Basic Math for All Certifications
Course # 1014 or 1014-V

Updated 2/2022
BASIC MATH FOR ALL CERTIFICATIONS
MARCH 8 - 11, 2022
COURSE #1014 OR 1014-V

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EMAIL: AMANDA.CARTER@TN.GOV

**Tuesday**
8:30 am  Math Fundamentals Review  
           Fractions, Decimals, Percentages, Exponents, Roots, Order of Operations
11:00     Lunch
12:15 pm  Solving Equations

**Wednesday**
8:30 am  Review Day 1
9:00      Metric System
9:30      Dimensional Analysis
11:00     Lunch
12:15 pm  Circumference and Area
1:00      Dimensional Analysis (Conversions)

**Thursday**
8:30 am  Circumference, Area, and Volume
12:00     Lunch
1:00 pm   Velocity and Flow

**Friday**
8:30 am  End of Week Review
11:00     Lunch
12:00 pm  Course Evaluation and Exam

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Section 1
Math Fundamentals Review
## Math Fundamentals Review

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## Fractions

Basic Math Concepts for Water and Wastewater Plant Operators

By Joanne Kirkpatrick Price
Summary

• Numerator
  • Top portion of a fraction
  • Indicates how many parts are being considered
• Denominator
  • Bottom portion of fraction
  • Tells how many equal parts the whole has been divided into

Denominator

• Bottom of fraction
• Gives the name of the fraction
  • Halves, thirds, fourths, fifths, twentieths, etc
  • A denominator of two indicates that the whole has been divided into two equal parts
Numerator

• Top of fraction
• Indicates number of equal parts

Equivalent Fractions

• Fractions with different numerators and denominators that refer to the same portion
• Fractions that represent equal parts of the whole
Decimals

Basic Math Concepts for Water and Wastewater
Plant Operators
By Joanne Kirkpatrick Price

Decimal System

- The word decimal comes from the Latin word meaning *decem*, meaning ten.
- The decimal system is based on ten and multiples of ten.
- In a place value system the size of any number depends on two things:
  - Which digits are used and
  - Where these digits are placed in relation to the decimal point

<table>
<thead>
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<th>Thousands</th>
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<th>Tens</th>
<th>Ones</th>
<th>Decimal Point</th>
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<tbody>
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Greater than one

Less than one
Percents and Decimals

- To convert from a decimal to a percent
  - Move the decimal point two places to the right
    \[ 0.46 \rightarrow 46.0\% \]
  - Multiply decimal by 100
    \[ 0.46 \times 100 = 46\% \]
- To convert from a percent to a decimal
  - Move the decimal two points to the left
  - Divide percent by 100
    \[ 79.5\% = 0.795 \]

Converting Decimals and Fractions

- To convert a fraction to a decimal
  - Simply divide the numerator by the denominator
    \[ \frac{1}{2} = 1 \div 2 = 0.5 \]
    \[ \frac{10}{13} = 10 \div 13 = 0.7692 \]
Key Words

• Of \(\rightarrow\) multiply
  \[5\% \text{ of } 100 = 0.05 \times 100\]

• Per \(\rightarrow\) divide
  \[25 \text{ miles per gallon} = 25 \frac{\text{miles}}{\text{gallon}}\]

• Is \(\rightarrow\) equals
POWERS & ROOTS

TERMS

- Exponent – indicates how many times a number is to be multiplied together
- Base – the number that is being multiplied
  \[ 7^4 = (7)(7)(7)(7) \]
- Power – entire expression (seven to the 4th power)
- Same rule applies to letters and measurement units
  \[ x^3 = (x)(x)(x) \text{ or } ft^2 = (ft)(ft) \]
- Any number that does not have an exponent is considered to have an exponent of 1
  \[ 10 = 10^1 \]
EXAMPLE 1

• Write the following numbers in expanded form:
  • $6^2$
  • $20^3$
  • $(20)(20)(20)$

• Write the factors using exponential notation:
  • $(4)(4)(4)$
  • $(2)(2)(2)(2)$

$2^4$
EXAMPLE 3

- Complete the following calculations
  - $27^2$
  - $14^5$
  - $5^{7.9}$

ROOTS

- Complete the following calculations
  - $\sqrt[3]{6400}$
  - $\sqrt[3]{912673}$
MULTIPLYING POWERS

• When multiplying powers with the same base, simply add exponents

\[ x^2 \cdot x^3 \]

\[ x^5 \]

\[ x^3 \cdot x^4 = (x)(x)(x)(x)(x) \]

EXAMPLE 7

• Simplify the following terms using the rule for multiplying powers:

• \[ 3^2 \cdot 3^5 \]

\[ 3^7 \]

• \[ x^3 \cdot x^3 \]

\[ x^6 \]
DIVIDING POWERS

• When dividing powers with the same base, subtract the power of the dominator from the power of the numerator

\[ \frac{x^5}{x^3} \]

EXAMPLE 8

• Simplify the following terms using the rule for dividing powers

\[ \frac{a^3}{a^2} \]

\[ \frac{9^5}{9^3} \]
ORDER OF OPERATIONS

Basic Math for Operators-in-Training

WHAT IS ORDER OF OPERATIONS?

• A set way to solve a calculation
  \[ 8 + 16 \div 4 \]

• Which way is the correct way?
PEMDAS

- Parenthesis
- Exponents
- Multiplication/Division
- Addition/Subtraction

\[
\begin{align*}
8 + 16 & \div 4 \\
24 & \div 4 \\
6 & \\
8 + 16 & \div 4 \\
8 & \div 4 \\
12 & \\
\end{align*}
\]

EXAMPLE 1

PEMDAS

Parenthesis
Exponents
Multiplication/Division
Addition/Subtraction

\[
(7 \times 3) \times 4 \div 2 - 5 \times 6
\]

Since Multiplication and Division are on the same “level,” work left to right.

\[
\begin{align*}
21 \times 4 & \div 2 - 5 \times 6 \\
84 & \div 2 - 5 \times 6 \\
42 & - 5 \times 6 \\
42 & - 30 \\
12 & \\
\end{align*}
\]

Skip the subtraction because it is on the next “level.”
EXAMPLE 2

PEMDAS
- Parenthesis
- Exponents
- Multiplication/Division
- Addition/Subtraction

\[
\begin{align*}
(7 + 2)^3 & - 5^2 + 12 \\
9^3 & - 5^2 + 12 \\
81 & - 5^2 + 12 \\
81 & - 25 + 12 \\
56 & + 12 \\
\end{align*}
\]

\[68\]
Basic Math
Math Fundamentals Review

Fractions, Decimals, and Percentages Practice Problems

Determine if the following are equivalent fractions (1-10).

1. \( \frac{1}{15} = \frac{4}{60} \)
2. \( \frac{145}{175} = \frac{29}{45} \)
3. \( \frac{60}{66} = \frac{10}{13} \)
4. \( \frac{140}{180} = \frac{32}{36} \)
5. \( \frac{5}{24} = \frac{25}{110} \)

Convert the following fractions to decimals.

6. \( \frac{3}{5} = \)
7. \( \frac{9}{13} = \)
8. \( \frac{7}{4} = \)
9. \( \frac{1}{3} = \)
10. \( \frac{5}{6} = \)
11. \( \frac{17}{53} = \)
12. \( \frac{2}{5} = \)
13. \( \frac{13}{169} = \)
14. \( \frac{22}{100} = \)
15. \( \frac{33}{99} = \)
Convert the following percents into decimals.

16. 16% = 0.16
17. 75% = 0.75
18. 20% = 0.20
19. 0.07% = 0.0007
20. 120% = 1.20
21. 88.7% = 0.887
22. 0.5% = 0.005
23. 112% = 1.12
24. 12.5% = 0.125
25. 57.94% = 0.5794

Convert the following decimals into a percent.

26. 0.531 = 53.1%
27. 0.66 = 66%
28. 1.21 = 121%
29. 0.08 = 8%
30. 19.5 = 1950%
31. 0.406 = 40.6%
32. 11.0 = 1100%
33. 1.0 = 100%
34. 0.278 = 27.8%
35. 0.785 = 78.5%

Solve the following word problems.

36. What is 10% of 55?
37. What is 15% of 125?
38. 50% of 840 is what?
39. What is 7% of 1125?

40. 110% of 50 is what?

41. What is 5% of 10.7?

42. 68% of 2140 is how much?

43. 4% of 4175 is what number?

44. What is 78.5% of 150,000?

45. You need to disinfect a 300,000-gallon storage tank. The method you are using calls for you to dose 5% of the tank volume with 50 mg/L chlorine. What is 5% of 300,000 gallons?
### Fractions, Decimals, and Percentages Answers

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<tr>
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<td>3</td>
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<td></td>
<td>27.8%</td>
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</tr>
<tr>
<td>4</td>
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<td>1.20</td>
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<td></td>
<td>78.5%</td>
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<tr>
<td>5</td>
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<td></td>
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Powers and Roots Practice Problems

Write the following numbers in expanded form as factors.

1. $6^2$ _________________

2. $10^4$ _________________

3. $x^3$ _________________

4. $5^0$ _________________

5. $13^6$ _________________

Write the following numbers using exponential notation.

6. $(4)(4)(4)$ ______

7. $(x)(x)(x)(x)$ ______

8. $(9)(9)$ ______

9. $(16)(16)(16)(7)(7)$ ______

10. $\frac{1}{(2)(2)(2)(2)(2)}$ ______
Solve the following problems.

