2020 Revised Basic Math
Answer Key

Explanation of diagonal movement and an example:

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5X = 20

Question #1 regarding Example #1: Is the ***X*** in the numerator? **YES**

Question #2 regarding Example #1: Is the ***X*** alone on one side of the equation? **NO**

How do we use diagonal movement to place ***X*** alone on one side of the equation?

Answer:

- Divide both sides by "5" to get ***X*** alone and **treat both sides of the equation equally**. Notice that the 5 was moved from the top of the left side to the bottom of the right side of the equation – **a diagonal move.**

$$\frac{\not{5}\mathbf{X}}{\not{5}} = \frac{20}{5}$$

FINAL ANSWER: 20 ÷ 5 = 4

Practice Problem: Steps to solving problems using unit cancellation

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Practice Problem: How many minutes are there in a day?

Problem Set Up

List all known and unknown data.

Unknown: $\frac{?\ \text{min}}{\text{day}}$ Known: $\frac{60\ \text{mins}}{\text{hr}}$ $\frac{24\ \text{hrs}}{1}$

Step 1: List unknown data including units in vertical format followed by an equal sign.

$$\frac{?\ \text{min}}{\text{day}} =$$

Step 2: Find data (known or a conversion) that has the same numerator unit as the unknown numerator. Place it to the right of the equal sign. Add a multiplication sign.

$$\frac{?\ \text{min}}{\text{day}} = \frac{60\ \text{min}}{1\ \text{hr}} \times$$

Positions your numerator unit

Steps 3 and 4: To cancel unwanted denominator unit, find data (known or a conversion) that has the same numerator unit. Place it to the right of data used in Step 2. Place a multiplication sign between each piece of data. Continue to place data (known or a conversion) into equation to systematically cancel all unwanted units until only the unknown denominator units remain.

$$\frac{?\ \text{min}}{\text{day}} = \frac{60\ \text{min}}{1\ \cancel{\text{hr}}} \times \frac{24\ \cancel{\text{hrs}}}{1\ \text{day}}$$

Cancel unwanted units that match

Step 5: Multiply the values of all numerators and place this value in the numerator of the answer. Multiply the values of all denominators and place this value in the denominator of the answer. Divide to calculate the final answer.

$$\frac{?\ \text{min}}{\text{day}} = \frac{60\ \text{min}}{1\ \cancel{\text{hr}}} \times \frac{24\ \cancel{\text{hrs}}}{1\ \text{day}} = \frac{1440\ \text{min}}{1\ \text{day}}$$

These are the correct units in both numerator and denominator

Pressure/Height Conversions

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Practice Problem calculating psi: The water level at the top of a fully filled water standpipe is 150 feet above the elevation of a water tap. The tank contains 50,000 gallons of water. What is the approximate pressure at the tap?

$$? \text{ psi} = \frac{1 \text{ psi}}{2.31 \text{ ft}} \times 150 \text{ ft} = \frac{150 \text{ psi}}{2.31} = \mathbf{64.9} \text{ psi}$$

Note: Remember pressure is not affected by volume, only **height**.

Practice Problem calculating height in ft: An elevated tank records a pressure of 25 psi, what is the height of water in the tank?

To calculate **height in ft** from psi:

$$? \text{ ft} = \frac{2.31 \text{ ft}}{1 \text{ psi}} \times 25 \text{ psi} = \mathbf{58} \text{ ft}$$

Temperature Conversions

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Practice Problem Solving for °C: Convert 60ºF into °C

$$°C = \frac{°F - 32}{1.8} \qquad \frac{60-32 = \mathbf{28}}{1.8} = \mathbf{15.5}°C$$

Practice Problem Solving for °F: Convert 20ºF into °C

°F = (ºC X 1.8) +32

ºF = 20 X 1.8 = 36 + 32 = **68 ˚F**

ANSWER KEY: 2020 Revised Basic Math
October 2020

Unaccounted Water Calculation

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Practice Problem: In one month a water system produced 5,500,000 gallons of water. Of the total water, 4,500,000 gallons were billed, 250,000 were used for fire protection and 200,000 gallons were used for flushing. What is the total unaccounted for water loss percentage for this month?

Step 1: Add total gallons accounted for (billed, fire protection and flushing)

Gallons Accounted for =**4,500,000** (billed) + **250,000** (fire protection) + **200,000** (flushing) = **4,950,000**
Step 2: Subtract "accounted for" from total produced to find "Unaccounted for"

5,500,000 – **4,950,000** (Step 1 Accounted for) = **550,000** (Unaccounted for)

Step 3: Divide "Unaccounted for" by total produced and multiply by 100 to equal the % unaccounted for

550,000 (Step 2 Unaccounted For) = **0.1** X 100 = **10** % Unaccounted for
5,500,000 (Total Produced)

Area of a Rectangle

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Practice Problem: The sedimentation basin for the filtration plant is 25 ft. x 15 ft. What is the area in square feet?

Area = (L) X (W) = 25 ft. X 15 ft. = **375** ft^2

Area of a Rectangle - Converting inches to feet

Practice Problem: The filter unit at the plant is 15 ft. 6 inches long, and 15ft. 6 inches wide. What is the area of the filter?

Step 1: Convert inches to feet

The first step in solving this problem is to change the inch units to feet units. The tank is 15 feet. 6 **inches** long, by 15 feet 6 **inches** wide.

$? \text{ ft} = \frac{1 \text{ ft}}{12 \text{ inches}} \times 6 \text{ inches} = \frac{6}{12} = \mathbf{0.5} \text{ ft}$

Step 2: Add 0.5 ft to the **length** and the **width** and insert into equation and multiply L X W.

Area = (L) X (W) = 15.5 ft X 15.5 ft = **240.25** ft^2

Area of a Circle

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Practice Problem: The day tank for the coagulant is 4 feet in diameter, what is the area in square feet?

Area = (0.785)(Diameter)^2 = (0.785)(4 ft)(4 ft) = **12.56** ft^2

Area of a Circle – Converting inches to feet

Practice Problem: The chemical feed tank is 20 inches in diameter, what is the area of the chemical feed tank?

Step 1: Convert inches to feet

$? \text{ ft} = \frac{1 \text{ ft}}{12 \text{ ~~inches~~}} \times 20 \text{ ~~inches~~} = \mathbf{1.67} \text{ ft}$

Step 2: Insert diameter (in ft) into area formula and do the math.

