Module Answer Key

Unit 1

Unit 1 Answer Key:

Unit 1, Exercise #1 - Laboratory Glassware:

Picture 1: A – volumetric Flask

Picture 2: C – Erlenmeyer Flask

Picture 3: B – beaker

Picture 4: A, B & C (note; a graduated cylinder is also present.)

Question 5: b. To Deliver

Question 6: c. Class A Volumetric Flask

Question 7: a. True

Unit 1, Exercise #2 - Laboratory Equipment:

1. b. 1 pH meter buffers should not be used more than this number of days

2. d. 121 °C Autoclaves must reach this temperature

3. c. 3 Balances must be calibrated with this number of weights

4. a. 0°C Sample freezer temperatures must be under this amount

5. c. 3 pH meters should be calibrated with this many buffers.

Unit 1, Exercise #3 - Sample Collection Tips:

1. For these types of drinking water samples, fill the vial completely with the sample (creating a meniscus) & check for air bubbles. Then, fill a second vial.

Ans: c. Volatile Organic Chemical samples

2. For these types of samples, if you are using a sterilized 125 mL blue-capped bottle prefixed with sodium thiosulfate, remove the bottle cap and hold it in your hand. Do not touch the inside of the cap or bottle. Fill sample bottle to neck (leave airspace) and do not overflow. Then cap the bottle and invert it several times to mix.

Ans: b. Total or Fecal Coliform Bacteria samples

3. When collecting wastewater samples, the use of personal floatation devices (PFDs) around any body of water (especially moving water) can save your life.

Ans: a. true

4. It is good to use commercial detergents for cleansing any glassware used in the storage or analysis of samples for phosphorus determination.

Ans: b. False

Unit 1 Review Exercise:

1. Coliform bacteria themselves don't usually cause illness but are usually present among other disease-causing organisms, so they are used as an indicator of sanitary quality of foods and water.

a. True

b. False

Ans: a. true

2. Environmental laboratory temperatures are read in °C.

a. True

b. False

Ans: a. true

3. Under Chapter 252, every 14 months, laboratories are required to give their staff which types of training? (Directions: choose the best answer)

a. Technical Training & Legal Training

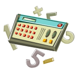
b. Legal Training & Ethics Training

c. Technical Training & Ethics Training

Ans: b. Legal Training & Ethics Training

Unit 2

Unit 2 Answer Key



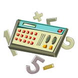
Practice #1 - Basic Math Calculations:

1. (85 x 17) + (22 x 12) =

Ans: 1,445 + 264 = 1,709

2. $\dfrac{(145 \times 9 \times 2) - (14 \times 9 \times 2) + 162}{(7 \times 5) - (10/2) + 150} =$

Ans: $\dfrac{2{,}610 - 252 + 162}{35 - 5 + 150} = \dfrac{2{,}520}{180} = 14$

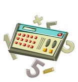


Practice #2 - Decimal Calculation:

1. 11.85 + 1.5 + 14 =

Ans:

$$\begin{array}{r} 14.0 \\ 1.5 \\ \underline{11.85} \\ 27.35 \end{array}$$



Practice #3 – Calculating Averages:

1. A drinking water system measured the pH of their system water at 4 different points in their distribution system. The pH levels were 7.5, 6.7, 7.7, and 6.5. Calculate the average of these pH readings.

Answer: b. 7.1

2. A drinking water system with a filter plant measured the finished water turbidity at the entry point to their distribution system and found the following 5 readings: 0.21 NTU, 0.2 NTU, 0.113 NTU, 0.3 NTU and 1 NTU. Calculate the average of these finished water turbidity readings (keep all the decimal places in the answer.)

Answer: c. 0.3646 NTU

Practice #4 – Solving for X:

Directions: Solve for x in the following problems.

1. $\frac{X}{200} = 2.4$ X = ______

Answer: Multiply both sides by 200; the 200"s on the one side cancel out to leave x.

$(\cancel{200})\ \frac{X}{\cancel{200}} = 2.4\ (200)$

X = 480

2. $10 = \frac{3000}{X}$ X = ______

Answer: Multiply both sides by x to move it into the numerator (the x's cancel out). Then divide by 10 on both sides of the equation (the 10's then cancel out).

$(\cancel{X})\ 10 = \frac{3000}{\cancel{X}} \longrightarrow (X)\ \frac{\cancel{10}}{\cancel{10}} = \frac{3000}{10}$

X = 300

Practice #5 – Solving Percentage Problems:

1. What percentage is 45 of 150?

Step 1: Determine what is known and what is unknown.

% = unknown

Part = 45

Whole = 150

Step 2: Find your formula: We are using the formula $\% = \frac{\text{Part}}{\text{Whole}} \times 100$

Step 3: Plug in your known numbers:

In this case, we are solving for % , so we just plug the numbers into the equation as is (using X as the unknown).