11. \((19)(19)(19) = \) ________________

12. \((0.785)(0.3333)^2(150) = \) ________________

13. \((0.785)(4)^2 = \) ________________

14. \((2^2)(3^4) = \) ________________

15. \((36)(14)(2^3) = \) ________________

16. \((5^3)(2^3) = \) ________________

17. \((5^5)(5^5) = \) ________________

18. \((7 \times 3)^2 = \) ________________

19. \((7.5^1)(2^2) = \) ________________

20. \((0.5^4)(2.2^{-2}) = \) ________________

21. \(144^{1/2} = \) ________________

22. \(\sqrt{6400} = \) ________________

23. \(\sqrt[3]{1000} = \) ________________

24. \(\sqrt[4]{4^3} = \) ________________

25. \(64^{1/3} = \) ________________

26. \((2)(3)(\sqrt{81}) = \) ________________
Powers and Roots Practice Problems Answers

1. $(6)(6)$
2. $(10)(10)(10)(10)$
3. $(x)(x)(x)$
4. 1
6. $4^3$
7. $x^4$
8. $9^2$
9. $(16^3)(7^2)$
10. $2^{-5}$
11. 6,859
12. 13.08
13. 12.56
14. 324
15. 4,032
16. 1,000
17. 9,765,625
18. 441
19. 30
20. 0.0129
21. 12
22. 80
23. 10
24. 8
25. 4
26. 54
Order of Operations Practice Problems

1. \((14 + 2) \times 8 - 4 = x\)

2. \(4 \times 3 + (3 + 6) = x\)

3. \((11 + 5) + 10 \times 5 = x\)

4. \((8 + 27 - 5) \times 6 = x\)

5. \((10 + 3) \times (7 - 5) = x\)

6. \((12 + 7) \times 9 + 2 = x\)
7. $2 \times 3 + (9 + 6) = x$

8. $(9 + 3) + 15 \times 5 = x$

9. $(10 + 20 - 6) \times 6 = x$

10. $(14 + 3) \times (12 + 5) = x$

11. $[14 + (15 - 3)] \times 7 = x$

12. $12 + [(17 + 4) + 2] = x$
13. \[7 + (18 - 3 + 2)] = x

14. \[\left((11 + 4) + 4\right) + 8 = x\]

15. \[10 + (18 - 3)] \times 7 = x

16. \[2 + \left((13 + 5) + 6\right) = x\]

17. \[\left((10 - 2) \times 5\right) - 10 = x\]

18. \[13 + [10 + (11 - 5)] = x\]
19. \[ 15 + [5 \times (17 - 6)] = x \]

20. \[ 8 + (14 - 7 - 6) = x \]

21. \[ 18 + [5 \times (11 - 4)^2] = x \]

22. \[ [(14 - 2) + 14 - 2]^2 = x \]

23. \[ 14 + [5 \times (4 + 3)^2] = x \]

24. \[ 18 + [(10 + 3) + 2^2] = x \]
25. \[4^{2} + (10 - 2 + 4^{2}) = x\]

26. \[6^{2} + (20 - 5 + 3^{2}) = x\]

27. \[18 + [(11 + 7) + 3^{2}] = x\]

28. \[((5 + 4)^{2} \times 2) + 2^{2} = x\]

29. \[((18 + 2) + (20 - 4)^{2}] = x\]

30. \[((10 - 4)^{2} + 6] - 4^{2} = x\]
### Order of Operations Practice Problems

#### Answers

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Section 2
Solving Equations and Variables
Introduction to Equations

Basic Math for All Certifications

Evaluating Expressions

• An expression is a statement of value
  – A statement of some type of quantity
    \[ 10 + 5 \quad 370 - x \]
  – The expression \( \frac{1}{2} (b)(h) \) gives the area of a triangle where \( b \) is the base of the triangle and \( h \) is the height
  – If \( b \) is 7 cm and \( h \) is 4 cm, then we can evaluate the expression
    \[
    \frac{1}{2} (7 \text{ cm})(4 \text{ cm}) = 14 \text{ cm}^2
    \]
Introduction to Equations

• An equation is when two expressions are set up equal to each other

\[
\begin{align*}
23 + 5 &= 205,000 - 1,975,000 = 85,000 \\
28 & \\
542 \times 2.1 &= 3 \div 4 = 0.75 \\
1138.2 &
\end{align*}
\]

Introduction to Equations

• Equations are “balanced”
  – The quantity on one side of the equal sign is equivalent to the quantity on the other side of the equal sign

\[
\begin{align*}
25 \times 4 &= 20 \times 5 \\
100 &= 100
\end{align*}
\]
Introduction to Equations

• Equations are “balanced”
  – It is vital to maintain that balance.
  
  \[25 \times 4 = 20 \times 5 + 15\]
  
  \[100 \not= 115\]
  
  – To maintain that balance, we whatever we do to one side of the equation, we must do the same to the other side

\[15 + 25 \times 4 = 20 \times 5 + 15\]

\[115 = 115\]

Variables

• So far, we have known all the numbers that we are working with

• In algebra, we start to see and work with variables
  – A variable is a symbol that represents different varying values
    
    \[x + 5\]
    
    If \(x = 1\),
  
    then \(x + 5 = 6\)
Introduction to Equations

• But what if we didn’t know the value of the variable?

\[ 25 \times y = 20 \times 5 \]

• We would need to solve the equation to find the value of the unknown (y)
  – This is accomplished by getting the unknown by itself on one side of the equal sign.

Introduction to Equations

\[ 25 \times y = 20 \times 5 \]

• 25 is on the same side of the equal sign as the unknown
  – To get rid of it, we have to perform the opposite function

\[ \frac{25 \times y}{25} \]

\[ (1)y = 20 \times 5 \]

\[ y = 100 \]

• Is this answer correct? NO
Introduction to Equations

• If y=100, and $25 \times y = 20 \times 5$
  – Does the equation balance out with the new information?

$25 \times 100 = 20 \times 5$
$2500 \neq 100$

• The equation is no longer balanced so it is untrue

Introduction to Equations

$25 \times y = 20 \times 5$

• How do we solve for the unknown without losing the balance?
  – Whatever we do to one side of the equation, we must also do to the other side

$\frac{25 \times y}{25} = \frac{20 \times 5}{25}$
$1 \times y = \frac{100}{25}$
$y = 4$

• Now, is the answer correct? YES
Introduction to Equations

• If $y=4$, and $25 \times y = 20 \times 5$
  – Does the equation balance out with the new information?

$$25 \times 4 = 20 \times 5$$
$$100 = 100$$

• The equation is balanced

Solving for $X$

• Rules for solving for $X$:
  – $X$ in numerator (top of fraction)
  – $X$ positive
  – $X$ alone
• Questions to ask:
  1. Is $X$ in the numerator and positive?
     • If no, use proper operations to move $X$ to other side of equal sign
  2. Is $X$ alone?
  3. What is keeping $X$ from being alone?
  4. What is it doing to $X$?
  5. What do we have to do to get rid of it?
Example 1

\[
x - 7 = 10
\]

\[
+7 \quad +7
\]

\[
x + 0 = 10 + 7
\]

\[
x = 17
\]

Example 2

\[
115 + 105 + 80 + x = 386
\]

Step 1. Simplify

\[
\begin{array}{c}
\frac{115}{300} \\
+105 \\
+80 \\
\end{array}
\]

\[
\begin{array}{c}
300 \quad x = 386 \\
\frac{300}{300} \\
\frac{300}{300} \\
\end{array}
\]

\[
0 + x = 386 - 300
\]

\[
x = 86
\]
Example 4

$17 + 23 + 7 - x = 38$

Step 1. Simplify

$$\begin{align*}
17 + 23 + 7 & = 47 \\
47 - x & = 38 \\
47 - 0 & = 38 + x \\
-38 & = -38 \\
9 & = x
\end{align*}$$

Step 2. Make $x$ positive

Example 1

$$730 = \frac{x}{3847}$$

Whatever you do to one side of the equation, must be done to the other side.
Example 2

Step 1. Simplify

What you do to one side of the equation, must be done to the other side.

\[
0.5 = \frac{(165)(3)(8.34)}{x}
\]

Solving for \(X^2\)

- Follow same procedure as solving for \(X\)
- Then take the square root

\[
x^2 = 15,625
\]

\[
\sqrt{x^2} = \sqrt{15,625}
\]

\[
x = 125
\]
Example 5

\[(0.785)(x^2) = 2826\]

\[
\frac{(0.785)(x^2)}{0.785} = \frac{2826}{0.785}
\]

\[x^2 = \frac{2826}{0.785}\]

\[x^2 = 3600\]

\[\sqrt{x^2} = \sqrt{3600}\]

\[x = 60\]
Solve for the unknown value.

**Addition**

1) \(3 + g = 10\)

4) \(7 + 10 + x + 7 + 9 = 41\)

2) \(x + 2 = 3\)

5) \(x + 93 = 165\)

3) \(x + 15 = 19 + 22\)

6) \(10.1 = 9.5 + x\)

**Subtraction**

7) \(3 = k - 2\)

10) \(9.5 - x = 8.7\)

8) \(x - 2 = 9\)

11) \(115 = x - 7.5\)

9) \(x - 93 = 65\)

**Multiplication**

12) \(10 = (2)(w)\)

13) \((5)(m) = 10\)

14) \(48 = (6)(m)\)
15) 16 = (2)(x)

16) (0.785)(0.33)(0.33)(x) = 0.49

17) 8.1 = (3)(x)(1.5)

18) 19,747 = (20)(12)(x)(7.48)

Division

19) 12 = \frac{t}{8}

20) 10 = \frac{x}{4}

21) \frac{2}{e} = 6

22) \frac{100}{x} = 50
23) \[ x = \frac{(165)(3)(8.34)}{0.5} \]

24) \[ 400 = \frac{(1.8)(x)}{42} \]

25) \[ 940 = \frac{x}{(0.785)(90)(90)} \]

26) \[ 56.5 = \frac{3800}{(x)(8.34)} \]

27) \[ 114 = \frac{(230)(1.15)(8.34)}{(0.785)(70)(70)(x)} \]

**Assorted Operations**

28) \[ 2 = \frac{x}{180} \]

29) \[ (5)(x) + 9 = 9 \]

30) \[ \frac{233}{x} = 44 \]
31) \[ 6 = \frac{(x)(0.18)(8.34)}{(65)(1.3)(8.34)} \]

32) \[ \frac{(3000)(3.6)(8.34)}{(0.785)(x^2)} = 23.4 \]

33) \[ (3.5)(x) - 62 = 560 \]

34) \[ 46 = \frac{(105)(x)(8.34)}{(0.785)(100)(100)(4)} \]

35) \[ 2.4 = \frac{(0.785)(5)(5)(4)(7.48)}{x} \]

36) \[ (x)(3.7)(8.34) = 3620 \]

37) \[ \frac{(15)(12)(1.25)(7.48)}{x} = 337 \]

38) \[ \frac{10}{x} = 50 \]
39) \( \frac{x}{(4.5)(8.34)} = 213 \)

40) \( 142 = (2)(x) + 13 \)

41) \( 109 = \frac{x}{(0.785)(80)(80)} \)

42) \( 2.5 = \frac{1,270,000}{x} \)

43) \( 0.59 = \frac{(170)(2.42)(8.34)}{(1980)(x)(8.34)} \)

44) \( 7 + (6)(x) = 37 \)

45) \( \frac{m-9}{8} = 4 \)

46) \( 2 = \frac{x+5}{9} \)

47) \( (7)(f) - 16 = 12 \)
<table>
<thead>
<tr>
<th></th>
<th>Solving Equations Practice Problems</th>
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<tr>
<td>1</td>
<td>g = 7</td>
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<td>13</td>
<td>m = 2</td>
<td>33</td>
</tr>
<tr>
<td>14</td>
<td>8 = m</td>
<td>34</td>
</tr>
<tr>
<td>15</td>
<td>8 = x</td>
<td>35</td>
</tr>
<tr>
<td>16</td>
<td>1.8 = x</td>
<td>36</td>
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<td>x = 5.7319</td>
<td>37</td>
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<tr>
<td>18</td>
<td>11.0 = x</td>
<td>38</td>
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<td>19</td>
<td>96 = t</td>
<td>39</td>
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<tr>
<td>20</td>
<td>40 = x</td>
<td>40</td>
</tr>
</tbody>
</table>

Answers

Solving Equations and Variables
Section 3

Metric System
METRIC SYSTEM

Metric System

• The metric system is a system of measurement that uses the meter, liter, and gram as base units of length, volume, and weight.
• US uses Imperial or Standard System of Measurement
• Metric prefixes are:
  - Mega-
  - Kilo-
  - Hecto-
  - Deka-
  - Deci-
  - Centi-
  - Milli-
  - Micro-

• When converting base units, move the decimal one place.
• When converting square units, move the decimal two places for each movement on the diagram.
• When converting cubic units, move the decimal three places for each movement on the diagram.
Metric System Conversions

• Based in units or powers of ten
• Converting from one unit to another involves just a movement of the decimal point

To convert from one unit to another:
1. Locate the place value of the units you wish to convert.
2. Locate the place value of the desired unit.
3. Move the decimal point of the number to the right or left the same number of places indicated by the diagram.