Area = (0.785)(D)^2 = (0.785)(1.67 ft)(1.67 ft) = **2.19** ft^2

Volume of a Rectangle in ft^3

The formula for volume of a rectangle is length X width X height or depth, or (L)(W)(H or D)

Note: For this equation, the terms "height" and "depth" are interchangeable.

Practice Problem: What is the volume of a clearwell that is 40 feet long, by 40 feet wide, by 12 feet deep?

V = (L)(W)(D) = (40 ft)(40 ft)(12 ft) = **19,200** ft^3

Volume of a Circular Tank in ft^3

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Example Problem: What is the volume in cubic feet of a tank that is 22 feet in diameter, and filled to 8 feet deep?

V= 0.785(Dia)^2(H)

V= 0.785(22 ft)(22 ft)(8 ft)

V= **3039.5 ft^3 or 3040 ft^3**

Volume of a Circular Tank in ft^3 – Converting inches to feet

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Practice Problem: What is the volume of a day tank that is filled to 3 feet, and is 20 inches wide?

Step 1: Convert inches to feet

?ft = 1 ft X 20 ~~inches~~ = **1.67** ft
12 ~~inches~~

Step 2: Insert diameter (in ft) into volume formula and do the math.

V = 0.785(1.67 ft)(1.67 ft)(3 ft) = **6.6** ft^3

Volume of a Rectangular Tank – Converting ft^3 to gallons

The problems in the previous examples requested the volume measured in units of cubic feet. More often, the volumes are measured in gallons. The conversion factor to go from cubic feet to gallons is:

1 ft^3 = 7.48 gallons

To convert ft^3 to gallons, use this equation:

Gallons = volume in ft^3 X 7.48

1 ft^3
7.48 gallons

Therefore, if we were asked to calculate the volumes in the previous problems in gallons instead of cubic feet, the solution would require one extra step.

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Practice Problem: What is the volume, in **gallons**, of a tank 40 feet square and filled to 12 feet deep?

Step 1: Solve the volume equation in ft^3:

V= (L)(W)(D) = (40 ft)(40 ft)(12 ft) = **19,200 ft^3**

Step 2: Convert ft^3 into gallons:

? gal = 7.48 gal X **19,200** ~~ft^3~~ = **143,616** gallons
1 ~~ft^3~~

Volume of a Circular Tank – Converting ft^3 to gallons

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Practice Problem: What is the volume, in gallons, of a day tank that is filled to 3 feet, and is 20 inches wide?

Step 1: Convert inches to feet

?ft = 1 ft / 12 ~~inches~~ X 20 ~~inches~~ = **1.67** ft

Step 2: Insert diameter (in ft) into volume formula and do the math.

V = 0.785(1.67 ft)(1.67 ft)(3 ft) = **6.6** ft^3

Step 3: Convert ft^3 into gallons:

? gal = 7.48 gal / 1 ~~ft^3~~ X **6.6** ~~ft^3~~ = **49.3** gallons

QUIZ # 1

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1. What is the **volume in ft^3**, of a sedimentation basin that is 22 feet long, and 15 feet wide, and filled to 10 feet?

V = (L)(W)(H) = (22ft)(15ft)(10ft) = **3300 ft^3**

2. What is the **volume in gallons** of a clear well that is 35 feet long, 30 feet wide, and filled to 18 feet?

Step 1: Solve the volume equation in ft^3

V = (L)(W)(D) = (35 ft)(30 ft)(18 ft) = **18900** ft^3

Step 2: Convert ft^3 into gallons:

? gal = 7.48 gal / 1 ~~ft^3~~ X **18900** ~~ft^3~~ = **141,372** gallons

3. What is the **volume in gallons** of a storage tank that is 20 feet in diameter, and filled to 18 feet?

Step 1: Solve the volume equation in ft^3:

V= 0.785(Dia)^2(H)

V=0.785(20 ft)(20 ft)(18 ft) = **5652** ft^3

Step 2: Convert ft^3 into gallons:

$$? \text{ gal} = \frac{7.48 \text{ gal}}{1 \text{ ft}^3} \times \mathbf{5652} \text{ ft}^3 = \underline{\mathbf{42,277}} \text{ gallons (rounded)}$$

4. What is the **volume in gallons** of a clear well that is 40 feet 8 inches square, and filled to 12 feet deep?

Step 1: Convert inches to feet

$$?\text{ft} = \frac{1 \text{ ft}}{12 \text{ inches}} \times 8 \text{ inches} = \underline{\mathbf{0.67}} \text{ ft}$$

Step 2: Insert diameter (in ft) into volume formula and do the math.

V = (L)(W)(D) = (40.67 ft)(40.67 ft)(12 ft) = **<u>19848.5</u>** ft^3

Step 3: Convert ft^3 into gallons:

$$? \text{ gal} = \frac{7.48 \text{ gal}}{1 \text{ ft}^3} \times \mathbf{19848.5} \text{ ft}^3 = \underline{\mathbf{148,467}} \text{ gallons}$$

5. What is the **volume in ft^3** of an elevated clear well that is 17.5 feet in diameter, and filled to 14 feet?

   Volume (ft^3) $(0.785)(D)^2(h)$ =

V = (0.785)(17.5ft)(17.5ft)(14ft) = **<u>3,366 ft^3</u>**

6. What is the **pressure (psi)** at the bottom of an elevated tank filled to 60 feet of water?

$$? \text{ psi} = \frac{1 \text{ psi}}{2.31 \text{ ft}} \times 60 \text{ ft} = \frac{60 \text{ psi}}{2.31} = \underline{\mathbf{26 \text{ psi}}}$$

7. Convert 80 ° F to **°C.**

$$°C = \frac{°F - 32}{1.8}$$

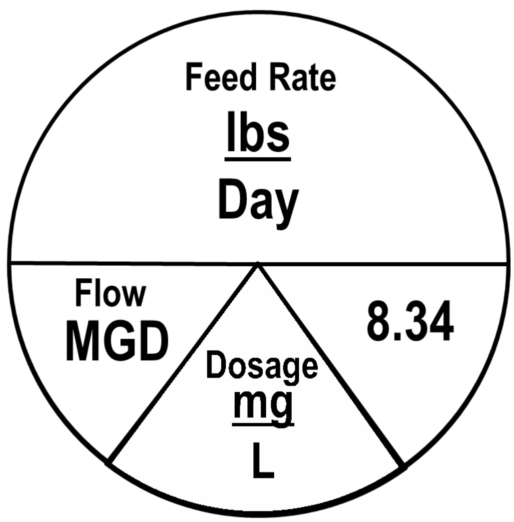
$$°C = \frac{80\ °F - 32}{1.8} = \frac{48}{1.8} = \underline{\mathbf{27\ °C}} \textbf{ (rounded)}$$

Equation #1: Solving for lbs/day using the Feed Rate Formula

$\frac{?lbs}{day}$ = Flow (MGD) X Dose(mg/L) X (8.34)

This feed rate formula is represented in the following diagram called the Davidson Pie which was created by Gerald Davidson, Manager, Clear Lake Oaks Water District, Clear Lake Oaks, CA.