$X\% = \frac{45}{150} \times 100$

X% = 0.3 x 100

X = 30%

2. What is 45% of 150?

Step 1: Determine what is known and what is unknown.

% = 45

Part = unknown

Whole = 150

Step 2: Find your formula; we are once again using the formula $\% = \frac{\text{Part}}{\text{Whole}} \times 100$

Step 3: Plug in your known numbers:

$45\% = \frac{X\ \text{Part}}{150} \times 100$

Step 4: Isolate x on one side of the equation

$(150)\ 45\% = \frac{X\ \text{Part}}{\cancel{150}} \times 100 \times (\cancel{150})$ (We'll multiply both sides of the equation by 150)

$$\frac{(150)\ 45\%}{100} = \frac{(X\ Part)\ \cancel{(100)}}{\cancel{100}}$$ (We’ll divide both sides of the equation by 100)

X Part = 67.5

Answer: 45% of 150 is 67.5

Practice #6 - Unit Conversions

1. How many milliliters (mL) are in 30 liters?

   X mL =

   Conversion relationship to use is 1 L = 1000 mL; vertical format can be written as $\frac{1{,}000\ mL}{1\ L}$

   $X\ mL = \frac{1000\ mL}{1\ L} \times$ ← *Conversion*

   $X\ mL = \frac{1000\ mL}{1\ L} \times 30\ L$ ← *Known*

   $X\ mL = \frac{1000\ mL}{1\ \cancel{L}} \times 30\ \cancel{L}$

   X = 30,000 mL

   Answer: **There are 30,000 mL in 1 liter**

2. How many grams are in 2,500 micrograms (ug)?

   X g =

Conversion relationship to use is 1 gram = 1,000,000 ug; vertical format can be written as $\frac{1\ g}{1{,}000{,}000\ ug}$

$X\ g = \frac{1\ gram}{1{,}000{,}000\ ug} \times$ ← *Conversion*

$X\ g = \frac{1\ gram}{1{,}000{,}000\ \cancel{ug}} \times 2{,}500\ \cancel{ug}$ ← *Known*

X = 0.0025 grams

Answer: **There are 0.0025 grams in 2,500 ug.**

Practice #7 - Converting between ppm and ppb

1. How many ppb are in 5.3 ppm?

X ppb =

Conversion relationship to use is 1 ppm = 1000 ppb; vertical format can be written as $\frac{1{,}000 \text{ ppb}}{1 \text{ ppm}}$

$$X \text{ ppb} = \frac{1000 \text{ ppb}}{1 \text{ ppm}} \quad x$$

$$X \text{ ppb} = \frac{1000 \text{ ppb}}{1 \cancel{\text{ppm}}} \quad x\ 5.3 \cancel{\text{ppm}}$$

X = 5,300 ppb

Answer: **There are 5,300 ppb in 5.3 ppm**

2. How many ppm are in 1.5 ppb?

X ppm =

Conversion relationship to use is 1 ppm = 1,000 ppb; vertical format can be written as $\frac{1 \text{ ppm}}{1{,}000 \text{ ppb}}$

$$X \text{ ppm} = \frac{1 \text{ ppm}}{1{,}000 \text{ ppb}} \quad x$$

$$X \text{ ppm} = \frac{1 \text{ ppm}}{1{,}000 \cancel{\text{ppb}}} \quad x\ 1.5 \cancel{\text{ppb}}$$

X = **= 0.0015 ppm**

Answer: There are 0.0015 ppm in 1.5 ppb.

Practice #8 - Temperature Conversion:

1. What is the ^{o} F value for 121^{o} C (the temperature autoclaves must reach)?

Ans: Fahrenheit = (^{o}C x 1.8) + 32^{o}

= (121º C x 1.8) + 32º
= (218º C) + 32º
= 250º F

3. If it is 30º C outside, will you need to wear a jacket?

Ans: Fahrenheit = (ºC x 1.8) + 32º
= (30º C x 1.8) + 32º
= (54º C) + 32º
= 86º F; no you will not need a jacket!

