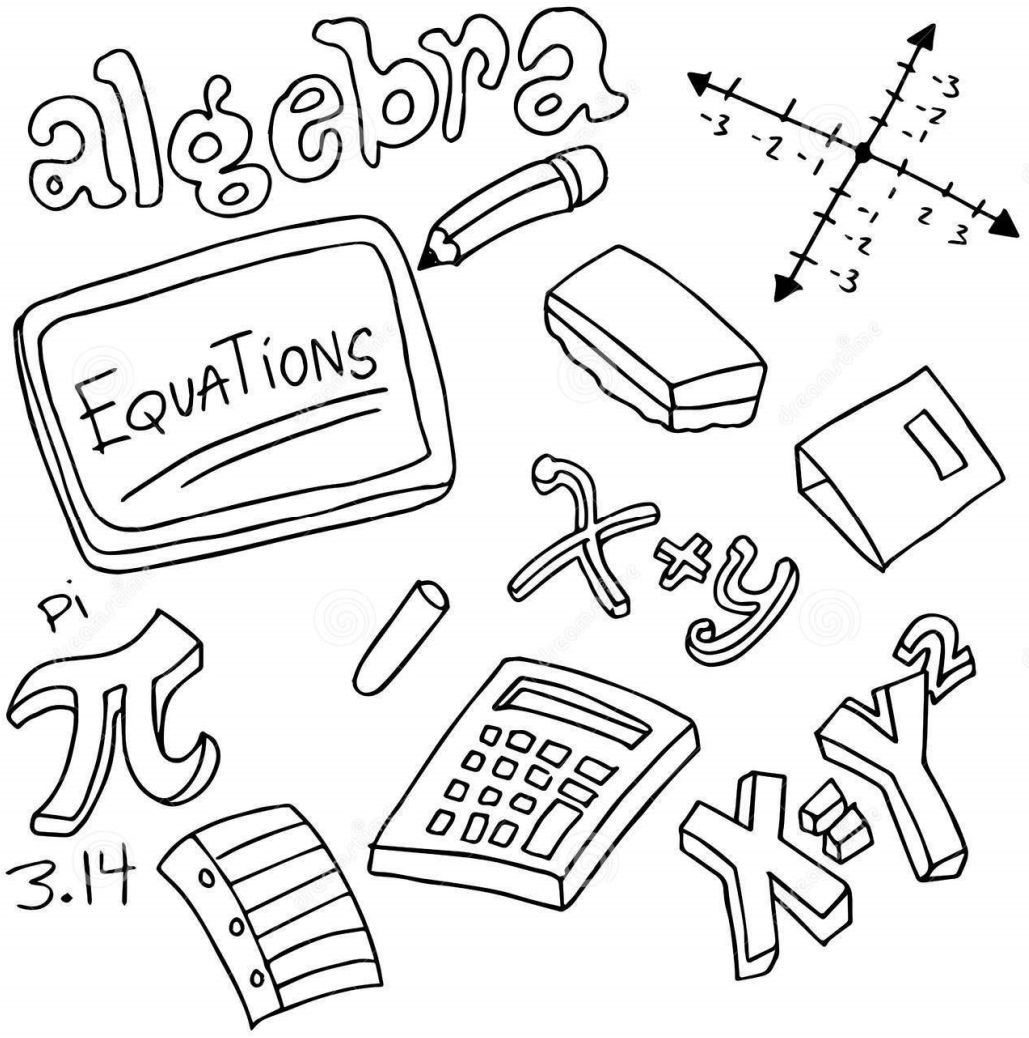
Applied Math for All Certifications

Course # 112 or 112-V



Fleming Training Center
Your Partner in Clean Water

TN Department of Environment & Conservation

Updated 12-2022

Applied Math for All Certifications

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Math Fundamentals Review

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Fractions

Basic Math Concepts for Water and Wastewater Plant Operators

By Joanne Kirkpatrick Price

Summary

- Numerator

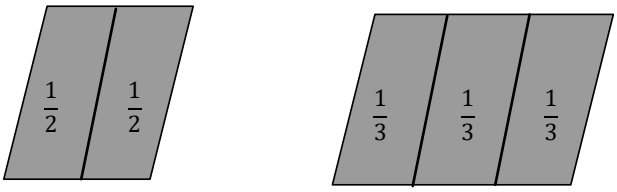
$$\frac{\text{Numerator}}{\text{Denominator}}$$

Division line

  - 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

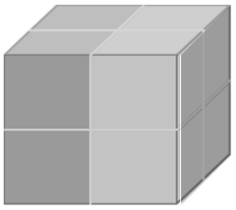
Denominator

- 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

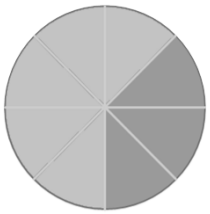


Numerator

- Top of fraction
- Indicates number of equal parts



$\frac{4}{8}$



$\frac{5}{8}$

Equivalent Fractions

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

$\frac{1}{2}$

$\frac{2}{4}$

$\frac{4}{8}$

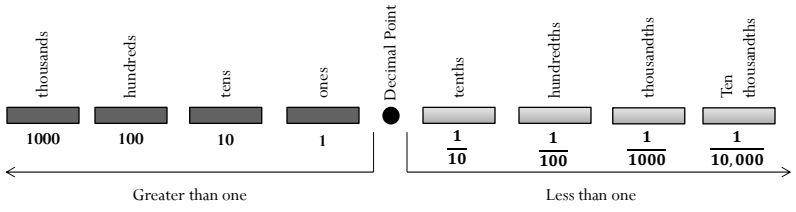
Decimals and Percents

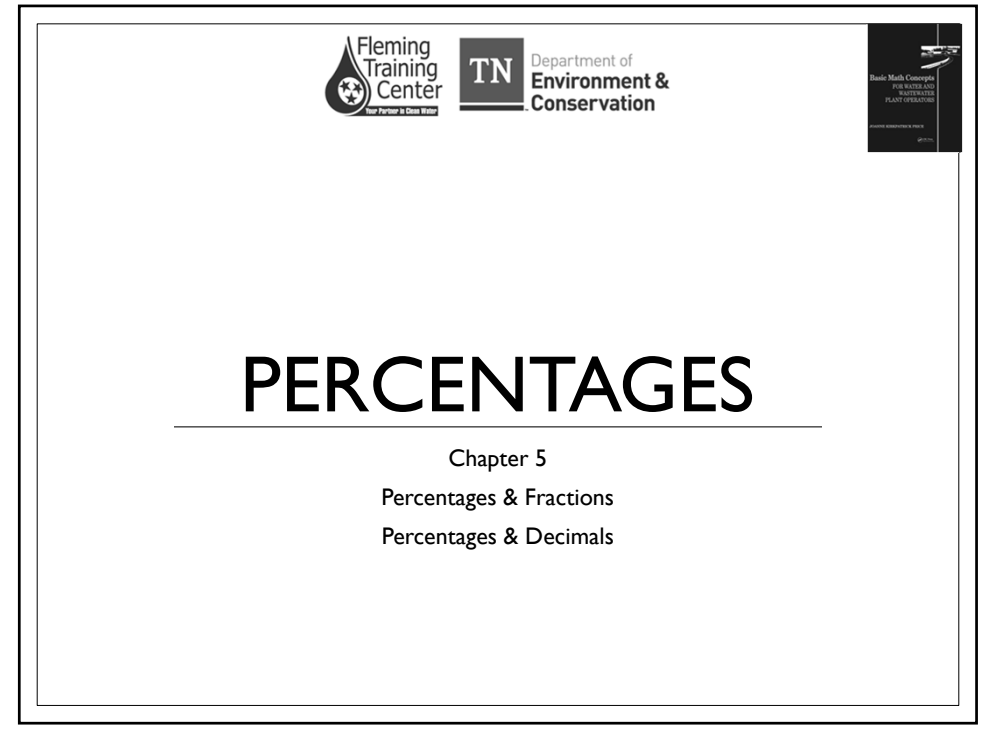
Basic Math Concepts for Water and Wastewater Plant Operators

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





Percentages

- Method of comparing one quantity with another
- *Percent* comes from Latin words *per centum*, meaning "by the hundreds"
- Indicates "how many per hundred"
  - Example: If 4 percent (%) are damaged, then 4 out of every 100 bottles are damaged.
- Three ways to convey this mathematically:
  - Percent: 4%
  - Fraction: $\frac{4}{100}$
  - Decimal: 0.04

Converting Decimals and Fractions

- To convert a fraction to a decimal
  - Simply divide the numerator by the denominator

$$\frac{1}{2} = 1 \div 2 = 0.5$$

$$\frac{10}{13} = 10 \div 13 = 0.7692$$

Percents & Decimals

- To convert from a decimal to a percent:

Option 1: Move the decimal point two places to the right.

Example: Express 0.46 as a decimal.

$$0.46 = 46.0\%$$

Option 2: Multiply decimal by 100.

Example: Express 0.46 as a decimal.

$$0.46 \times 100 = 46.0\%$$

Percents & Decimals

- To convert from a percent to a decimal:

Option 1: Move decimal point two places to the right.

Example: Express 82% as a decimal number.

$$82\% = 82.0\%$$

$$82.0\% = 0.82$$

Option 2: Divide decimal by 100.

$$82 \div 100 = 0.82$$

Calculating Percent Problems

- The following equation may be used to calculate percent:

$$\% = \frac{\text{Part}}{\text{Whole}} \text{ x } 100\%$$

- Example: 17 is what percent of 54?

$$\% = \frac{17}{54} \text{ x } 100\%$$

$$\% = 0.31 \text{ x } 100\%$$

$$\% = 31\%$$

Key Words in Math

Key Words

- Of ⟹ multiply

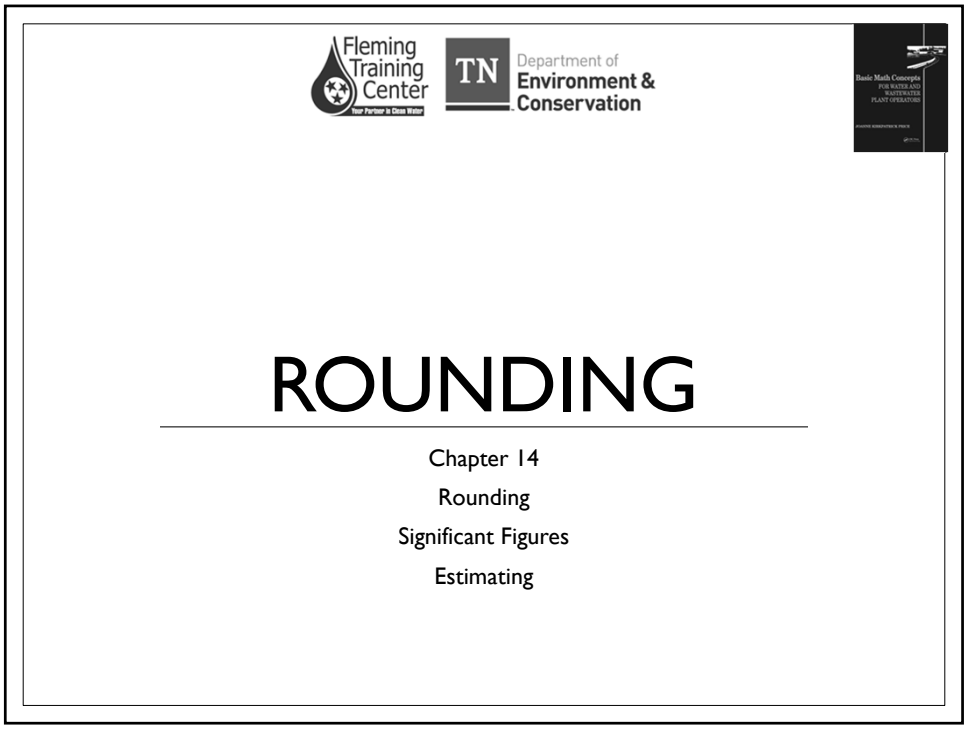
  $5\% \text{ of } 100 = 0.05 \times 100$

- Per ⟹ divide

  $25 \text{ miles per gallon} = 25 \frac{\text{miles}}{\text{gallon}}$

- Is ⟹ equals

  1 foot is 12 inches 1 foot = 12 inches



ROUNDING

Chapter 14

Rounding

Significant Figures

Estimating

Rounding Numbers

- *Rounding* means making a number simpler but keeping its value close to what it was.
  - The result is less accurate, but easier to use.
- Procedure depends the relationship between the number to the right of the "rounding place" and five (5)
  - If the digit is less than 5, round down.
  - If the digit is 5 or greater, round up.