Davidson Pie



Key Acronyms: MG = million gallons or MGD = million gallons per day

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Practice Problem: If a water treatment plant is putting out 14 MGD, and dosing soda ash at the rate of 5 mg/l, how many pounds will they use every day?

$\frac{?lbs}{day}$ = Flow(MGD) X Dose(mg/L) X (8.34)

$\frac{?\ lbs}{day}$ = 14 X 5 X 8.34 = **584**

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Practice Problem: If a water treatment plant is making 0.150 MGD, and the chlorine dose is 1.2 mg/l, how many pounds of gas chlorine will they use?

? lbs/day = Flow(MGD) X Dose(mg/L) X (8.34)

? lbs/day = (0.15)(1.2)(8.34) = **1.5**

Converting from GPD to MGD before solving with the formula

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Practice Problem: If a water treatment plant is making water at the rate of 300,000 gallons per day, and the chlorine dose is 2.0 mg/l, how many pounds of gas chlorine will they use daily?

Step 1: Convert gallons per day into million gallons per day (MGD) using unit cancellation.

$$?\frac{MG}{day} = \frac{1\ MG}{1{,}000{,}000\ \cancel{gallons}} \times \frac{300{,}000\ \cancel{gallons}}{day} = 0.30\ MGD$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.30 x 2.0 x 8.34 = **5** lb/day

Converting from GPM to MGD before solving with the formula

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Practice Problem: A water treatment plant operates at the rate of 200 gallons per minute. They dose soda ash at 5 mg/L. How many pounds of soda ash will they use in a day?

Step 1: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$?\frac{MG}{day} = \frac{1\ MG}{1{,}000{,}000\ \cancel{gallons}} \times \frac{200\ \cancel{gal}}{\cancel{minute}} \times \frac{1440\ \cancel{minutes}}{day} = \frac{0.288\ MG}{day}$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

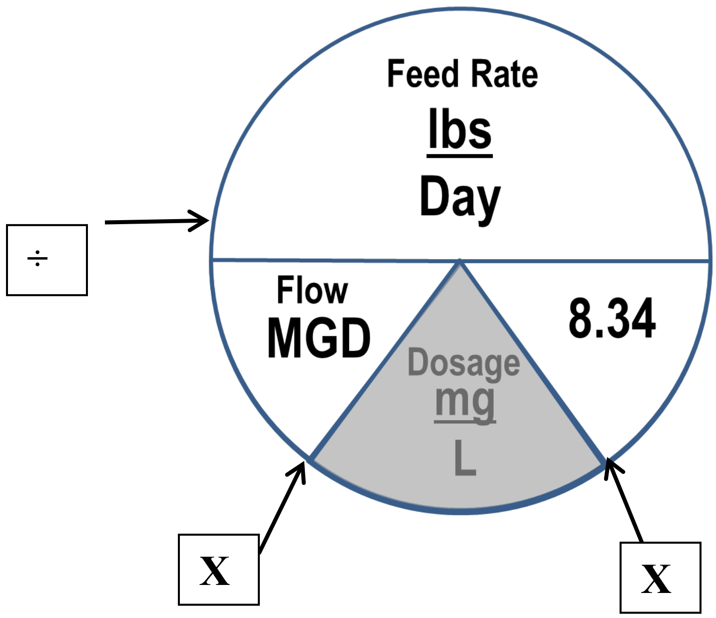
Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.288 x 5 x 8.34 = **12** lb/day

Equation #2: Solving for Dose (mg/L) using the Feed Rate Formula

An operator can also use the pie chart formula to calculate the dose if the known factors are the feed rate in pounds per day, and the flow rate.

? Dose (mg/L) = $\frac{\text{Feed Rate, (lbs/ day)}}{\text{Flow(MGD)(8.34)}}$



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Practice Problem: A water treatment plant produces 150,000 gallons of water every day. It uses an average of 2 pounds of permanganate for iron and manganese removal. What is the dose of the permanganate?

Step 1: Set up the variables in vertical format.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$

Step 2: Insert known values into equation.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}} = \frac{\text{(2) lbs/day}}{(0.15)(8.34)}$

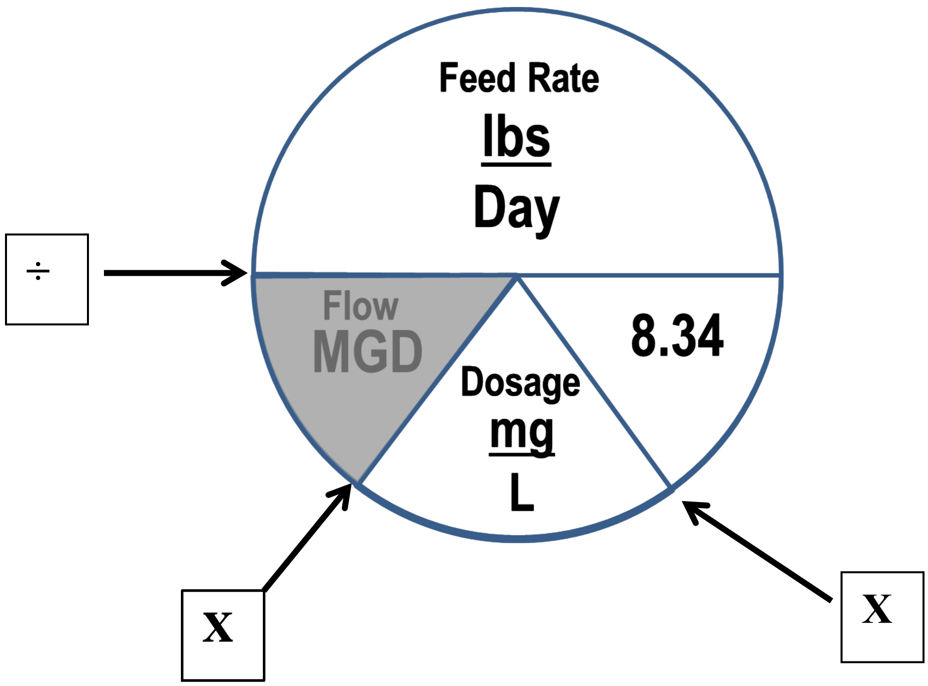
Step 3: Multiply 0.15 x 8.34 in the denominator = 1.25 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{\text{2 (numerator)}}{\text{1.25 (denominator)}}$ = $\frac{\textbf{1.56}\text{ mg}}{\text{L}}$

Equation #3: Solving for Flow (MGD) using the Feed Rate Formula

Lastly, the pie chart formula can be used to calculate the flow if the dose and feed rate in pounds per day are known factors.