Example: Convert 2500 mL into L.
1. .
2. .
3. Move 3 places to the left.

\[ 2500 \text{ mL} = \]
Section 4
Dimensional Analysis
CONVERSIONS

Chapter 8
“Box Method” of Conversions
Metric System Conversions

“Box Method” of Conversions

• Helps to determine if you multiply or divide to convert units
• Three considerations:
  • When moving from a smaller box to a larger box, multiply.
  • When moving from a larger box to a smaller box, divide.
  • Be sure the unit with the number 1 associated with it is on the left and always have a number greater than 1 on the right side of the equation.

1 mile = 5280 ft
“Box Method” of Conversions

• Step 1. Draw box diagram.
  • Make two boxes, one smaller and one larger.
  • Box on left will always hold the number 1 and therefore be the smaller box.
• Step 2. Determine if need to multiply or divide.

Example (multiplying): 12 kW is equivalent to how many horsepower? (1 kW = 1.341 hp)

1. Draw box diagram. Place unit with 1 associated with it in small box.

   \[
   \begin{array}{c}
   \text{kW} \\
   \rightarrow \\
   \text{hp}
   \end{array}
   \]

2. Going from kW to hp means going from left to right so we multiply by 1.341

   \[
   \begin{align*}
   \text{hp} &= (12 \text{ kW}) \left( \frac{1.341 \text{ hp}}{1 \text{ kW}} \right) \\
   &= \frac{(12 \text{ kW})(1.341 \text{ hp})}{(1)(1 \text{ kW})} \\
   \text{hp} &= \frac{16.092 \text{ kW} \cdot \text{hp}}{1 \text{ kW}} = 16.092 \text{ hp}
   \end{align*}
   \]
“Box Method” of Conversions

• Example (dividing): Express 5.1 feet in terms of meters. (1 m = 3.28 ft)

1. Draw box diagram. Place unit with 1 associated with it in small box.

   \[
   \begin{array}{c}
   \text{m} \\
   \text{ft}
   \end{array}
   \]

2. To go from feet (ft) to meters (m) means going from a larger to smaller box, so we divide by 3.28

   \[
   m = \frac{5.1 \text{ ft}}{3.28 \text{ ft/m}} = 1.5549 \text{ m}
   \]

• If conversion contains a decimal fraction (value less than 1):

1. Divide both sides by decimal fraction
2. Set up conversion using box method

• Example: Express 8.2 feet in terms of meters. (1 ft = 0.3048 m)

   \[
   \begin{array}{c}
   \text{ft} \\
   \text{m}
   \end{array}
   \]

1. \[
   \frac{1 \text{ ft}}{0.3048 \text{ m}} = \frac{0.3048 \text{ m}}{0.3048 \text{ m}}
   \]
   \[
   \frac{1 \text{ ft}}{0.3048 \text{ m}} = 3.28 \text{ ft/m}
   \]
   
   1 meter = 3.25 ft

2. \[
   (8.2 \text{ feet}) \div \left( 3.28 \frac{\text{m}}{\text{ft}} \right) = 2.5 \text{ ft}
   \]
Dimensional Analysis - Basics

- Basic concepts involved when using dimensional analysis:
  - Units written in abbreviated or horizontal form should be written in a vertical format.
  - Any unit which is a common factor to both the numerator and denominator of a fraction may be divided out.
  - An exponent of a unit indicates how many times that unit is to be multiplied together.
  - Expression can be rewritten in expanded form.
Dimensional Analysis

• The process of manipulating our units of measurement is called *dimensional analysis*.

• An easy way to think of this is to imagine a ruler that has inches on one side and centimeters on the other.

  • If we measure a piece of string with either side, we get two different numbers with different units, but they represent the same real-world length.

  • That is the goal of dimensional analysis: to get the same real-world value represented with different units.

---

Dimensional Analysis

• To solve a problem using dimensional analysis:
  1. Identify the starting factor.
  2. Identify answer units.
  3. Determine conversion factors needed.
  4. Set conversion factor to multiply the starting factor.
      • Ensure the conversion factors are in the correct format.
  5. Cancel units that appear in both the numerator and denominator.
  6. Simplify the fractions.
  7. Solve.
Dimensional Analysis - Example

Set up a conversion to change 756 centimeters into inches.

1. Identify starting factor: 756 cm
2. Identify answer units: inches
3. Determine conversion factor(s) needed: 1 in = 2.54 cm
4. Set up original factor to multiply conversion factor.
   • Ensure correct set up by paying attention to the units.
   \[
   \left( \frac{756 \text{ cm}}{1} \right) \left( \frac{1 \text{ inch}}{2.54 \text{ cm}} \right) = ?
   \]
   \[
   \frac{(756)(\text{cm})(1)(\text{inch})}{(1)(2.54)(\text{cm})} = ?
   \]

Dimensional Analysis - Example (cont'd)

5. Eliminate common factors in numerator and denominator (cancel like units)
   \[
   \frac{(756)(1 \text{ cm})(1)(\text{inch})}{(1)(2.54)(1 \text{ cm})}
   \]

6. Simplify the fractions.
   \[
   \frac{756 \text{ in}}{2.54}
   \]

7. Solve.
   \[
   297.64 \text{ ft}
   \]
### Dimensional Analysis & Complex Fractions

- When the units of a given problem are written as a complex fraction, one simple rule will help convert this to a basic problem:
  - Invert the denominator and multiply.

**Example:**

\[
\frac{4140 \text{ gal}}{1 \text{ min}} \div \left( \frac{60 \text{ sec}}{1 \text{ min}} \right) = ? \text{ gps}
\]

\[
\frac{4140 \text{ gal}}{60 \text{ sec}} = ? \text{ gps}
\]

\[
\frac{4140 \text{ gal}}{1 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}} = ? \text{ gps}
\]

\[
\frac{(4140) \text{ (gal)}}{(1 \text{ min})} \times \frac{(1 \text{ min})}{(60 \text{ (sec)})} = ? \text{ gps}
\]

\[
? \text{ gps} = \frac{(4140) \text{ (gal)}}{(60 \text{ (sec)})} = 69 \text{ gal} \text{ sec}
\]

---

### Metric - English Conversions

- To convert between metric and standard (English) units:
  - Find conversion equation that relates the units given to those desired.
  - Use the box method of conversions to complete the conversion.
  - Make final metric system conversions, if needed.
Basic Math
Dimensional Analysis Practice Problems

Use dimensional analysis to solve the following equations.

1. 4200 feet = ___________ miles
2. 17 feet = ___________ yds
3. 30 yds = ___________ inches
4. 70 cm = ___________ inches
5. 0.6 feet = ___________ inches
6. 492 inches = ___________ feet
7. 20 feet = ___________ m
8. 35 yds = ___________ feet
9. ¼ mile = ___________ feet
10. 122 inches = ___________ feet
11. 28 in = ___________ ft
12. 4.7 mi = ___________ ft
13. 3.7 ft = ___________ in.
14. 1800 ft = ___________ mi
15. 260 ft = ___________ yds
16. 200 mm = ___________ m
17. 32 in = ___________ cm
18. 105 yds = ___________ m
19. 37 m = ___________ yds
20. 100 cm = ___________ in.
21. 40 km = ___________ m
22. 180 mm = ___________ m
23. 78.5 in² = ___________ ft²
24. 0.9 acre = ___________ ft²
25. 4 acres = ___________ ft²
26. 500 yd² = ___________ ft²
27. 9.5 ft² = ___________ in²
28. 25,000 ft² = ___________ acres
<p>| | | | | | |</p>
<table>
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<tr>
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<th></th>
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<tr>
<td>29.</td>
<td>1 yd² =</td>
<td>___________</td>
<td>in²</td>
<td>45.</td>
<td>1017 in² =</td>
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<tr>
<td>30.</td>
<td>1,640 yd² =</td>
<td>___________</td>
<td>ft²</td>
<td>46.</td>
<td>25 yd³ =</td>
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<tr>
<td>31.</td>
<td>135,000 ft² =</td>
<td>___________</td>
<td>ac</td>
<td>47.</td>
<td>2.2 ac-ft =</td>
</tr>
<tr>
<td>32.</td>
<td>4.8 ac =</td>
<td>___________</td>
<td>sq ft</td>
<td>48.</td>
<td>0.6 yd³ =</td>
</tr>
<tr>
<td>33.</td>
<td>0.46 ac =</td>
<td>___________</td>
<td>sq ft</td>
<td>49.</td>
<td>17,260 ft³ =</td>
</tr>
<tr>
<td>34.</td>
<td>2,100 sq in =</td>
<td>___________</td>
<td>sq ft</td>
<td>50.</td>
<td>1500 in³ =</td>
</tr>
<tr>
<td>35.</td>
<td>520 mL =</td>
<td>___________</td>
<td>L</td>
<td>51.</td>
<td>2.7 gal =</td>
</tr>
<tr>
<td>36.</td>
<td>2.5 L =</td>
<td>___________</td>
<td>mL</td>
<td>52.</td>
<td>50 L =</td>
</tr>
<tr>
<td>37.</td>
<td>120 ft³ =</td>
<td>___________</td>
<td>m³</td>
<td>53.</td>
<td>1 lb =</td>
</tr>
<tr>
<td>38.</td>
<td>250 mL =</td>
<td>___________</td>
<td>fl. oz</td>
<td>54.</td>
<td>21 ft³ =</td>
</tr>
<tr>
<td>39.</td>
<td>2400 mL =</td>
<td>___________</td>
<td>L</td>
<td>55.</td>
<td>600 mL =</td>
</tr>
<tr>
<td>40.</td>
<td>15 L =</td>
<td>___________</td>
<td>mL</td>
<td>56.</td>
<td>92,600 ft³ =</td>
</tr>
<tr>
<td>41.</td>
<td>250,000 m² =</td>
<td>___________</td>
<td>km²</td>
<td>57.</td>
<td>3 ft³ =</td>
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<tr>
<td>42.</td>
<td>2.2 mL =</td>
<td>___________</td>
<td>L</td>
<td>58.</td>
<td>48,000 cu ft =</td>
</tr>
<tr>
<td>43.</td>
<td>155,000 mm³ =</td>
<td>___________</td>
<td>cm³</td>
<td>59.</td>
<td>310,000 lbs =</td>
</tr>
<tr>
<td>44.</td>
<td>40 ft³ =</td>
<td>___________</td>
<td>m³</td>
<td>60.</td>
<td>186,000 gal =</td>
</tr>
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</table>
61. $120 \text{ ft}^3 = \underline{\phantom{0000}} \text{ lbs}$

