# Practice Problems

**Problem 1**
Find the volume of a storage tank that has a diameter of 80 feet and a height of 20 feet in gallons.

**Problem 2**
A 60 foot diameter storage tank has a height of 22 feet. The tank is filled to a sidewall depth (SWD) of 16 feet. Determine the volume at this depth, in cubic feet.

**Problem 3**
Determine the gallons of water in a 1 mile section of 16 inch ductile iron pipeline.

**Problem 4**
A 12 inch diameter well is 300 feet deep and has a static water level 60 feet below the surface. Determine the volume, in gallons.

**Problem 5**
A small community of 2778 people has a 500,000 gallon tank that just meets their daily water demand. Calculate the average per capita usage in GPCD.

**Problem 6**
A small community's primary storage tank has a maximum capacity of 750,000 gallons. Supply to the storage tank has been interrupted. How many hours can the tank supply to the community of 5,500 people if the average per capita usage is 170 GPD?

**Problem 7**
Calculate the average theoretical detention time, in hours, for a contact clarifier that is 80 feet in diameter and has a sidewall depth of 12 feet. The daily flow through the system is 4.35 MGD.

**Problem 8**
To settle turbidity, a 0.5 MGD water plant requires an alum feed of 18.0 mg/L. Calculate the amount of alum required, in lbs/day.

**Problem 9**
If 16.34 lbs/day of zinc orthophosphate has been fed to a 1 MGD water system, determine the average dose in mg/L.

**Problem 10**
If the following average chlorine feed readings were recorded over a period of 4 days, determine the overall average chlorine dosage in mg/L for a 2.4 MGD system. Monday – 23 pounds, Tuesday – 33 pounds, Wednesday – 18 pounds, Thursday 19 pounds.

**Problem 11**
A small 300,000 GPD system has switched from gas chlorination to 65% HTH. Determine how many pounds per day of HTH that will be needed if dosage is 2.8 mg/L.

**Problem 12**
Determine the number of pounds of chlorine required to disinfect an 18 inch diameter well that is 500 feet deep and a static well level at 85 feet. The dosage level is 25 mg/L by AWWA standards.

**Problem 13**
Determine the dosage in mg/L if the demand is found to be 0.8 mg/L and the residual in the water system is 0.2 mg/L.
A= 1.0 mg/L

**Problem 14**
The discharge gauge on a centrifugal pump indicates a discharge pressure of 80 psi find the head in feet.

**Problem 15**
Calculate the force in pounds on the bottom of a wet well that is 8 feet long, 6 feet wide and filled with 7 feet of water.

**Problem 16**
Determine the volume of water a pump can discharge from a storage tank in gallons, if the pump operates at 450 GPM for 2.5 hours.

**Problem 17**
A pump operates at 165 GPM to fill a 100,000 gallon storage tank. Calculate the amount of time in hours it will take to fill it.

**Problem 18**
Calculate the water horsepower needed to pump 129 GPM at a head of 127 feet.

**Problem 19**
A pump station discharges at 694.4 GPM at 65 psi to a reservoir above the city. The pumps are 65% efficient. Determine the brake horsepower required for this application.

**Problem 20**
A water customer serves 2,500 service connections. A typical residential customer uses approximately 10,000 gallons of water per month. Determine the average amount of revenue the company may expect to generate if the following schedule is used:

| | |
|---|---|
| 0-7,500 gallons | $1.25/1,000 gallons |
| 7,500 – 15,000 gallons | $1.50/1,000 gallons |

# Math Problem Set

Solutions

# Problem 1

Find the volume of a storage tank that has a diameter of 80 feet and a height of 20 feet in gallons.

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**What is the problem asking for?**
Volume of the storage tank in gallons

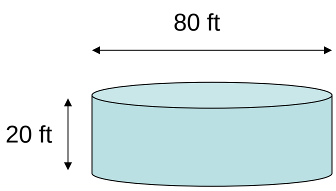
**What information are you given? Is there extra information?**
Tank dimensions: Diameter = 80 feet and Height= 20 feet

**Are there any equations that can help you?**
Volume of a cylinder = $\pi r^2 h$

**Do you have the information needed to solve to problem?**

# Problem 1
# Solution

Picture it!




Important to know

Radius = Diameter/2

$\pi$(pi)= 3.14

***pi is unitless***

Volume of a cylinder = $\pi r^2 h$

r=40 ft and h=20 ft

Fill in the equation:

Volume = (3.14)*(40 ft)*(40 ft)*(20 ft)

Volume = 100,480

What are the units? $ft^3$

Is this what the problem asked for? No!