Example Problem: A water treatment plant uses 14 pounds of chlorine gas to treat their water daily. The chlorine dose is 1.5 mg/l. What is their flow rate in MGD?



Vertical Format: **Flow, MGD =** **Feed Rate, lbs/per day** / **(Dose, mg/L)(8.34)**

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Practice Problem: A water treatment plant uses 8 pounds of chlorine daily and the dose is 17 mg/l. How many gallons are they producing?

Step 1: Set up the variables in vertical format and insert known values

$$? \text{ Flow (MGD)} = \frac{\text{Feed Rate, lbs/day}}{(\text{Dose})(8.34)} = \frac{(8)\text{ lb/day}}{(17)(8.34)}$$

Step 2: Multiply 17 x 8.34 in the denominator = 141.78 (basic math rule)

Step 3: Perform the **FLOW** division: $\frac{8 \text{ (numerator)}}{141.78 \text{ (denominator)}}$ = 0.056425 MGD

Unit Cancellation Steps to solve for gallons/day

$$? \frac{\text{gallons}}{\text{day}} = \frac{1{,}000.000 \text{ gallons}}{1 \text{ ~~MG~~}} \times \frac{0.056425 \text{ ~~MG~~}}{\text{day}} = 56{,}425 \frac{\text{gallons}}{\text{day}}$$

Quiz # 2

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1. How many **pounds per day** will be required if the dose is 13 mg/L, and the flow treated is 1 MGD?

$$? \frac{\text{lbs}}{\text{day}} = \text{Flow(MGD)} \times \text{Dose(mg/L)} \times (8.34) = (1)(13)(8.34) = \mathbf{108} \frac{\text{lbs}}{\text{day}}$$

2. How many **pounds per day** will be required if the dose is 13 mg/l, and the flow is at the rate of 695 gpm?

Step 1: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$? \frac{\text{MG}}{\text{day}} = \frac{1 \text{ MG}}{1{,}000{,}000 \text{ ~~gallons~~}} \times \frac{695 \text{ ~~gal~~}}{\text{~~minute~~}} \times \frac{1440 \text{ ~~minutes~~}}{\text{day}} = 1.0 \frac{\text{MG}}{\text{day}}$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

1.0 x 13 x 8.34 = **108** lb/day

3. How many **pounds per day** will be needed to dose 335,000 gallons of water at 4 mg/L?

Step 1: Convert gallons per day into million gallons per day (MGD) using unit cancellation.

$$?\frac{MG}{day} = \frac{1\ MG}{1{,}000{,}000\ \text{gallons}} \times \frac{335{,}000\ \text{gallons}}{day} = 0.335\ MGD$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.335 x 4.0 x 8.34 = **11** lb/day

4. What is the **dose** if 2.5 MGD were treated with 31 pounds of chlorine?

Step 1: Set up the variables in vertical format.

$$?\ \text{Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$$

Step 2: Insert known values into equation.

$$?\ \text{Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}} = \frac{\text{(31) lbs/day}}{(2.5)(8.34)}$$

Step 3: Multiply 2.5 x 8.34 in the denominator = 20.85 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{31\ \text{(numerator)}}{20.85\ \text{(denominator)}} = \mathbf{1.5}\ \frac{mg}{L}$ (rounded)

5. How many **pounds** will be required if the flow is 95 gpm, and the dose is 7mg/L, and the plant **runs for 12 hours per day**?

Step 1: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$?\ \frac{MG}{day} = \frac{1\ MG}{1{,}000{,}000\ \text{gallons}} \times \frac{95\ gal}{minute} \times \frac{60\ minutes}{hr} \times \frac{12\ hrs}{day} = 0.0684\ \frac{MG}{day}\ \text{for 12 hrs}$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.0684 x 7 x 8.34 = **4** lb/day (rounded)

Practice problems:

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1. How many **pounds per day** will be used when the dose is 5 mg/L, and the flow rate is 350 gpm?

Step 1: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$? \frac{MG}{day} = \frac{1 \ MG}{1{,}000{,}000 \ \cancel{gallons}} \times \frac{350 \ \cancel{gal}}{\cancel{minute}} \times \frac{1440 \ \cancel{minutes}}{day} = 0.5 \ \frac{MG}{day}$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.5 x 5 x 8.34 = **21** lb/day (rounded)

2. How many **pounds per day** will be needed if the flow rate is 80,000 gpd, and the dose is 25 mg/L?

Step 1: Convert gallons per day into million gallons per day (MGD) using unit cancellation.

$$? \frac{MG}{day} = \frac{1 \ MG}{1{,}000{,}000 \ \cancel{gallons}} \times \frac{80{,}000 \ \cancel{gallons}}{day} = 0.08 \ MGD$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.08 x 25 x 8.34 = **17** lb/day

3. How many **pounds per day** will be used if the flow rate is 47 gpm through each filter, and there are 2 filters, and the dose is 7 mg/L?

Step 1: Determine **total flow rate** for both filters by multiplying by 2

47 X 2 = 94 gpm

Step 2: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$? \frac{MG}{day} = \frac{1 \ MG}{1{,}000{,}000 \ \cancel{gallons}} \times \frac{94 \ \cancel{gal}}{\cancel{minute}} \times \frac{1440 \ \cancel{minutes}}{day} = 0.135 \ \frac{MG}{day}$$

Step 3: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.135 x 7 x 8.34 = **8** lb/day (rounded)

4. How many **pounds per day** will be used if the flow rate is 50 gpm, the dose is 4 mg/L, and the plant operates for 16 hours each day?

