Math Levels 1 thru 4 - Chemical Feed Applications
Shortened Version
Work at Your Own Pace

Estimated Time to Complete 2 to 3 hours

Math Levels 1 thru 4 - Chemical Feed Applications
Shorter Version
Formulas, Units, and Constant Factors Used

8.34	weight of 1 gallon of water in pounds
7.48	gallons per cubic foot
3.14	Pi used to calculate Square Footage of a circular tank when Radius is used
0.785	¼ Pi used to calculate Square Footage of a circular tank when diameter is used
gph	Gallons per Hour
gpm	Gallons per Minute
1,440	Minutes in a Day
MGD	Million Gallons per Day as a flow rate, more commonly used than gallons per day in formulas and calculations
MG	Million Gallons, capacity of a clarifier, basin, or selector in Million Gallons
ppm	parts per million – is the amounts of parts added to or are in the water per 1,000,000 total parts of water (on a volume to volume or weight to weight comparison). Example: the liquid chemical product is dosed at 4 parts of product to1,000,000 parts of water
mg/L	milligram per liter – a weight to volume comparison, the unit mg/L is often considered (incorrectly) interchangeable with ppm. A **liter** of **water** weighs 1 kilogram. That's 1,000 grams. A **milligram**. It is 1/1000 th of a gram, making it 1/1,000,000 of a kilogram. Saying this another way, the liquid chemical product is dosed at 4 milligrams (of product weight) to 1 liter of water.
ppd	Pounds per Day – pounds of a chemical dosed to water in a 24 hour period or pounds of pollutant per day in a water flow.
Pounds Formula	Pounds formula is one of the most used formulas by water and wastewater operators. Use to calculate: • Pounds per day of a chemical being added to a water flow • Pounds per day of a pollutant entering a tank or stream • Pound of solids within a given basin or selector ppd = mg/L x 8.34 x flow in MGD pounds = mg/L x 8.34 x volume in MG of a basin or selector
TSS	Total Suspended Solids, expressed as a concentration (mg/L) or a quantity (ppd – pounds per day or just pounds)
cfs	Cubic Feet per Second (example: 1 cfs = 60 cf / min)
SG	Specific Gravity is the density relationship of a liquid to water (example: 8.34 lbs. x 1.2 SG = 10.008 ppg) or the density relationship of a gas to air (Chlorine gas has a SG of 2.5 - 2.5 times heavier than air)
Dose, mg/L=	Demand, mg/L + Residual, mg/L
Demand, mg/L =	Dose, mg/L – Residual, mg/L
Residual, mg/L =	Dose, mg/L – Demand. mg/L
Convert % to mg/L	% x 10,000
Convert mg/L to %	Mg/L / 10,000 Note: 10,000 x 100 = 1,000,000

Name _____

WATER AND WASTEWATER OPERATORS
Level 1
Chemical Feed Applications

Find the area of a rectangle if the length is 60 feet and width is 12 feet. (show units)

Find the capacity (in gallons) of tank that is 60 feet long, 12 feet wide and 8 feet deep. (use 7.48 gallons/cu ft)

Find the area of a circular tank with a radius of 12 feet.

Find the capacity (in gallons) of a circular tank with a radius of 12 feet and a depth of 10 feet.

Determine the chlorinator setting in pounds per day if

Chlorinator Feed Rate (lbs/day) = (0.05 MGD) (3 mg/L) (8.34 lbs/gal)

Estimate the chlorine dose in mg/L if

$$\text{Chlorine Dose, mg/l} = \frac{1.25 \text{ lbs/day}}{(0.05 \text{ MGD})\ (8.34 \text{ lbs/gal})}$$

Name _____

WATER AND WASTEWATER OPERATORS
Level 1a
Chemical Feed Applications

Find the area of a rectangle if the length is 40 feet and width is 20 feet. (show units)

Find the capacity (in gallons) of tank that is 40 feet long, 20 feet wide and 10 feet deep. (use 7.48 gallons/cu ft)

Find the area of a circular tank with a diameter of 8 feet.

Find the capacity (in gallons) of a circular tank with a diameter of 8 feet and a depth of 10 feet.

Determine the chlorinator setting in pounds per day if

flow rate = 20,000 gallons per day
chlorine dosage = 2.5 mg/L

Chlorinator Feed Rate (lbs/day) = _____

Calculate the daily average flow from the following:

Chlorine Dose, mg/l = 2.5
pounds per day of chlorine added = 1.0

Flow in MGD = _____

Name _____

WATER AND WASTEWATER OPERATORS
Level 2
Chemical Feed Applications

1. What should be the chlorine dose of a water that has a chlorine demand
e of 1.7 mg/l if a residual of 0.4 mg/l is desired.