# Conversion

The calculated value needs to be converted from:

$ft^3 \rightarrow$ gallons

Is there a conversion factor that relates the two units? Yes!

7.48 gallons = 1 $ft^3$

**Setup the conversion:**

$$\frac{100{,}480\ \cancel{ft^3}}{} \left| \frac{7.48\ gallons}{1\cancel{ft^3}} \right.$$

**Complete the calculation:**

100,480 * 7.48 = 751,590.4 gal

**Is this what the problem asked for? Yes!**

# Problem 2

A 60 foot diameter storage tank has a height of 22 feet. The tank is filled to a sidewall depth (SWD) of 16 feet. Determine the volume at this depth, in cubic feet.

**What is the problem asking for?**
Volume of the water in storage tank in cubic feet

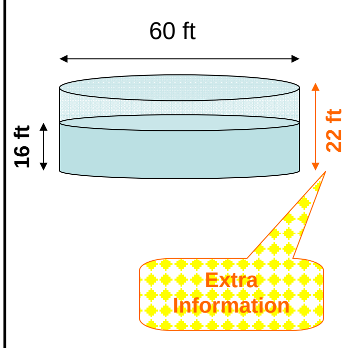
**What information are you given? Is there extra information?**
Tank dimensions: Diameter = 60 ft; Height= 22 ft; SWD = 16 ft

**Are there any equations that can help you?**
Volume of a cylinder = $\pi r^2h$

**Do you have the information needed to solve to problem?**

# Problem 2 Solution

Picture it!




Volume of a cylinder = $\pi r^2h$

r=30 ft and h=16 ft

Fill in the equation:

Volume = (3.14)*(30 ft)*(30 ft)*(16 ft)

Volume = 45,216

What are the units? $ft^3$

Is this what the problem asked for? Yes!

The final answer is 45,216 $ft^3$

# Problem 3

Determine the gallons of water in a 1 mile section of 16 inch ductile iron pipeline.

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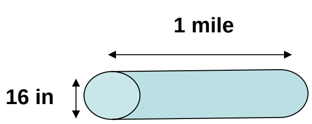
**What is the problem asking for?**
Volume of water in the pipeline in gallons

**What information are you given? Is there extra information?**
Pipe dimensions: Diameter = 16 inches and Length= 1 mile

**Are there any equations that can help you?**
Volume of a cylinder = $\pi r^2 L$

**Do you have the information needed to solve to problem?**

# Problem 3
# Solution




***Take note*** *– there are three dimensions listed in this problem:*

- *gallons*
- *inches*
- *miles*

***Is this going to be an issue?***

***Looking forward***:
**Conversions**

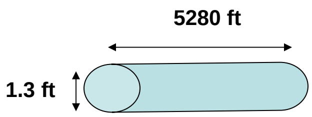
7.48 gallons = 1 $ft^3$
1 ft = 12 inches
1 mile = 5,280 ft

Complete necessary conversions before filling the equation:
Length = 1 mile = 5280 feet

Diameter:

$$\frac{\cancel{16}\text{ in}}{} \left| \frac{1\text{ ft}}{\cancel{12}\text{ in}} \right. = \mathbf{1.33\ ft}$$

# Problem 3
# Solution Continued




Volume of a cylinder = $\pi r^2 h$
r=0.67 ft and L=5280 ft

Fill in the equation:

Volume = (3.14)*(0.67 ft)*(0.67 ft)*(5280 ft)

Volume = 7442.4 $ft^3$

What are the units? $ft^3$

Is this what the problem asked for? No!

Conversion factor:
7.48 gallons = 1 $ft^3$

$$\frac{7004.7\ \cancel{ft3}}{} \Big| \frac{7.48\ \text{gallons}}{1\ \cancel{ft3}} = \boxed{55{,}669.2\ \text{gallons}}$$

Final Answer

# Problem 4

A 12 inch diameter well is 300 feet deep and has a static water level 60 feet below the surface. Determine the volume, in gallons.

**What is the problem asking for?**
Volume of the water in the well in cubic feet

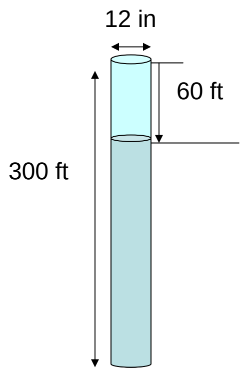
**What information are you given? Is there extra information?**
Well dimensions:
Diameter = 12 in; Depth= 300 ft; SWL = 60 ft from surface

**Are there any equations that can help you?**
Volume of a cylinder = $\pi r^2 L$

**Do you have the information needed to solve to problem?**

# Problem 4
# Solution

Picture it!