Step 1: Convert gallons per minute into million gallons per day (MGD) using unit cancellation.

$$? \frac{MG}{day} = \frac{1\ \ MG}{1{,}000{,}000\ \cancel{gallons}} \times \frac{50\ \cancel{gal}}{\cancel{minute}} \times \frac{60\ \cancel{minutes}}{hr} \times \frac{16\ hrs}{day} = 0.048\ \frac{MG}{day} \text{ for 16 hrs}$$

Step 2: Use MGD in feed rate formula to solve for lbs/day

Feed Rate, lbs per day = Flow(MGD) x Dose(mg/L) x 8.34

0.048 x 4 x 8.34 = **1.6** lb/day

5. What is the **dose** if the total water treated is 650,000 gallons, and 22 pounds of chemical was used?

Step 1: Set up the variables in vertical format.

$$? \text{ Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$$

Step 2: Insert known values into equation.

$$? \text{ Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}} = \frac{\text{(22) lbs/day}}{(0.65)(8.34)}$$

Step 3: Multiply 0.65 x 8.34 in the denominator = 20.85 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{\text{22 (numerator)}}{\text{5.42 (denominator)}} = \mathbf{4}\ \frac{mg}{L}$ (rounded)

6. What is the **dose** if the plant uses 120 pounds of chemical each day to treat 1,350,000 gallons daily?

Step 1: Set up the variables in vertical format.

$$? \text{ Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$$

Step 2: Insert known values into equation.

$$? \text{ Dose (mg/L)} = \frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}} = \frac{\text{(120) lbs/day}}{(1.35)(8.34)}$$

Step 3: Multiply 1.35 x 8.34 in the denominator = 11.25 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{\text{120 (numerator)}}{\text{11.25 (denominator)}}$ = **11.** $\frac{\text{mg}}{\text{L}}$ (rounded)

7. What is the **dose** if the operator uses 18 pounds of chemical to treat 650,000 gpd?

Step 1: Set up the variables in vertical format.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$

Step 2: Insert known values into equation.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$ = $\frac{\text{(18) lbs/day}}{\text{(0.65)(8.34)}}$

Step 3: Multiply 0.65 x 8.34 in the denominator = 5.42 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{\text{18 (numerator)}}{\text{5.42 (denominator)}}$ = **3.3** $\frac{\text{mg}}{\text{L}}$ (rounded)

Feed Rate Calculations Using Flow with a % Strength (i.e., % pure) Solution

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Practice Problem: A water plant uses 15% sodium hypochlorite to disinfect the water. The dose is 1.2 mg/L. They treat 0.25 million gallons per day. How many pounds of sodium hypochlorite will need to be fed?

Step 1: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? Pounds per day = flow x dose x 8.34 = (0.25)(1.2)(8.34) = **2.5** pounds of chlorine is required.

Step 2: Calculate # of pounds of 15% solution needed to achieve Step 1 feed rate.
a) Convert % purity of solution into a decimal:

$\frac{15\%}{100\%}$ = **0.15**

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{2.5 \text{ pounds}}{0.15 \text{ (\% purity as a decimal)}}$ = **16.7** pounds of 15% hypochlorite.

TIP: Answer will always be more pounds than Step 1 result because solution is not 100% pure.

Practice Problem: A water plant doses liquid alum at 5 mg/L and treats 1.5 MGD. How many pounds of liquid alum will be required daily to do this? Liquid alum is 48½% pure.

Step 1: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? Pounds per day = flow x dose x 8.34 = (1.5)(5)(8.34) = **62.55** pound alum.

Step 2: Calculate # of pounds of 15% solution needed to achieve Step 1 feed rate.

a) Convert % purity of solution into a decimal:

$\frac{48.5\%}{100\%}$ = **0.485**

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{62.55 \text{ pounds}}{0.485 \text{ (\% purity as a decimal)}}$ = **128.96** or 129 pounds of liquid alum.

Feed Rate Calculations Using <u>Volume</u> with a % Strength (i.e., % pure) Solution

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Practice Problem: Calculate the amount of calcium hypochlorite to dose a 500,000 gallon storage tank to a dose of 25 mg/L using granular calcium hypochlorite that indicates it is 65% chlorine.

Step 1: Convert volume (in gallons) into MG so that the feed rate (lbs) formula can be used.

$$?MG = \frac{1\ MG}{1{,}000{,}000\ gal} \times (500{,}000)\ gal = \mathbf{0.5}\ MG$$

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? lbs = volume(MG) x dose(mg/L) x 8.34 = (0.5)(25)(8.34) = **104.25** pounds of chlorine is required.

Step 3: Calculate # of pounds of 65% solution needed to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$$\frac{65\%}{100\%} = \mathbf{0.65}$$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$$\frac{104.25\ pounds}{0.65} = \mathbf{160.39}$$ pounds of 65% calcium hypochlorite.

Calculating "Active Ingredient" Weight

Active ingredient weight is the number of pounds of "active ingredient" per gallon of a % solution that cause a chemical reaction.

- This "active ingredient" weight value is then used in a calculation with the 100% pure "lbs/day" feed rate to determine the "gal/day" feed rate.

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Calculating the Weight of the "Active ingredient" of a % Solution Chemical

Practice Problem: How many pounds of caustic soda are there in a gallon of caustic soda that is 25% pure that has a specific gravity of 1.28?

Step 1: Solve weight equation (lbs/gal) for 1 gallon of chemical

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

$$1.28 \times 8.34 \frac{pounds}{gallon} = 10.67 \frac{pounds}{gallon}$$

Step 2: Determine the "active ingredient" weight of the caustic soda based on the % purity of solution

a) Convert % purity of solution into a decimal:

$$\frac{25\%}{100\%} = 0.25$$

b) Multiply the weight of a gallon (from step 1) by the % purity of the product (as a decimal).

$$10.67\ \frac{\text{pounds}}{\text{gallon}} \times 0.25 = \underline{\mathbf{2.66}}$$ pounds of caustic soda in a gallon of 25% caustic soda solution

This "active ingredient" weight provides the pounds of available caustic soda that is found in each gallon of 25% caustic soda solution. Within the 10.67 pounds of 25% caustic solution, there are 2.66 pounds of active ingredients.

Using "Active Ingredient" Weight to Convert Feed Rate from lbs/day to gal/day

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Practice Problem: A water plant uses sodium hypochlorite (12.5%) to disinfect the water which provides 1.2 lbs/gal of available chlorine ("active ingredient" weight). The chlorine dosage is 1.6 mg/L. They treat 600,000 gallons per day. How many **gallons** of sodium hypochlorite will need to be fed?