Place Value System

- In order to round, you must know the place value system:
  - To the left of the decimal point are the following place values:

Place Values Greater Than One (1)

1,000,000	100,000	10,000	1,000	100	10	1	•
Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Units	Decimal Point

Place Value System

- In order to round, you must know the place value system:
  - To the right of the decimal point are the following place values:

Place Values Less Than One (1)

•	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1,000}$	$\frac{1}{10,000}$	$\frac{1}{100,000}$	$\frac{1}{1,000,000}$
Decimal Point	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths

POWERS & ROOTS

BASIC MATH CONCEPTS FOR WATER AND WASTEWATER PLANT OPERATORS BY JOANNE KIRKPATRICK PRICE

TERMS

- Exponent – indicates how many times a number is to be multiplied together
- Base – the number that is being multiplied

base → 7^4 ← exponent $= (7)(7)(7)(7)$

- Power – entire expression (seven to the 4th power)
- Same rule applies to letters and measurement units

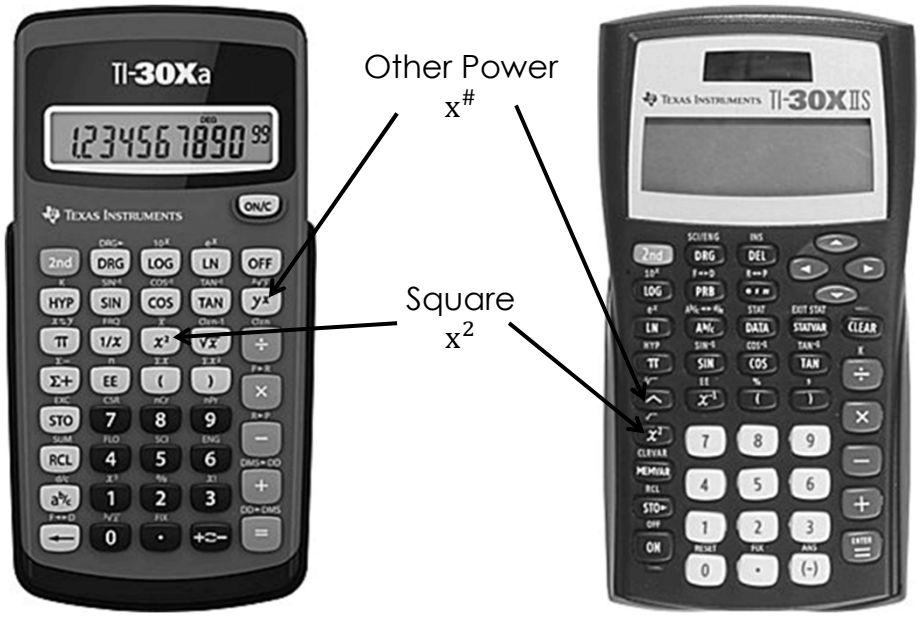
$$x^3 = (x)(x)(x) \text{ or } ft^2 = (ft)(ft)$$

- 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
    - $(6)(6)$
  - 20^3
    - $(20)(20)(20)$
- Write the factors using exponential notation:
  - $(4)(4)(4)$
    - 4^3
  - $(2)(2)(2)(2)$
    - 2^4



EXAMPLE 3

- Complete the following calculations
- 27^2
  - 729
- 14^5
  - 537824
- $5^{7.9}$
  - 332554.66

MULTIPLYING POWERS

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

$$x^2 * x^3$$

$$x^{2+3}$$

$$x^5$$

$$x^3 \bullet x^4 = (x)(x)(x)(x)(x)(x)(x)$$

$$x^7$$

DIVIDING POWERS

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

$$\frac{x^5}{x^3}$$

$$x^{5-3}$$

$$x^2$$

$$\frac{x^8}{x^5}$$

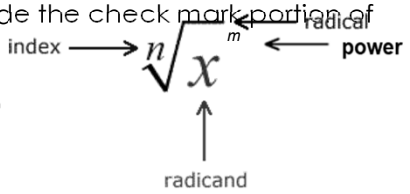
$$\frac{(\cancel{x})(\cancel{x})(\cancel{x})(\cancel{x})(\cancel{x})(x)(x)(x)}{(\cancel{x})(\cancel{x})(\cancel{x})(\cancel{x})(\cancel{x})}$$

$$x^3$$

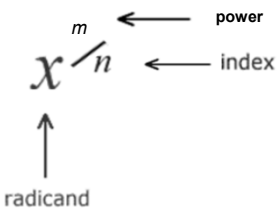
ROOTS

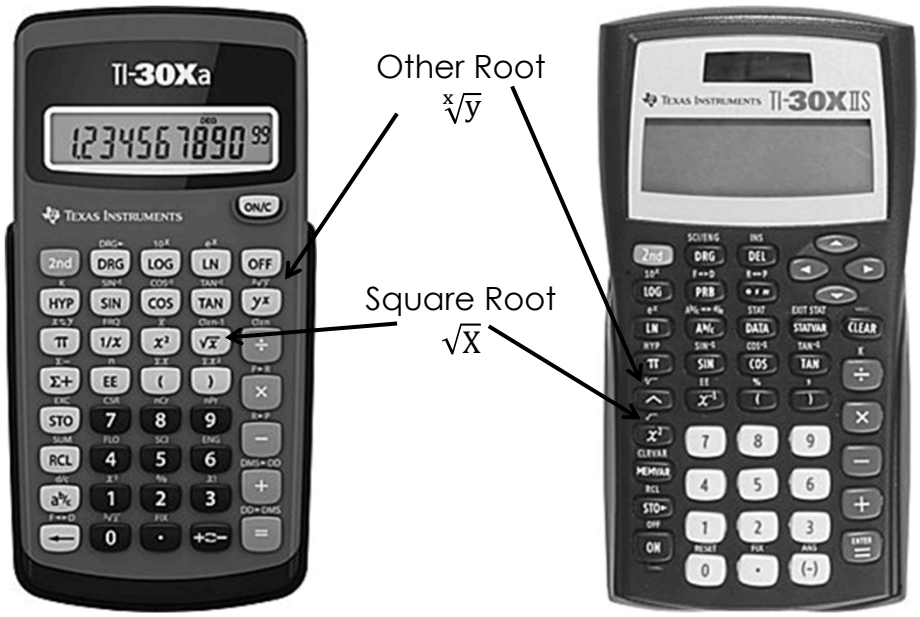
- The *index* indicates the root to be taken.
  - The small number tucked inside the check mark portion of the radical sign.
- Noted one of two ways:

1. By using a radical: $\sqrt[3]{1728^1}$



2. By using a fractional exponent: $1728^{1/3}$





ROOTS

- Complete the following calculations
- $\sqrt{6400}$
  - 80
- $\sqrt[3]{912673}$
  - 97

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

$$8 + 16 \div 4$$
$$24 \div 4$$
$$6$$

$$8 + 16 \div 4$$
$$8 + 4$$
$$12$$

EXAMPLE 1

PEMDAS

Parenthesis
Exponents
Multiplication/Division
Addition/Subtraction

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

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

$$21 \times 4 \div 2 - 5 \times 6$$

Since Multiplication and Division are on the same "level," work left to right

$$84 \div 2 - 5 \times 6$$

$$42 - 5 \times 6$$

Skip the subtraction because it is on the next "level"

$$42 - 30$$

$$12$$

EXAMPLE 2

PEMDAS

Parenthesis
Exponents
Multiplication/Division
Addition/Subtraction

$$[(7+2)^2 - 5^2] + 12$$

$$[9^2 - 5^2] + 12$$

$$[81 - 5^2] + 12$$

$$[81 - 25] + 12$$

$$56 + 12$$

$$68$$

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% =

17. 75% =

18. 20% =

19. 0.07% =

20. 120% =

21. 88.7% =

22. 0.5% =

23. 112% =

24. 12.5% =

25. 57.94% =

Convert the following decimals into a percent.

26. 0.531 =

27. 0.66 =

28. 1.21 =

29. 0.08 =

30. 19.5 =

31. 0.406 =

32. 11.0 =

33. 1.0 =

34. 0.278 =

35. 0.785 =

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

1. yes
2. no
3. no
4. no
5. no
6. 0.6
7. 0.69
8. 1.75
9. 0.33
10. 0.83
11. 0.32
12. 0.4
13. 0.08
14. 0.22
15. 0.33
16. 0.16
17. 0.75
18. 0.20
19. 0.0007
20. 1.20
21. 0.887
22. 0.005
23. 1.12
24. 0.125
25. 0.5794
26. 53.1%
27. 66%
28. 121%
29. 8%
30. 1950%
31. 40.6%
32. 1100%
33. 100%
34. 27.8%
35. 78.5%
36. 5.5
37. 18.75
38. 420
39. 78.75
40. 55
41. 0.535
42. 1455.2
43. 167
44. 117,750
45. 15,000

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. $(7x3)^2$ = _____

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. $\sqrt{4}^3$ = _____

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
5. $(13)(13)(13)(13)(13)(13)$
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. $[(11 + 4) + 4] + 8 = x$

15. $[10 + (18 – 3)] \times 7 = x$

16. $2 + [(13 + 5) + 6] = x$

17. $[(10 – 2) \times 5] – 10 = x$

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. $[(18 + 2) + (20 - 4)^2] = x$

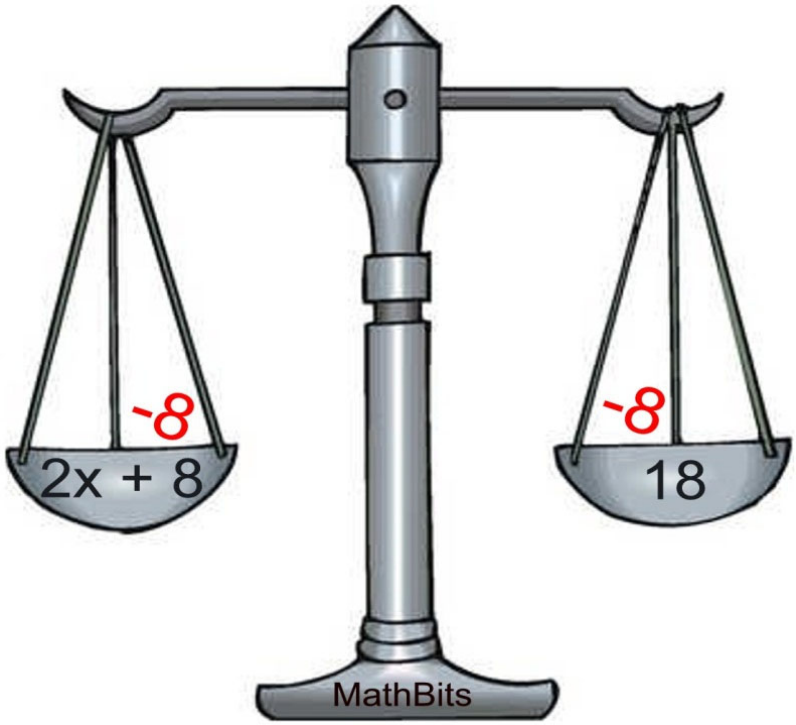
30. $[(10 - 4)^2 + 6] - 4^2 = x$

Order of Operations Practice Problems
Answers

1.	124	**16.**	26
2.	21	**17.**	30
3.	66	**18.**	29
4.	180	**19.**	70
5.	26	**20.**	9
6.	173	**21.**	263
7.	21	**22.**	576
8.	87	**23.**	259
9.	144	**24.**	35
10.	289	**25.**	40
11.	182	**26.**	60
12.	35	**27.**	45
13.	24	**28.**	166
14.	27	**29.**	276
15.	175	**30.**	26

Section 2

Solving Equations and Variables



Introduction to Equations

Basic Math for All Certifications

Introduction to Equations

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

$$\begin{array}{r} 23 \\ +5 \\ \hline 28 \end{array} \qquad 2{,}057{,}000 - 1{,}975{,}000 = 85{,}000$$

$$\begin{array}{r} 542 \\ \times\ 2.1 \\ \hline 1138.2 \end{array} \qquad 3 \div 4 = 0.75$$

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

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

$$100 = 100$$

Introduction to Equations

- Equations are “balanced”
  - It is vital to maintain that balance.

$$25 \times 4 = 20 \times 5 + 15$$

$$100 \neq 115$$

  - To maintain that balance, 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 and can be represented by any letter.