Unit 2 Practice Quiz:

1. Solve the following equation: $\frac{385 + (21/7) - (5 \times 13 \times 4)}{17 + 11 - (6 \times 4)} = \frac{385 + 3 - 260}{28 - 24} = \frac{128}{4} = 32$

2. What is the sum of 1.1 + 0.98 + 1.231 + 2?

Line up the decimals places to add the numbers:

1.1
0.98
1.231
2.0
5.311

1. Given the temperatures of 93 °F, 99 °F, 101 °F, and 91 °F, calculate the average.

$$\frac{93\ °F + 99\ °F + 101\ °F + 91\ °F}{4}$$

= 96 °F

2. 4. Solve for X in the following equation: 5X = 20

$X = \frac{20}{5}$

$X = 4$

5. Solve for X in the following equation: $2.5 = \frac{1,000}{X}$

$X\ (2.5) = \frac{1,000}{\cancel{X}}\ (\cancel{X})$

7.5 X = 1,000

$\frac{\cancel{2.5}\ X}{\cancel{2.5}} = \frac{1,000}{2.5}$

$X = \frac{1,000}{2.5}$

X = 400

6. What percentage is 15 of 60?

$X\% = \frac{15}{60} \times 100$

X% = 0.25 x 100

X = 25%

7. What is 15% of 60?

$15\% = \frac{X\ Part}{60} \times 100$

$(60)\ 15\% = \frac{X\ Part}{\cancel{60}} \times 100 \times (\cancel{60})$ (We'll multiply both sides of the equation by 60)

$\frac{(60)\ 15\%}{100} = \frac{(X\ Part)\ (\cancel{100})}{\cancel{100}}$ (We'll divide both sides of the equation by 100)

X Part = 9

Answer: 15% of 60 = 9

8. How many centimeters are in 2 meters?

Step 1: List unknown data including units followed by an equal sign (you can use "X" for the unknown number.

Example:
Unknown: X cm =

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

Example: $X\ cm = \frac{100\ cm}{1\ m} \times$ *Conversion*

Step 3: To cancel unwanted denominator units, find data (known or conversion) that has the same numerator unit. Place it to the right of the data used in step 2. Continue to place data (known or conversion) into the equation to systematically cancel unwanted units until only the unknown denominator units remain.

Example: $X\ cm = \frac{100\ cm}{1\ \cancel{m}} \times 2\ \cancel{m}$ *Known*

Step 4: Do the Math (multiply all numerator values, multiply all denominator values (if there are any), then divide the numerator by the denominator).

X cm = 100 cm x 2 = **200 cm**

9. A 300 milliliter BOD bottle contains how many liters of sample?

Step 1: List unknown data including units followed by an equal sign (you can use "X" for the unknown number).

X L =

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

$X\ L = \frac{1\ L}{1{,}000\ mL} \times$

Step 3: To cancel unwanted denominator units, find data (known or conversion) that has the same numerator unit. Place it to the right of the data used in step 2. Continue to place data (known or conversion) into the equation to systematically cancel unwanted units until only the unknown denominator units remain.

$$X\ L = \frac{1\ L}{1{,}000\ \cancel{mL}} \times 300\ \cancel{mL}$$

Step 4: Do the Math (multiply all numerator values, multiply all denominator values, then divide the numerator by the denominator).

$$X\ L = \frac{1\ L}{1{,}000\ \cancel{mL}} \times 300\ \cancel{mL}$$

$$= 0.3\ L$$

10. If the body temperature is 97°F, what is the equivalent Celsius temperature?

$$\text{Celsius} = (°F - 32°) \times \frac{5}{9}$$

$$\text{Celsius} = (97°F - 32°) \times \frac{5}{9}$$

$$\text{Celsius} = (65) \times \frac{5}{9}$$

$$= 36.1°\ C$$

Unit 3

Unit 3 Answer Key:

Exercise #1 - pH:

1. Choose whether the following are a. Acids or b. Bases

Chemical	Is it an acid or a base?
Sodium Hydroxide - NaOH	a. Acid b. Base
Sodium Carbonate - Na_2CO_3	a. Acid b. Base
Sulfuric Acid - H_2SO_4	a. Acid b. Base

Boric Acid - H_3BO_3	a. Acid b. Base
Barium Hydroxide - $Ba(OH)_2$	a. Acid b. Base

1. Answers:

    Sodium Hydroxide (NaOH) = b. Base

    Sodium Carbonate (Na_2CO_3) = b. Base

    Sulfuric Acid (H_2SO_4) = a. Acid

    Boric Acid (H_3BO_3) = a. Acid

    Caesium Hydroxide (CsOH) = b. Base

2. If Hydrochloric Acid – HCl - is added to water, will it raise or lower the pH?

Answer: b. Hydrochloric Acid is an acid, which will lower the pH

3. If Calcium Hydroxide – $Ca(OH)_2$ – (known as slaked lime) is added to water, will it raise or lower the pH?

Answer: a. Calcium Hydroxide is a base, which will raise the pH.

Exercise 2 – Solution Dilution Concepts

1. We have 1.11 L of an 18 M H_2SO_4 solution. We dilute the solution to 200 L to create a 0.1 M H_2SO_4 .solution.

Question 1-1: What is our stock solution concentration?

Answer: b. 18 M

Question 1-2. What are the units of volume for both our stock solution and diluted solution?

Answer: c. liters (L)

Question 1-3: What will be the concentration of our diluted solution?