Step 1: Convert flow in gallons (per day) into MGD so that the feed rate (lbs/day) formula can be used.

$$?\ \text{MGD} = \frac{1\ \text{MG}}{1{,}000{,}000\ \cancel{\text{gal}}} \times \frac{600{,}000\ (\cancel{\text{gal}})}{1\ \text{day}} = \underline{\mathbf{0.6}}\ \text{MGD}$$

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.6)(1.6)(8.34) = <u>**8**</u> pounds of chlorine is required.

Step 3: Use "active ingredient" weight with unit cancellation steps to convert lbs/day to **gal/day**

Active Ingredient Weight of 12.5% hypo solution

Feed Rate of 100% pure chlorine

$$\frac{?\ \text{gal}}{\text{day}} = \frac{1\ \text{gallon}}{1.2\ \text{lbs}} \times \frac{8\ \text{lbs}}{\text{day}} = \frac{\mathbf{6.67}\ \text{gal}}{\text{day}}$$

NOTE: When you are given the "active ingredient" weight of a solution to solve a feed rate problem, you do not need to use the % purity factor because it was used to derive the active ingredient weight.

Quiz: 3

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1. How many **pounds** of alum (48.5 %) are required to treat 0.75 MGD with a dose of 12 mg/L?

Step 1: Solve for pounds (feed rate) for 100 % pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.75)(12)(8.34) = **75** pounds of chlorine is required.

Step 2: Calculate # of pounds of 65% solution needed to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$\frac{48.5\%}{100\%} = \mathbf{0.485}$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{75 \text{ pounds}}{0.485 \text{ (\% purity as a decimal)}} = \mathbf{155}$ pounds of 48.5% alum.

2. How many **pounds** of calcium hypochlorite (65 %) are needed to treat 500,000 gallons per day with a dose of 2 mg/L?

Step 1: Convert flow in gallons (per day) into MGD so that the feed rate (lbs/day) formula can be used.

? MGD = $\frac{1 \text{ MG}}{1{,}000{,}000 \text{ gal}} \times \frac{500{,}000 \text{ (gal)}}{1 \text{ day}} = \mathbf{0.5}$ MGD

Step 2: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.5)(2)(8.34) = **8.34** pounds of chlorine is required.

Step 3: Calculate # of pounds of % solution needed (in this example, 65%) to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$\frac{65\%}{100\%} = 0.65$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{\text{8.34 pounds}}{0.65}$ = **12.8** pounds of 65% calcium hypochlorite.

3. How many **pounds** of sodium hypochlorite (12½ %) are needed to treat a flow of 150 gallons per minute at a dose of 0.7 mg/L?

Step 1: Convert flow in gallons (per minute) into MGD so that the feed rate (lbs/day) formula can be used.

$?\text{MGD} = \frac{1\text{ MG}}{1{,}000{,}000\ \cancel{\text{gal}}} \times \frac{\text{volume of flow } \cancel{(\text{gal})}}{1\ \cancel{\text{min}}} \times \frac{1440\ \cancel{\text{min}}}{\text{day}}$

$?\ \frac{\text{MG}}{\text{day}} = \frac{1\ \text{MG}}{1{,}000{,}000\ \cancel{\text{gallons}}} \times \frac{150\ \cancel{\text{gal}}}{\cancel{\text{minute}}} \times \frac{1440\ \cancel{\text{minutes}}}{\text{day}} = 0.216\ \frac{\text{MG}}{\text{day}}$

Step 2: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.216)(0.7)(8.34) = **1.26** pounds of chlorine is required.

Step 3: Calculate # of pounds of % solution needed (in this example, 65%) to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$\frac{12.5\%}{100\%}$ = 0.125

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{\text{1.26 pounds}}{0.125}$ = **10** pounds of 12.5% sodium hypochlorite.

4. How many **pounds** of caustic soda are needed to dose water at 17 mg/L if you are treating 1,400,000 gallons per day? The caustic soda concentration is 50 percent.

Step 1: Solve for pounds (feed rate) for 100 % pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (1.4)(17)(8.34) = **198** pounds of chlorine is required.

Step 2: Calculate # of pounds of 65% solution needed to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$\frac{50\%}{100\%} = \mathbf{0.5}$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$\frac{\text{198 pounds}}{\text{0.5 (\% purity as a decimal)}} = \mathbf{397}$ pounds of 50% PAC

5. How many **pounds** of chlorine gas are required to treat 750,000 gallons of water to a dose of 50 mg/L for a 24 hour period?

Step 1: Convert flow in gallons (per day) into MGD so that the feed rate (lbs/day) formula can be used.

? MGD = $\frac{\text{1 MG}}{\text{1,000,000 gal}}$ X $\frac{\text{750,000 (gal)}}{\text{1 day}}$ = **0.75** MGD

Step 2: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.75)(50)(8.34) = **313** pounds of chlorine is required.

6. A treatment plant uses 12.5% hypochlorite to disinfect the water. The required hypochlorite dosage is 2 mg/L and the plant flow is 300,000 gpd. How many **gallons** of 12.5% hypochlorite are required (12.5% hypo has 1.25 lbs/gal available chlorine)?

Step 1: Convert flow in gallons (per day) into MGD so that the feed rate (lbs/day) formula can be used.

? MGD = $\frac{\text{1 MG}}{\text{1,000,000 gal}}$ X $\frac{\text{300,000 (gal)}}{\text{1 day}}$ = **0.3** MGD

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? pounds per day = flow x dose x 8.34 = (0.3)(2)(8.34) = **5** pounds of chlorine is required.

Step 3: Use "active ingredient" weight with unit cancellation steps to convert lbs/day to **gal/day**

Active Ingredient Weight of 12.5% hypo solution

Feed Rate of 100% pure chlorine

$$? \frac{gal}{day} = \frac{1 \text{ gallon}}{1.25 \text{ lbs}} \times \frac{5 \text{ lbs}}{day} = \frac{\mathbf{4} \text{ gal}}{day}$$

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Calculating the Weight of a Solution

Another consideration in water chemistry calculations is the weight of the product being used. For example, the weight of a gallon of water is 8.34 pounds. We learned earlier that there are 7.48 gallons in a cubic foot of water.