Volume of a cylinder = $\pi r^2 h$

$r=0.5$ ft

$h= (300-60) = 240$ ft

Fill in the equation:

Volume = (3.14)*(0.5 ft)*(0.5 ft)*(240 ft)

Volume = 188.4 $ft^3$

Is this what the problem asked for? No!

Conversion factor:
7.48 gallons = 1 $ft^3$

$$\frac{188.4\ \cancel{ft3}}{} \,\Big|\, \frac{7.48\ \text{gallons}}{1\ \cancel{ft3}} = \boxed{\begin{array}{c}\textbf{1409.23 gallons}\\ \text{Final Answer}\end{array}}$$

# Problem 5

A small community of 2778 people has a 500,000 gallon tank that just meets their daily water demand. Calculate the average per capita usage in GPCD.

**What is the problem asking for?**
The average amount of water each community member uses per day (GPCD)

**What information are you given? Is there extra information?**
Population: 2,778; Tank Capacity: 500,000 gallons

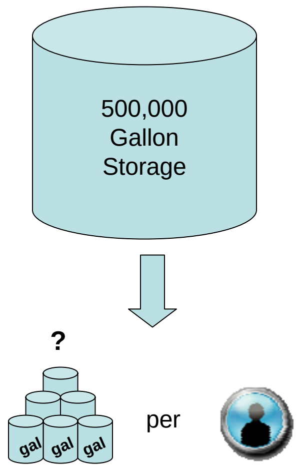
**Are there any equations that can help you?**

$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

**Do you have the information needed to solve to problem?**

# Problem 5
# Solution

Picture it!




$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

Population: 2,778

Tank Capacity: 500,000 gallons

Fill in the equation:

$$\text{GPCD} = \frac{500{,}000\ \text{gpd}}{2{,}778}$$

GPDC = 180

# Problem 6

A small community's primary storage tank has a maximum capacity of 750,000 gallons. Supply to the storage tank has been interrupted. How many hours can the tank supply to the community of 5,500 people if the average per capita usage is 170 GPD?

**What is the problem asking for?**
How many hours supply does the tank have

**What information are you given? Is there extra information?**
Tank Capacity = 750,000 gallons; Population = 5,500; Average per capita usage = 170 GPD; There is no resupply

**Are there any equations that can help you?**

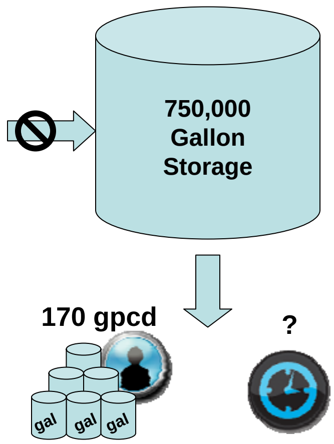
$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

*Alter*

**Do you have the information needed to solve to problem?**

# Problem 6
# Solution

Picture it!




Gallons/Capita/Day =

$$\frac{\text{Total Water Use , gpd}}{\text{Population}}$$

GPCD = 170
Volume = 750,000 gal
Population = 5,500

Fill in the equation:

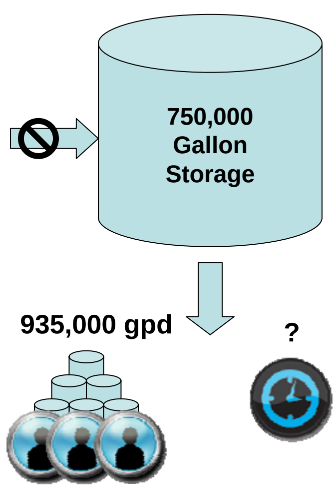
$$170 \text{ gpcd} = \frac{\text{total water use}}{5{,}500 \text{ people}}$$

Rearrange:
Total water use = 170*5,500
= 935,000 gallons/day

***Is this the answer? No***

# Problem 6
# Solution

Picture it!




We just calculated how much water the whole community uses per day
**935,000 gallons/day**

***Comparing the community needs to the actual stored water tells us that we have less than 1 day (24 hours) of storage.***

To complete the calculation set it up as an equivalent ratio:

$$\frac{935{,}000 \text{ gallons}}{24 \text{ hours}} = \frac{750{,}000 \text{ gallons}}{X \text{ hours}}$$

$$X \text{ hours} = \frac{750{,}000 \text{ gallons} \times 24 \text{ hrs}}{935{,}000 \text{ gallons}} = \textbf{19.25 hrs}$$

# Problem 7

Calculate the average theoretical detention time, in hours, for a contact clarifier that is 80 feet in diameter and has a sidewall depth of 12 feet. The daily flow through the system is 4.35 MGD.

