# CPO © Math Helper 

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## Math Conversions

- Ounces to Pounds
- Ounces $\div 16=$ pounds
- Fluid Ounces to Gallons
- Fluid ounces $\div 128=$ gallons
- Yards to Feet
- Yards X 3 = Feet
- Meters to Feet
- Meters X 3.28 = Feet
- Square Inches to Square Feet
- Square Inches - 144 = Square Feet


## Conversion Problems

- You need to add 400 fl oz of muriatic acid to the pool.
How much is that in gallons?
$400 \div 128=3.125$ gallons
- Your pool measures 100 yards in length and 75 meters in width. What are the measurements in feet?

100 yards $\times 3=300$ feet

75 meters $\times 3.28=246$ feet

- You want to add 110 ounces of sodium bicarbonate to your pool. How much is this in pounds?
$110 \mathrm{oz} \div 16=6.875$ pounds
- Your DE filter grids has a filter surface area of 1000 sq inches. What is this measurement in square feet?
$1000 \div 144=6.94$ square feet


## Area of Rectangle

- Formula

Length (L) X Width (W) Length


Width

## Example:

- Your swimming pool has a length of 75 feet and width of 34 feet. What is the area?

Length $=75$ feet
Area $=$ Length $X$ Width
Area $=75 \mathrm{ft} \quad \mathrm{X} 34 \mathrm{Ft}$
Area $=2,550 \mathrm{sq} . \mathrm{ft}$.

$$
\text { Width }=34 \text { feet }
$$

## Area of Circle

- Formula

Area $=$ radius (r) X radius (r) X 3.14 Radius $=1 / 2$ of diameter

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## Example:

- You have a spa with a diameter of 10 feet. What is the area of the spa?
Area $=$ r X r X 3.14
$r=$ radius
radius $=$ diameter $\div 2$
radius $=10 \div 2=5 \mathrm{ft}$.


Area $=5 \times 5 \times 3.14$
Area $=78.5$ sq. ft .

## Pool Volume (Gallons)-Rectangle Constant Slope Pool <br> - Gallons (Volume) =

Area X Average Depth X 7.5

Remember Area of Rectangle = L X W
Average Depth $=($ deep end + shallow end $) \div 2$
7.5 represents how many of gallons of water in one cubic foot of water


## Question:

- Your swimming pool has a shallow depth of 3 feet and a deep end depth of 10 feet The pool has a length of 60 feet and a width of 12 meters. What is the volume of the pool in gallons?

Length $=60 \mathrm{ft}$.
Shallow depth = 3 ft .
Deep depth $=10 \mathrm{ft}$.

Width $=12$ meters

## Answer:

- Gallons (Volume) $=$

Area X Average Depth X 7.5
First thing to do is look at all measurements and are then in feet. If they are not then use conversions to change to feet as follows:
The only measure not in feet is the width of 34 meters.
To convert this measure, do as follows:
12 meters $\mathrm{X} 3.28=39.36$ feet

This pool is a rectangle and the formula for Area is:

$$
\begin{aligned}
& A=\text { Length } X \text { Width } \\
& A=60 \quad X 39.36=2,361.60 \text { sq. } \mathrm{ft} .
\end{aligned}
$$

Average depth $=$ (shallow depth + deep depth $) \div 2$

$$
=(3 \text { feet }+10 \text { feet }) \div 2=6.5 \text { feet }
$$

Now we can fill in the formula with the info:
Volume = Area X Average Depth X 7.5

$$
\begin{aligned}
& =2,361.6 \text { sq. ft. X } 6.5 \mathrm{ft} . \mathrm{X} 7.5 \\
& =115,128 \text { gallons }
\end{aligned}
$$

## Volume of Rectangle-Multi-depth Pool

Volume $=$ Area X Average Depth X 7.5


Side View of pool

## Question:

- Your pool measures 28 yards long by 50 feet wide. Deep end length is 10 yards. The deep end is a constant 14 feet in depth and the shallow end slopes from 3 feet to 10 feet.
What is the volume in gallons?
Overall Length $=28$ yards