2. Estimate the chlorine demand for a water, if the chlorine dose is
e 2.8 mg/L and the chlorine residual is 0.2 mg/L.

3. What is the chlorine dosage (in mg/L) if you are using 14 pounds per day
e and the flow is .54 MGD ?

4. The volume of a cylinder with a radius of 5 ft and a height of 8 ft
e is_____ ft3.
a. 251 b. 328 c. 451 d. 628

5. The flow is 35,000 gpd. This is_____mgd.
e a. 0.35 b. 0.035 c. 0.0035 d. 0.00035

6. Determine the capacity, in gallons, of an in ground storage tank
e 16-feet long, 12-feet wide, and 6-feet deep.

7. Convert 1.0 mgd to gallons per hour.
e

8. Convert 1.0 mgd to gpm.
e

Name _____

WATER AND WASTEWATER OPERATORS
Level 2a
Chemical Feed Applications

1. Estimate the chlorine demand for a water, if the chlorine dose is
e 1.6 mg/L and the chlorine residual is 0.7 mg/L.

2. What is the chlorine dosage (in mg/L) if you are using 27 pounds per day
e and the flow is 1.25 MGD ?

3. The flow is 125,000 gpd. This is_____mgd.
e a. 1.25 b. 0.125 c. 0.0125 d. 0.00125

4. Determine the capacity, in gallons, of a pump station wet well
e 24-feet long, 10-feet wide and 4-feet deep when full.

5. What should be the chlorine dose of a water that has a chlorine demand
e of 0.7 mg/l if a residual of 0.5 mg/l is desired.

6. A pump station has nine 150-pound chlorine cylinders in storage.
e Chlorine is dosage at 1.3 mg/l and the flow rate averages 2.3 MGD.
How many days' supply of chlorine is there in storage?

7. For hydrogen sulfide control six (6) mg/l chlorine is added
m continuously to a sewage pump station flow that averages 15 MGD. How much chlorine is expected to be used in 30 days?

8. Convert 72.5 gph to gpm.
e

Name _____

WATER AND WASTEWATER OPERATORS
Level 3
Chemical Feed Applications

1. Four mg/l chlorine is added continuously to a water flow that
m averages 5 MGD. How much chlorine will be used in 30 days?

2. Liquid 50% Hydrogen Peroxide has a specific gravity of 1.2. How much does
m 300 gallons of it weigh?

3. What should be the setting on a chlorinator in pounds per 24 hours if
m a pump usually delivers approximately 425 gallons per minute and the desired chlorine dose is 1.7 mg/L.

4. The chlorine demand of a certain water is 3 mg/l. The operator treats
m 250,000 gallons of water with 10 pounds of chlorine gas. What residual is expected?

5. What should be the chlorine dose of a water that has a chlorine demand
e of 0.3 mg/l if a residual of 0.7 mg/l is desired.

6. Estimate the chlorine dosage in mg/l for a sewage flow having 2 parts
e (mg/l) of hydrogen sulfide. Use the theoretical dosage of 8.87 parts of chlorine to one part of hydrogen sulfide.

7. What is the chlorine dosage (in mg/L) if you are using 24 pounds per day
e and the flow is .90 MGD ?

Name _____

WATER AND WASTEWATER OPERATORS
Level 3a
Chemical Feed Applications

1. A chlorine dosage of 4 mg/l is required to treat a particular water. If
m the flow is 120 gpm and the calcium hypochlorite being used has 65% available chlorine (by weight), how many pounds of calcium hypochlorite will be added to the water in 24 hours?

2. How many pounds of pure hydrogen peroxide are being fed per day at a
m sewage pump station, if 50 gallons of 50% hydrogen peroxide are added each day? (50% H_2O_2 has specific gravity of 1.2)

3. A storage tank is to be disinfected with 50 mg/l of chlorine. If the tank
m holds 50,000 gallons how many pounds of 65% calcium hypochlorite must be added to the water?