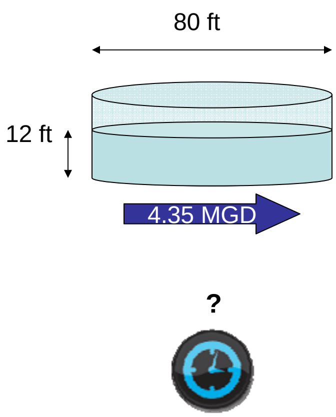
**What is the problem asking for?**
Theoretical (projected) detention time of a clarifier

**What information are you given? Is there extra information?**
Clarifier dimensions: Diameter = 80 ft; SWD = 12 ft;
Flow = 4.35 MGD

**Are there any equations that can help you?**
Volume of a cylinder = $\pi r^2 h$
Detention Time = Volume/Flow

**Do you have the information needed to solve to problem?**

# Problem 7 Solution




Part 1

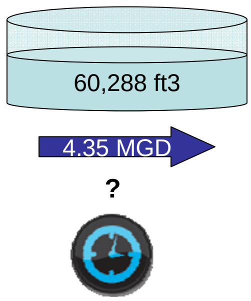
Volume of a cylinder = $\pi r^2 h$
Volume = (3.14)(40)(40)(12)
Volume = 60,288 ft3

Part 2

Detention Time = Volume/Flow
Volume = 60,288 ft3
Flow = 4.35 MGD

Are the units compatible? No

# Problem 7
# Solution




1 ft3 = 7.48 gallons

1 MG = 1,000,000 gallons

**<u>Conversions:</u>**

**60,288 ft$^3$ → gallons**

$$\frac{60{,}288\ \cancel{ft^3}}{} \,\Big|\, \frac{7.48\ gallon}{1\cancel{ft^3}} = 450954.24\ gal$$

**4.35 MGD → GPD**

$$\frac{4.35\ \cancel{MG}}{Day} \,\Big|\, \frac{1{,}000{,}000\ gal}{\cancel{MG}} = 4{,}350{,}000\ gpd$$

Convert to hours!

Detention Time = Volume/Flow

$$\text{Detention Time} = \frac{450{,}945\ gal}{4{,}350{,}000\ gal/d} = 0.1\ d$$

Detention time = 2.5 hours

# Problem 8

To settle turbidity, a 0.5 MGD water plant requires an alum feed of 18.0 mg/L. Calculate the amount of alum required, in lbs/day.

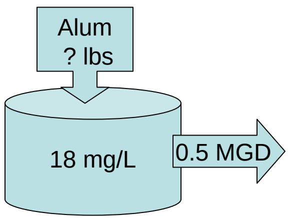
**What is the problem asking for?**
Pounds of alum needed everyday

**What information are you given? Is there extra information?**
Plant capacity = 0.5 MGD; dosage = 18 mg/L

**Are there any equations that can help you?**
Feed Rate, lbs/day = (Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

**Do you have the information needed to solve to problem?**

# Problem 8
# Solution




Feed Rate, lbs/day =
(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

Capacity = 0.5 MGD
Dosage = 18 mg/L

Feed Rate = (18 mg/L)(0.5 MGD)(8.34 lb/gal)
Feed Rate = 75.06 lbs/day

***Is the answer in the correct units?***

# Problem 9

If 16.34 lbs/day of zinc orthophosphate has been fed to a 1 MGD water system, determine the average dose in mg/L.

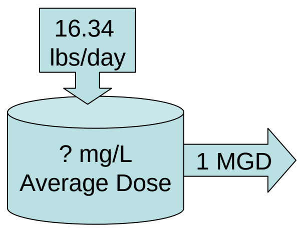
**What is the problem asking for?**
The average dose in mg/L

**What information are you given? Is there extra information?**
Feed rate = 16.34; Plant capacity = 1 MGD

**Are there any equations that can help you?**
Feed Rate, lbs/day = (Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

**Do you have the information needed to solve to problem?**

# Problem 9
# Solution




Feed Rate, lbs/day =
(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

Rearrange the equation

$$\text{Dosage, mg/L} = \frac{\text{Feed Rate, lbs/day}}{(\text{Capacity, MGD})(8.34\ \text{lb/gal})}$$

Capacity = 1 MGD
Feed Rate = 16.34 lbs/day

$$\text{Dosage} = \frac{16.34\ \text{lbs/day}}{(1\ \text{MGD})(8.34\ \text{lb/gal})}$$

= **1.96 mg/L**

***Is the answer in the correct units?***

# Problem 10

If the following average chlorine feed readings were recorded over a period of 4 days, determine the overall average chlorine dosage in mg/L for a 2.4 MGD system. Monday – 23 lbs, Tuesday – 33 lbs, Wednesday – 18 lbs, Thursday 19 lbs.