62. $81,400 \text{ lbs} = \underline{\phantom{0000}} \text{ gal}$

63. $35,300 \text{ ft}^3 = \underline{\phantom{0000}} \text{ gal}$

64. $1.75 \text{ ac-ft} = \underline{\phantom{0000}} \text{ ft}^3$

65. $42 \text{ yds}^3 = \underline{\phantom{0000}} \text{ ft}^3$

66. $420,000 \text{ ft}^3 = \underline{\phantom{0000}} \text{ ac-ft}$

67. $128,355 \text{ in}^3 = \underline{\phantom{0000}} \text{ ft}^3$

68. $145 \text{ mg} = \underline{\phantom{0000}} \text{ g}$

69. $12 \text{ g} = \underline{\phantom{0000}} \text{ mg}$

70. $515 \text{ lbs} = \underline{\phantom{0000}} \text{ kg}$

71. $75 \text{ kg} = \underline{\phantom{0000}} \text{ lbs}$

72. $30 \text{ hp} = \underline{\phantom{0000}} \text{ kW}$

73. $8 \text{ g} = \underline{\phantom{0000}} \text{ g}$

74. $230 \text{ mg} = \underline{\phantom{0000}} \text{ g}$

75. $30 \text{ kg} = \underline{\phantom{0000}} \text{ g}$

76. $320 \text{ mg/L} = \underline{\phantom{0000}} \%$

77. $210 \text{ mg/L} = \underline{\phantom{0000}} \%$

78. $1.2\% = \underline{\phantom{0000}} \text{ mg/L}$

79. $0.26\% = \underline{\phantom{0000}} \text{ mg/L}$

80. $0.01\% = \underline{\phantom{0000}} \text{ mg/L}$

81. $12 \text{ gpg} = \underline{\phantom{0000}} \text{ mg/L}$

82. $110 \text{ mg/L} = \underline{\phantom{0000}} \text{ gpg}$

83. $9.1 \text{ gpg} = \underline{\phantom{0000}} \text{ mg/L}$

84. $14.2 \text{ gpg} = \underline{\phantom{0000}} \text{ mg/L}$

85. $195 \text{ mg/L} = \underline{\phantom{0000}} \text{ gpg}$

86. $18 \text{ kW} = \underline{\phantom{0000}} \text{ hp}$

87. $3.6 \text{ cfs} = \underline{\phantom{0000}} \text{ gpm}$

88. $1820 \text{ gpm} = \underline{\phantom{0000}} \text{ gpd}$

89. $45 \text{ gps} = \underline{\phantom{0000}} \text{ cfs}$

90. $8.6 \text{ MGD} = \underline{\phantom{0000}} \text{ gpm}$

91. $2.92 \text{ MGD} = \underline{\phantom{0000}} \text{ gpm}$

92. $385 \text{ cfm} = \underline{\phantom{0000}} \text{ gpd}$
93. $1,662,000 \text{ gpd} = \underline{\text{？}} \text{ gpm}$  \hspace{1cm} 94. $3.77 \text{ cfs} = \underline{\text{？}} \text{ MGD}$

**Conversion Word Problems (WW and DS so far)**

95. The total weir length for a sedimentation tank is 142 feet 7 inches. Express this length in terms of feet only.

96. A one-eighth mile section of pipeline is to be replaced. How many feet of pipeline is this?

97. 2.7 miles of pipe is how many meters?

98. The distance between your plant and the nearest customer is 1.535 kilometers. What is this distance in miles?

99. The length of the pipe between Main St. and Beach Ave. as measured on a map is 0.224 miles. The purchasing department requires you to submit all distances in feet when you place an order for new pipes. What is the distance in feet?
100. The depth of water in the grit channel is 52 inches. What is the depth in feet?

101. The length of pipe between Main Street and Beach Avenue as measured on a map is 0.224 miles. The purchasing department requires you to submit all distances in feet when you place an order for new pipes. What is the distance in feet?

102. The Mountaintop Water Distribution System has approximately 2,430 miles of pipelines delivering water to customers. A visitor from Great Britain asks for the system pipe length in kilometers. Calculate the length in km.

103. The length of the pipe connecting the Lear Reservoir to the distribution system is 2.45 miles. What is this length in feet?

104. The length of the pipe connecting the Lear Reservoir to the distribution system is 2.45 miles. What is this length in feet?

105. The diameter of the transmission pipe from Silver Lake to the Charles Thorpe Treatment Plant is 48 inches. What is the diameter in feet?
106. The distance between Deco St. and Sand Ave. is 368 yards. What is this distance in inches?

107. The distance between your plant and the nearest customer is 1.535 kilometers. What is this distance in yards?

108. Express 5.1 feet in terms of meters.

109. For solids treatment, a total of 60,000 ft$^2$ will be required. How many acres is this?

110. A pipe has a cross-sectional area of 452 in$^2$. How many ft$^2$ is this?

111. The minimum area required for building a 1 MG storage facility is 900 ft$^2$. What is this size in acres?

112. During a fire flow test at hydrant No. 22456, the gauge shows a flow of 3.3 cubic feet per second at a pressure of 20 PSI. To satisfy local fire code reporting requirements, calculate the flow rate be reported in gallons per minute.
113. Fire flow tests were conducted and lasted 2 hours and showed an average flow of 897 gpm. Convert the flow from gpm to ac-ft/day so the production department can estimate the amount of non-revenue water flowed during the test.

114. Based on the required chlorine residual in the distribution system, you need to set your booster chlorinator pump at 34 gpd. The calibration chamber at the pump inlet is graduated in milliliters. What is the required setting in mL/min?

115. The Three Crowns Water System has a maximum daily demand of approximately 250 MGD. A visitor from France asks what that is in m$^3$/day. What should you tell the visitor?

116. The minimum area required for building a 1-MG storage reservoir is 900 ft$^2$. What is this area in acres?

117. The foundation area required for your new chemical storage building is 2,880 in$^2$. What is the area of this foundation in ft$^2$?

118. The Three Crowns Water System franchise area covers an area of 3.2141 square miles. What is this service area in acres?
119. The foundation for your new storage tank requires an area of 53.2 yd². What is the area of foundation in m²?

120. From your maps, measurements, and calculations, the southwest corner of the Beach Ave. and Main St. intersection is 4,569 m². What is this area in square inches?

121. One gallon is equivalent to 3.785 liters. How many gallons are equivalent to 75 L?

122. A screening pit must have a capacity of 400 ft³. How many yd³ is this?

123. A reservoir contains 50 ac-ft of water. How many ft³ of water does it contain?

124. How many gallons of sludge can be pumped to a digester that has 3,400 ft³ of volume available?

125. How many cubic feet of sludge are removed when 16,000 gal are withdrawn?
126. If 1,400 gal of solids are removed from the primary settling tank, how many pounds of solids are removed?

127. How many gallons are required to fill a tank that holds 6,500 lb of water?

128. How many pounds does exactly 100 gal of water weigh?

129. How many gallons are there in 82 ft$^3$?

130. Convert 2,445 gal to cubic feet.

131. How much does 725 gal of water weigh in pounds?

132. Convert 15.0 acre-ft to cubic feet.

133. Convert 4,078,611 ft$^3$ to acre-feet.
134. How many million gallons are there in 22 ac-ft?

135. How many million gallons are there in 43,000 ac-ft?

136. How many gallons are there in 8,492 ft³?

137. Convert 45 lb/MG to mg/L.

138. Sunny Slope water system daily maximum demand is 556,000 gallons. What is this system demand in ft³?

139. Based on the dimensions of your storage reservoir, you calculate the total volume to be 210,000 ft³. How many million gallons (MG) of water can you store at this reservoir?

140. The operator withdraws 5,690 gal of solids from the digester. How many pounds of solids have been removed?
141. Sludge added to the digester causes 2,996 cubic foot change in the volume of sludge in the digester. How many gallons of sludge have been added?

142. A trench is to be excavated 3 feet wide, 5 feet deep, and 800 feet long. The total amount of soil removed will be 12,000 ft³. What is the volume in cubic yards of the trench?

143. While repairing a leak on Main Street, the field crew excavated a rectangular area with dimensions of approximately 8 ft x 11 ft x 24 ft. You are required to order fill material for the excavation in cubic yards. Based on your calculations, the volume of the excavation is 2,112 ft³. What is the volume in yd³?

144. Sunny Slope Water System serves a small mountain community, which has a daily average water demand of 367,800 gallons. Calculate the capacity of a storage tank that can supply this amount of daily demand in cubic feet.

145. A tank has a capacity of 60,000 ft³. What is the gallon capacity of the tank?

146. 550,000 lbs of digested sludge are to be sent to the drying beds. Assuming each gallon of digested sludge weighs 8.34 lb/gal, how many ft³ will be sent to the drying beds?
147. A tank contains 188,000 gallons. How many cubic feet is this?

148. Convert 60,000 lbs of sludge to ft³. Assume the sludge weighs the same as water, 8.34 lb/gal.

149. If a tank contains 107,000 lbs of water, how many gallons of water does it contain?

150. How much does 20 ft³ of water weigh in kg?

151. A tank contains 500 gallons of water. How many lbs of water does it contain?

152. The required volume for a screening pits is 325 ft³. What is this volume in yd³?

153. The capacity of a small segment of pipeline has been calculated to be 2,512 in³. How many ft³ is this?
   a. 1.4537 ft³
154. The volume of a trickling filter is 20,000 ft\(^3\). To calculate the organic loading as gpd/ac-ft, the volume must be expressed as ac-ft. What is the volume of the trickling filter in acre-feet?