4. Determine the setting on a chlorinator in pounds per day if the flow is 5.2 MGD and the chlorine dose is 1.2 mg/L.

5. Estimate the chlorine demand for a water if the chlorine dose is
e 1.6 mg/L and the chlorine residual is 0.7 mg/L.

6. What should be the setting on a chlorinator in pounds per 24 hours if
m a pump usually delivers approximately 150 gallons per minute and the desired chlorine dose is 1.2 mg/L.

7. The chlorine demand of a certain water is 2.1 mg/l. The operator treats 250,000 gallons of water with 10 pounds of chlorine gas. What should the residual be?

Name _____

WATER AND WASTEWATER OPERATORS
Level 3b
Chemical Feed Applications

1. Determine how many gallons of 12.4% (by weight) sodium hypochlorite must be fed to a flow rate of 5.8 MGD to satisfy a 2.7 mg/l chlorine demand and leave a 0.6 mg/l residual (assume 12.4% sol. weighs 10.0 lbs/gal).

2. How many gallons per minute is equal to <u>one cubic foot per second</u>?
m

3. If your normal 24 hour usage of 10% sodium hypochlorite is 52 gallons;
m how many gallons of 5.25% sodium hypochlorite would you have to use?

4. If 12 pounds per hour of a chemical is fed into a flow of 1120 gpm, how
h many mg/l are you dosing at?

5. If you treat 700,000 gallons per day of water with 3 mg/l of pure H_2O_2.
m How many gallons of 50% H_2O_2 will you use in 30 days?
(H_2O_2 at 50% weighs 10.01 pounds per gallon)

6. A rectangular wet well is 8 feet wide and 12 feet long. With no pumps
m running, the level rises 4.25 feet in 3 minutes. What is the rate of flow entering the wet well? <u>Give the answer in gpm.</u>

7. If a chemical costs $2.30 per pound, what would be the daily cost to
m treat 2.5 MGD at a dosage of 8 mg/l?

Name _____

WATER AND WASTEWATER OPERATORS
Level 4
Chemical Feed Applications

1. h Determine the setting on a hypochlorinator in gallons per day if the desired chlorine feed rate is 30 pounds per day and the hypochlorite solution contains 1.8 percent chlorine. (Assume the solution weighs 8.4 pounds per gallon.)

2. h How much sodium hypochlorite is required to dose a well at 50 mg/l? The casing diameter is 16 inches (1.33 ft) and the length of the water-filled casing is 120 feet. Sodium hypochlorite is 5.25 percent or 52,500 mg/l chlorine. Select the closest answer. (Hint: V1C1)

   a. 0.8 gallons b. 1.0 gallons c. 1.2 gallons
   d. 3.0 gallons e. 6.0 gallons

3. m What is the percentage (by atomic weight) of Fe in $FeSO_4$?

4. h At 0.5 pounds of Fe (iron) per gallon of liquid $FeSO_4$, how many gallons must be fed per day to dose 8 mg/l of Fe to a flow of 1.0 MGD?

5. h How many gallons of water must be added to thirty gallons of six percent hypochlorite solution to produce a 1.8 percent hypochlorite solution?

6. m Determine the chemical feed pumping rate (in GPH) from the following information:

   The chemical day tank's diameter is 36".
   The chemical feed pump ran continuously for 29 hours.
   The chemical day tank's level dropped 17.5" during that 29 hours.

Name _____

WATER AND WASTEWATER OPERATORS
Level 4a
Chemical Feed Applications

1. Determine how many gallons of 13.06% (by weight) sodium hypochlorite must be fed to a flow rate of 4.5 mgd to satisfy a 1.8 mg/l chlorine demand and leave a 0.8 mg/l residual (assume 13.06% sol. weighs 10.0 lbs/gal).

2. How may gallons per hour is equal to <u>one cubic foot per second</u>?
m

3. How many gallons of water can a pipe 300 feet long and 9 inches in diameter hold?

4. If your normal 24 hour usage of 15% sodium hypochlorite is 177 gallons;
m how many gallons of 10% sodium hypochlorite would you have to use? (Assume both percentages are by volume.)

5. If 6 pounds per hour of a chemical is fed into a flow of 700 gpm, how
h many mg/l are you dosing at?

6. A rectangular wet well is 6.5 feet wide and 9 feet long. With no pumps
m running, the level rises 3.75 feet in 5 minutes. What is the rate of flow entering the wet well?

7. Hydrogen sulfides at an average level of 4 mg/l are causing an odor
m problem at a sewage pump station. From past experience you know that you must feed 5 mg/l of Fe for each mg/l of H_2S. How many gallons of $FeSO_4$ must be fed per day to remove the H_2S? (Your liquid $FeSO_4$ has 1.0 pounds of Fe per gallon.) Assume a flow rate of 2.0 MGD.