**What is the problem asking for?**
Overall average chlorine dosage

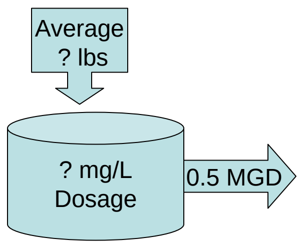
**What information are you given? Is there extra information?**
Time period = 4 days; Flow rate = 2.4 MGD;
Chlorine feed readings: Monday=23 lbs, Tuesday=33 lbs, Wednesday=18 lbs; Thursday=19 lbs

**Are there any equations that can help you?**
Feed Rate, lbs/day = (Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

**Do you have the information needed to solve to problem?**

# Problem 10
# Solution

| Mon | Tues | Wed | Thurs |
|---|---|---|---|
| 23 lb | 33 lb | 18 lb | 19 lb |




Average Feed rate

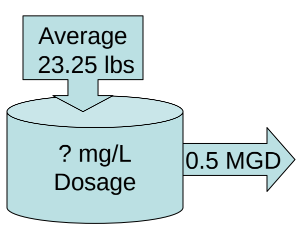
$$\frac{23 + 33 + 18 + 19}{4} = 23.25 \text{ lbs}$$

Feed Rate, lbs/day =
(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

Rearrange the equation

$$\text{Dosage, mg/L} = \frac{\text{Feed Rate, lbs/day}}{(\text{Capacity, MGD})(8.34 \text{ lb/gal})}$$

# Problem 10
# Solution




Feed Rate, lbs/day =
(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

Capacity = 2.4 MGD
Average Feed Rate = 23.25 lbs/day

$$\text{Dosage} = \frac{23.25 \text{ lbs/day}}{(2.4 \text{ MGD})(8.34)} =$$

Dosage = 1.16 mg/L

***Is the answer in the correct units?***

# Problem 11

A small 300,000 GPD system has switched from gas chlorination to 65% HTH. Determine how many pounds per day of HTH will be needed if the dosage is 2.8 mg/L.

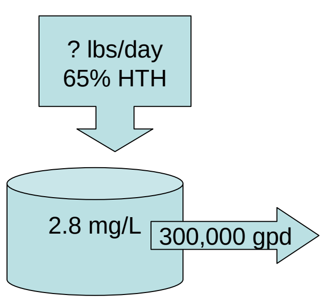
**What is the problem asking for?**
Pounds of HTH needed per day

**What information are you given? Is there extra information?**
Plant capacity=300,000; HTH Purity=65%; dosage=2.8 mg/L

**Are there any equations that can help you?**
Feed Rate, lbs/day = (Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

**Do you have the information needed to solve to problem?**

# Problem 11 Solution




$$\text{Feed Rate, lbs/day} = \frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34\ \text{lb/gal})}{\text{Purity, decimal percentage}}$$

Capacity = 300,000 gpd = 0.3 MGD

Dosage = 2.8 mg/L

Purity = 65 % = 0.65

$$\text{Feed Rate} = \frac{(2.8\ \text{mg/L})(0.3\ \text{MGD})(8.34\ \text{lb/day})}{0.65}$$

Feed Rate = 10.78 lb/day

***Is the answer in the correct units?***

# Problem 12

Determine the number of pounds of chlorine required to disinfect an 18 inch diameter well that is 500 feet deep and a static well level at 85 feet. The dosage level is 25 mg/L by AWWA standards.