Answer: d. 0.1 M

2. Reagent water may be prepared by distillation, adsorption or reverse osmosis. Reagent water may **not** be prepared by deionization.

Answer: b. False (Reagent water may be prepared by any of these 4 methods; deionization uses an ion-exchange process.)

Unit 3 Exercise:

1. Aportion of a total amount of a solution is known as an:

a. Analysis

b. Analyte

c. Acid

d. Aliquot

Answer: d. Aliquot

2. We dilute a solution by adding a diluent:

a. True

b. False

Answer: a. True

3. If Potassium Hydroxide - KOH - is added to water, will it raise or lower the pH?

a. Raise the pH

b. Lower the pH

Answer: a. Potassium Hydroxide is a base, which will raise the pH.

4. A 1.5 mL of a 1.0 M salt-water solution is being diluted to make 3 mL of a 0.5 M salt-water solution.

What is the concentration of the stock solution?

a. 1.5 mL

b. 1.0 M

c. 3 mL

d. 0.5 M

Answer: b. 1.0 M

5. You aliquot 5 mL of a 3 ppm standard. You dilute this solution with a diluent to make 15 mL of a working solution at 1 ppm.

What is our stock solution concentration?

a. 1 ppm

b. 15 mL

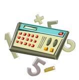
c. 3 ppm

d. 5 mL

Answer: c. 3 ppm

Unit 4

Unit 4 Answer Key:



Unit 4, Practice 1 – Solution Dilution Calculations:

1. You have 1 L of a 0.13 M aqueous solution of salt water. You want to dilute the solution to 0.05 M of salt water; what will be the volume of the diluted solution?

a. 1.67 liters

b. 26 liters

c. 16.7 liters

d. 2.6 liters

Answer: d. 2.6 liters

Step 1: Make a list of what is known and what is not:

- Concentration of Stock Solution (M 1) = 0.13 M salt water solution
- Volume of Stock Solution (V 1) = 1 L
- Concentration of Diluted Solution (M 2) = 0.05 M salt water solution
- Volume of Stock Solution (V 2) = unknown

Step 2: Find the formula you will use. Since both solution units are the same – they are both Molarity (M) units - and both volumes are in liters (L), we can use $M_1V_1 = M_2V_2$

(Conc of solution 1)(Volume of solution 1) = (Conc of solution 2)(Volume of solution 2)

Step 3: Plug the numbers into the equation.

(0.13 M) (1 L) = (0.05 M) (X)

Step 4: Isolate the unknown item on one side of the equation:

$$\frac{(0.13\text{ M})(1\text{ L})}{0.05\text{ M}} = \frac{(\cancel{0.05\text{ M}})(X)}{\cancel{0.05\text{ M}}} \longrightarrow 2.6\text{ L}$$

d. The volume of the diluted solution will be 2.6 L (which means you add enough water to the salt water solution to make 2.6 liters.)

2. What volume of a 1,000 mg/L NH_3 stock solution must be used to create 1 liter of a 25 mg/l NH_3 diluted solution?

a. 0.025 L

b. 2.5 L

c. 0.4 L

d. 40 L

Answer: a. 0.025 L

Step 1: Make a list of what is known and what is not:

- Concentration of Stock Solution (M 1) = 1,000 mg/L NH_3
- Volume of Stock Solution (V 1) = unknown
- Concentration of Diluted Solution (M 2) = 25 mg/L NH_3
- Volume of Diluted Solution (V 2) = 1 L

Step 2: Find the formula you will use. Since both solution units are the same – they are both mg/L units - and both volumes are in liters (L), we can use $M_1V_1 = M_2V_2$

(Conc of solution 1)(Volume of solution 1) = (Conc of solution 2)(Volume of solution 2)

Step 3: Plug the numbers into the equation.

$(1{,}000 \text{ mg/L } NH_3)\ (X) = (25 \text{ mg/L } NH_3)\ (1 \text{ L})$

Step 4: Isolate the unknown item on one side of the equation

$$\frac{(\cancel{1{,}000 \text{ mg}}\text{/L } NH_3)\ (x)}{\cancel{1{,}000 \text{ mg}}\text{/L}} = \frac{(25 \text{ mg/L } NH_3)\ (1 \text{ L})}{1{,}000 \text{ mg/L}} \longrightarrow \mathbf{0.025 \text{ L}}$$

Unit 4, Practice #2 - Solution Concentration Calculation:

You want to make 8 L of a 24 mg/L salt water solution. How many mg of salt will you need?

a. 3 mg

b. 0.333 mg

c. 19.2 mg

d. 192 mg

Answer: d. 192 mg of salt

Step 1: Make a list of what you know and what you don't:

Solution Concentration (C) = 24 mg/L
Mass of Solute (M) = unknown
Volume of Solution (V) = 8L