Name _____

WATER AND WASTEWATER OPERATORS
Level 4b
Chemical Feed Applications

1. Determine how many gallons of $FeSO_4$ that must be fed per day from the following information:
   The $FeSO_4$ you are using weighs 9.92 pounds per gallons,
   it contains 3.5 % Fe (by weight), and
   the desired dosage has been determined to be 45 pounds of iron per day.

2. A chlorine dosage of 3 mg/l is required to treat a particular water. If the flow is 1.5 mgd and the calcium hypochlorite being used has 65% available chlorine, how many pounds will be added to the water in 24 hours?

3. A wet well has 5 float switches. They are as follows from the highest to the lowest:

   High level alarm @ elevation 522.75'
   Second pump on @ elevation 521.25'
   First pump on @ elevation 519.50'
   Pumps off @ elevation 517.75'
   Low level alarm @ elevation 516.75'

   Tank floor is @ elevation 515.00'

   The wet well tank is 6 ft by 10 ft. If there is an electrical failure shutting down both pumps and the flow entering the wet well is 60 gpm. How long will it be before the alarm will sound if the first pump had just started as the electrical failure occurred?

4. The background fluoride in the water is 0.1 mg/l and the desired fluoride level is 1.1 mg/l. The daily flow rate is 155,000 gallons. How many pounds of fluoride are needed per day?

5. A well house uses 125 pounds of soda ash per day. The average flow is 1.2 MGD. How many days will a one-ton pallet last?

Scratch Paper

Scratch Paper

LEVEL 1

1) 720 sf __= 60’ x 12’ _____

2) 43,084.8 gallons__= 720 sf x 8’ x 7.48 _____

3) 452.16 sf __= 3.14 x 12’ x 12’ _____

4) 33,821.57 gallons___= 452.16 sf x 10’ x 7.48 _____

5) 1.251 ppd __= 0.05 mgd x 3 mg/L x 8.34 _____

6) 2.998 or 3.00 mg/l ___= __1.25 ppd / (0.05 x 8.34)_____

LEVEL 1a

1) 800 sf _____= 40’ x 20’_____

2) 59,840 gallons___= 800 sf x 10’ deep x 7.48 _____

3) 50.24 sf ____= 0.785 x 8’ x 8’ _____

4) 3,757.95 gallons_= 0.785 x 8’ x 8’ x 10’ x 7.48 _____

5) 0.417 ppd ___= 0.02 MGD x 8.34 x 2.5 mg/L _____

6) 0.04796 MGD __= 1.0 ppd / (2.5 mg/L x 8.34) _____

LEVEL 2

1) 2.1 mg/l dose___= 1.7 mg/L Demand + 0.4 mg/L Residual_____

2) 2.6 mg/l demand___= 2.8 mg/L Dose – 0.2 mg/L Residual _____

3) 3.1 mg/l dose____= 14 ppd / (0.54 x 8.34) _____

4) d. 628 ft3___= 3.14 x 5’ x 5’x 8’ _____

5) b. 0.035 mgd____= 35,000 / 1,000,000 _____

6) 8,617 gallons__= 16’ x 12’x 6’ x 7.48 _____

7) 41,667 gallons___= 1,000,000 / 24 hours _____

8) 694 gpm___= __1,000,000 / 1440 mins. / day _____

LEVEL 2A

1) 0.9 mg/l demand__= 1.6 mg/L Dose – 0.7 mg/L Residual _____

2) 2.6 mg/l dose____= 27 ppd (8.34 x 1.25 MGD) _____

3) b. 0.125 mgd____= 125,000 gpd / 1,000,000 _____

4) 7,181 gallons___= 24’ x 10’ 4’ x 7.48 _____

5) 1.2 mg/l dose___= 0.7 mg/L Demand + 0.5 Residual _____

6) 54 days____= 1,350 # of Cl2 / 25 ppd _____

7) 22,518 pounds in 30 days___= 6 mg/L x 15 MGD x 8.34 x 30 days_____

8) 1.21 gpm___= 72.5 gph / 60 mins/hour _____

LEVEL 3

1) 5,004 lbs. = 4 mg/L x 8.34 x 5 MGD x 30 days _____

2) 3,002 lbs. = 300 gallons x 1.2 SG x 8.34 ppg (water) _____

3) 8.68 ppd_ = 0.61 MGD x 8.34 x 1.7 mg/L (425 gpm / 694 = 0.612)