Practice Problem: What would be the weight of 100 gallons of water?

$$? \text{ lbs} = 8.34 \frac{lbs}{gal} \times 100 \text{ gal} = \underline{834} \text{ lbs}$$

Using Specific Gravity to calculate the weight of a solution

To calculate the weight of various chemicals we need to factor in the specific gravity of the chemical being used. Specific gravity is the weight of a substance compared to the weight of a gallon of water. Specific gravity information is found on the Safety Data Sheets (SDS) and is used to calculate the weight of a substance.

Total Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

Practice Problem: What is the weight of a gallon of sodium hypochlorite if the specific gravity is 1.11?

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

$$? \frac{lbs}{gal} = 1.11 \times 8.34 \frac{lbs}{gal} = \mathbf{9.26} \frac{lbs}{gal}$$

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Practice Problem: What is the weight of a gallon of crankcase oil if the specific gravity is 0.89?

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

$? \frac{\text{lbs}}{\text{gal}} = 0.89 \times 8.34 \frac{\text{lbs}}{\text{gal}} = \mathbf{7.4} \frac{\text{lbs}}{\text{gal}}$

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Calculating the weight of a drum

If you want to determine the weight of a drum or tank of solution, you must include that volume in your calculation.

Drum Weight, lbs = (gallons of drum or tank) x (S.G.) x (8.34 lbs/gal)

Practice Problem: What would be the weight of a 50 gallon drum of 50% caustic soda if the specific gravity of the product is 1.53

Drum Weight, lbs = (gallons of drum or tank) x (S.G.) x (8.34 lbs/gal)

? Drum weight, lbs = 50 x 1.53 x 8.34 = **638** lbs.

Calculating "Active Ingredient" Weight

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Practice Problem: What is the active ingredient weight of 48.5% alum that has a specific gravity of 1.33.

Step 1: Solve weight equation (lbs/gal) for 1 gallon of chemical

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

$1.33 \times 8.34 \frac{\text{lbs}}{\text{gal}} = 11.09 \frac{\text{lbs}}{\text{gal}}$

Step 2: Determine the "active ingredient" weight of the solution based on the % purity of solution

a) Convert % purity of solution into a decimal:

48.5 = 0.485

100

b) Multiply the weight of a gallon (from step 1) by the % purity of the product (as a decimal).

11.09 lbs x 0.485 = **<u>5.37</u>** pounds of available alum in a gallon of 48.5 % alum
gal

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<u>Calculating the active ingredient weight of a drum of solution</u>

You can also calculate how many pounds of active ingredients there are in drum or tank of a liquid product.

? lbs of active ingredient within drum = drum volume (gal) x active ingredient weight (lbs/gal)

Example Problem: How many pounds of active ingredient are there in a 55 gallon drum of liquid alum if the product is 48½ percent pure with a specific gravity of 1.33 and the active ingredient weight is 5.37 lbs of alum/gal of product?

? lbs of active ingredient within drum = active ingredient weight (lbs/gal) X drum volume (gal)

? lbs of active ingredient within drum = 5.37 <u>lbs</u> X 55 ~~gal~~
~~gal~~

= **<u>295.8</u>** lbs of active ingredient (alum) within the 48.5% solution

Alternative Method of Calculating Active Ingredient Weight of a Drum:

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Example Problem: How many pounds of active ingredient are there in a 55 gallon drum of liquid alum if the product is 48½ percent pure with a specific gravity of 1.33 and the active ingredient weight is 5.37 lbs of alum/gal of product?

Step 1: Solve weight equation (lbs/gal) for the drum

Drum Weight, lbs = (gallons of drum or tank) x (S.G.) x (8.34 lbs/gal)

? Drum Weight, lbs = 55 gal X 1.33 X 8.34

= 610 lbs

Step 2: Determine the "active ingredient" weight of the solution based on the % purity of solution

a) Convert % purity of solution into a decimal:

$\frac{48.5}{100} = 0.485$

b) Multiply the weight of the drum (from step 1) by the % purity of the product (as a decimal).

610 lbs X 0.485 = **295.8** lbs of active ingredient (alum) within the 48.5% alum solution

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Math Concept Exercise

1. In order to use the Feed Rate formula which is lbs/day = Flow x Dosage x 8.34, name the units of measurement for the **flow**:

   a) MGD

   b) gpm

   c) gpd

   d) All of the above units can be used

2. If you have a flow in **gpm**, what calculation do you use to convert it to **MGD**?

   a) Multiply gpm X 24 and divide by 1,000,000

   b) Multiply gpm x 60 and divide by 1,000,000

   c) Multiply gpm x 1440 and divide by 1,000,000

   d) Divide flow in gpm by 1,000,000

3. If you have a flow in **gpd**, what calculation do you use to convert it to **MGD**?

   a) Divide flow in gpd by 100
   b) Divide flow in gpd by 10,000
   c) Divide flow in gpd by 100,000
   d) Divide flow in gpd by 1,000,000

4. When using "active ingredient" weight to solve for "gallons", what calculation do you use?

   a) ? gals = 1 gal / 1.63 lbs X "lbs" (as a % solution feed rate)

   b) ? gals = 1.63 lbs / gal X "lbs" (as a % solution feed rate)

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Final Quiz :

1. What is the **volume in gallons** of a water tank that is 25 feet in diameter, and filled to a depth of 17 feet?

Step 1: Solve the volume equation in ft^3:

V= 0.785(Dia)^2(H)

V=0.785(25 ft)(25 ft)(17 ft) = **8340.6** ft^3

Step 2: Convert ft^3 into gallons:

? gal = $\frac{7.48 \text{ gal}}{1 \text{ ft}^3}$ X **8340.6** ft^3 = **62,388** gallons (rounded)

2. What is the **volume in gallons** in a sedimentation basin that is 50 feet long, 35 feet wide, and filled to a depth of 12 feet?

Step 1: Solve the volume equation in ft^3:

V= (L)(W)(H)

V=(50 ft)(35 ft)(12 ft) = **21,000** ft^3

Step 2: Convert ft^3 into gallons:

? gal = $\frac{7.48 \text{ gal}}{1 \text{ ft}^3}$ X **21,000** ft^3 = **157,080** gallons (rounded)

3. How many **pounds** of chemical will be fed if the dose required is 13 mg/L, and the amount of water to be treated is 175,000 gallons per day?

Step 1: Convert flow (in gallons) into MG so that the feed rate (lbs) formula can be used.