Step 2: Find the formula you will use. Since we are dealing with solution concentration, solute mass, and solution volume, we use the formula that has all of those variables.

$$\text{Solution Concentration} = \frac{\text{Mass (of Solute)}}{\text{Volume (of Solution)}} \longrightarrow C = \frac{M}{V}$$

Step 3: Make sure the concentration units are equivalent to the mass over volume units. In this case, they are, so we can go ahead and plug in our numbers.

$$\frac{24 \text{ mg}}{1 \text{ L}} = \frac{M \text{ mg}}{8 \text{ L}}$$

Step 4: Isolate the unknown item on one side of the equation:

$$8\text{ L} \times \frac{24\text{ mg}}{1\text{ L}} = \frac{M\text{ mg}}{\cancel{8\text{ L}}} \times \cancel{8\text{ L}} \longrightarrow \frac{(8\cancel{\text{L}})(24\text{ mg})}{1\cancel{\text{L}}} \longrightarrow \text{192 mg of salt}$$

Unit 4, Practice #3 - Solution Concentration Calculation:

You want to make 800 mL of a 3,000 mg/L $CaCl_2$ solution. How many grams of $CaCl_2$ will you need?

a. 0.192 grams

b. 2.4 grams

c. 37 grams

d. 3.75 grams

Answer: b. 2.4 grams

Step 1: Make a list of what you know and what you don't:

Solution Concentration (C) = 3,000 mg/L
Mass of Solute (M) = unknown
Volume of Solution (V) = 800 mL

Step 2: Find the formula you will use. Since we are dealing with solution concentration, solute mass, and solution volume, we use the formula that has all of those variables.

$$\text{Solution Concentration} = \frac{\text{Mass (of Solute)}}{\text{Volume (of Solution)}} \longrightarrow C = \frac{M}{V}$$

Step 3: Make sure the concentration units are equivalent to the mass over volume units. In this case, they are not, but can be converted.

We have to convert our volume (mL) to be equivalent to the volume in our concentration (the L in mg/L..)

X Liters =

$$X\text{ L} = \frac{1\text{ L}}{1{,}000\text{ mL}} \times$$

$$X\text{ L} = \underline{1\text{ L}} \quad \times \quad 800\ \cancel{\text{mL}}$$

$$\frac{\qquad}{1{,}000\ \cancel{mL}}$$

$= 0.8\ L$

Now can go ahead and plug in our numbers into C = M/V

$$\frac{3000\ mg}{1\ L} = \frac{x\ mg}{0.8\ L}$$

Step 4: Isolate the unknown item on one side of the equation:

$$0.8\ L \times \frac{3000\ mg}{1\ L} = \frac{x\ mg}{0.8\ \cancel{L}} \times \cancel{0.8\ L} \longrightarrow \frac{(0.8\cancel{L})(3000\ mg)}{1\ \cancel{L}} \longrightarrow 2400\ mg\ of\ CaCl_2$$

We have one more step, since we are asked for grams; therefore, we have to convert milligrams to grams.

X g =

$$X\ g = \frac{1\ g}{1{,}000\ mg} \times$$

$$X\ g = \frac{1\ g}{1{,}000\ \cancel{mg}} \times 2400\ \cancel{mg}$$

$= 2.4$ grams of $CaCl_2$

Unit 4 Practice Quiz:

1. What volume of a 10.0 M aqueous salt water stock solution must be used to prepare 3.0 L of a 4.0 M salt water solution?

a. 7.5 liters

b. 1.2 liters

c. 0.1 liters

d. 0.7 liters

Answer: b. 1.2 liters

Step 1: Make a list of what is known and what is not:

- Molarity of Stock Solution (M 1) = 10.0 M salt water solution
- Volume of Stock Solution in liters (V 1) = unknown
- Molarity of Diluted Solution (M 2) = 4.0 M salt water solution
- Volume of Stock Solution (V 2) = 3.0 L

Step 2: Find the formula you will use. Since both solution units are Molarity (M) units and both volumes are in liters (L), we can use $M_1V_1 = M_2V_2$

(Molarity of solution 1)(Volume of solution 1 in liters) = (Molarity of solution 2)(Volume of solution 2 in liters)

Step 3: Plug the numbers into the equation.