Deep end length $=10$ yards

## Answer:

## First you must divide the pool into two sections, shallow and deep. <br> Volume (V1) <br> 


ards

- Next, convert yards to feet for shallow end of pool.
- To determine shallow end length Total Length is 28 yards and Deep end length given was 10 yards. Shallow end length thus is figured by 28 yards - 10 yards = 18 yards
Diving well length in feet $=10$ yards $\times 3=30 \mathrm{ft}$. Shallow end length in feet $=18$ yards $\mathbf{x} 3=54 \mathrm{ft}$.
(V1)Shallow area volume $=$ Length x Width x Avg. Depth x 7.5
(deep end + shallow end) $\div 2=$ average depth
$(10+3) \div 2=6.5$ feet
$\left(\mathrm{V}_{1}\right)$ Shallow area volume $=54 \times 50 \times 6.5 \times 7.5=131,625$ gallons
(V2)Deep area volume $=$ Length $x$ Width $x$ Depth $x 7 \cdot 5$
(V2)Deep area volume $=30 \times 50 \times 14 \times 7 \cdot 5=157,500$ gallons
$\left(\mathrm{V}_{1}\right)$ Shallow end volume $+\left(\mathrm{V}_{2}\right)$ Deep end volume $=$ Total volume $(\mathrm{VT})$ 131,625 gallons + 157,500 gallons $=289,125$ gallons


## Volume(Gallons) of Circular Pool or

## Spa

- Volume (gallons) = Area x Average Depth X 7.5


Remember that Area of Circle is
Area $=$ r X r X 3.14
R is $1 / 2$ of the diameter

Average depth is actually the constant depth in the pool or spa

## Question:



- Your spa measures 10 feet is diameter and has a constant depth of 3 feet. What is the volume of this spa?
- First calculate the radius

Diameter $\div 2=$ radius
10 feet $\div \mathbf{2}=5 \mathrm{ft}$.


- Radius $x$ radius $\times 3.14 \times$ depth $\times 7.5=$ volume (gallons) 5 ft . X 5ft. X 3.14 X 3 ft . X $7.5=1,766.25$ gallons


## Filter Surface Area of DE Filter

- Your D.E. Filter has 10 grids measuring 16 inches by 16 inches. Each grid filters from both sides. What is the filter surface area?
Formula
Square inches to square feet
Sq. in. $\div \mathbf{1 4 4}$ sq. in./sq. ft. = sq. ft.


16 in. $x 16$ in. $=256$ sq. inches
256 sq. in. $x 2$ sides $=512$ sq. inches/ grid
512 sq. in./grid $\times 10$ grids $=5,120$ sq. in. $\div 144$ sq. in./sq. ft. $=\mathbf{3 5} .5$ sq. ft.

## Calculation for Water Replacement

- Your swimming pool is 55 feet in length and 23 feet in width. You return to the pool on a Friday and find that the auto-fill failed to operate. Your pool water level is 5 inches too low. How many gallons must be added?

Gallons = area $\times$ avg. depth $\times 7.5$
Avg. depth for 1 inch $=0.0833$ feet
Gallons $=55 \times 23 \times 0.0833 \times 7.5$
Gallons $_{1 \text { inch }}=790.3 \quad$ X 5 inches lost
Gallons $_{5 \text { inches }}=\mathbf{3 , 9 5 1 . 5}$

## Calculate Heater Sizing

- Formula

BTU's $=8.33 \mathrm{X}$ Volume X temperature rise in Farenheit Question:
Your spa is 1,200 gallons and the temperature on the spa water went from 89 deg Farenheit to 100 deg Farenheit. How many BTU's will this require?
Answer:

$$
\begin{aligned}
\text { BTU's } & =8.33 \mathrm{X} \text { Volume } \mathrm{X} \text { temp rise } \\
& =8.33 \mathrm{X} \mathrm{1,200} \mathrm{gallons} \mathrm{X} \mathrm{in} \mathrm{degree} \mathrm{rise} \\
& =109,956 \text { BTU's }
\end{aligned}
$$

## Flow Rate Calculation

- Measured in gallons per minute (gpm)
- Can be read by using various different kinds of flow meters.
- Flow rate $=$ Pool Volume $\div$ Turnover Rate $\div 60$

Question:
Your pool has a volume of 120,000 gallons and a 6 hour turnover rate. What is the flow rate?

## Answer:

- Flow rate $=$ Pool Volume $\div$ Turnover Rate $\div 60$

$$
\begin{aligned}
& =120,000 \div 6 \div 60 \\
& =333 \mathrm{gpm}
\end{aligned}
$$

## Turnover Rate Calculation

- Measured in hours
- Standard Turnover Rates to Know:
- Pools = 6 hours
- Spa $=30$ minutes ( 0.5 hours)
- Turnover Rate $=$ Pool Volume $\div$ Flow rate $\div 60$

Question:
Your pool is 135,000 gallons and a flow rate of 350 gpm .
What is the turnover rate?

