694.5 \text{ gpm})}{(90' - 35')}$

Specific Capacity = $\frac{833.4 \text{ gpm}}{55'}$

Specific Capacity = 15.15

38) Looking for pounds/day of caustic
453.6 grams = 1 pound
Adding 358 grams per minute
1440 minutes in a day, so 358 grams X 1440=
515520 grams per day
515520 grams ÷ 453.6 grams = lbs.
lbs. = 1136.5

39) psi = ?
psi = 2.31 ft of head is equivalent to .433 psi
psi = 40 feet X .433 psi
psi = 17.32

40) Gallons = ?
Gallons = 190 ml/min X 1440 min/ day X 30 days
Gallons = 8,208,000 ml used in 30 days
1 gallon = 3,785 ml
Gallons = 8,208,000 ml ÷ 3,785 ml
Gallons /30 days = 2168.6

41) lbs. = ?
lbs. = ppm X 8.34 X MG
lbs. = 0.07 ppm X 8.34 X 6.8 MG X 365 days
lbs. = 1448.99 or 1449 lbs. of 100% removal
lbs. at 91 % removal = .91 X 1449 lbs = 1318.6 lbs.

42) dosage (ppm) = lbs. of chemical ÷ (8.34 X MG)
dosage (ppm) = 519 lbs. ÷ (8.34 X 29.2 MG)
dosage (ppm) = 519 lbs. ÷ 243.53
dosage (ppm) = 2.13

43) Flow (gpm) = ?
Flow = A X V
Flow = (6' X 4') X 1.9 fps
Flow = 24 ft^2 X 1.9 fps
Flow = 45.6 ft^3/sec
Flow (gpm) = 45.6 ft^3/sec X 448.8 gpm
Flow (gpm) = 20465.28

44) Specific Gravity = ?
Specific Gravity = weight of chemical ÷ 8.34 lbs.
Specific Gravity = 14.2 lbs. ÷ 8.34 lbs.
Specific Gravity = 1.7

45) First, find the chlorine dosage
Dosage = Demand + Residual
Dosage = 2.1 mg/L + 0.8 mg/L
Dosage = 2.9 mg/L
Then use the lbs. formula but solve for the unknown quantity.
lbs. = ppm (mg/L) X 8.34 X MG

$$\text{MGD} = \frac{\text{lbs. per day}}{\text{dosage X 8.34}}$$

$$\text{MGD} = \frac{\text{800 lbs. per day}}{\text{2.9 mg/L X 8.34}}$$

MGD = 33.076 rounded to 33 MGD

46) Yeah, I know, you hate me. A lot of numbers!
6 filters X 35' X 18' X 9' X 7.48 gallons = 254469.6
1 basin 475' X 60' X 11' X 7.48 gal = 2344980 gal
2 floc basins X 30' X 15' X 10' X 7.48 gal = 67320
Total volume = 2666769.6 gallons
Flow 15 MGD converted to gpm = 15 X 694.5 gpm
Flow 10417.5 gpm
Detention Time = Volume (gals) ÷ Flow (gpm)
DT = 2,666,769.6 gallons ÷ 10,417.5 gpm
DT = 255.98 or 256 minutes
DT = 60 minutes/ hr so convert to hrs.
DT = 256 minutes ÷ 60 minutes
DT = 4.3 hours

47) gpm = ?
gpm = 15750 gpm ÷ 2.5 hours (minutes)
gpm = 15750 gpm ÷ 150 minutes
gpm = 105

48) Velocity = ?
V = Q ÷ A
V = (120 gpm ÷ 448.8 gpm) ÷ (.785 X .833' X 8.33')
V = .27 ft^3/sec ÷ .544 ft^2
V = .50 (actually .496) fps

49) At 25 strokes per minute delivers 45 gpm
15 strokes per minute = ? gpm
45 strokes per minute = ? gpm
15 spm ÷ 25 spm = 0.6 (spm-strokes per minute)
45 gpm X 0.6 = 27 gpm So 15 spm = 27 gpm
45 spm ÷ 25 spm = 1.8
45 gpm X 1.8 = 81 gpm So 45 spm = 81 gpm

50) How long = ?

How long = volume (gals) ÷ flow (gpm)

How long = (300' X 75' X 14' X 7.48 gallons) ÷ 1450 gpm

How long = 2356200 gallons ÷ 1450 gpm

How long = 1624.96 or 1625 minutes

How long (hrs) = 1625 minutes ÷ 60 minutes

How long (hrs) = 27 hours

51) Dosage = ?

$$\text{Dosage (ppm)} = \frac{\text{lbs. of chemical}}{8.34 \text{ X MG}}$$

$$\text{Dosage (ppm)} = \frac{\text{32 lbs of Chlorine}}{8.34 \text{ X } 3.2 \text{ MG}}$$

Dosage (ppm) = 1.2

52) lbs.= ?

$$\text{lbs} = \frac{\text{ppm X } 8.34 \text{ X MG}}{\text{\% purity}}$$

$$\text{lbs.} = \frac{2.6 \text{ ppm X } 8.34 \text{ X } 27.4 \text{ MG}}{.11}$$

lbs.= 5401.3

53) lbs. = ?