155. After conducting a hydrant fire flow test for 4 hours, you estimated the volume of water used to be approximately 47,000 gallons. What is the volume of water used in ac-ft?

156. The excavation at the corner of Main Ave. and Chicago St. requires 134 ft\(^3\) of fill material. What is the required amount of fill material in yd\(^3\)?

157. Based on the dimensions of your storage reservoir, you calculate the total volume to be 210,000 ft\(^3\). How many million gallons (MG) of water can you store at this reservoir?

158. The flow through a pipeline is 8.4 cfs. What is the flow in gpd?

159. A treatment plant receives a flow of 6.31 MGD. What is the flow in gpm?

160. Convert 8.2 ft\(^3\)/sec to gallons per minute.
   a. 3,680.16 gal/min
161. Convert 5.1 MGD to cfs.

162. Convert 11.9 MGD to cubic feet per second.

163. Convert 5.6 ft³/sec to gallons per minute.

164. Convert 3.2 ft³/sec to millions of gallons per day.

165. During a fire flow test, the gauge shows a flow of 79.3 ft³/sec. What is the flow at this location in ac-ft/day?

166. Based on your measurements, the maximum flow out of a ¼ inch pipe at your chemical pump effluent is 24.5 gpd. What is the flow rate in mL/min?

167. The current flow rate is 4.55 MGD. What is the flow rate in gallons per minute?

168. The influent meter reads 27.8 MGD. What is the current flow rate in gallons per day?
169. The flow rate entering the grit channel is 2.39 MGD. What is the flow rate in cubic feet per second?

170. The flow meter indicates that the current flow rate is 1,469 gpm. What is the flow rate in MGD?

171. The totalizing flow meter indicates that 30,669,969 gallons of wastewater have entered the treatment plant in the last 24 hours. What is this flow rate in MGD?

172. The flow in a channel is determined to be 3.96 cubic feet per second. What is the flow rate in millions of gallons per day?

173. The flow in a pipeline is 2.3 cfs, what is this flow in gpm?

174. The flow to a treatment plant is 2,450,000 gpd. At this rate, what is the average cfs flow?

175. A flow of 4.61 MGD is equivalent to a flow of how many cfs?
176. The flow through a pipeline is 2.8 cfs. What is this flow in gpd?

177. A treatment plant receives a flow of 3.61 MGD. What is this flow in gpm?

178. The Three Crowns Water System minimum water demand per day is 198 MGD. What is the minimum demand in ft³/sec?

179. The Top View Reservoir that supplies water to Pressure Zone No. 3 holds 2 MG and the maximum flow out of the reservoir is 2 MGD. What is the flow out of the reservoir in m³/day?

180. Based on an MSDS sheet, the lethal oral dosage of your cleaning solution is 0.66 g/11 kg. What is this dosage in oz/lb?

181. Convert the concentration of a solution that has 52,600 ppm to a percent.

182. 12 kW is equivalent to how many horsepower?

183. The suspended solids concentration of a primary clarifier is 340 mg/L. What is this concentration expressed as a %?
184. A waste activated sludge has a total solids concentration of 0.6%. What is this expressed as mg/L?

185. The suspended solids concentration of the return activated sludge is 6800 mg/L. What is this concentration expressed as a percent?

186. A concentration of 195 mg/L is equivalent to a concentration of what percent?

187. The suspended solids in a water measures 2 gpg. What is this concentration in mg/L?

188. A suspended solid removal is 110 mg/L. What is this concentration in grains per gallon?

189. During a fire flow test at Beach Ave. the gauge shows a flow of 79.3 L/sec. What is the flow at this location in ac-ft/day?

190. During a fire flow test at Brady Ave. the gauge shows a flow of 2.6 ft³/sec. What is the flow at this location in gpm?
191. In the process of preparing an ammonia analyzer calibration solution, you are required to mix 500 g of powder into 1 gallon of water. What is the weight of the powder in lb?

192. Your specialized tool shipment from Europe is going to cost you $24 per kilogram to ship. How many pounds can you ship for $75?

193. A total of 5.4 lbs of hypochlorite are dissolved in 80 gallons of water. For a solution with the same concentration, how many pounds of hypochlorite must be dissolved in 30 gallons of water?

194. You are asked to calculate the volume of a 20-ft section of 18-inch diameter steel pipe. The volume of the pipe is needed as part of the calculations to determine the amount of chlorine powder to uses to disinfect this section of pipe. However, to be able to calculate the volume, you will need to convert the pipe diameter from inches to feet. What is the diameter of the pipe in feet?

195. The service area of Pine Creek Water Authority covers approximate 36 mi\(^2\). To estimate the population density in this area, the engineering department needs you to calculate the size of the service area in acres.

196. You need to order 2.4 metric tons of fill material to your job site at the corner of Beach Ave. and Main St. What is the weight of your order in pounds?
197. In the process of preparing a free-chlorine analyzer calibration solution, you are required to mix 50 grams of powder into 100 ml of water. What is the weight of the powder in lb?

198. After completing work on the well #6 you are required to disinfect the well with 200 mg/L of free chlorine. As part of the calculations to estimate the required amount of chlorine, you calculate the volume of water in the well to be 400 cm$^3$. What is the volume of the water in the well in gallons?

199. Convert 23 lb/million gallons to milligrams per liter.

200. A circular clarifier receives a flow 2.7 MGD. If the surface loading rate is 428 gpd/sq ft, what is the sq ft area of the clarifier?

201. The average flow to a stabilization pond is 520 gpm. What cubic feet volume will be required for the pond if a 30-day retention time is desired? (Assume the flow to the pond is steady and continuous.)
Section 5
Perimeter, Circumference and Area
PERIMETER AND CIRCUMFERENCE

Basic Math for All Certifications

**Perimeter**

- Distance around any angular area or object

- General perimeter equation:
  \[ P = L_1 + L_2 + L_3 + L_4 + \ldots \]

- Perimeter of a square
  \[ P = 4 \times L \]

- Perimeter of a rectangle
  \[ P = (2)(L) + (2)(W) \]
Parts of a Circle

- **Diameter** is distance across the center of a circle.
- **Radius** is distance from circle's center to the edge.
- **Circumference** is the distance around a circle or a circular object.
- **Pi** (3.14) is a mathematical constant.
  - $\pi = 3.14159265359$

Circumference = (3.14)(Diameter)

Example 1

- Find the circumference of a 6-inch diameter pipe.
  
  Circumference = ($\pi$)(diameter)
  
  $C = (3.14)(6 \text{ inches})$
  
  $C = 18.84 \text{ inches}$

- Find the perimeter of a rectangular tank that is 15 ft by 22 ft.
  
  Perimeter = 2(length) + 2(width)
  
  $P = 2(15 \text{ ft}) + 2(22 \text{ ft})$
  
  $P = 30 \text{ ft} + 44 \text{ ft}$
  
  $P = 74 \text{ ft}$
Suggested Strategy

• Disregarding all numbers, what type of problem is it?
  • What diagram, if any, is associated with the concept identified?
• What information is required to solve the problem and how is it expressed in the problem?
  • Create a Table of Data
• Which formula best matches the information given?
  • Can anything be converted so it does match?
• Plug values into formula.
  • Be sure to make the units match with the formula.
• What is the final answer?
• Does the answer make sense?

Area

• Area is the measurement of the amount of space on the surface of an object
• Two-dimensional measurement
• Measured in: in², ft², mi², m², acres
  • Units will always come out squared
Area of Rectangle

Area = (length)(width)

\[ A = (L)(W) \]

Example 1

- Find the area in ft\(^2\) of a rectangular basin that is 20 feet long and 17 feet wide.

\[ A = (L)(W) \]

\[ A = (20 \text{ ft})(17 \text{ ft}) \]

\[ A = 340 \text{ ft}^2 \]
Area of a Circle

Area = (0.785) (Diameter)²

A = (0.785)(D)²

A circle takes up 78.5% of a square.

Example 2

• Find the area of the cross section of a pipe in ft² that has a diameter of 2 feet.

Area = (0.785)(D)²

A = (0.785)(2 ft)(2 ft)

A = 3.14 ft²
Area of Right Triangle

\[ \text{Area} = \frac{\text{(base)} \times \text{(height)}}{2} \]

\[ A = \frac{b \times h}{2} \]

Example 3

- Determine the area in ft\(^2\) of a right triangle where the base is 23 feet long with a height of 16 feet.

\[ A = \frac{(23 \, \text{ft}) \times (16 \, \text{ft})}{2} \]

\[ A = \frac{368 \, \text{ft}^2}{2} \]

\[ A = 184 \, \text{ft}^2 \]
Area of Cylinder

Total Exterior Surface Area

Area

\[ A = A_1 + A_2 + [(3.14)(D)h]\]

Example 4

- Find the total exterior surface area (in ft\(^2\)) of a pipeline that is 2 ft in diameter and 20 feet long.

\[
A = A_1 + A_2 + [(3.14)(D)(h)]
\]

\[
A_1 = (0.785)(D)^2
\]

\[
A_1 = (0.785)(2ft)(2ft)
\]

\[
A_1 = 3.14ft^2
\]

\[
A = 3.14ft^2 + 3.14ft^2 + [(3.14)(2ft)(20ft)]
\]

\[
A = 3.14ft^2 + 3.14ft^2 + 125.6ft^2
\]

\[
A = 131.88 \text{ ft}^2
\]
Area of Cone - Lateral Surface Area

Area = (3.14)(radius)\sqrt{radius^2 + height^2}

\[ A = (3.14)(r)\sqrt{r^2 + h^2} \]

Example 5

• Find the lateral area (in ft²) of a cone that is 3 feet tall and has a radius of 1.5 feet.

\[ A = (3.14)(1.5\text{ft})\sqrt{(1.5\text{ft})(1.5\text{ft}) + (3\text{ft})(3\text{ft})} \]

\[ A = (3.14)(1.5\text{ft})\sqrt{2.25\text{ft}^2 + 9\text{ft}^2} \]

\[ A = (3.14)(1.5\text{ft})\sqrt{11.25\text{ft}^2} \]

\[ A = (3.14)(1.5\text{ft})(3.3541\text{ft}) \]

\[ A = 15.80\text{ft}^2 \]
Area of Cone - Total Surface Area

\[ A = (3.14)(r)(r + \sqrt{r^2 + h^2}) \]

Example 6

• Find the total surface area in ft² of a cone that is 4.5 feet deep with a diameter of 6 feet.

\[ A = (3.14)(3ft)(3ft + \sqrt{(3ft)(3ft) + (4.5ft)(4.5ft)}) \]
\[ A = (3.14)(3ft)(3ft + 29.25ft^2) \]
\[ A = (3.14)(3ft)(8.4083ft) \]
\[ A = 79.21ft^2 \]
Basic Math
Perimeter, Circumference, and Area
Practice Problems

Perimeter Calculations

1. Three sides of an object measure 25 ft, 78 ft, and 55 ft. What is the length of the fourth side (in feet) if the perimeter measures 240 ft?