$$x + 5 = ?$$
$$\text{If } x = 1,$$
$$\text{then } x + 5 = 6$$

Introduction to Equations

- But what if we don't know the value of the variable?

$$25 \times y = 20 \times 5$$

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

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

$$\frac{25 \times y}{25} = \frac{20 \times 5}{25}$$

$$1 \times y = \frac{100}{25}$$

$$y = 4$$

- 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

$$\begin{array}{r} x - 7 = 10 \\ +7 \quad +7 \end{array}$$

$$x + 0 = 10 + 7$$

$$x = 17$$

Example 2

$$115 + 105 + 80 + x = 386$$

Step 1. Simplify

$$\begin{array}{r} 115 \\ +105 \\ \underline{+80\ } \\ 300 \end{array}$$

$$300 + x = 386$$
$$\underline{-300} \qquad \underline{-300}$$
$$0 + x = 386 - 300$$
$$x = 86$$

Example 3

$$17 + 23 + 7 - x = 38$$

Step 1. Simplify

$$\begin{array}{r} 17 \\ +23 \\ \underline{+7\ } \\ 47 \end{array}$$

$$47 - x = 38$$
$$+x \quad +x$$
$$47 - 0 = 38 + x$$
$$47 = 38 + x$$

Step 2. Make x positive

$$-38 \quad -38$$
$$47 - 38 = 0 + x$$
$$9 = x$$

Example 4

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

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

$$\frac{3847}{1} \times 730 = \frac{x}{3847} \times \frac{3847}{1}$$

$$(3847)\,(730) = \frac{(x)\cancel{(3847)}}{\cancel{(3847)}(1)}$$

$$(3847)(730) = x$$

$$2{,}808{,}310 = x$$

Example 5

Step 1. Simplify

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

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

$$0.5 = \frac{4128.3}{x}$$

$$\frac{x}{1} \times 0.5 = \frac{4128.3}{\cancel{x}} \times \frac{\cancel{x}}{1}$$

$$(x)(0.5) = 4128.3$$

$$\frac{(x)(\cancel{0.5})}{\cancel{0.5}} = \frac{4128.3}{0.5}$$

$$x = \frac{4128.3}{0.5}$$

$$x = 8256.6$$

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

$$(0.785)(x^2) = 2826$$

$$\frac{\cancel{(0.785)}(x^2)}{\cancel{0.785}} = \frac{2826}{0.785}$$

$$x^2 = \frac{2826}{0.785}$$

$$x^2 = 3600$$

$$\sqrt{x^2} = \sqrt{3600}$$

$$x = 60$$

Applied Math for All Certifications
Solving for an Unknown Value
Example Problems

1. $8.1 = (3)(x)(1.5)$

2. $109 = \frac{x}{(0.785)(80)(80)}$

3. $2.5 = \frac{1{,}270{,}000}{x}$

4. $114 = \frac{(230)(1.15)(8.34)(x)}{(0.785)(70)(70)}$

5. $(x^2)(10)(7.48) = 10{,}771.2$

Basic Math
Solving Equations

Solve for the unknown value.

Addition

1) $3 + g = 10$

2) $x + 2 = 3$

3) $x + 15 = 19 + 22$

4) $7 + 10 + x + 7 + 9 = 41$

5) $x + 93 = 165$

6) $10.1 = 9.5 + x$

Subtraction

7) $3 = k - 2$

8) $x - 2 = 9$

9) $x - 93 = 65$

10) $9.5 - x = 8.7$

11) $115 = x - 7.5$

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) $\frac{m-9}{8} = 4$

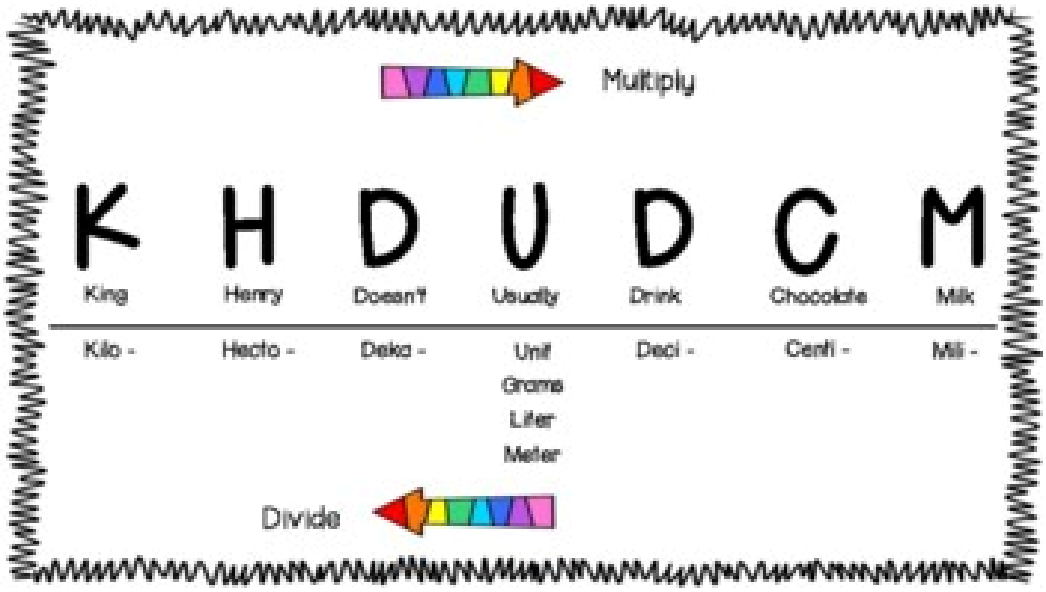
46) $2 = \frac{x+5}{9}$

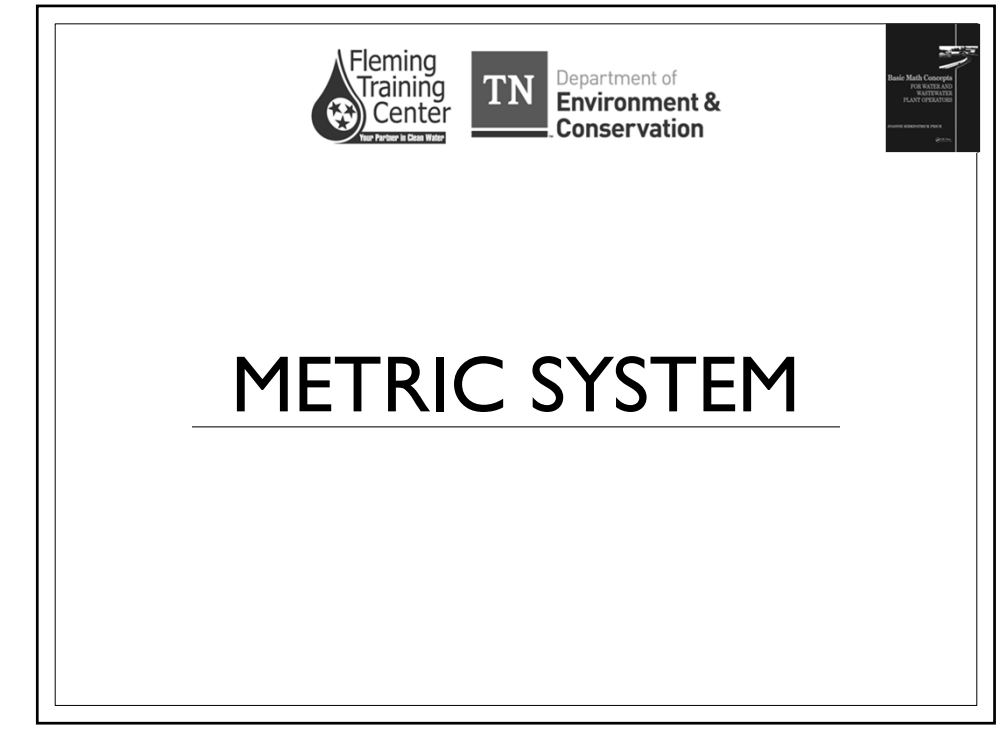
47) $(7)(f) - 16 = 12$

Solving Equations Practice Problems Answers		
1. g = 7	21. 0.333 = e	41. 547,616 = x
2. x = 1	22. 2 = x	42. x = 508,000
3. x = 26	23. x = 8256.6	43. x = 0.35
4. x = 8	24. 9,333.33 = x	44. x = 5
5. x = 72	25. 5,976,990 = x	45. m = 41
6. 0.6 = x	26. x = 8.0643	46. 13 = x
7. k = 5	27. x = 0.005	47. f = 4
8. x = 11	28. 360 = x	
9. x = 158	29. x = 0	
10. 0.8 = x	30. x = 5.29	
11. 122.5 = x	31. 2816.67 = x	
12. 5 = w	32. 70.02 = x	
13. m = 2	33. x = 177.71	
14. 8 = m	34. 1649.42 = x	
15. 8 = x	35. x = 244.66	
16. x = 5.7319	36. x = 117.31	
17. 1.8 = x	37. 4.99 = x	
18. 11.0 = x	38. 0.2 = x	
19. 96 = t	39. x = 7,993.89	
20. 40 = x	40. 64.5 = x	

Section 3

Metric System





METRIC SYSTEM

Metric System

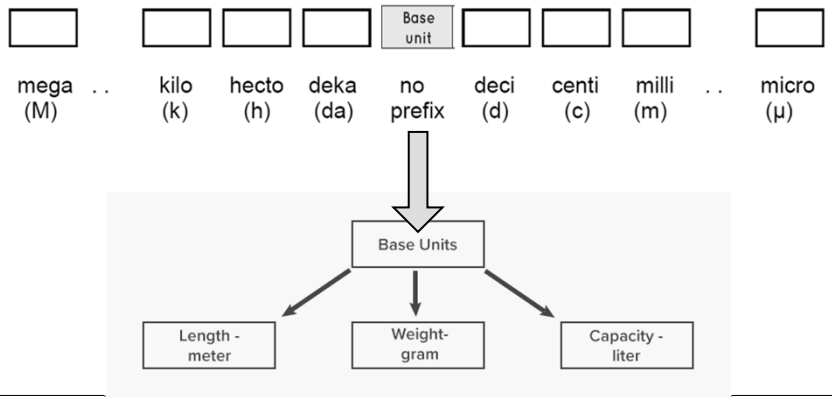
- The *metric system* is a system of measurement that uses the meter, liter, and gram as base units of length, volume, and weight.
  - US uses Imperial or Standard System of Measurement
- Metric prefixes are:

Mega-	Deci-
Kilo-	Centi-
Hecto-	Milli-
Deka-	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



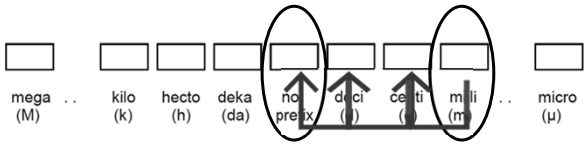
Metric System Conversions

- 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. .

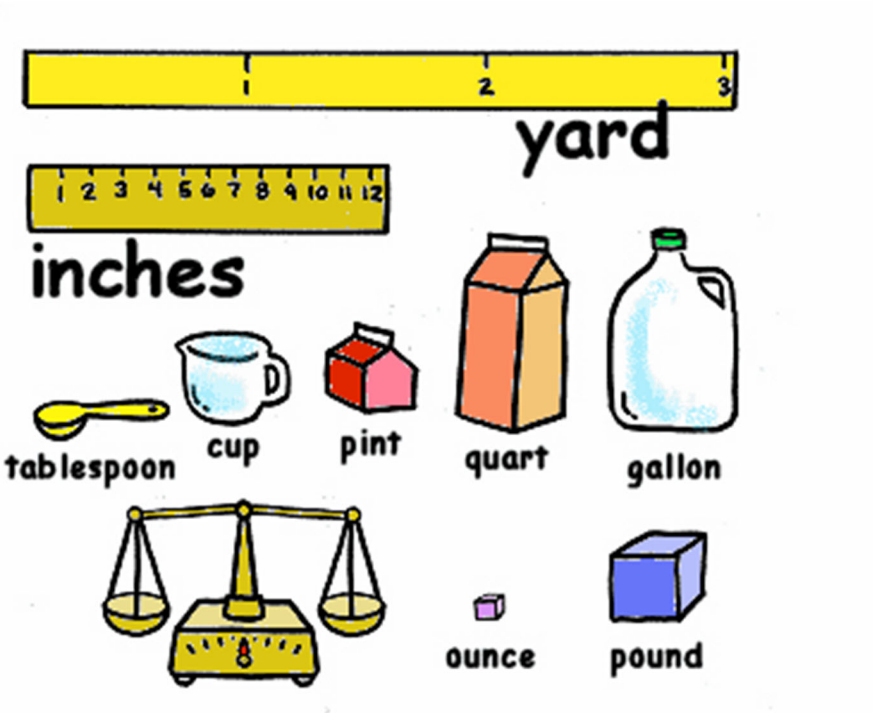


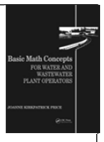
3. Move 3 places to the left.