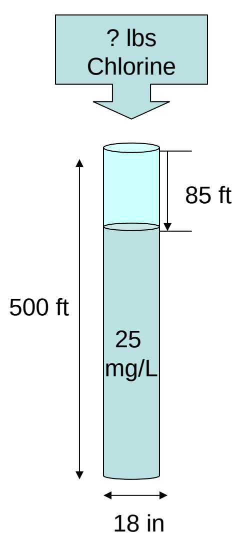
**What is the problem asking for?**
Pounds of chlorine needed to disinfect the well

**What information are you given? Is there extra information?**
Well dimensions: Diameter = 18 in; Depth= 500 ft; SWL = 85 ft
Required dosage level = 25 mg/L

**Are there any equations that can help you?**
Feed rate equation
Volume of a cylinder = $\pi r^2 L$

**Do you have the information needed to solve to problem?**

# Problem 12
# Solution




Feed Rate, lbs/day =
(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)
Dosage = 25 mg/L

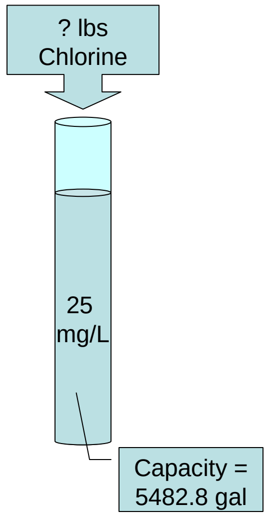
Need to calculate capacity
Volume of a cylinder = $\pi$ r2h
r = 9/12 = 0.75 ft
h = (500-85) = 415 ft

Volume = (3.14)(0.75)(0.75)(415) = 732.99 ft3
Convert ft3 → gallons
Conversion factor 1 ft3 = 7.48 gallons

$\dfrac{733 \text{ ft3}}{} \Big| \dfrac{7.48 \text{ gallons}}{\text{ft3}}$ = 5482.8 gallons

***Is the answer in the correct units?***

# Problem 12
# Solution




Feed Rate, lbs/day =

(Dosage, mg/L)(Capacity, MGD)(8.34 lb/gal)

Dosage = 25 mg/L

Capacity = 5482.8 gallons = 0.0055 MGD

Feed Rate = (25 mg/L)(0.0055 MGD)(8.34lb/gal)

Feed Rate = 1.15 lbs/day

***Is the answer in the correct units?***

# Problem 13

Determine the dosage in mg/L if the demand is found to be 0.8 mg/L and the residual in the water system is 0.2 mg/L.

**What is the problem asking for?**
Dosage in mg/L

**What information are you given? Is there extra information?**

Demand = 0.8 mg/L; Residual = 0.2 mg/L

This is a relationship you should know. It is not listed on equation sheet

**Are there any equations that can help you?**
Relationship: Dose = Demand + Residual

Chlorine Dose → Chlorine Demand + Chlorine Residual

Dose = 0.8 mg/L + 0.2 mg/L = 1.0 mg/L

***Is the answer in the correct units?***

# Problem 14

The discharge gauge on a centrifugal pump indicates a discharge pressure of 80 psi find the head in feet.

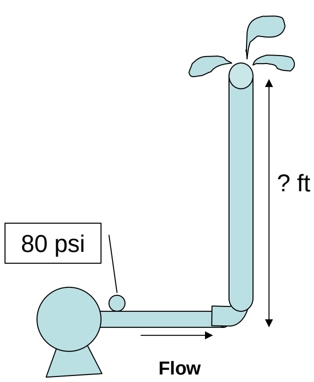
**What is the problem asking for?**
Head in feet

**What information are you given? Is there extra information?**
Discharge pressure = 80 psi

**Are there any equations that can help you?**
No. Conversion 1 psi = 2.31 feet

**Do you have the information needed to solve to problem?**

# Problem 14 Solution




Need to convert
80 psi → feet

Conversion Factor
1 psi = 2.31 ft

$$\frac{80\text{ psi}}{} \left| \frac{2.31\text{ ft}}{1\text{ psi}} \right. = 184.8\text{ ft}$$

## Problem 15

Calculate the force in pounds on the bottom of a wet well that is 8 feet long, 6 feet wide and filled with 7 feet of water.

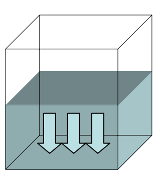
**What is the problem asking for?**
How much force is applied to the bottom of the wet well

**What information are you given? Is there extra information?**
Well dimensions: Length = 8 ft; Width = 6 ft; SWD = 7 ft

**Are there any equations that can help you?**
Volume of a rectangular box = Length*Width*Height *or*
Force = Pressure*Area

**Do you have the information needed to solve to problem?**

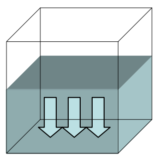
## Problem 15
## Solution - A



Volume = Length x Width x Height
Length = 8 ft
Width = 6 ft
Depth = 7 ft
Volume = (8 ft)(6 ft)(7 ft)
= 336 $ft^3$
Convert $ft^3$ → pounds
1 $ft^3$ = 62.4 lbs

$$\frac{336\,\cancel{ft^3} \mid 62.4\text{ lbs}}{\mid 1\,\cancel{ft^3}} = 20966.4\text{ lbs}$$