2. What is the perimeter (feet) of a rectangular tank that is 50 feet long and 20 feet wide?

3. The lengths of each side of a fenced area are as follows: 87 ft, 100 ft, 82 ft, 105 ft. What is the perimeter of the fenced area in feet?

Circumference

4. The diameter of a circle is 50 ft. What is the distance around the circle in feet?

5. If the radius of a circle is 5 ft, what is the circumference of that circle in feet?

6. The diameter of a storage tank is 60 ft. What is the distance around the tank in feet?
Area of a Rectangle

7. Find the area in square feet for a rectangular shaped sedimentation basin that is 392 ft in length and 71.5 ft in width.

8. A basin is 12 ft by 22 ft. What is the surface area of the water in ft²?

9. A tank is 60 feet long, 15 feet wide, and 10 feet deep. What is the area in ft²?

10. What is the surface area (ft²) of a rectangular settling basin 42.2 ft long by 12.9 ft wide?

11. A rectangle has a length of 5 feet and a width of 3 feet. What is the square feet area of the rectangle?

Area of a Triangle

12. What is the area (ft²) of a triangle that has a base of 50 ft and a height of 32 ft?

13. Calculate the area (ft²) of a triangle with a base of 32 meters and height of 62 meters.

Area of a Circle

14. What is the area, in ft², of a tank if the tank's diameter is 30.4 feet?
15. A new 12 inch main must be installed. The total amount of pipe needed will be 5280 feet. What is the cross-sectional area in ft$^2$?

16. What is the cross-sectional area in ft$^2$ of a pipe that is 14 inches in diameter?

17. The diameter of a circle is 5 feet. What is its area?

**Total Exterior Surface Area of a Cylinder**

18. A pipeline 1250-ft long has been capped and needs to be wrapped. What is the total exterior surface area in ft$^2$ for the 16-inch main?

19. What is the exterior surface area in square feet of a cylindrical tank that is 18.0 ft high and 112.0 ft in diameter? Assume the tank is on the ground and the top is flat.

**Lateral Surface Area of a Cone**

20. What is the lateral surface area (in ft$^2$) of a cone with a radius of 12.5 ft and a height of 18 ft?

21. Calculate the lateral surface area of a cylinder with a radius of 60 feet and a height of 120 feet.
**Total Surface Area of a Cone**

22. A chemical hopper is cone shaped and covered. It has a diameter of 4 feet and a depth of 7 feet. Calculate the total surface area of the hopper (in ft²).

23. Calculate the total surface area (in ft²) of a cone that has a diameter of 15 feet and a height of 7 feet.

**Miscellaneous Calculations**

24. The top dimensions of a rectangular tank are 12 ft by 20 ft. What is the surface area of the tank in square feet?

25. A small cylindrical storage tank has a diameter of 7 ft. How many square feet of paint would it take to cover the outside if the tank is 15 feet tall? The bottom of the tank will need to be painted, too.

26. A circular clarifier has a diameter of 40 ft. What is the surface area of the clarifier in square meters?

27. What is a tank’s diameter if the surface area is 6720 ft²?

28. The length of a rectangle is 8 inches, and the width is 5 inches. What is the perimeter of the rectangle in feet?
29. Three sides of an object have lengths of 20 in, 82 in, and 25 in. If the perimeter of the object measures 215 in, what is the length of the fourth side in inches?

30. If the circumference of a tank is 376.8 ft, what is the diameter of the tank in feet?

31. What is the cross-sectional area (square inches) of a pipe with a diameter of 7 inches?

32. The length of one side of an aeration basin is 150 ft. If the perimeter is 390 ft, what is the length of the other three sides in feet? Assume the other 3 sides are all the same length.

33. What is the surface area in square feet of a rectangular filter bed with a length of 25 feet and a width of 10 meters?

34. The surface area of the settling tank the treatment plant is 125 ft\(^2\) and the length of the tank is 15 feet long. How long is the width of the settling tank in feet?

35. A cylindrical shaped storage tank needs painted. The height of the tank is 25 meters, and the radius of the tank is 4 meters. A gallon of paint covers 10 square meters. How many gallons of paint are required to repaint the tank?

36. The surface area of a tank is 2000 ft\(^2\). If the width of the tank is 25 feet, what is the length of the tank?
37. The radius of a tank is 35 ft. What is the circumference of the tank in feet?

38. If one side of a square measures 6 inches, what is its perimeter in inches?

39. The circumference of a tank is known to be 266.9 ft. What is the length of the diameter of that tank in feet?

40. What is the exposed exterior surface area of a ground-level storage tank in square feet that is 16.25 ft high and has a diameter of 125 ft? Assume the top is flat.

41. The weir diameter of a clarifier is 50 ft. What is the total ft of weir that encircles the clarifier?

42. A circular clarifier has a diameter of 40 ft. What is the sq. ft. surface area of the water surface in the clarifier?

43. A circular clarifier has a surface area of 1200 ft². What is the diameter of the clarifier?

44. The radius of a tank is 2 ft. What is the circumference of the tank in feet?

45. What is the sq. ft area of a rectangle 5 ft by 4 ft?
46. The top of a tank has a surface area of 3150 ft$^2$. If the width of the tank is 35 ft, what is the length of the tank?

47. Calculate the surface area in square feet of a square with sides 25 meters in length.

48. Calculate the area (ft$^2$) of a circle with the diameter of 600 ft.

49. What is the internal surface area of copper tubing with a length of 30 feet and internal diameter of 0.5 inches?

50. A circular water tower that is tapered at the bottom has a diameter of 36 feet and a height of 52 feet from the top to the beginning of the taper. The cone created by the taper has a height of 20 feet. Calculate the total exterior surface of the tank in square feet.
### Perimeter, Circumference and Area

#### Practice Problems

**Answers**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>85 ft</td>
<td>18. 5,236.12 ft(^2)</td>
</tr>
<tr>
<td>2.</td>
<td>140 ft</td>
<td>19. 16,177.28 ft(^2)</td>
</tr>
<tr>
<td>3.</td>
<td>374 ft</td>
<td>20. 860.15 ft(^2)</td>
</tr>
<tr>
<td>4.</td>
<td>157 ft</td>
<td>21. 25276.51 ft(^2)</td>
</tr>
<tr>
<td>5.</td>
<td>31.4 ft</td>
<td>22. 58.28 ft(^2)</td>
</tr>
<tr>
<td>6.</td>
<td>188.4 ft</td>
<td>23. 418.23 ft(^2)</td>
</tr>
<tr>
<td>7.</td>
<td>28,028 ft(^2)</td>
<td>24. 240 ft(^2)</td>
</tr>
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<td>8.</td>
<td>264 ft(^2)</td>
<td>25. 406.63 ft(^2)</td>
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<tr>
<td>9.</td>
<td>900 ft(^2)</td>
<td>26. 116.69 m(^2)</td>
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<tr>
<td>10.</td>
<td>544.38 ft(^2)</td>
<td>27. 92.52 ft(^2)</td>
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<tr>
<td>11.</td>
<td>15 ft(^2)</td>
<td>28. 2.17 ft(^2)</td>
</tr>
<tr>
<td>12.</td>
<td>800 ft(^2)</td>
<td>29. 88 in</td>
</tr>
<tr>
<td>13.</td>
<td>992 ft(^2)</td>
<td>30. 120 ft</td>
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<tr>
<td>14.</td>
<td>725.47 ft(^2)</td>
<td>31. 38.47 ft(^2)</td>
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<tr>
<td>15.</td>
<td>0.785 ft(^2)</td>
<td>32. 130 ft</td>
</tr>
<tr>
<td>16.</td>
<td>1.07 ft(^2)</td>
<td>33. 820.21 ft(^2)</td>
</tr>
<tr>
<td>17.</td>
<td>19.63 ft(^2)</td>
<td>34. 8.33 ft</td>
</tr>
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Section 6
Volume

Volume of water displaced

Soli
Volume

- Volume is the capacity of an object or how much it will hold

- Measured in
  - cubic units (ft³, m³, yd³, etc.) or
  - liquid volume units (gallons, liters, million gallons, acre-feet)

- The answer will come out in cubic units
  - You must then convert it to liquid volume units
Volume of a Rectangle

Volume = (length)(width)(height)

Vol = (l)(w)(h)

Example 1

- Determine the volume in m³ for a tank that measures 30 meters by 15 meters by 25 meters.

\[
\text{Vol} = (l)(w)(h) \\
\text{Vol} = (30\text{m})(15\text{m})(25\text{m}) \\
\text{Vol} = 11250\text{m}^3
\]
Volume of a Cylinder

Volume = (0.785)(Diameter²)(height)

Vol = (0.785)(D²)(h)

Example 2

• Determine the volume in ft³ for a tank that is 20 feet tall with a diameter of 7.5 ft.

Vol = (0.785)(D)²(h)

Vol = (0.785)(7.5ft)(7.5ft)(20ft)

Vol = 883.13 ft³
Volume of a Cone

Volume = \( \left( \frac{1}{3} \right) (0.785)(\text{Diameter}^2)(\text{height}) \)

Vol = \( \left( \frac{1}{3} \right) (0.785)(D^2)(h) \)

Example 3

- Determine the volume in gallons of a conical tank that is 8 feet wide and 15 feet tall.

\[
\begin{align*}
\text{Vol} &= \left( \frac{1}{3} \right) (0.785)(8\text{ft})(8\text{ft})(15\text{ft}) \\
\text{Vol} &= (0.3333)(753.6 \text{ ft}^3) \\
\text{Vol} &= 251.1749 \text{ ft}^3 \\
\text{Vol, gal} &= (251.1749 \text{ ft}^3)(7.48 \text{ gal/ft}^3) \\
\text{Vol, gal} &= 1878.78 \text{ gallons}
\end{align*}
\]
Basic Math
Volume Practice Problems

Volume of a Cuboid (Rectangle)

1. An oxidation ditch is 50 feet long, 30 feet deep and 20 feet wide. How many gallons of water can the ditch hold?

2. What is the volume of a tank in gallons that is 5’8” wide, 9’7” long, and 3’1” deep?

3. A new 8 inch main must be laid for 1.5 miles. What is the total number of gallons of water to be disinfected?

4. A section of 6-inch diameter pipeline is to be filled with chlorinated water for disinfection. If a 1/4 mile of pipeline is to be disinfected, how many gallons of water will be required to fill the pipe completely?