(10.0 M) (x L) = (4.0 M) (3.0 L)

Step 4: Isolate the unknown item on one side of the equation:

$$\frac{(10.0\text{ M})(x\text{ L})}{10.0\text{ M}} = \frac{(4.0\text{ M})(3.0\text{ L})}{10.0\text{ M}} \longrightarrow \quad 1.2\text{ L}$$

2. You have a 4000 ppm standard. You need to make 200 mL of a 40 ppm working solution. How many mL of standard will you need?

a. 4 mL

b. 2 mL

c. 40 mL

d. 20 mL

Step 1: Make a list of what is known and what is not:

- Concentration of Stock Solution (M 1) = 4,000 ppm standard
- Volume of Stock Solution (V 1) = unknown
- Concentration of Diluted Solution (M 2) = 40 ppm
- Volume of Diluted Solution (V 2) = 200 mL

Step 2: Find the formula you will use. Since both solution concentration units are the same – they are both ppm units - and both volumes are in milliliters (mL), we can use $M_1V_1 = M_2V_2$

(Conc of solution 1)(Volume of solution 1) = (Conc of solution 2)(Volume of solution 2)

Step 3: Plug the numbers into the equation.

(4,000 ppm) (x) = (40 ppm) (200 mL)

Step 4: Isolate the unknown item on one side of the equation

$$\frac{(\cancel{4{,}000\ ppm})\,(x)}{\cancel{4{,}000}\ ppm} = \frac{(40\ ppm)\,(200\ mL)}{4{,}000\ ppm} \longrightarrow \frac{8{,}000\ mL}{4{,}000}$$

= b. 2 mL

3. How many grams of sugar would you need if you want to make 450 mL of a 2500 mg/L sugar water solution?

a. 1.125 grams

b. 5.557 grams

c. 180 grams

d. 2.95 grams

Answer: a. 1.125 grams

Step 1: Make a list of what you know and what you don't:

Solution Concentration (C) = 2500 mg/L
Mass of Solute (M) = unknown
Volume of Solution (V) = 450 mL

Step 2: Find the formula you will use. Since we are dealing with solution concentration, solute mass, and solution volume, we use the formula that has all of those variables.

$$\text{Solution Concentration} = \frac{\text{Mass (of Solute)}}{\text{Volume (of Solution)}} \longrightarrow C = \frac{M}{V}$$

Step 3: Make sure the concentration units are equivalent to the mass over volume units.

In this case, they are not, but can be converted.

We have to convert our volume (mL) to be equivalent to the volume in our concentration (the L in mg/L..)

X Liters =

$$X\ L = \frac{1\ L}{1{,}000\ mL} \times$$

Conversion

$$X\ L = \frac{1\ L}{} \times 450\ \cancel{m}L$$

$1{,}000\ m\cancel{L}$ *Known*

$X = 0.45\ L$

Now can go ahead and plug in our numbers.

$$\frac{2500\ mg}{1\ L} = \frac{x\ mg}{0.45L}$$

Step 4: Isolate the unknown item on one side of the equation:

$$0.45\ L \times \frac{2500\ mg}{1\ L} = \frac{x\ mg \times 0.45\cancel{L}}{0.45\cancel{L}} \longrightarrow \frac{(0.45\cancel{L})\ (2500\ mg)}{1\ \cancel{L}} = 1125\ \text{mg of sugar}$$

We have one more step, since we are asked for grams; therefore, we have to convert milligrams to grams.

$X\ g =$

$$X\ g = \frac{1\ g}{1{,}000\ mg} \times$$

$$X\ g = \frac{1\ g}{1{,}000\ \cancel{mg}} \times 1125\ \cancel{mg}$$

X = 1.125 grams of sugar

Unit 5

Unit 5 Answer Key:

Unit 5 Exercise:

Multiple Choice: Choose one best answer unless otherwise indicated.

1. Fill in the letter of the correct maximum sample holding time for the parameter. Selections can be used more than once.

a. no max holding time; analyze immediately b. 30 hours c. 14 days d. 6 months

Ans:

b. 30 hours	Total Coliform Bacteria
a. No max holding time; analyze immediately	Chlorine Residual
a. No max holding time; analyze immediately	temperature
c. 14 days	Alkalinity
d. 6 months	Metals (except Hg)
a. No max holding time; analyze immediately	pH

2. Under Chapter 252, for water baths, heating blocks, and ovens, temperatures are to be recorded once a ____________

   a. day

   b. week

   c. month

Ans: a. day

3. Calibrate analytical balances, pH meter, and conductivity meters weekly.

   a. True

   b. False

Ans: b. False (calibrate every day or before each use, whichever is less frequent.)

Circle the letter of the correct amount of calibration or monitoring time.

A = once a day

B = once a week

C = once a month

D = once every 3 months

E = once every 12 months

Answers:

4. Check *burette delivery volume *If not Class A glassware*	D = once every 3 months
5. Record refrigerator temperatures	A = once a day
6. Calibrate conductivity meter	A = once a day
7. Calibrate glass, liquid filled thermometers	E = once every 12 months
8. Record incubator temperature	A = once a day, four hours apart
9. Verify the autoclave sterilization capability (by utilizing appropriate biological indicators)	C = once a month

Unit 6

Unit 6 Answer Key:

Unit 6, Exercise #1 - QA and Quality Manual Questions:

Choose the best answer to fill in the blank.