# Problem 15
# Solution - B



Conversion
Length = 8 ft = 96 in
Width = 6 ft = 72 in

Force = (Pressure, psi) * (Area, in2)
We need to calculate pressure and area

Area = Length x Width
= (96 in)(72 in)
= 6912 in2

Pressure: Convert ft to psi
2.31 ft = 1 psi

$\frac{7 \text{ ft} \mid 1 \text{ psi}}{\mid 2.31 \text{ ft}} = 3.03$ psi

Force = (3.03 psi)(6912 ins) = 20943.4 lbs

# Problem 16

Determine the volume of water a pump can discharge from a storage tank in gallons, if the pump operates at 450 GPM for 2.5 hours.

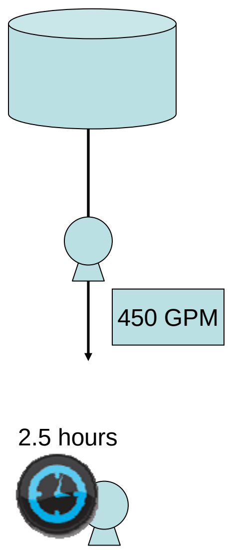
**What is the problem asking for?**
Volume of the water discharged from a storage tank in gallons

**What information are you given? Is there extra information?**
Pumping rate = 450 GPM; Time 2.5 hours

**Are there any equations that can help you?**
You need to know that Flow = Volume/Time

**Do you have the information needed to solve to problem?**

# Problem 16
# Solution




Flow = Volume/Time
Flow = 450 GPM or $\frac{450 \text{ gal}}{\text{min}}$
Time = 2.5 hours
We can solve the problem with what we know, but the units are not compatible. Minutes would work better.

Conversion Factor:
1 hour = 60 minutes

$$\frac{2.5 \ \cancel{\text{hours}}}{} \Big| \frac{60 \text{ minutes}}{1 \ \cancel{\text{hour}}} = 150 \text{ minutes}$$

Setup the solution:

$$\frac{450 \text{ gallon}}{\text{minute}} = \frac{\text{Volume}}{150 \text{ minutes}}$$

Volume = $\frac{450 \text{ gallons}}{\cancel{\text{minute}}}$*(150 $\cancel{\text{minutes}}$)= **67,500 gallons**

# Problem 17

A pump operates at 165 GPM to fill a 100,000 gallon storage tank. Calculate the amount of time in hours it will take to fill it.

**What is the problem asking for?**
The amount of time it will take to fill the storage tank

**What information are you given? Is there extra information?**

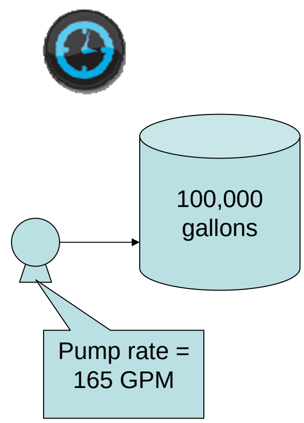
Pump discharge rate = 165 GPM;
Tank capacity = 100,000 gal

**Are there any equations that can help you?**
You need to know that Flow = Volume/Time

**Do you have the information needed to solve to problem?**

# Problem 17 Solution

Time = ? hours




Flow = Volume/Time

Flow = 165 GPM or 165 $\frac{\text{gal}}{\text{min}}$

Volume = 100,000 gallons

Setup the solution:

$$165 \text{ gal/min} = \frac{100{,}000 \text{ gallons}}{\text{Time}}$$

$$\text{Time} = \frac{100{,}000 \text{ } \cancel{\text{gallons}}}{\left(\frac{165 \text{ } \cancel{\text{gallons}}}{\text{min}}\right)} = 606 \text{ minutes}$$

$$\frac{606 \text{ minutes}}{} \left| \frac{1 \text{ hour}}{60 \text{ min}} \right. = 10.1 \text{ hours}$$

**= 10 hours 6 minutes**

# Problem 18

Calculate the water horsepower needed to pump 129 GPM at a head of 127 feet.