$2500.\text{mL} = \square$

Section 4

Dimensional Analysis





DIMENSIONAL ANALYSIS

Chapter 15

The Basics

Problems Involving Complex Fractions

Dimensional Analysis - Basics

- Basic concepts to use 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

Set up a conversion to change 756 cm into inches. (cont'd)

5. Eliminate common factors in numerator and denominator (cancel like units)

$$\frac{(756)(1\ \cancel{\text{cm}})(1)(\text{inch})}{(1)(2.54)(1\ \cancel{\text{cm}})}$$

6. Simplify the fractions.

$$\frac{756\text{ in}}{2.54}$$

7. Solve.

$$297.64\text{ in}$$

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: $(4140\ \text{gpm}) \div \left(60\ \frac{\text{sec}}{\text{min}}\right) = ?\ \text{gps}$

$$\frac{\frac{4140\ \text{gal}}{\text{min}}}{\frac{60\ \text{sec}}{\text{min}}} = ?\,\text{gps}$$

$$\left(\frac{4140\ \text{gal}}{1\ \text{min}}\right) \times \left(\frac{1\ \text{min}}{60\ \text{sec}}\right) = ?\,\text{gps}$$

$$\frac{(4140)(\text{gal})(\cancel{1\ \text{min}})}{(\cancel{1\ \text{min}})(60)(\text{sec})} = ?\,\text{gps}$$

$$?\,\text{gps} = \frac{(4140)(\text{gal})}{(60)(\text{sec})} = \frac{69\ \text{gal}}{\text{sec}}$$

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.

Applied Math for All Certifications
Dimensional Analysis
Example Problems

1. Convert 5 cubic feet to gallons.

2. Convert 75 pounds of water into gallons.

3. Convert 56 ft^3/sec to gallons/minute.

4. Convert 3.45 MGD to cubic feet per second.

5. How many mL are in 0.75 L?

6. How many pounds are 97 L of water?

Applied Math for All Certifications
Dimensional Analysis
Practice Problems

Use dimensional analysis to solve the following equations. Assume all liquids are water unless otherwise stated.

Linear Measurements

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

Area Measurements

23. 78.5 in^2 =_____ ft^2

24. 0.9 acre =_____ ft^2

25. 4 acres =_____ ft^2

26. 500 yd^2 =_____ ft^2

27. 9.5 ft^2 =_____ in^2

28. 25,000 ft^2 =_____ acres

29. 1 yd^2 =_____ in^2

30. 1,640 yd^2=_____ ft^2

31. 135,000 ft^2 =_____ ac

32. 4.8 ac =_____ sq ft

33. 0.46 ac =_____ sq ft

34. 2,100 sq in =_____ sq ft

Volume & Weight Measurements

35. 520 mL =_____L

36. 2.5 L =_____ mL

37. 120 ft^3 =_____m^3

38. 250 mL =_____gal

39. 2400 mL =_____ L

40. 15 L =_____ mL

41. 250,000 m^3 =_____ac-ft

42. 2.2 mL =_____ L

43. 155,000 mm^3 =_____cm^3

44. 40 ft^3 =_____m^3

45. 1017 in^3 =_____ ft^3

46. 25 yd^3 =_____ ft^3

47. 2.2 ac-ft =_____ yd^3

48. 0.6 yd^3 =_____ ft^3

49. 17,260 ft^3 =_____ yd^3

50. 1500 in^3 =_____ ft^3

51. 2.7 gal = _____ L

52. 50 L =_____ gal

53. 1 lb =_____ g

54. 21 ft^3 =_____ yd^3

55. 600 mL =_____ gal

56. 92,600 ft^3 =_____ ac-ft

57. 3 ft^3 =_____in^3

58. 48,000 cu ft =_____ gal

59. 310,000 lbs =_____ft^3

60. 186,000 gal =_____lbs

61. 120 ft^3 =_____lbs

62. 81,400 lbs =_____gal

63. 35,300 ft^3 =_____ gal

64. 1.75 ac-ft =_____ft^3

65. 42 yd^3 =_____ ft^3

66. 420,000 ft^3 =_____ ac-ft

67. 128,355 in^3 =_____ft^3

68. 145 mg =_____g

69. 12 g =_____ mg

70. 515 lbs =_____ kg

71. 75 kg =_____lbs

72. 30 hp =_____ kW

73. 8 g =_____ mg

74. 230 mg =_____g

75. 30 kg =_____g

Concentration

76. 320 mg/L =_____%

77. 210 mg/L =_____%

78. 1.2% =_____ mg/L

79. 0.26% =_____ mg/L

80. 0.01% =_____ mg/L

81. 12 gpg =_____ mg/L

82. 110 mg/L =_____gpg

83. 9.1 gpg =_____mg/L

84. 14.2 gpg =_____mg/L

85. 195 mg/L =_____gpg

86. 18 kW =_____ hp

Flow Measurements

87. 3.6 cfs =_____ gpm

88. 1820 gpm =_____ gpd

89. 45 gps =_____ cfs

90. 8.6 MGD =_____ gpm

91. 2.92 MGD =_____gpm

92. 385 cfm =_____gpd

93. 1,662,000 gpd =_____gpm

94. 3.77 cfs =_____ MGD

Conversion Word Problems

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 Church Street and Second Avenue as measured on a map is 1.98 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 diameter of the transmission pipe from Silver Lake to the Charles Thorpe Treatment Plant is 48 inches. What is the diameter in feet?

105. The distance between Deco St. and Sand Ave. is 368 yards. What is this distance in inches?

106. Express 5.1 feet in terms of meters.

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

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

109. The minimum area required for building a 1 MG storage facility is 9000 ft^2. What is this size in acres?

110. 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.

111. 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.

112. 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?

113. 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?

114. 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?

115. The Three Crowns Water System franchise area covers an area of 3.2141 square miles. What is this service area in acres?

116. The foundation for your new storage tank requires an area of 53.2 yd^2 . What is the area of foundation in m^2?

117. From your maps, measurements, and calculations, the southwest corner of the Beach Ave. and Main St. intersection is 4,569 m^2. What is this area in square inches?

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

119. A screening pit must have a capacity of 400 ft^3. How many yd^3 is this?

120. A reservoir contains 50 ac-ft of water. How many ft^3 of water does it contain?

121. How many pounds of sludge can be pumped to a digester that has 3,400 ft^3 of volume available? The sludge weighs 7.5 pounds per gallon.

122. How many cubic feet of sludge are removed when 16,000 gallons are withdrawn?

123. If 1,400 gal of solids are removed from the primary settling tank, how many pounds of solids are removed? The solids have a concentration of 9.4 lb/gal.

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

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

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

127. Convert 2,445 gal to cubic feet.

128. How much does 725 gal of water weigh in kilograms?

129. Convert 15.0 acre-ft to cubic feet.

130. Convert 4,078,611 ft^3 to acre-feet.

131. How many million gallons are there in 22 ac-ft?

132. How many million gallons are there in 430 ac-ft?

133. How many gallons are there in 8,492 ft^3?

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

135. Sunny Slope water system daily maximum demand is 556,000 gallons. What is this system demand in ft^3?

136. 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?

137. The operator withdraws 5,690 gal of solids from the digester. How many pounds of solids have been removed? The solids have a density of 8.94 lb/gal.

138. 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?

139. 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 ft^3. What is the volume in cubic yards of the trench?

140. 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 ft^3. What is the volume in yd^3?

141. 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.

142. A tank has a capacity of 60,000 ft^3. What is the gallon capacity of the tank?

143. 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 ft^3 will be sent to the drying beds?

144. A tank contains 188,000 gallons. How many cubic feet is this?

145. Convert 60,000 lbs of sludge to ft^3. Assume the sludge weighs the same as water, 8.34 lb/gal.

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

147. How much does 20 ft^3 of water weigh in kg?

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

149. The required volume for a screening pits is 325 ft^3. What is this volume in yd^3?

150. The capacity of a small segment of pipeline has been calculated to be 2,512 in^3. How many ft^3 is this?

151. 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?

152. 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?

153. 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?

154. Based on the dimensions of your storage reservoir, you calculate the total volume to be 1,573,000 ft^3. How many million gallons (MG) of water can you store at this reservoir?

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

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

157. Convert 8.2 ft^3/sec to gallons per minute.

158. Convert 5.1 MGD to cfs.

159. Convert 11.9 MGD to cubic feet per second.

160. Convert 5.6 ft^3/sec to gallons per minute.

161. Convert 3.2 ft^3/sec to millions of gallons per day.

162. During a fire flow test, the gauge shows a flow of 79.3 ft^3/sec. What is the flow at this location in ac-ft/day?

163. 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?

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

165. The influent meter reads 27.8 MGD. What is the current flow rate in gallons per day?

166. The flow rate entering the grit channel is 2.39 MGD. What is the flow rate in cubic feet per second?

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

168. 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?

169. 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?

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

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

172. A flow of 4.61 MGD is equivalent to a flow of how many cfs?

173. The flow through a pipeline is 2.8 cfs. What is this flow in gpd?

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

175. The Three Crowns Water System minimum water demand per day is 198 MGD. What is the minimum demand in ft^3/sec?

176. 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 m^3/day?

177. Based on an MSDS sheet, the lethal oral dosage of your cleaning solution is 0.66 grams/11.0 Liter. What is this dosage in lb/gal?

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

179. 12 kW is equivalent to how many horsepower?

180. The suspended solids concentration of a primary clarifier is 340 mg/L. What is this concentration expressed as a %?

181. A waste activated sludge has a total solids concentration of 0.6%. What is this expressed as mg/L?

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

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

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

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

186. 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?

187. During a fire flow test at Brady Ave. the gauge shows a flow of 2.6 ft^3/sec. What is the flow at this location in gpm?

188. 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?

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

190. 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?

191. 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 used 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?

192. 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.

193. 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?

194. In the process of preparing a free-chlorine analyzer calibration solution, you are required to mix 473 grams of powder into 100 ml of water. What is the weight of the powder in lb?

195. After completing work on 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?

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

197. 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?

198. 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.)

Basic Math Dimensional Analysis Practice Problems Answers							
1.)	0.80 mi	26.)	4,500 ft^2	51.)	10.22 L	76.)	0.032%
2.)	5.67 yd	27.)	1,368 in^2	52.)	13.21 gal	77.)	0.021%
3.)	1,080 in	28.)	0.57 ac	53.)	453.59 g	78.)	12,000 mg/L
4.)	27.56 in	29.)	1,296 in^2	54.)	0.78 yd^3	79.)	2,600 mg/L
5.)	7.2 in	30.)	14,760 ft^2	55.)	0.16 gal	80.)	100 mg/L
6.)	41 ft	31.)	3.1 ac	56.)	2.13 ac-ft	81.)	205.2 mg/L
7.)	6.10 m	32.)	209,088 ft^2	57.)	5,184 in^3	82.)	6.43 gpg
8.)	105 ft	33.)	20,037.6 ft^2	58.)	359,040 gal	83.)	155.61 mg/L
9.)	1,320 ft	34.)	14.58 ft^2	59.)	4,969.29 ft^3	84.)	242.82 mg/L
10.)	10.17 ft	35.)	0.52 L	60.)	1,551,240 lb	85.)	11.40 gpg
11.)	2.33 ft	36.)	2,500 mL	61.)	7,485.98 lbs	86.)	24.13 hp
12.)	24,816 ft	37.)	3.4 m^3	62.)	9,760.19 gal	87.)	1,615.68 gpm
13.)	44.4 in	38.)	0.07 gal	63.)	264,044 gal	88.)	2,620,800 gpd
14.)	0.34 mi	39.)	2.4 L	64.)	76,230 ft^3	89.)	6.02 cfs
15.)	86.67 yd	40.)	15,000 mL	65.)	1,134 ft^3	90.)	5,972.22 gpm
16.)	0.20 m	41.)	202.8 ac-ft	66.)	9.64 ac-ft	91.)	2027.78 gpm
17.)	81.28 cm	42.)	0.0022 L	67.)	74.28 ft^3	92.)	4,146,912 gpd
18.)	95.76 m	43.)	0.16 cm^3	68.)	0.15 g	93.)	1,154.17 gpm
19.)	40.46 yd	44.)	1.13 m^3	69.)	12,000 mg	94.)	2.44 MGD
20.)	39.37 in	45.)	0.59 ft^3	70.)	233.6 kg	95.)	142.58 ft
21.)	40,000 m	46.)	675 ft^3	71.)	165.35 lb	96.)	660 ft
22.)	0.18 m	47.)	3,549.33 yd^3	72.)	22.38 kW	97.)	4345.23 m
23.)	0.55 ft^2	48.)	16.2 ft^3	73.)	8,000 mg	98.)	0.95 mi
24.)	39,204 ft^2	49.)	639.26 yd^3	74.)	0.23 g	99.)	1182.72 ft
25.)	174,240 ft^2	50.)	0.87 ft^3	75.)	30,000 g	100.)	4.33 ft