1. A quality manual must be kept by all ________________ Pa. laboratories.

a. operating

b. accredited

c. wastewater

Answer: b. accredited

2. A written laboratory document that provides detailed instructions for the performance of all aspects of a test, analysis, operation or action is known as a _______.

a. SOP

b. QCP

c. QAP

d. OPS

Answer: a. SOP

Unit 6, Exercise #2 - QC Sample Definitions:

1. QC Sample Definition Matching Exercise Table:

Directions: Fill in the left hand column of the table with the name of the QC sample beside the proper description

a. Blank Sample b. Sample duplicate c. Spike d. Reference sample

Letter of Correct Sample Title	Description
i. b.	Replicate aliquots of the same sample taken through the entire analytical procedure.
ii. a.	A sample that lacks the parameters of interest.
iii. d.	A quality assurance sample composed of standard reference material.
iv. c.	A known and verified mass or activity of the target analyte of interest added to reagent water or environmental sample to determine recovery efficiency or for other quality control purposes.

Choose the best answer.

2. A double blind sample is identified as a quality assurance sample to the contract laboratory performing the analyses, but the concentrations of the parameters of concern are unknown to laboratory personnel.

a. True

b. False

Answer: b. False – this is the definition for a single blind sample.

Unit 6, Exercise #3 – More QC Sample Definitions:

1. Sample duplicates are useful for analyzing laboratory performance, but PT samples are not.

   a. True

   b. False

Answer: b. False, since both types of samples are useful for analyzing laboratory performance.

2. Analytical quality control is important in an environmental laboratory because the concentration of chemicals in a sample may be extremely low and close to the detection method of the analytical method.

   a. True

   b. False

Answer: a. True

Unit 6, Exercise #4 - General Laboratory QC:

1. In an analytical run, what is the highest amount of samples that can be contained in sample batch?

a. 5

b. 10

c. 15

d. 20

Answer: d. 20

Unit 6 Review Exercise:

Multiple Choice: Choose one best answer unless otherwise indicated.

1. Any time that a method has not been performed by the laboratory or analyst in a ______ month period, an IDOC must be performed.

a. 3 months

b. 6 months

c. 9 months

d. 12 months

Ans: d. 12 months

2. A LCS is a sample of a controlled matrix known to be free of the analyte of interest, to which a known and verified concentration of analyte has been added and that is taken through a few, but not all, of the preparation and analytical steps in the method.

a. True

b. False

Answer: b. False, since a LCS sample is taken through <u>all</u> of the preparation and analytical steps in the method.

3. Proficiency Testing (PT) samples must be analyzed at least once every ____ ________ for each analyte and by each method used to analyze compliance samples.

a. 3 months

b. 6 months

c. 9 months

d. 12 months

Ans: d. 12 months

4. Any environmental samples associated with a contaminated method blank shall be reprocessed for analysis. In addition, the source of contamination of the method blank shall be:

a. Disregarded since it was just the method blank, not the actual sample

b. Investigated and measures taken to minimize or eliminate the contamination.

c. Ignored, since these types of contaminant sources can never be determined anyway

Answer: b. Investigated and measures taken to minimize or eliminate the contamination.

Unit 7

Unit 7 Answer Key:

Unit 7 Exercise:

Multiple Choice: Choose one best answer unless otherwise indicated.

1. Your lab is going to obtain an additional field of accreditation from the state of Pennsylvania. You perform PT studies (which you pass) and then do an IDOC analysis. Is this acceptable?

a. Yes, you are supposed to do PT studies prior to an IDOC analysis.
b. Yes, because you only need PT studies, not an IDOC analysis.
c. Yes, because you only need an IDOC analysis, not any PT studies.
d. No, you are supposed to do an IDOC analysis prior to PT studies

Answer: d. No, you are supposed to do an IDOC analysis prior to PT studies

2. Before your laboratory does the aforementioned testing in question #1, what other 2 steps should it do?

a. Choose an approved method and develop a SOP

b. Choose an approved method and send in the application for the FOA

c. Send in the application for the FOA and develop a SOP

Answer: a. Choose an approved method and develop a SOP

3. All Pennsylvania environmental laboratories performing testing or analysis of wastewater for compliance with the Clean Streams Law must be accredited by the Pa. DEP or NELAP.

a. True

b. False

Answer: a. True

Unit 8

Unit 8 Answer Key:

Unit 8, Practice #1 – Rounding Calculations:

1. Round 9.875 to two decimal points.

Ans: 9.88

2. Round 9,637 to the nearest thousand.

Ans: 10,000

3. Round 9,637 to the nearest hundred.

Ans: 9,600

4. Round 9,637 to the nearest tens.

Ans: 9,640

Unit 8, Practice #2 – Rounding an Average:

1. A Pa. DEP wastewater permit was issued with an average monthly limit of 3.0 mg/L for ammonia-nitrogen.

Sample results for the monitoring period are as follows:
1.10 mg/L
3.52 mg/L
2.71 mg/L
3.56 mg/L

What is the average rounded result for the monitoring period?

a. 2.9 mg/L
b. 3.1 mg/L
c. 2.0 mg/L
d. 3.0 mg/L

Ans: = d. 3.0 mg/L.