4) 1.8 mg/l residual_ 10 ppd / (8.34 x 0.25 MGD) then 4.8 mg/L – 3.0 mg/L

5) 1.0 mg/l dose__ = 0.3 mg/L demand + 0.7 mg/L residual __

6) 17.74 ppd_= 2 parts H2S x 8.87 parts Cl2 required ___

7) 3.2 mg/l dose = 24 ppd / (8.34 x 0.90 MGD) ____

LEVEL 3A

1) 8.88 lbs__ = 4 mg/L x 0.173 MGD x 8.34 / 0.65 (65%)

2) 250 pounds of pure H2O2__= 50 gallons x 8.34 x 1.2 SG x 0.50 (50%) _

3) 32 lbs__= 0.05 MGD x 8.34 x x 50 mg/L / 0.65 (65%)

4) 52 ppd = 5.2 MGD x 8.34 x 1.2 mg/L _____

5) 0.9 mg/l demand_ = 1.6 mg/L Dose – 0.7 mg/L Demand

6) 2.16 ppd__= 0.216 MGD x 8.334 x 1.2 SG (150 gpm / 694 = 0.216 MGD)

7) 2.7 mg/l residual__ 10 ppd / (0.25 MG x 8.34) ___ then 4.8 mg/L Dose – 2.1 mg/L Residual

LEVEL 3B

1) 129 gallons___= 159.63 ppd / 1.24 ppg _ (5.8 MGD x 8.34 x 3.3 mg/L= 159.63)

2) 448.8 gpm = 60 cf/min x 7.48 (1 cfs = 60 cf/min)

3) 99 gallons (v1c1=v2c2)___52 x 10 = V2 x 5.25 ____

4) 21.45 mg/l (figure #/day)_= 288 ppd / (8.34 x 1.61 MGD) ___(1120 gpm / 694 = 1.61 MGD)

5) 104 gallons _= 0.7 MGD x 8.34 x 3 mg/L / 5.005 ppg x 30 days (10.01 ppg x 0.50 = 5.005 ppg)

6) 1,017 gpm_ _ = 3052 gallons / 3 mins.

7) $383.64/day__ = 2.5 MGD x 8.34 8 mg/L x $2.30

LEVEL 4

1) 200 gpd___(198.4 gpd)_First 8.4 x 0.018 then 30 ppd/ 0.1512 ppg_____

2) c. 1.2 gallons V1C1=V2C2 _= 1,246 x 50 mg/L = V2 x 52,500 _____

3) 36.8%__First Fe 56 + S 32 + O (4 x 16) then 56/152 _____

4) 133.44 gallons _First 8 mg/L x 1.0 MGD x 8.34 then 66.72 / 0.5 ppg _

5) 70 gallons (100 total) V1C1=V2C2 _100 gallons total – 30 original gallons

6) 2.66 gph__= 77.07 gallons in 29 hours _____

LEVEL 4A

1) 74.7 GPD_First 4.5 MGD x 8.34 x 2.6 mg/L then 97.58 ppd / 1.306 ppg _

2) 26,928 gph _ 1 cf/Sec = 60 cf/min = 3,600 cf/hr x 7.48_

3) 991 gallons__= 0.75' x 0.75, x 0.785 x 300' x 7.48

4) 265.5 gallons (V1C1) 177 x 15% = V2 x 10%

5) 17.13 mg/l First 6 pph = 144 ppd then 144 ppd / (8.34 x 1.008 MGD) ____

6) 328 gpm__= 6.5 ' x 9' x 3.75' x 7.48 / 5 mins. _____

7) 333.6 gpd _= 4 mg/L H2S x 5 mg/L Fe x 8.34 x 2 MGD / 1.0 ppg Fe

LEVEL 4B

1) 129.6 gallons_ First 9.92 ppg x 0.035 then 45 ppd/ 0.3472 ppg ____

2) 57.74 lbs___ First 3 mg/L x 1.5 MGD x 8.34 then 37.53 ppd / 0.65 __

3) 24.3 mins._ First FP to HLA is 3.25' then 6' x 10' x 3.25 x 7.48 then 1458.6 / 60 gpm

4) 1.29 ppd___= 1.0 mg/L x 0.155 MGD x 8.34 _____

5) 16 days___= 2000 lbs / 125 ppd_____