Basic Math Dimensional Analysis Practice Problems Answers			
101.) 10,454.4 ft	126.) 613.36 gal	151.) 0.46 ac-ft	176.) 7,570.82 m^3/day
102.) 3,910.6 km	127.) 326.87 ft^3	152.) 0.14 ac-ft	177.) 0.0005 lb/gal
103.) 12,936 ft	128.) 2742.64 gal	153.) 4.96 yd^3	178.) 5.26%
104.) 4 ft	129.) 653,400 ft^3	154.) 11.77 MG	179.) 16.09 hp
105.) 13,248 in	130.) 93.63 ac-ft	155.) 5,428,684.8 gpd	180.) 0.034%
106.) 1.55 m	131.) 7.17 MG	156.) 4,381.94 gpm	181.) 6,000 mg/L
107.) 1.38 ac	132.) 140.11 MG	157.) 3,680.16 gpm	182.) 0.68%
108.) 3.14 ft^2	133.) 63,520.16 gal	158.) 7.89 cfs	183.) 0.02%
109.) 0.21 ac	134.) 5.39 mg/L	159.) 18.41 cfs	184.) 34.2 mg/L
110.) 1,481.04 gpm	135.) 74,331.55 ft^3	160.) 2,513.28 gpm	185.) 6.43 gpg
111.) 3.96 ac-ft/day	136.) 1.57 MG	161.) 2.07 MGD	186.) 5.56 ac-ft/day
112.) 89.37 mL/min	137.) 50,868.6 lb	162.) 157.29 ac-ft/day	187.) 1,166.88 gpm
113.) 946,352.78 m^3/day	138.) 22,410.08 gal	163.) 64.40 mL/min	188.) 1.10 lb
114.) 20 ft^2	139.) 444.44 yd^3	164.) 3159.72 gpm	189.) 6.89 lb
115.) 2057.02 ac	140.) 78.22 yd^3	165.) 27,800,000 gpd	190.) 2.025 lb
116.) 44.48 m^2	141.) 49,171.12 ft^3	166.) 3.7 cfs	191.) 1.5 ft
117.) 7,081,957.31 in^2	142.) 448,800 gal	167.) 2.12 MGD	192.) 26,040 ac
118.) 19.81 gal	143.) 8,816.48 ft^3	168.) 736.08 MGD	193.) 4800 lb
119.) 14.81 yd^3	144.) 25,133.69 ft^3	169.) 2.56 MGD	194.) 1.04 lb
120.) 2,178,000 ft^3	145.) 961.80 ft^3	170.) 1,032.24 gpm	195.) 1.06 gal
121.) 190,740 lb	146.) 12,829.74 gal	171.) 3.79 cfs	196.) 2.76 mg/L
122.) 2,139.04 ft^3	147.) 1,247.66 lb	172.) 7.13 cfs	197.) 6308.41 ft^2
123.) 13,160 lb	148.) 4170 lb	173.) 1,809,561.6 gpd	198.) 3,003,208.56 cfd
124.) 779.38 gal	149.) 12.04 yd^3	174.) 25,806.94 gpm	
125.) 834 lb	150.) 1.45 ft^3	175.) 306.37 cfs	

Section 5

Circumference and Area

PERIMETER AND CIRCUMFERENCE

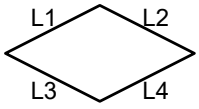
Basic Math for All Certifications

Perimeter

P = perimeter
L = length of side
W = width of side

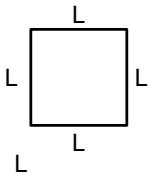
- Distance around any angular area or object
- General perimeter equation:

$$P = L1 + L2 + L3 + L4 + \ldots$$



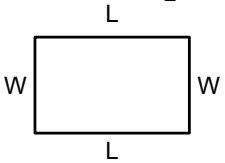
- Perimeter of a square

$$P = 4 \times L$$



- Perimeter of a rectangle

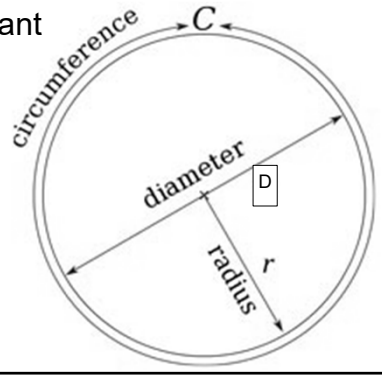
$$P = (2)(L) + (2)(W)$$



Parts of a Circle

- **Diameter** is distance across the center of 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
  - $\pi = 3.14159265359$

$$\text{Circumference} = (3.14)(\text{Diameter})$$



Example 1

- Find the circumference (in inches) of a 6-inch diameter pipe.

$$\text{Circumference} = (3.14)(\text{diameter})$$

$$\text{C} = (3.14)(6 \text{ inches})$$

$$\text{C} = 18.84 \text{ inches}$$

- Find the perimeter (in feet) of a rectangular tank that is 15 ft by 22 ft.

$$\text{Perimeter} = 2(\text{length}) + 2(\text{width})$$

$$\text{P} = 2(15 \text{ ft}) + 2(22 \text{ ft})$$

$$\text{P} = 30 \text{ ft} + 44 \text{ ft}$$

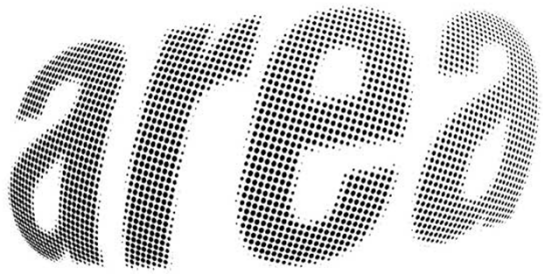
$$\text{P} = 74 \text{ ft}$$

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

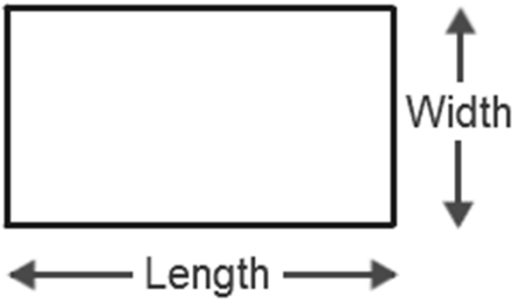
- Area is the measurement of the amount of space on the **surface** of an object
- Two-dimensional measurement
- Measured in: in^2, ft^2, mi^2, m^2, acres
  - Units will always come out squared



Area of Rectangle

$$\text{Area} = (\text{length})(\text{width})$$

$$\text{A} = (\text{L})(\text{W})$$



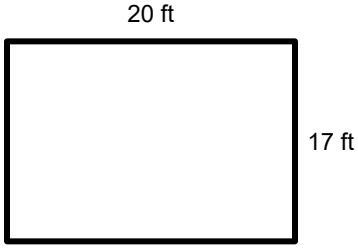
Example 1

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

$$\text{A} = (\text{L})(\text{W})$$

$$\text{A} = (20\ \text{ft})(17\ \text{ft})$$

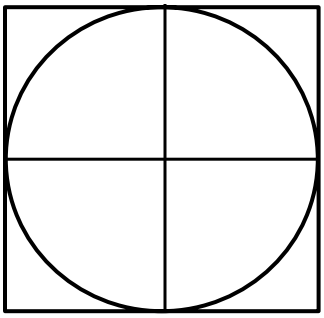
$$\text{A} = 340\ \text{ft}^2$$



Area of a Circle

$$\text{Area} = (0.785)\ (\text{Diameter}^2)$$

$$\text{A} = (0.785)(\text{D}^2)$$



A circle takes up 78.5% of a square.

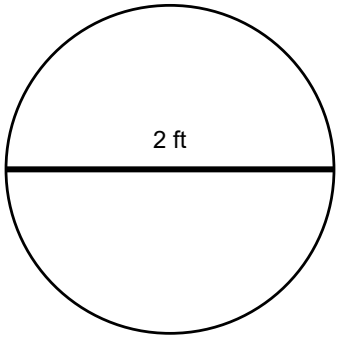
Example 2

- Find the area of the cross section of a pipe in ft^2 that has a diameter of 2 feet.

$$\text{Area} = (0.785)(\text{D}^2)$$

$$\text{A} = (0.785)(2\ \text{ft})(2\ \text{ft})$$

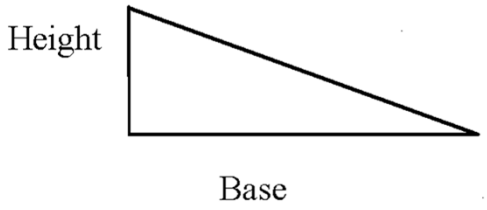
$$\text{A} = 3.14\ \text{ft}^2$$



Area of Right Triangle

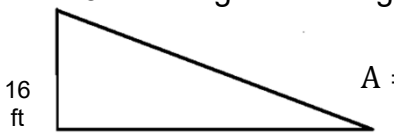
$$\text{Area} = \frac{(\text{base})(\text{height})}{2}$$

$$A = \frac{(b)(h)}{2}$$



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.



$$A = \frac{(b)(h)}{2}$$

$$A = \frac{(23\ \text{ft})(16\ \text{ft})}{2}$$

$$A = \frac{368\ \text{ft}^2}{2}$$

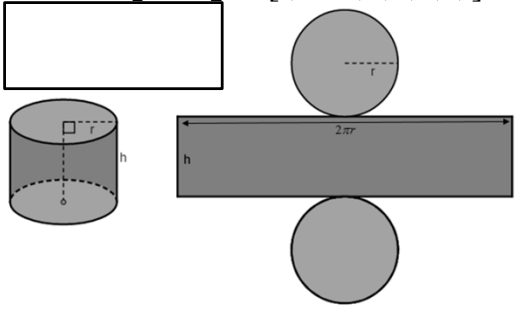
$$A = 184\ \text{ft}^2$$

Area of Cylinder

Total Exterior Surface Area

Area
$= [\text{surface area of end \#1}] + [\text{surface area of end \#2}]$
$+ [(3.14)(\text{Diameter})(\text{height})]$

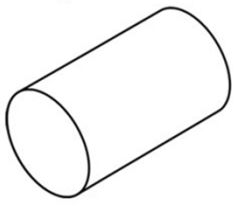
$$A = A_1 + A_2 + [(3.14)(D)(h)]$$



Example 4

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

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



$$A_1 = (0.785)(D^2)$$

$$A_1 = (0.785)(2ft)(2ft)$$

$$A_1 = 3.14ft^2$$

$A_1 = A_2$

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

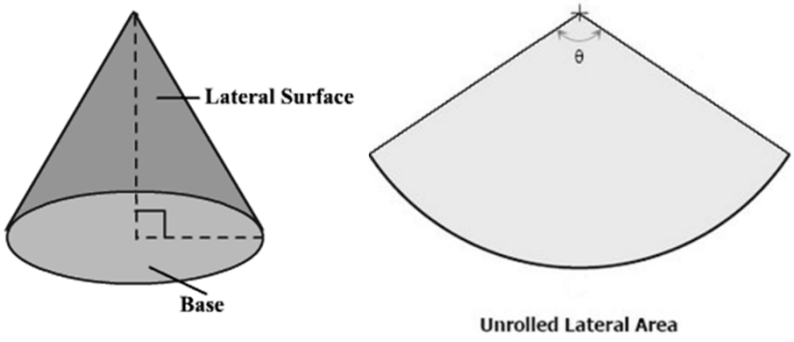
$$A = 3.14ft^2 + 3.14ft^2 + 125.6ft^2$$

$$A = 131.88\ ft^2$$

Area of Cone - Lateral Surface Area

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

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

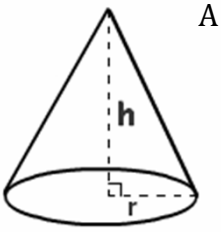


Example 5

- Find the lateral area (in ft^2) of a cone that is 3 feet tall and has a radius of 1.5 feet.