?MG = $\frac{1\ MG}{1{,}000{,}000\ gal}$ X (175,000) gal = **0.175** MG

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? lbs = volume(MG) x dose(mg/L) x 8.34 = (0.175)(13)(8.34) = **19** pounds of chlorine is required. (rounded)

4. What is the **dose** if a water plant used 40 pounds of chemical, and treated 1.2 million gallons of water?

Step 1: Set up the variables in vertical format.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$

Step 2: Insert known values into equation.

? Dose (mg/L) = $\frac{\text{Feed Rate, lbs/day}}{\text{(Flow, MGD)(8.34)}}$ = $\frac{\text{(40) lbs/day}}{(1.2)(8.34)}$

Step 3: Multiply 2.5 x 8.34 in the denominator = 10 (basic math rule)

Step 4: Perform the **DOSE** division: $\frac{\text{40 (numerator)}}{\text{10 (denominator)}}$ = **4** $\frac{mg}{L}$

5. The target dose for a system is 1.2 mg/L. They are treating an average of 300,000 gallons each day. How many **lbs** of sodium hypochlorite (12½ %) will they need to feed?

Step 1: Convert volume (in gallons) into MG so that the feed rate (lbs) formula can be used.

$$?MG = \frac{1\ MG}{1{,}000{,}000\ gal} \times (300{,}000)\ gal = \mathbf{0.3}\ MG$$

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? lbs = volume(MG) x dose(mg/L) x 8.34 = (0.3)(1.2)(8.34) = **3** pounds of chlorine is required.

Step 3: Calculate # of pounds of 65% solution needed to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$$\frac{12.5\%}{100\%} = \mathbf{0.125}$$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$$\frac{3\ pounds}{0.125} = \mathbf{24}$$ pounds of 65% calcium hypochlorite.

6. The specific gravity of the hypochlorite is 1.11. If the system needs to feed 24 pounds of hypochlorite, how many **gallons** will that require?

Step 1: Solve weight equation (lbs/gal) for 1 gallon of chemical

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

$$1.11 \times 8.34\ \frac{pounds}{gallon} = 9.26\ \frac{pounds}{gallon}$$

Step 2: Use weight of gallon of hypochlorite solution with unit cancellation steps to convert lbs/day to **gal/day**

Weight of hypo solution

Feed Rate

$$\frac{?gal}{day} = \frac{1\ gallon}{9.26\ lbs} \times \frac{24\ lbs}{day} = \frac{\mathbf{2.6}\ gal}{day}\ \text{(rounded)}$$

7. How many **pound**s of chlorine will be needed to disinfect a 250,000 gallon tank if a 50 mg/L dose is required?

Step 1: Convert volume (in gallons) into MG so that the feed rate (lbs) formula can be used.

$?MG = \frac{1\ MG}{1,000,000\ gal} \times (250,000)\ gal = \mathbf{0.25}\ MG$

Step 2: Solve for pounds per day (feed rate) for 100 % pure chemical (no impurities).

? lbs = volume(MG) x dose(mg/L) x 8.34 = (0.5)(25)(8.34) = **104.25** pounds of chlorine is required.

8. What is the **weight** of the water that is in a container one foot long, one foot wide, and filled to a depth of 1 foot?

Step 1: Solve the volume equation in ft^3:

V= (L)(W)(H)

V=(1 ft)(1 ft)(1 ft) = **1** ft^3

Step 2: Convert ft^3 into gallons:

$? gal = \frac{7.48\ gal}{1\ \cancel{ft^3}} \times \mathbf{1}\ \cancel{ft^3} = \mathbf{7.48}$ gallons

Step 3: Convert gallons into lbs.

$? lbs = \frac{8.34\ lbs}{\cancel{gal}} \times 7.48\ \cancel{gal} = \mathbf{62.4}$ lbs

9 How many **pounds** of aluminum sulfate (48.5%) are required to dose water at 21 mg/L if the amount of water treated is 2 MGD?

Step 1: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? Pounds per day = flow x dose x 8.34 = (2)(21)(8.34) = 350.28 pound alum.

Step 2: Calculate # of pounds of 48.5% solution needed to achieve Step 1 feed rate.

a) Convert % purity of solution into a decimal:

$$\frac{48.5\%}{100\%} = 0.485$$

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the % purity of the solution (as a decimal).

$$\frac{350.28 \text{ pounds}}{0.485 \text{ (\% purity as a decimal)}} = \textbf{722} \text{ pounds of liquid alum.}$$

10. Convert a flow of 65 gallons per minute to the **MGD** unit.

$$?MGD = \frac{1 \text{ MG}}{1{,}000{,}000 \text{ gal}} \times \frac{\text{volume of flow (gal)}}{1 \text{ min}} \times \frac{1440 \text{ min}}{\text{day}}$$

$$?\frac{\text{MG}}{\text{day}} = \frac{1 \text{ MG}}{1{,}000{,}000 \text{ gallons}} \times \frac{65 \text{ gal}}{\text{minute}} \times \frac{1440 \text{ minutes}}{\text{day}} = 0.0936 \frac{\text{MG}}{\text{day}}$$

11. How **high (in ft)** is the water column if the pressure at the bottom measures 40 psi?

$$? \text{ ft} = \frac{2.31 \text{ ft}}{1 \text{ psi}} \times 40 \text{ psi} = \mathbf{92} \text{ ft}$$

12. Convert 17º C to **ºF.**

°F = (ºC X 1.8) +32
°F = (17 X 1.8) = 31 + 32 = **63** °F

13. What is the **% unaccounted water** if a system records the following readings:

The master meter reading is 1,500,000 gallons.
The meter reading total is 965,000 gallons
Another 100,000 gallons were used for flushing, and 35,000 gallons were metered at a blow-off.

Step 1: Add total gallons accounted for (billed, blow-off, and flushing)

Gallons Accounted for =**965,000** (billed) + **35,000** (blow-off) + **100,000** (flushing) = **1,100,000**

Step 2: Subtract "accounted for" from total produced to find "Unaccounted for"

1,500,000 – **1,100,000** (Step 1 Accounted for) = **400,000** (Unaccounted for)

Step 3: Divide "Unaccounted for" by total produced and multiply by 100 to equal the % unaccounted for

$$\frac{\mathbf{400{,}000} \text{ (Step 2 Unaccounted For)}}{1{,}500{,}000 \text{ (Total Produced)}} = \mathbf{0.266} \times 100 = \mathbf{27} \text{ \% Unaccounted for (rounded)}$$