## Answer:

- Turnover Rate $=$ Pool Volume $\div$ Flow rate $\div 60$

$$
\begin{aligned}
& =135,000 \div 350 \div 60 \\
& =6.42 \text { hours }
\end{aligned}
$$

## Filter Media Rate

- How fast can water go through a filter media type??
- Answer = filter media rate Use table below to find your Filter Media Rate (FMR) to fill in any of the following formulas on next slide.

| Filter Type | Filter Media Rate |
| :---: | :---: |
| Rapid Rate Sand Filter | $3 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$. |
| Diatomaceous Earth w/slurry | $2.5 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$. |
| Diatomaceous Earth | $2.0 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$. |
| Cartridge | $0.375 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$. |
| High Rate Sand | $5-20 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$. |

- Filter Area = FA
- Flow Rate = FR
- Filter Media Rate = FMR

Formulas:
FA $=F R \div F M R$
$\mathrm{FMR}=\mathrm{FR} \div \mathrm{FA}$
FR = FA X FMR

## Question:

- Your flow rate on your pool is measured at 250 gpm . The DE filter on your pools uses 3 ft . by 3 ft . square filter grids. How many filter grids are needed?
Answer:
Remember:
Vacuum DE filter systems filter from both sides of the grid. One grid is 3 ft . by 3 ft .
Area $=\mathrm{L}$ X W $=3 \mathrm{ft} . \mathrm{X} 3 \mathrm{ft} .=9 \mathrm{sq} . \mathrm{ft}$.
The DE filters from both sides
Thus 9 sq. ft. X 2 sides $=18$ sq. ft. for one DE grid

$$
\mathrm{L}=3 \mathrm{ft} .
$$

Diameter $=$

$$
\mathrm{W}=3 \mathrm{ft} .
$$

Now find the FMR on the chart provided previously
You find it is $2.0 \mathrm{gpm} / \mathrm{sq}$. ft. for a vacuum DE filter
Now determine what formula you need:
FA $=\mathrm{FR} \div$ FMR
$\mathrm{FA}=250 \mathrm{gpm} \div 2.0 \mathrm{gpm} / \mathrm{sq} . \mathrm{ft}$.
$=125$ sq. ft.
The number of DE filter grids $=125$ sq. $\mathrm{ft} . \div 18$ sq. ft/grid $=7$ grids

## Question:

- Your pool has a pool with 5 sand filters that each have a diameter of 7 feet. Calculate the total filter area.
Answer:
Remember that with sand filters the only part considered is the top of the sand bed when calculating filter area. This is a circle and to get filter area use the following formula:
Area $=$ r X r X $3.14 \quad$ here $r=3.5 \mathrm{ft}$
$=3.5$ X 3.5 X 3.14
$=38.47$ sq. ft. But this is only for one filter
To calculate for all 5 filters, take 38.47 sq . ft. X 5 filters

$$
=192.33 \mathrm{sq} . \mathrm{ft} .
$$

## Question:

- If you use the previous sand filter system with a 15 $\mathrm{gpm} / \mathrm{sq}$. ft . what is the max flow rate the system can be run at?
Find the formula that is needed:
FR = FA X FMR
Use total filter area (FA) from previous question of 192.33 sq. ft.

FR $=192.33$ sq. ft. $\mathrm{X} 15 \mathrm{gpm} /$ sq. ft .
$=2,884 \mathrm{gpm}$

## Replacement Interval of Spa Water

- Water in spa or therapy pool would be replaced based on the user load in that facility.
- Also this method is used to replace the water when the Total Dissolved Solids (TDS) increases by 1500 ppm over the start up value.
- Use the following formula to calculate: Replacement (days) $=$ Spa Volume $\div 3 \div$ Avg. users/day


## Question:

- Your spa is 1400 gallons and has 10 users per day.

How often should the spa water be replaced?
Replacement ( days) $=$ Spa Volume $\div 3 \div$ Avg users/day

$$
\begin{aligned}
& =1,400 \div 3 \div 10 \\
& =47 \text { days }
\end{aligned}
$$

## Question 2:

Your TDS has increased above the 1500 ppm start up
value for spa of 1400 gallons with 25 users per day?
What to do?
You need to replace the water in the spa.
Use calculation below:
Replacement (days) $=$ Spa Volume $\div 3 \div$ Avg users/day

$$
\begin{aligned}
& =1400 \div 3 \div 25 \\
& =19 \text { days }
\end{aligned}
$$

## How Much Chemical to Add with Product Label Information

- You want to be able to calculate how much chemical for your desired change if you have a chemical label to get information off of.
Complete information in following format:

Amount chemical
from product label

X Pool Volume X Desired Change volume treated change from by from product label product label

## Question:

- You have a 75,0oo gallon pool. You have an algae problem in the pool so you want to an algaecide to the pool water with a label that states the following:



## Answer:

Amount X Actual pool volume $\begin{array}{ll}\text { Chemical } & \text { volume treated } \\ & \text { on product label }\end{array}$

X Desired change change from product label

There is no desired chemcial change or change on product label so that part of formula is left empty 54 fl . Oz X 75,000 $=81 \mathrm{fl} . \mathrm{Oz}$ 50,000

To convert to gallons:
$81 \mathrm{fl} \mathrm{oz} \div 128=0.63$ gallons

## Question:

You have a 90,0oo gallon pool.
Your pool water is cloudy and you test a free chlorine level below 1 ppm.
You decide to treat the pool with 12 ppm of additional chlorine using sodium hypochlorite. The label states that 35 fluid ounces will raise the chlorine level 12 ppm in 10,000 gallons. How much sodium hypo should be added?