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

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



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

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

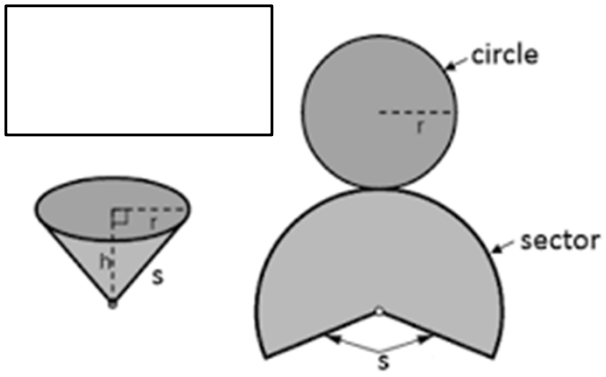
$$A = (3.14)(1.5\text{ft})(3.3541\text{ft})$$

$$A = 15.80\text{ft}^2$$

Area of Cone - Total Surface Area

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

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



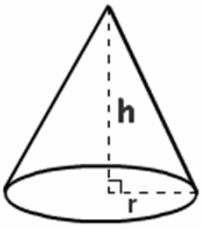
Example 6

- Find the total surface area in ft^2 of a cone that is 4.5 feet deep with a diameter of 6 feet.

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

$$A = (3.14)(3\text{ft})(3\text{ft} + \sqrt{(3\text{ft})(3\text{ft}) + (4.5\text{ft})(4.5\text{ft})}\ )$$

$$A = (3.14)(3\text{ft})(3\text{ft} + \sqrt{9\text{ft}^2 + 20.25\text{ft}^2}\ )$$



$$A = (3.14)(3\text{ft})(3\text{ft} + \sqrt{29.25\text{ft}^2}\ )$$

$$A = (3.14)(3\text{ft})(3\text{ft} + 5.4083\text{ft})$$

$$A = (3.14)(3\text{ft})(8.4083\text{ft})$$

$$A = 79.21\text{ft}^2$$

$$\text{radius} = \frac{1}{2}\text{D}$$

$$r = \left(\frac{1}{2}\right)6\text{ft}$$

$$r = 3\text{ ft}$$

Applied Math for All Certifications
Perimeter, Circumference, and Area
Example Problems

1. A rectangular basin measures 50 ft wide by 125 ft long. What is the perimeter of the tank, in feet?

2. Calculate the circumference in ft of a circular clarifier that is 30 feet in diameter.

3. A sedimentation tank is 20 feet long and 12 feet wide and 15 ft deep. What is the area (ft^2) of the water surface in the tank?

4. What is the cross-sectional area (ft^2) of an 18 inch water main?

5. A triangular portion of the treatment plant grounds is not being used. How many square feet does this represent if the height of the triangle is 140 ft and the base is 180 ft?

6. Calculate the lateral surface area, in ft^2, for a conical tank that 30 feet tall and 20 feet wide.

7. Determine the total surface area, in ft^2, of a conical tank that is 15 feet tall and 30 feet wide.

8. A new water tank needs to be painted. What is the total exterior surface area if the cylindrical tank is 50 feet in diameter and 30 feet tall, in ft^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 ft^2?

9. A tank is 60 feet long, 15 feet wide, and 10 feet deep. What is the surface area of the water in ft^2?

10. What is the surface area (ft^2) 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 (ft^2) of a triangle that has a base of 50 ft and a height of 32 ft?

13. Calculate the area (m^2) of a triangle with a base of 32 meters and height of 62 meters.

Area of a Circle

14. What is the area, in ft^2, of the top of a circular 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 not 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 (in ft^2) of a cone 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 ft^2).

23. Calculate the total surface area (in ft^2) 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. A water tank needs to be aerated. If the tank has a total surface area of 6,720 ft^2, what is the tank diameter, in feet?

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? The tank is raised off the ground.

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 ins square feet that is 16.25 ft high and has a diameter of 125 ft? Assume the top is flat and that the tank is sitting on the ground.

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 ft^2. 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?

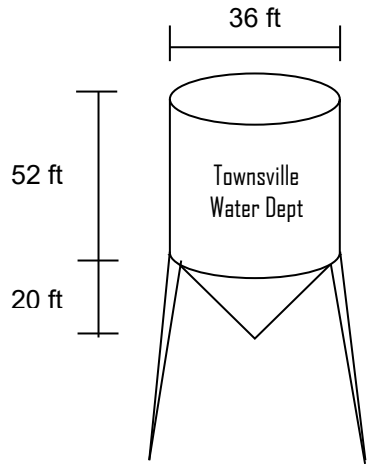
46. The top of a tank has a surface area of 3150 ft^2. If the width of the tank is 35 ft, what is the length of the tank in feet?

47. Calculate the surface area (in square feet) of a square with sides measuring 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 (ft^2) of copper tubing with a length of 30 feet and internal diameter of 0.5 inches? The ends of the tube are open.

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.

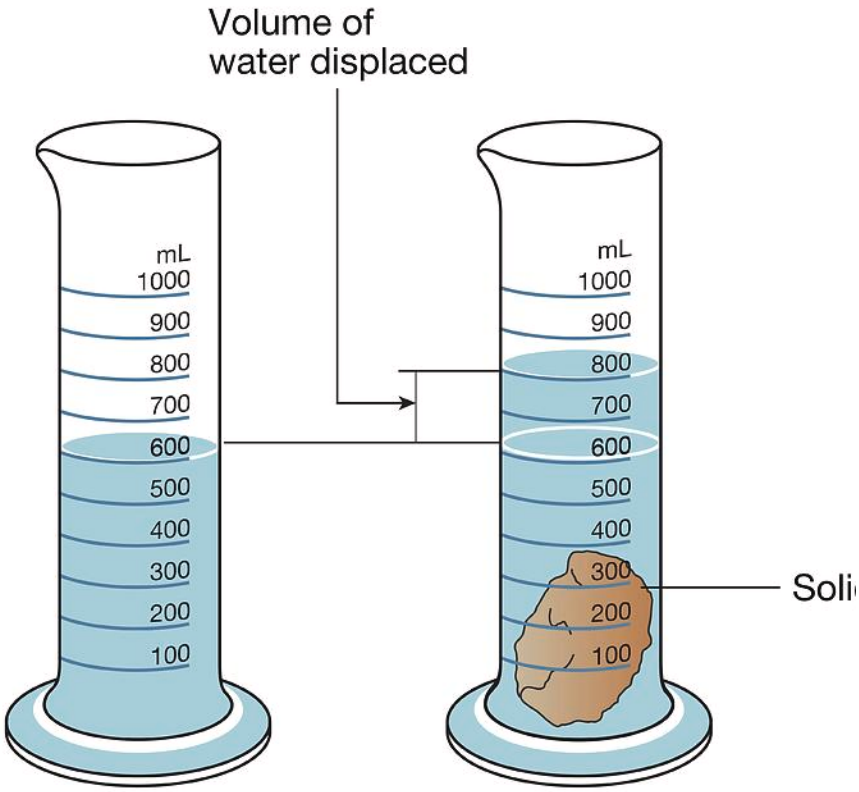


Perimeter, Circumference and Area
Practice Problems
Answers

1. 85 ft	18. 5,236.12 ft^2	35. 20 gal
2. 140 ft	19. 26,024.32 ft^2	36. 80 ft
3. 374 ft	20. 860.15 ft^2	37. 219.8 ft
4. 157 ft	21. 25,276.51 ft^2	38. 24 in
5. 31.4 ft	22. 58.28 ft^2	39. 85 ft
6. 188.4 ft	23. 418.23 ft^2	40. 18,643.75 ft^2
7. 28,028 ft^2	24. 240 ft^2	41. 157 ft
8. 264 ft^2	25. 406.63 ft^2	42. 1,256 ft^2
9. 900 ft^2	26. 116.69 m^2	43. 39.10 ft
10. 544.38 ft^2	27. 92.52 ft^2	44. 12.56 ft
11. 15 ft^2	28. 2.17 ft^2	45. 20 ft^2
12. 800 ft^2	29. 88 in	46. 179,520 ft
13. 992 ft^2	30. 120 ft	47. 6,727.44 ft^2
14. 725.47 ft^2	31. 38.47 ft^2	48. 282,600 ft^2
15. 0.785 ft^2	32. 80 ft	49. 3.93 ft^2
16. 1.07 ft^2	33. 820.21 ft^2	50. 8416.23 ft^2
17. 19.63 ft^2	34. 8.33 ft	

Section 6

Volume



Volume

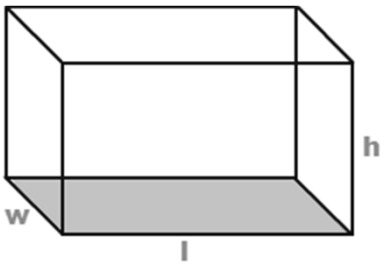
Volume

- Volume is the capacity of an object or how much it will hold
- Measured in
  - cubic units (ft^3, m^3, yd^3, 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

$$\text{Volume} = (\text{length})(\text{width})(\text{height})$$

$$\text{Vol} = (\text{l})(\text{w})(\text{h})$$



Example 1

- Determine the volume in m^3 for a tank that measures 30 meters by 15 meters by 25 meters.

$$\text{Vol} = (\text{l})(\text{w})(\text{h})$$

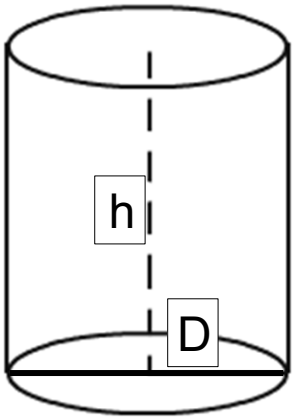
$$\text{Vol} = (30\ \text{m})(15\ \text{m})(25\ \text{m})$$

$$\text{Vol} = 11{,}250\text{m}^3$$

Volume of a Cylinder

$$\text{Volume} = (0.785)(\text{Diameter}^2)(\text{height})$$

$$\text{Vol} = (0.785)(\text{D}^2)(\text{h})$$



Example 2

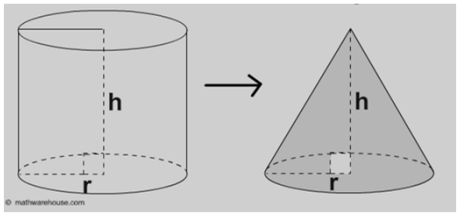
- Determine the volume in ft^3 for a tank that is 20 feet tall with a diameter of 7.5 ft.

$$\text{Vol} = (0.785)(\text{D}^2)(\text{h})$$

$$\text{Vol} = (0.785)(7.5\text{ft})(7.5\text{ft})(20\text{ft})$$

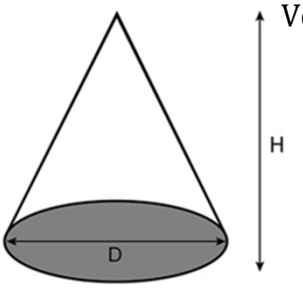
$$\text{Vol} = 883.13\ \text{ft}^3$$

Volume of a Cone



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

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



Example 3

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

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

$$\text{Vol} = \left(1/3\right)(0.785)(8\text{ft})(8\text{ft})(15\text{ft})$$

$$\text{Vol} = (0.3333)(753.6\ \text{ft}^3)$$

$$\text{Vol} = 251.1749\ \text{ft}^3$$

$$\text{Vol, gal} = (251.1749\ \cancel{\text{ft}^3})(7.48\ \frac{\text{gal}}{\cancel{\text{ft}^3}})$$

$$\text{Vol, gal} = 1878.78\ \text{gallons}$$

Applied Math for All Certifications
Volume
Example Problems

1. What is the volume in ft^3 of water contained in a cylindrical tank that is 20 feet across with water to a depth of 28 feet?

2. A screenings pit contains 3.5 feet of water. Calculate the number of gallons in the pit that is 5 feet wide, 5 feet long, and 15 feet tall.

3. How many cubic feet of water is contained in a conical clarifier if the water is 8 feet deep and the distance across the clarifier at the water level is 21.7 feet?