5. A reservoir is found to average 56 ft in depth. The shape of the lake is approximately circular with a diameter of approximately 570 ft. How many acre-feet of water does the lake contain?

6. How many liters of chemical can be contained if a tank that has a diameter of 10.5 feet can be filled to a height of 9.0 feet?

7. A new section of 12-inch diameter pipe is to be disinfected before it is put into service. If the length of the pipeline is 2000 ft, how many gallons of water will be needed to fill the pipeline?
8. If a trench is 346 ft long, 4.4 ft wide, and 5.7 ft deep, how many cubic yards of soil were excavated?

9. The diameter of a tank is 60 ft. When the water depth 25 feet, what is the volume of water in the tank, in ft³?
10. An aeration basin is 45 feet by 45 feet and is 30 feet deep. What is the total volume of water, in cubic feet, that the basin can hold?

11. A trench is to be excavated 2.5 feet wide, 4 feet deep and 900 feet long. What is the cubic yards volume of the trench?

12. A pipe is 16 inches in diameter and 550 ft long. How many gallons does the pipe contain when full?

13. A 1500 ft 10-inch diameter sewer main flows 4 inches full. What are the gallons of water contained in that section of line?

14. A trench that is 156 ft long, 3.8 ft wide and 5.8 ft deep fills with water. How many gallons are contained in the trench?

15. A tank is 12 ft wide, 20 ft long and 15 ft deep. If the depth of the water is 11 feet, what is the volume of water in the tank in gallons?

16. What is the volume of a trench in cubic feet if it is 245 ft in length, 4.2 feet in width and 5.8 ft deep?
   a.
17. A tank is 25 ft wide, 75 ft long, and can hold water to a depth of 10 ft. What is the total volume of the tank, in gallons?

18. Calculate the volume, in cubic feet, of a circular clarifier 7 ft deep and 40 ft in diameter.

19. Calculate the volume of an aeration basin, in gallons, that has the following dimensions: 10 ft high, 60 ft long, 20 ft wide.

20. What is the cubic yard volume of a trench 500 ft long, 2.25 ft wide and 4 feet deep?

21. The diameter of a tank is 70 ft. When the water depth is 30 ft, what is the volume of wastewater in the tank, in gallons?

22. A cylindrical tank is 12 ft in diameter and 24 ft in height. What is the approximate capacity in gal?

23. Determine the capacity of wastewater (in cubic feet) in a section of rectangular channel that is 600 feet long. The channel is 6 feet across and can flow up to 5 feet deep.

24. What is the capacity in gallons of wastewater of a 10-inch diameter, 1,800-foot section of pipeline?
25. Approximately how many gallons of wastewater would 800 foot of 8-inch pipe hold?

26. The dimensions of a tank are 60 feet wide, 10 feet deep and 15 feet long. Calculate the volume of the tank in cubic feet.

27. Calculate the volume of water in cu. ft. in a section of rectangular channel that is 4 feet deep, 5 feet wide, 500 feet long.

28. A tank is 25 ft wide, 75 ft long and can hold water to a depth of 10ft. What is the volume of the tank in gallons?

29. The diameter of a tank is 60 ft. When the water depth is 25 ft, what is the volume of the water in tank in gallons?

30. A tank is 12 ft wide, 20 ft long, and 15 ft deep. If the depth of the water in the tank is 11 ft, how many gallons of water are in the tank?

31. A tank is 15 ft wide, 17 feet long, and 12 feet deep. If the tank has 7.5 feet of water in the tank, how many cubic feet of water can be added to the tank?

32. A new section of 12-inch diameter pipe is to be disinfected before it is put into service. If the length of the pipe is 2,000 ft, how many gallons of water will be needed to fill the pipeline?
   a. 11,743.6 gal
33. A section of 6-inch diameter pipeline is to be filled with chlorinated water for disinfection. If ¼ mile of pipeline is to be disinfected, how many gallons of water will be required?

34. What is the diameter of a pipe (in feet) that is 750 feet long and holds 1324 ft$^3$ of water?

35. Calculate the volume of water in gallons in a 6-foot-deep channel that is holding 4 feet of water. The channel is 5 feet wide and 1,200 feet long.

36. A tank is 12 ft wide and 20 ft long. If the depth of water is 11 feet. What is the volume of water in the tank in gallons?

37. Determine the amount of water, in gallons, to be disinfected in a new 36-inch water main that is 2 miles long.

38. A tank will hold 7,500 gallons. What is the volume of water in the tank if the depth is 12.5 feet, width is 20 feet, and the length is 25 feet?

39. Calculate the volume (in ft$^3$) of a cone shaped chemical hopper with a diameter of 12 feet and a depth of 18 feet.

40. What is the gallon capacity of a wet well that is 12 feet wide, 10 feet long, and 10 feet deep?
41. What is the gallon capacity of a rectangular clarifier 70 feet long, 20 feet wide and an available water depth of 10 feet?

42. A clarifier has a diameter of 70 feet and an available water depth of 12 feet. What is the capacity of the clarifier in gallons?

43. A standard rate trickling filter has a diameter of 70 feet with an average depth of 6.5 feet. How many acre-feet of liquid can the filter hold?

44. Calculate the volume (in ft$^3$) of a rectangle with sides of 65 cm and 50 cm and a height of 22 cm.

45. Calculate the volume of a cone with a height of 7 meters and a radius of 2 meters.

46. Calculate the volume of soda in a can with a height of 6 inches and a radius of 0.167 feet.

47. A rectangular tank is used to store finished water. The dimensions are 15 meters long, 10 meters wide, and 8 meters in depth. The tank is 3/5 full. How many liters of finished water are in this tank?

48. The volume of the settling tank in a filtration plant is 7500 cubic feet. The area it must fit in is 12 meters wide by 20 feet long and the depth of the tank cannot exceed 10 feet. Will the settling tank fit into this area?
49. We need to know the diameter of our cylindrical shaped holding tank. We know the tank holds 300,000 liters and the height of the tank is 10 meters. Calculate the diameter of the tank in meters.

50. The diameter of a tank is 80 ft. If the water depth is 30 ft, what is the volume of the water in the tank, in gallons?

51. A tank is 20 feet wide, 12 feet deep, and 70 feet long. Calculate the cubic feet capacity of the tank.

52. *A tank 25 ft wide and 80 ft long is filled with water to a depth of 13 feet. How many pounds of water can the tank hold?

53. *A round water storage tank currently has 3.75 feet of water. How many more cubic feet of water can be contained in the tank if it is 50 feet across and 14 feet deep?

54. What is the cubic feet volume of water in a 350 ft long section of channel that measures 5 feet across and holds 2.97 feet of water?

55. A new section of 10-inch diameter pipe is to be disinfected before it is put into service. If the length of the pipeline is 1500 ft, how many gallons of water will be needed to fill the pipeline?

56. A section of 6-inch diameter pipeline is to be filled with chlorinated water for disinfection. If 0.34 miles of pipeline is to be disinfected, how many gallons of chlorinated water will be required to fill the pipe?
57. An effluent launder (channel) measures 5 feet wide and has water flowing to a
depth of 3.7 feet. What is the volume of water, in gallons, for a 1000-foot section of
channel?

58. A trench is to be excavated that is 3 ft wide, 3.5 ft deep, and 600 ft long. What is
the cubic yards volume of the trench?

59. A pond is 6 feet deep. If the rectangular pond measures 440 ft by 670 ft, how many
ac-ft of water could it hold?

60. A trench is 250 yards long, 2 ft wide and 2 ft deep. What is the cubic feet volume of
the trench?

61. What is the cubic feet volume of water contained in a rectangular channel that is 6
feet wide and flows 3.5 feet deep? The section of trench in question is 600 feet
long.

62. The diameter of a tank is 70 ft. If the water depth in the tank is 23 ft, what is the
volume of water in the tank, in gallons?

63. The dimensions of a tank are given as follows: L = 20 ft; W = 80 ft; d = 15 ft.
Calculate the volume of water in the tank (in ft$^3$).

64. A trench is dug to repair a pipeline that is 300 yards long, 2 ft wide and 2.5 feet
deep. How many cubic yards of soil were removed from the trench?
65. A cylindrical tank 60 feet wide. If the tank contains water to a depth of 13 feet, how many million gallons (MG) of water are in the tank?

<table>
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<tr>
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<th>Volume Practice Problems</th>
<th>Answers</th>
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Section 7
Velocity and Flow

\[ Q = A \times v \]
Velocity & Flow

Basic Math for All Certifications

Velocity
Velocity

- The speed at which something is moving
- Measured in:
  - ft/min
  - ft/sec
  - miles/hr
  - etc

\[
\text{Velocity} = \frac{\text{distance}}{\text{time}}
\]

Example 1

- Blue dye is placed in a sewer line at a manhole. Three (3) minutes later, the dye appears in a manhole 125 feet down stream. What is the velocity of the flow in ft/min?

\[
\text{Velocity} = \frac{\text{distance}}{\text{time}}
\]

\[
\text{Vel} = \frac{125 \text{ ft}}{3 \text{ min}}
\]

\[
\text{Vel} = 41.67 \text{ ft/min}
\]
Flow Rate

- The volume of water that flows over a period of time
  - Measured in $\text{ft}^3/\text{sec}$, $\text{ft}^3/\text{min}$, $\text{gal}/\text{day}$, $\text{MG}/\text{D}$

Flow = (Area)(Velocity)

$Q = AV$
Example 2

- Water is flowing at velocity 3 ft/sec through a channel that is 2 feet wide and 18 inches deep. What is the flow in cubic feet per second?

\[ Q = AV \]

\[
Q = \left( \frac{18 \text{ in}}{1} \right) \left( \frac{1 \text{ ft}}{12 \text{ in}} \right) \frac{d}{1.5 \text{ ft}}
\]

\[ Q = (2 \text{ ft})(1.5 \text{ ft})(3 \text{ ft/sec}) \]

\[ Q = 9 \text{ ft}^3/\text{sec} \]

---

Example 3

- Determine the flow in ft³/sec through a 5-foot pipe that is flowing full at a velocity of 4.5 ft/sec.

\[ Q = AV \]

\[ A = (0.785)(D^2) \]

\[ Q = (0.785)(D^2)(\text{vel}) \]

\[ Q = (0.785)(5\text{ ft})(5\text{ ft})(4.5 \text{ ft/sec}) \]

\[ Q = 88.3 \text{ ft}^3/\text{sec} \]
Basic Math
Velocity and Flow
Practice Problems

**Velocity**

1. A cork is placed in a channel and travels 370 feet in 2 minutes. What is the velocity of the wastewater in the channel, ft/min?