## Answer:

Amount X
Chemical $\underset{\begin{array}{l}\text { volume treated } \\ \text { on product label }\end{array}}{ } \quad \begin{gathered}\text { X }\end{gathered} \quad \begin{gathered}\text { Desired change } \\ \text { change from } \\ \text { product label }\end{gathered}$
35 fl. Oz. X 90,000 X $\quad 12 \mathrm{ppm}$
$10,000 \quad 12 \mathrm{pm}$

35 fl . Oz X 9 X $1=315 \mathrm{fl} . \mathrm{Oz}$
Convert to gallons
$315 \mathrm{fl} \mathrm{oz} \div 128=2.5$ gallons

## Saturation Index

- This is done to determine if pool water is properly balanced. The following chart is used to find the factors to use in formula:

| TDS below 1,000 ppm | TDS 1,000 <br> ppm or <br> higher |
| :---: | :---: |
| 12.1 | 12.2 |


| Temperature |  | Calcium <br> Hardness |  | Total <br> Alkalinity |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| De <br> g F | De <br> g C | Tf | Pp <br> m |  | Pp <br> m | Af |
| 32 | 0.0 | 0.0 | 25 | 1.0 | 25 | 1.4 |
| 37 | 2.8 | 0.1 | 50 | 1.3 | 50 | 1.7 |
| 46 | 7.8 | 0.2 | 75 | 1.5 | 75 | 1.9 |
| 53 | 11.7 | 0.3 | 100 | 1.6 | 100 | 2.0 |
| 60 | 15.6 | 0.4 | 125 | 1.7 | 125 | 2.1 |
| 66 | 18.9 | 0.5 | 150 | 1.8 | 150 | 2.2 |
| 76 | 24.4 | 0.6 | 200 | 1.9 | 200 | 2.3 |
| 84 | 28.9 | 0.7 | 250 | 2.0 | 250 | 2.4 |
| 94 | 34.4 | 0.8 | 300 | 2.1 | 300 | 2.5 |
| 105 | 40. | 0.9 | 400 | 2.2 | 400 | 2.6 |
| 6 |  |  | 800 | 2.5 | 800 | 2.9 |

- Use the following Scale to determine if water is balanced, corrosive or scaling:

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- Formula

Saturation $\operatorname{Index}(\mathrm{SI})=\mathrm{pH}+\mathrm{Tf}+\mathrm{Cf}+\mathrm{Af}-\mathrm{TDSf}$

Question:
Calculate the Saturation Index for water that has a total alkalinity of 250 ppm , a pH of 7.6, a calcium hardness of 125 ppm , a temperature of $84^{\circ} \mathrm{F}$, and a total dissolved solids of 500 ppm .

## Answer:

- $\mathrm{SI}=\mathrm{pH}+\mathrm{Tf}+\mathrm{Cf}+\mathrm{Af}-\mathrm{TDSf}$ pH will always be the tested value and does not come from the factor chart, thus just filled into the formula

Next you get all your factors from the factor chart on previous slide

$$
\begin{aligned}
& \begin{aligned}
\mathrm{SI} & =7.6+0.7+1.7+2.4-12.1 \\
& =0.3
\end{aligned} \\
& \text { Water is balanced }
\end{aligned}
$$

## Question:

- Calculate the Saturation Index for water that has a total alkalinity of 175 ppm , a pH of 7.8 , a calcium hardness of 225 ppm , a temperature of $77^{\circ} \mathrm{F}$, and a total dissolved solids of $1,500 \mathrm{ppm}$.
- Answer:

$$
\mathrm{SI}=\mathrm{pH}+\mathrm{Tf}+\mathrm{Cf}+\mathrm{Af}=\mathrm{TDSf}
$$

If you look at factor chart you will find some values not exactly on the chart. Rule of thumb is to always round up to next value no matter what on the chart.

$$
\begin{aligned}
\mathrm{SI} & =7.8+0.7+2.0+2.3-12.2 \\
& =+0.6
\end{aligned}
$$

Water is not balanced, it is scaling.

- If you have any additional questions you may contact me, Lauren Broom at:

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Thanks and good luck in this class!