Applied Math for All Certifications
Volume
Practice Problems

Volume of a Cuboid (Rectangle)

1. 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?

2. 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?

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

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

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

6. If a trench is 346 ft long, 4.4 ft wide, and 5.7 ft deep, how many cubic yards of soil were excavated?

Volume of a Cylinder

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

8. The diameter of a cylindrical tank is 60 ft. When the water depth 25 feet, what is the volume of water in the tank, in ft^3?

9. 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?

10. 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?

Volume of a Cone

11. The diameter of a conical tank is 60 ft. When the water depth is 25 ft, what is the volume of the water in the tank, in ft^3?

12. Calculate the volume of a cone (in cubic meters) with a height of 7 meters and a radius of 2 meters.

Miscellaneous Problems

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

14. A channel 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 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?

16. 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?

17. 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.

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

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

20. 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?

21. 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?

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

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

24. 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 million gallons?

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

26. What is the capacity in gallons of wastewater of a 10-inch diameter, 1,800-foot section of pipeline?

27. Approximately how many gallons of wastewater would 800 foot of 8-inch pipe hold?

28. 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.

29. 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.

30. 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?

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

32. 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?

33. 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?

34. 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?

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

39. What is the gallon capacity of a wet well that is 12 feet wide, 10 feet long, and 10 feet deep?

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

41. 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?

42. 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?

43. Calculate the volume of soda (in^3) in a can with a height of 6 inches and a radius of 2 inches.

44. 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 kiloliters (kL) of finished water are in this tank?

45. 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?

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

47. 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?

48. *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?

49. 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?

50. A new section of 16-inch diameter pipe is to be disinfected before it is put into service. If the length of the pipeline is 1250 ft, how many gallons of water will be needed to fill the pipeline?

51. 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?

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

53. 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?

54. 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?

55. 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?

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

57. 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.

58. 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?

59. 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).

60. 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?

61. 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?

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

63. A cylindrical tank is 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?

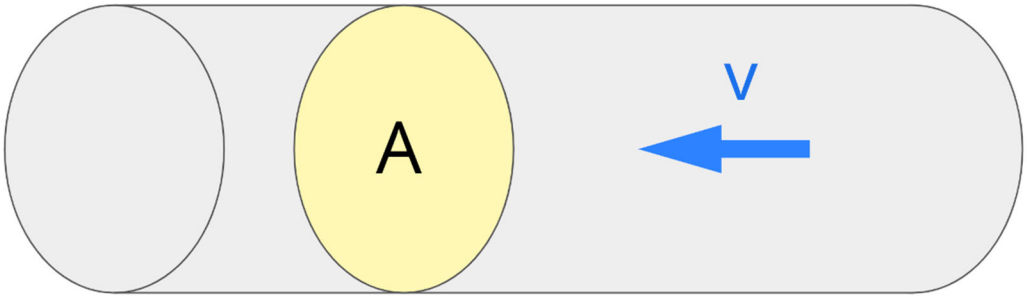
64. What is the diameter of a pipe (in feet) that is 750 feet long and holds 1324 ft^3 of water?

65. *The volume of the settling tank in a filtration plant is 75,000 cubic feet. The area it must fit in is 12 feet wide by 20 feet long and the depth of the tank cannot exceed 10 feet. Will the settling tank fit into this area?

Volume Practice Problems Answers					
1.	60,750 ft^3	23.	166.67 yd^3	45.	1,127,385.6 gal
2.	5,968.2 ft^3	24.	0.86 MG	46.	16,800 ft^3
3.	2.52 ft^3	25.	6,764.31 gal	47.	1,622,400 lb
4.	224,400 gal	26.	7,339.1628 gal	48.	20,115.63 ft^3
5.	1,252.46 gal	27.	2,087.9599 gal	49.	5,197.5 ft^3
6.	321 yd^3	28.	9,000 ft^3	50.	6,116.44 gal
7.	8,792 ft^3	29.	10,000 ft^3	51.	2,635.26 gal
8.	70,650 ft^3	30.	140,250 gal	52.	20,670.80 gal
9.	11,743 gal	31.	528, 462 gal	53.	138,380 gal
10.	327.8 ac-ft	32.	26,928 gal	54.	233.33 yd^3
11.	23,550 ft^3	33.	1,147.5 ft^3	55.	31.8 ac-ft
12.	29.31 m^3	34.	1,937.69 gal	56.	3,000 ft^3
13.	22,056 L	35.	179,520 gal	57.	12,600 ft^3
14.	25,718.04 gal	36.	19747.2 gal	58.	661,751 ft^3
15.	11,743.6 gal	37.	558,055.87 gal	59.	24,000 ft^3
16.	333.33 yd^3	38.	678.24 ft^3	60.	166.67 yd^3
17.	18,000 ft^3	39.	1,200 ft^3	61.	1,937.69 gal
18.	5,741.03 gal	40.	104,720 gal	62.	46,750 gal
19.	6,116.46 gal	41.	345,261.8 gal	63.	0.27 MG
20.	19,747 gal	42.	0.57 ac-ft	64.	1.5 ft
21.	140,250 gal	43.	75.36 in^3	65.	No
22.	89,760 gal	44.	720 kL	66.	6.18 m

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?

$$\text{Velocity} = \frac{\text{distance}}{\text{time}}$$

$$\text{Vel} = \frac{125 \text{ ft}}{3 \text{ min}}$$

$$\text{Vel} = 41.67 \ ^{ft}/_{min}$$

Flow Rate

Flow Rate

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

$$\text{Flow} = (\text{Area})(\text{Velocity})$$

$$Q = AV$$

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?

$$Q = AV$$

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

$$Q = (l)(w)(\text{velocity})$$

$$Q = (2\text{ ft})(1.5\text{ ft})\left(3\ {}^{\text{ft}}/_{\text{sec}}\right)$$

$$Q = 9\ {}^{\text{ft}^3}/_{\text{sec}}$$

Example 3

- Determine the flow in ft^3/sec through a 5-foot pipe that is flowing full at a velocity of 4.5 ft/sec.

$$Q = AV \qquad A = (0.785)(D^2)$$

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

$$Q = (0.785)(5\text{ft})(5\text{ft})\left(4.5\ {}^{\text{ft}}/_{\text{sec}}\right)$$

$$Q = 88.3\ {}^{\text{ft}^3}/_{\text{sec}}$$

Applied Math for All Certifications
Velocity and Flow
Example Problems

1. A bobber is placed in a channel and travels 450 feet in 2 ½ minutes. What is the velocity of the water flowing in the channel in ft/min?

2. A channel 30 inches wide has water flowing to a depth of 2 feet. If the velocity of the water is 2.75 ft/sec, what is the flow in the channel in ft^3/sec? And gal/min?

3. The flow through a 24-inch pipe is moving at a velocity of 5.4 ft/sec. What is the flow rate in gal/min?

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/min)?

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 wide and 10 ft deep. 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 (MGD) 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 (MGD) 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 (gpd) for July, if the total flow for the month was 29.73 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)?

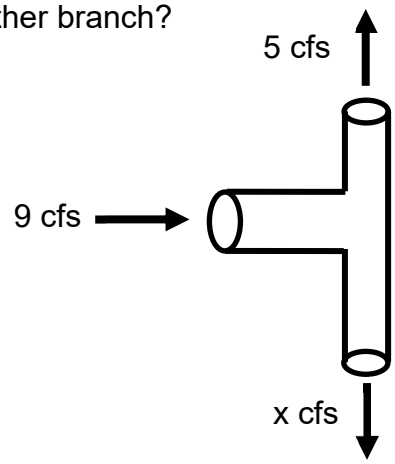
34. A fluorescent dye is used to estimate the velocity of flow in a sewer. The dye is injected into the water at one manhole and the travel time to the next manhole 500 ft away is noted. The dye first appears at the downstream manhole is 195 seconds. The dye continues to be visible until the total elapsed 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 cfm flow for that day?

36. The velocity in a 10-inch pipeline is 2.4 ft/sec. If the 10-inch pipeline flows into an 12-inch diameter pipeline, what is the ft/sec velocity in the 12-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 (fps) 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		
1. 185 ft/min	15. 253,661.76 gal/day	29. 237.81 gal/min
2. 210 ft/min	16. 133.33 ft/min	30. 3.13 ft/sec
3. 2.2 ft/sec	17. 7,926.93 gal/min	31. 2.21 ft/sec
4. 272.73 ft/min	18. 1.5 ft/sec	32. 5,990,967.74 gal/day
5. 120 ft/min	19. 9.47 MGD	33. 2.6 ft/sec
6. 10.8 ft^3/sec	20. 9.13 MGD	34. 19.23 ft/sec
7. 1533.33 ft^3/min	21. 4.12 MGD	35. 291.52 ft^3/min
8. 654.46 gal/min	22. 1201.2 ft/min	36. 2.88 ft/sec
9. 635.8 gal/min	23. 101.78 gal/min	37. 1,000 ft/min
10. 2.67 ft/sec	24. 5.0 MGD	38. 4 ft^3/sec
11. 86.35 ft^3/min	25. 27.44 ft/sec	39. 4.06 ft/sec
12. 782.91 gal/min	26. 3,809,523.8 gal/day	40. 136.83 MG
13. 229.05 gal/min	27. 3.91 MGD	41. 2,404.50 gal/min
14. 7,170,172.42 gal/day	28. 4.5 fps	42. 6.67 MGD

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 ft^3 /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 ft^3 /sec ?

8. A channel is 2.5 ft wide and the water is flowing at a velocity of 3 ft/sec. I f the flow through the channel is measured to be 6.4 ft^3 / 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 ft^3/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?

More Velocity and Flow Problems
Answers

1. 1.55 ft/sec
2. 333.33 ft/sec
3. 88 ft/sec
4. 160 ft/min
5. 0.13 ft/min
6. 8.83 ft^3/sec
7. 12.5 ft^3/sec
8. 0.85 ft
9. 2,356.2 gpm
10. 522 ft^3/min
11. 0.037 ft/sec
12. 28.3 ft^3/sec
13. 1.09 ft^3/sec
14. 176.15 gpm
15. 10 in
16. 346,671.01 gph
17. 9,512 gpm
18. 2.25 MGD
19. 465,046.56 gpd
20. 9.09 ft sec
21. 6 in
22. 1,174,360 gpd

Section 8

Feed Rate & Dosage

Feed Rate & Dosage

Chemical Feed Rate

- In chemical dosing, a measured amount of chemical is added to the water/wastewater to achieve a goal
- The amount of chemical can depend on
  - the type of chemical used
  - the reason for dosing
  - the flow rate being treated
- Two expressions most often used to describe amount of chemical added or required:

  milligrams per liter (mg/L)

  pounds per day (lb/day)

Chemical Feed Rate

- mg/L is a measure of concentration
  - A ratio of the milligrams of chemical in each liter of water
  - Example: If a concentration of 5 mg/L is needed in 3 liters of solution, then a total of 15 mg chemical would be required to treat 3 liters.

$$5\ \text{mg/L} = \frac{5\ \text{mg}}{1\ \text{L}}$$

$$\frac{5\ \text{mg} \times 3}{1\ \text{L} \times 3} = \frac{15\ \text{mg}}{3\ \text{L}}$$

  - The amount of chemical required to dose depends on 2 factors:
    - Desired concentration (mg/L)
    - Amount of water/wastewater to be treated (MGD or MG)

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Determining Dosage

- Feed rate (water flowing)

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = \frac{(\text{dose, mg/L})(\text{flow, MGD})(8.34\ \text{lb/gal})}{\text{chemical concentration}}$$

- Feed rate (water stationary)

$$\text{feed rate, lb} = \frac{(\text{dose, mg/L})(\text{flow, MG})(8.34\ \text{lb/gal})}{\text{chemical concentration}}$$

- If chemical concentration is not provided, assume it to be 100% pure
- *Dose is always measured in mg/L and mg/L is almost always dose*

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Example 1

- The plant must achieve a dosage of 3.1 mg/L if it is to meet the disinfection requirements. Determine the chemical feeder setting in lb/day on a bleach solution of 7.5% that is being fed to a plant effluent of 2.8 MGD.