$$\text{lbs.} = \frac{\text{ppm X } 8.34 \text{ X MG}}{\text{\% purity}}$$

$$\text{lbs.} = \frac{50 \text{ ppm X } 8.34 \text{ X } (.785 \text{ X } 1.5' \text{ X } 1.5' \text{ X } 7920' \text{ X } 7.48 \text{ gal})}{.65}$$

$$\text{lbs.} = \frac{50 \text{ ppm X } 8.34 \text{ X } .10 \text{ MG } (104{,}635.5 \div 1{,}000{,}000)}{.65}$$

lbs. = 64.15

lbs. = 64.15 ÷ .5 lbs.

tablets = 128.3 or 129 tablets

54) Strength of Solution = $\frac{\text{Weight of chemical}}{\text{Weight of solution}}$

Strength of Solution = $\frac{50 \text{ lbs.}}{(8.34 \text{ X } 400) + 50 \text{ lbs.}}$

Strength of Solution = $\frac{50 \text{ lbs.}}{3386 \text{ lbs.}}$

Strength of Solution = 0.0147

Turned into a percentage (multiplied by 100)

Strength of Solution = 1.47%

55) A couple different ways to do this one.

The easiest way to me is:

Tank- 48” (4’) X 60” (5’)

Volume (gallons) = .785 X D’ X D’ X L’ X 7.48 gal

Volume = .785 X 4’ X 4’ X 5’ X 7.48 gallons

Volume = 469.7 or 470 gallons

Volume = 470 gallons ÷ 50 equal volumes

Volume per mark = 9.4 gallons

56) You treated 91,276,981 gallons

You billed - 79,950,354 gallons

Difference 11,326,627 gallons

Percentage = 11,326,627 ÷ 91,276,981

Gives you 0.12 then X 100 to turn into %

Water loss % = 12

57) Again, a couple of ways to do this one
If 757 ml is added each day, then:
30 days X 757 ml = 22,710 ml used in 30 days
3,785 ml = 1 gallon so.....
22,710 ml of caustic ÷ 3,785 ml = 6 gallons

58) Pump uses 41.03 kilowatts
1 horsepower = .746 kilowatts
41.03 kilowatts ÷ .746 kilowatts (1 HP)
HP = 55

59) 1 ft of head = .433 psi.
Standpipe is 95 feet tall but the gauge is 5 feet above grade.
95 feet – 5 feet = 90 feet
90 feet X .433 psi
38.97 psi

60) 1 ft^3/sec = 448.8 gpm
3.7 ft^3/sec X 448.8 gpm = 1660.56 gpm
Now there are two (at least) ways to go
1 MGD = 694.5 gpm
1660.56 gpm ÷ 694.5 gpm = 2.39 or 2.4 MGD
Or

$$\frac{1660.56 \text{ gpm X } 1440 \text{ minutes}}{1,000,000} =$$

Either way, the answer is:
2.39 or 2.4 MGD

61) We are treating 1.2 MGD with 8.5% available sodium hypochlorite to obtain a dosage of 2.8 mg/L. So we are starting out looking for POUNDS!

$$\text{Lbs} = \frac{\text{ppm X 8.34 X MG}}{\text{\% purity}}$$

$$\text{Lbs} = \frac{\text{2.8 ppm X 8.34 X 1.2 MG}}{.085}$$

$$\text{Lbs} = \frac{28}{.085}$$

Lbs = 329.4 lbs of 8.5% bleach
Each gallon of bleach weighs 1.4 times more than water or 11.7 (11.676) lbs/gallon.

$$\text{Gallons} = \frac{\text{329.4 lbs of bleach}}{\text{11.7 lbs/gallon}}$$

Gallons = 28.2 (28.15) gallons

62) Looking for POUNDS.
We weren't given any ppm figure so maybe this is a conversion problem.
45ml/minute for 12 hours = 45 ml X 60 min/hr X 12 hours = 32,400 ml
32,400 ml ÷ 3785ml/gal = 8.56 or 8.6 gallons of solution.
8.6 gallons X 8.34 lbs/gallon = 71.7 lbs
71.7 lbs X 1.2 specific gravity = 86.0 lbs

63) **10.5 = .0525 X 100 to turn it into a percentage**
= 5.25 % of the solution fed
If we fed 5.25% of the solution, we fed 5.25% of the chlorine so……..
5.25% X 28.6 total lbs of chlorine (20 lbs ÷ 70%)=
.0525 X 28.6 = 1.5 lbs of chlorine

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ON RECYCLED PAPER

Why do utilities, excavators, contractors and the public have to call Kentucky811 prior to disturbing the earth?

The Kentucky Dig Law (KRS 367.4901 to KRS 367.4917) has been in affect since 1994. The law requires all persons excavating to call at least two full business days before digging, and no more than 10 business days prior to digging. The act in its entirety can be viewed at the following Web site: www.kentucky811.org.