2. The distance between manhole #1 and manhole #2 is 105 feet. A fishing bobber is dropped into manhole #1 and enters manhole #2 in 30 seconds. What is the velocity of the wastewater in the sewer in ft/min?

3. A float travels 300 feet in a channel in 2 minutes and 14 seconds. What is the velocity in the channel, ft/sec?

4. A float travels 400 ft in a channel in 1 min 28 seconds. What is the estimated velocity in the channel (ft/sec)?

5. A float is placed in a channel. It takes 2.5 minutes to travel 300 feet. What is the velocity in feet per minute in the channel? (Assume that float is traveling at the average velocity of the water.)

**Flow Through a Channel**

6. A channel is 3 feet wide with water flowing to a depth of 2 feet. If the velocity in the channel is found to be 1.8 fps, what is the cubic feet per second flow rate in the channel?
7. A channel is 4 feet wide with water flowing to a depth of 2.3 feet. If a float placed in the channel takes 3 minutes to travel a distance of 500 feet, what is the cubic-feet-per-minute flow rate in the channel?

8. A tank is 15 ft long and 10 ft wide. With the discharge valve closed, the influent to the tank causes the water level to rise 7 inches in 1 minute. What is the gpm flow to the tank?

9. A tank is 10 ft by 10 ft. With the discharge valve closed, the influent to the tank causes the water level to rise 1.7 ft in 2 minutes. What is the gpm flow to the tank?

10. A flow of 10 cfs is travelling through a channel 2.5 feet wide. If the water is flowing to a depth of 18 inches, what is the velocity of the water in fps?

Flow Through a Full Flowing Pipe

11. A 12-inch diameter pipe is flowing full. What is the cubic feet per minute flow rate in the pipe if the velocity is 110 feet/min?

12. A 10-inch diameter pipeline has water flowing at a velocity of 3.2 fps. What is the gpm flow rate through the pipeline if it is flowing full?
13. A 6-inch diameter pipe has water flowing at a velocity of 2.6 fps. What is the gpm flow rate through the pipeline? Assume the pipe is flowing full.

14. A 24-inch main has a velocity of 212 feet/min. What is the gpd flow rate for the pipe?

15. What would be the gpd flow rate for a 6" line flowing at 2 feet/second?

**Miscellaneous Calculations**

16. A stick is placed in a channel and travels 40 feet in 18 seconds. What is the velocity of flow through the channel in fpm?

17. A 36" water main has just been installed. According to the Design Criteria for the State of Tennessee, the minimum flushing velocity is 2 ft/sec. If the main is flushed at 2.5 ft/second, how many gallons/minute should be flushed from the hydrant?

18. A cork placed in a channel travels 30 feet in 20 seconds. What is the velocity of the cork in feet per second?

19. A certain pipe has a diameter of 18 inches. If the pipe is flowing full, and the water is known to flow a distance of 830 yards in 5 minutes, what is the MGD flow rate for the pipe?
20. A 36” water main has just been installed. If the main is flows at 2 ft/second, how many MGD will the pipe deliver?

21. The flow totalizer for the month of October was 127.6 MG. What was the average daily flow (gpd) for that month?

22. A channel 42 inches wide has water flowing to a depth of 2.6 ft. If the velocity of the water is 2.2 fps, what is the cfm flow in the channel?

23. A pump discharges into a 2-foot diameter barrel. If the water level in the barrel rises 26 inches in 30 seconds, what is the gpm flow rate into the barrel?

24. Calculate the maximum flow allowable in MGD for a primary sedimentation tank to maintain a target detention time of 2.3 hours. Tank volume is 478,720 gallons.

25. An 8-inch diameter flowing full delivers 537 gpm. What is the velocity of flow in the pipeline (ft/sec)?

26. A treatment plant has a total capacity of 60 MGD. The daily flow is 4/9 of the plant capacity. If 1/7 of the daily flow is industrial waste, how many gallons of the industrial waste are treated daily?

27. The flow totalizer reading for the month of November was 117.3 MG. What was the average daily flow (gpd) for November?
28. The velocity in an 8-inch diameter pipe is 3.6 ft/sec. If the flow then travels through a 10-inch diameter section of pipeline, what is the ft/sec velocity in the 10-inch pipeline?

29. A 6-inch diameter pipeline has water flowing at a velocity of 2.7 fps. What is the gpm flow rate through the pipeline?

30. An 8-inch diameter pipe flowing full delivers 490 gpm. What is the ft/sec velocity of the flow in the pipeline?

31. A channel has a rectangular cross-section. The channel is 6 ft wide with water flowing to a depth of 2.6 ft. If the flow rate through the channel is 15,500 gpm, what is the velocity of the water in the channel (ft/sec)?

32. What was the average daily flow for July, if the total flow for the month was 185.72 million gallons?

33. A channel has a rectangular shape. The channel is 5 ft wide with water flowing to a depth of 2.3 feet. If the flow rate through the channel is 13,400 gpm, what is the velocity of the water in the channel (ft/sec)?

34. A fluorescent dye is used to estimate the velocity of flow in a sewer. The dye is injected into the water at one manhole and the travel time to the next manhole 500 ft away is noted. The dye first appears at the downstream manhole is 195 seconds. The dye continues to be visible until the total elapsed time is 221 seconds. What is the ft/sec velocity of flow through the pipeline?
35. The total flow for one day at a plant was 3.14 MG. What was the average gpm flow for that day?

36. The velocity in a 10-inch pipeline is 2.4 ft/sec. If the 12-inch pipeline flows into an 10-inch diameter pipeline, what is the ft/sec velocity in the 8-inch pipeline?

37. A fluorescent dye is used to estimate the velocity of flow in a sewer. The dye is injected into the water at one manhole and the travel time to the next manhole 300-feet away is noted. The dye first appears at the downstream manhole is 77 seconds. The dye continues to be visible until the total elapsed time is 95 seconds. What is the ft/min velocity of flow through the pipeline?

38. The flow entering the leg of a tee connection is 9 cfs. If the flow through one branch of the tee is 5 cfs, what is the flow through the other branch?

39. The velocity in a 10-inch diameter pipeline is 2.6 ft/sec. If the 10-inch pipeline flows into an 8-inch diameter pipeline, what is the velocity in the 8-inch pipeline?
40. The average velocity in a full-flowing pipe is measured and known to be 2.9 fps. The pipe is a 24” main. Assuming that the pipe flows 18 hours per day and that the month in question contains 31 days, what is the total flow for the pipe in MG for that month?

41. A water main with a diameter of 18 inches is determined to have a velocity of 182 feet per minute. What is the flow rate in gpm?

42. The daily flow to a treatment plant is 40 MGD. If 1/6 of the flow is industrial, how many gallons of industrial waste are treated daily?
## Velocity and Flow Practice Problems Answers

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<td>185 ft/min</td>
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<td>253,661.76 gal/day</td>
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<td>210 ft/min</td>
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<td>2.2 ft/sec</td>
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Basic Math
Velocity and Flow
Practice Problems #2

1. A float travels 500 ft in a channel in 5 minutes and 22 seconds. What is the velocity in ft/sec?

2. A cork is placed in a channel and travels 50 ft in 9 seconds, what is the velocity in ft/min?

3. A car travels at a speed of 60 mph, what is the velocity in ft/sec?

4. The distance between a manhole A and manhole B is 400 ft. A float is dropped into manhole A and enters manhole B in 2 minutes and 30 seconds. What is the velocity of the water in ft/min?

5. A garden snail travelled 15 inches in 10 minutes, what is the snail's velocity in ft/min?

6. A channel 3 ft wide has water flowing to a depth of 11 inches. If the velocity of the water is 3.2 ft/sec, what is the flow through the channel in ft³/sec?

7. A channel 30 inches wide has water flowing at a depth of 2 ft. If the length of the channel is 5,000 ft and the velocity through the channel is 2.5 ft/sec, what is the flow through the channel in ft³/sec?
8. A channel is 2.5 ft wide, and the water is flowing at a velocity of 3 ft/sec. If the flow through the channel is measured to be 6.4 ft³/sec, what is the depth of the water in the channel in ft?

9. A channel is 3 ft wide, and the water is flowing at a velocity of 210 ft/min. If the water is 6 inches deep in the channel, what is the flow through the channel in gpm?

10. A channel is 24 inches wide and has water to a depth of 18 inches. If the water is flowing at a velocity of 2.9 ft/sec, what is the flow rate in cubic feet/min?

11. The flow through a channel is 100 gpm. If the channel is 3 ft wide and has water to a depth of 2 ft, what is the velocity of the water in ft/sec?

12. The flow through a 3 ft diameter pipeline is moving at a velocity of 4 ft/sec. What is the flow through the pipe in cubic feet/sec?

13. The flow through a 10-inch diameter pipe is moving at a velocity of 2 ft/sec. What is the flow rate in cubic ft/sec?

14. A 6-inch diameter pipe has water flowing at a velocity of 120 ft/min. What is the flow rate in gpm?

15. The flow through a pipe is 0.82 ft³/sec. If the velocity of the flow is 1.5 ft/sec, and the pipe is flowing full, what is the diameter of the pipe in inches?
16. A 2 ft main has water flowing at a velocity of 4.1 ft/sec. What is the flow through the pipe in gph?

17. A 3 ft diameter main has just been installed. According to the Design Criteria for the State of Tennessee, the minimum flushing velocity is 2.5 ft/sec. If the main is flushed at a velocity of 3 ft/sec, how many gallons per minute will be flushed from the hydrant?

18. A pipe has a diameter of 24 inches. If the pipe is flowing full, and the water is known to flow a distance of 200 ft in 3 minutes, what is the flow rate for the pipe in MGD?

19. What is the flow rate in gpd for a 6-inch main flowing at a velocity of 220 ft/min?

20. If the flow through a 10-inch diameter pipe is 3.2 MGD, what is the velocity of the water in ft/sec?

21. The flow through a pipe is 320 gpm. If the velocity through the pipe is 3.6 ft/sec what is the diameter of the pipe in inches?

22. A certain pipe has a diameter or 10 inches. If the water in the pipe is known to travel 200 yds in 3 minutes, what is the flow rate for the pipe in gpd?
## Velocity and Flow #2

### Practice Problems Answers

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