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = \frac{(\text{dose, mg/L})(\text{flow, MGD})(8.34 \text{ lb/gal})}{\text{chemical concentration}}$$

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = \frac{(3.1 \text{ mg/L})(2.8 \text{ MGD})(8.34 \text{ lb/gal})}{0.075}$$

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = \frac{(72.3912)}{0.075}$$

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = 965.22 \text{ lb/day}$$

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Example 2

- A chlorinator setting is 30 lb per 24 hr. If the flow being chlorinated is 1.25 MGD, what is the chlorine dosage (mg/L)?

$$\text{feed rate, } {}^{\text{lb}}/_{\text{day}} = \frac{(\text{dose, mg/L})(\text{flow, MGD})(8.34 \text{ lb/gal})}{\text{chemical concentration}}$$

$$30 \text{ lb/day} = (\text{x mg/L})(1.25 \text{ MGD})(8.34 \text{ lb/gal})$$

$$30 \text{ lb/day} = (\text{x mg/L})(1.25 \text{ MGD})(8.34 \text{ lb/gal})$$

$$\frac{30}{10.425} = \frac{(\text{x})(10.425)}{10.425}$$

$$2.8777 \text{ mg/L} = \text{x}$$

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Applied Math for All Certifications
Feed Rate and Dosage
Example Problems

1. Determine the feed rate in lb/day for a system that wants to dose 2.6 mg/L of 65% HTH. The plant averages 150,000 gallons per day.

2. How many gallons per day of 0.08% sodium hypochlorite would a system need to feed to obtain the required dose of 1.9 mg/L if the system treats 2.0 MGD?

3. A booster chlorination station feeds 90 lbs/day of chlorine gas to disinfect 900,000 gpd. What is the dose in mg/L?

Applied Math for All Certifications
Feed Rate & Dosage
Practice Problems

Pounds

1. If a storage tank holds 1,000,000 gallons filled to the overflow, and the initial chlorine dose needs to be 15 mg/L, how many pounds of HTH 65% available chlorine will it take to get the required dose?

2. The desired chlorine dosage is 10 mg/L. Determine the lb/day setting on a dry chemical feeder if the flow is 3,450,000 gpd.

3. The required dose for a water sample is 12 mg/L. If the flow to be treated is 1,660,000 gpd, what should the dry chemical feed setting be in lb/day?

4. How many pounds of calcium hypochlorite that contains 64.3% available chlorine are needed to disinfect a water main that is 24 inches in diameter, if the pipeline is 781 ft long and the dosage required is 50 mg/L?

5. A 1.75 MG storage tank needs to be disinfected with a sodium hypochlorite solution that contains 12% available chlorine and weighs 8.97 lb/gal. If the chlorine dosage is to be 50 mg/L, how many gallons of sodium hypochlorite are required?

Dose

6. A water treatment plant is treating 16.4 MGD. If the chlorine feed rate is 415 lb/day, what is the chlorine dosage in mg/L?

7. What is the chlorine dosage at a water treatment plant, if the chlorinator is set on 320 lb/day and the plant is treating 11.6 MGD?

8. A 2-foot diameter pipe that is 2.45 miles long was disinfected with chlorine. If 126.9 lbs of chlorine were used, what was the initial dosage in mg/L?

Practice Problems

9. The 50,000-gallon storage tank is disinfected using AWWA Chlorination Method 3 with 50 mg/L using HTH. How many pounds of HTH 65% available chlorine would be required?

10. What is the dosage in milligrams per liter for a treatment plant that uses 855 lb/day of chlorine and treats 45.25 MGD?

11. You have just laid 5,000 feet of 10-inch line and it needs disinfecting. How many lbs of 65% HTH chlorine will be required to dose the line with 25 mg/L? The main can hold approximately 20,400 gallons.

12. A section of an old 8" water main has been replaced. The 350-foot section of pipe needs to be disinfected. What is the volume (in gallons) to be disinfected?

13. You have just laid ¾ mile long section of 16-inch line that holds 41,335 gal, and it needs disinfecting. How many pounds of 65% HTH chlorine will be required to dose the line with 10 mg/L?

14. A flow of 3,880,000 gpd is to be disinfected with liquid chlorine. If the chlorine dosage desired is 3.4 mg/L, what should be the chlorinator setting in lb/day?

15. You have just laid 25,000 feet of 2 ft line and it needs disinfecting. How many lbs of 65% HTH chlorine will be required to dose the line with 25 mg/L?

16. A company contends a new product effectively controls roots in sewer pipes at a concentration of 150 mg/L if the contact time is 60 minutes. How many pounds of chemical are required, assuming perfect mixing, if 450 feet of 6-inch sewer were to be treated?

17. A round storage tank that is going to be put back into service requires disinfection at a dosage of 30 mg/L. If the tank has a diameter of 102 ft and is 28.1 ft tall at the overflow, how many gallons of 10.25% sodium hypochlorite solution will be? Assume the hypochlorite solution weighs the same as water, 8.34 lb/gal.

18. A wastewater flow of 3.8 cfs requires a chlorine dose of 15 mg/L. What is the desired chlorine feed rate in lbs/day?

19. You need to disinfect a water storage tank that has just been repaired. You have decided to use AWWA Chlorination Method 3 to disinfect the tank. This method requires you to make up a 50 mg/L available chlorine solution that will fill approximately 5% of the tank volume. The tank holds 3 MG. How many lbs of HTH 65% available chlorine will have to be added to meet the above-mentioned requirements?

20. You have just laid 200 feet of 8-inch line, and it needs disinfecting. How many lbs of 65% HTH chlorine will be required to dose the line with 25 mg/L?

21. To neutralize a sour digester, one pound of lime is added for every pound of volatile acids in the digester sludge. If the digester contains 195,000 gallons of sludge with a volatile acid level of 2,100 mg/L, how many pounds of lime should be added?

22. How many pounds per day of lime are being used to treat 4.5 MGD with a dosage of 7.2 mg/L? The lime is 89% pure.

23. A 24-inch pipeline, 427 feet long, was disinfected with calcium hypochlorite tablets with 65% available chlorine. Determine the chlorine dosage in mg/L, if 7.0 lb of calcium hypochlorite was used. Assume that the hypochlorite is so diluted that it weighs 8.34 lb/gal.

24. A plant can treat 8.5 MGD with alum. Jar tests indicate that the best alum dose for a water unit is 8 mg/L. The flow to be treated is 6,440,000 gpd. Determine the gallons per day setting for the liquid alum chemical feeder if the liquid alum contains 6.15 lb of alum per gallon of solution.

25. Determine the setting on a dry alum feeder in pounds per day when the flow is 1.3 MGD. Jar tests indicate that the best alum dose is 12 mg/L.

26. To control hydrogen sulfide (H2S) and odors in an 8-inch sewer, the chlorine dose must be 10 mg/L when the flow is 0.37 MGD. Determine the chlorine feed rate in lbs/day.

27. A water plant is treating 1.8 MGD with 2.0 mg/L liquid alum. How many gpd of liquid alum will be required? The liquid alum contains 5.36 lbs dry alum/gallon.

28. The desired dose of a polymer is 4 mg/L. The polymer literature provided indicates the compound is 60% active polymer. If a flow of 4.2 MGD is to be treated, how many lbs/day of polymer compound must be fed?

29. A wastewater plant has a flow of 2,570 gpm. If the chlorinator is feeding 93 pounds per day, what is the dose in mg/L?

30. The average daily flow for a water plant is 0.75 MGD. If the polymer dosage is kept at 1.8 mg/L, how many pounds of polymer will be used in 30 days?

31. To inactivate and control slime in the collection system, 40% sodium hydroxide (NaOH) can be fed at about 8,000 mg/L over one hour. If the NaOH solution is used to treat a section of 12-inch sewer 800 ft long, calculate the volume in gallons of NaOH solution required. (Assume 1 gallon solution weighs 7.24 lbs)

32. The chlorinator is set to feed 31.5 lbs of chlorine per 24 hours for a plant flow of 1.6 MGD. Calculate the chlorine concentration in mg/L.

33. The operator wishes to remove 3,440 pounds per day of solids from the activated sludge process. The waste activated sludge concentration is 3,224 mg/L. What is the required flow in MGD?

34. The flow to the plant is 4,440,000 gpd. Jar testing indicates that the optimum alum dose is 9 mg/L. What should the gallons per day setting be for the solution feeder if the alum solution is 60% solution. Assume the solution weighs 8.34 lb/gal.

35. A water plant is treating 8.2 MGD with 2.0 mg/L liquid alum. How many gpd of liquid alum will be required? The liquid alum contains 5.36 lbs dry alum/gallon.

36. The average flow for a water plant is 13.5 MGD. The jar test indicates that the best alum dose is 1.8 mg/L. How many pounds per day will the operator feed?

37. The effluent from a wastewater lagoon requires a chlorine dose of 18 mg/L. If the average daily flow is 1,095,000 gpd and sodium hypochlorite (15% available chlorine) is to be used to disinfect the wastewater, how many lbs/day of hypochlorite are required?

38. A treatment plant is treating 24.2 MGD with a 64% calcium hypochlorite solution. The dosage is 1.25 mg/L. If the flow rate is reduced to 17.8 MGD and the dosage is also reduced to 1.20 mg/L, how many pounds per day of calcium hypochlorite are needed for the new flow rate?

39. For algae control of a reservoir, a dosage of 0.5 mg/L copper is desired. The reservoir has a volume of 20 MG. How many pounds of copper sulfate (25% available copper) will be required?

40. A jar test indicates that 1.8 mg/L of liquid ferric chloride should be fed to treat 2,778 gpm of water. How many mL/min should be fed by a metering pump? Ferric chloride contains 4.59 lbs dry chemical per gallon of liquid solution.

41. A water plant used 167 gallons of a liquid chemical in one day. How many mL/min was pumped?

42. The average daily flow for a water plant is 7.5 MGD. Jar test results indicate the best polymer dosage is 1.8 mg/L. How many pounds of polymer will be used in 90 days?

43. A pond has an average length of 250 ft, an average width of 75 ft and an average depth of 10 ft. If the desired dose of copper sulfate is 0.8 lbs/acre-ft, how many pounds of copper sulfate will be required?

44. What should the setting be on a chlorinator in pounds per day if the dosage desired is 2.70 mg/L and the pumping rate from the well is 845 gpm?

45. A water treatment plant is feeding an average of 210 lb/day of chlorine. If the dosage is 3.25 mg/L, what is the number of millions of gallons per day being treated?

46. Determine the setting on a dry alum feeder when the flow is 5.4 MGD. Jar tests indicate that the best alum dose is 8 mg/L. What would be the setting in grams per minute?

47. A water plant fed 52 grams per minute of dry alum while treating 2.6 MGD. Calculate the mg/L dose.

48. The desired chemical dose in a reservoir is 5 mg/L. The reservoir has a volume of 62 acre-ft. How many lbs of chemical (25% available copper) will be required?

49. The average flow for a water plant is 8,890 gpm. A jar test indicates that the best polymer dose is 3.1 mg/L. How many pounds will the plant feed in one week? (Assume the plant runs 24 hour/day, 7 days/week.)

50. Your town has been receiving complaints about odors in your sewer system. To correct the problem, you have decided to feed calcium hypochlorite (65% available chlorine). The recommended dose is 15 mg/L chlorine. If your flow is 69 gpm, how much calcium hypochlorite is required, lbs/day?

Applied Math for All Certifications Feed Rate & Dosage Answers		
1. 192.46 lbs	18. 307.22 lb/day	35. 25.52 gal/day
2. 287.73 lb/day	19. 96.23 lbs	36. 202.66 lb/day
3. 166.13 lb/day	20. 0.17 lbs	37. 1095.88 lb/day
4. 11.9 lbs	21. 3415.23 lb	38. 278.35 lb/day
5. 677.95 gal	22. 303.61 lb/day	39. 333.6 lbs
6. 3.03 mg/L	23. 54.56 mg/L	40. 13.08 gal/day
7. 3.31 mg/L	24. 69.87 gal	41. 736.59 lb/day
8. 50.09 mg/L	25. 130.10 lb/day	42. 112.59 lb/day
9. 32.09 lbs	26. 30.86 lb/day	43. 3.44 lbs
10. 2.27 mg/L	27. 5.60 gal/day	44. 27.4 lb/day
11. 6.54 lbs	28. 233.52 lb/day	45. 7.75 MGD
12. 913.48 gal	29. 0.40 mg/L	46. 360.29 lb/day
13. 5.3 lbs	30. 337.77 lbs	47. 2.4 mg/L
14. 110.02 lb/day	31. 108.28 gal	48. 3371.36 lb/day
15. 188.36 lbs	32. 2.36 mg/L	49. 2316.81 lb
16. 0.83 lbs	33. 0.13 MGD	50. 19.12 lb/day
17. 502.42 gal	34. 66.6 gal/day	