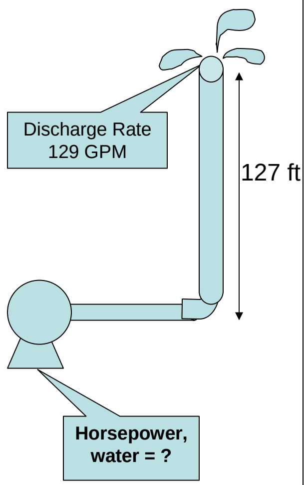
**What is the problem asking for?**
The necessary horsepower

**What information are you given? Is there extra information?**
Pumping rate = 129 GPM; Head = 127 ft

**Are there any equations that can help you?**
**Horsepower $_{\text{water}}$ Equation**

**Do you have the information needed to solve to problem?**

# Problem 18
# Solution




$$\text{Horsepower, water (whp)} = \frac{(\text{Flow, gpm})*(\text{Head, ft})}{3960}$$

Flow (pumping rate) = 129 GPM
Head = 127 ft

Fill in the equation:

$$\text{Horsepower, water} = \frac{(129\ \text{GPM})(127\ \text{feet})}{3960}$$

Horsepower = **4.137 whp**

# Problem 19

A pump station discharges at 694.4 GPM at 65 psi to a reservoir above the city. The pumps are 65% efficient. Determine the brake horsepower required for this application.

**What is the problem asking for?**
Brake horsepower

**What information are you given? Is there extra information?**

Discharge rate = 694.4 GPM; Efficiency = 65%; Pressure = 65 psi

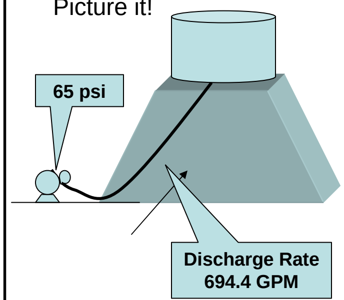
**Are there any equations that can help you?**

$$\text{Horsepower, Brake} = \frac{(\text{Flow, gpm})(\text{Head, ft})}{3960\ (\text{Decimal Pump Efficiency})}$$

**Do you have the information needed to solve to problem?**

# Problem 19 Solution

Picture it!




**The equation needs head (ft)**
65 psi → Head in feet

Conversion factor: 1 psi = 2.31 ft

$$\frac{65 \cancel{psi} \mid 2.31 \text{ ft}}{\mid 1 \cancel{psi}} = 150.15$$

Horsepower, Brake =

$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{3960 \text{ (Decimal Pump Efficiency)}}$$

Flow = 694.4 gpm
Head = 150.15 ft
Efficiency = 64% = 0.64

Fill in the equation:
Horsepower, Brake =

$$\frac{(694.4 \text{ GPM})(150.15 \text{ ft})}{3960\ (0.65)}$$

Brake Horsepower = 40.5 bhp

# Problem 20

A water supplier serves 2,500 service connections. A typical residential customer uses approximately 10,000 gallons of water per month. Determine the average amount of revenue the company may expect to generate annually if the following schedule is used:

| | |
|---|---|
| 0-7,500 gallons | \$1.25/1,000 gallons |
| 7,500 – 15,000 gallons | \$1.50/1,000 gallons |

**What is the problem asking for?**
Annual revenue (\$)

**What information are you given? Is there extra information?**
Service connections =2,500; Average usage = 10,000 gal

**Are there any equations that can help you?** No

**Do you have the information needed to solve to problem?**

# Problem 20
# Solution

2,500

Average Use:
10, 000 gal/month


per

What is the water utilities monthly income?


This problem needs to be solved in steps:

- Determine how much each connection is charged per month
  1. Determine what rates will be applied to the amount of used gallons
  2. Multiply the appropriate rate and the gallons designated to each rate block
- Calculate the total revenue the utility generates for all of the connections each month

***Setting the values up in a chart can be helpful***

# Problem 20
# Solution

| Usage Blocks<br>Set up water utility | Price<br>In Usage Blocks | Gallons Used<br>In each usage block | Each Customer Pays |
|---|---|---|---|
| 0<br>to<br>7,500 gal | $\frac{\$1.25}{1,000\ \cancel{gal}}$ | x 7, 500 ~~gal~~ | = $ 9.38 |
| 7,500<br>to<br>15,000 gal | $\frac{\$1.50}{1,000\ \cancel{gal}}$ | x 2,500 ~~gal~~ | = $ 3.75 |
| Total | | | $ 13.13 |

Total monthly revenue = Number of connections x Average Monthly Bill
= 2,500 x $13.13
= $32,825
Total Annual Income
$32,825 x 12 months = **$393,756/year**