Step 1: Average the unrounded results

$$\frac{2.10\text{ mg/L} + 3.52\text{ mg/L} + 2.71\text{ mg/L} + 3.56\text{ mg/L}}{4} = \frac{11.89\text{ mg/L}}{4} = 2.9725$$

Step 2:

(a) Go one number past the last significant digit and underline that number, which you will use for rounding. The last significant digit is .$\underline{0}$.

(b) Cross out any other digit past the one significant digit, since they are not used in the rounding calculation.

(c) To round, if the number past the significant digit is 5 or more, round your compliance number up; if not, keep the number as is and report with the proper number of significant digits.

Use the digit to the right of the last significant digit of the compliance number, and round the answer.

$2.9\underline{7}\cancel{25} \longrightarrow 3.0$ (Note: this is not an exceedance.)

The 2 and 5 to the right of the 7 get ignored.
7 is more than 5, so the number 9 gets rounded higher.

= 3.0 mg/L.

2. A Pa. DEP drinking water system performed arsenic monitoring for 4 quarters; the drinking water MCL for arsenic is 0.010 mg/L.

Arsenic sample results for the monitoring period are as follows:

- Quarter 1 = 0.0163 mg/L
- Quarter 2 = 0.0162 mg/L
- Quarter 3 = 0.0104 mg/L
- Quarter 4 = 0.0100 mg/ L

What is the average result for the monitoring period?

a. 0.014 mg/L
b. 0.013 mg/L
c. 0.012 mg/L
d. 0.031 mg/L

Ans: = b. 0.013 mg/L.

Step 1: Average the unrounded results

$$\frac{0.0163 \text{ mg/L} + 0.0162 \text{ mg/L} + 0.0104 \text{ mg/L} + 0.0100 \text{ mg/L}}{4} = \frac{0.0529 \text{ mg/L}}{4} = 0.013225 \text{ mg/L}$$

Step 2:

(d) Go one number past the last significant digit and underline that number, which you will use for rounding. The last significant digit is .00$\underline{0}$.

(e) Cross out any other digit past the one significant digit, since they are not used in the rounding calculation.

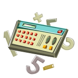
(f) To round, if the number past the significant digit is 5 or more, round your compliance number up; if not, keep the number as is and report with the proper number of significant digits.

Use the digit to the right of the last significant digit of the compliance number, and round the answer.

$0.013\underline{2}\cancel{25} \longrightarrow$ 0.013 (Note: this **is** an exceedance, since it is greater than 0.010 mg/L)

The 2 and 5 to the right of the first 2 get ignored.
2 is less than 5, so the number 3 does not get rounded higher.

= 0.013 mg/L.



Unit 8, Practice #3 – Relative Percent Difference:

A duplicate analysis of a sample found results of 12 mg/L and 13 mg/L. What is the relative percent difference of these results?

a. 20%

b. 200%

c. 8%

d. 0.08%

Answer: c. 8%

$$\text{RPD} = 100 \times \left[\frac{12 \text{ mg/ L} - 13 \text{ mg/L}}{(12 \text{ mg/L} + 13 \text{ mg/L}) \div 2} \right]$$

$$\text{RPD} = 100 \times \left[\frac{1 \text{ mg/L}}{12.5 \text{ mg/L}} \right]$$

$$\text{RPD} = 100 \times 0.08$$

RPD = 8%

Unit 8, Practice #4 – Acceptance Criteria Determination:

An effluent sample is tested twice for a contaminant and the results obtained are 0.109 and 0.115 mg/L. The relative percent difference for duplicate samples of this contaminant is required to be less than 10%. Is the % difference between these duplicate levels acceptable?

a. Yes

b. No

Answer: a. Yes

$$RPD = 100 \times \left[\frac{0.109 \text{ mg/ L} - 0.115 \text{ mg/L}}{(0.109 \text{ mg/L} + 0.115 \text{ mg/L}) \div 2} \right]$$

$$RPD = 100 \times \left[\frac{0.006 \text{ mg/L}}{0.112 \text{ mg/L}} \right]$$

RPD = 100 x 0.053571

RPD = 5.357% (which is less than 10%)

Unit 8, Practice #5 – Acceptance Criteria Determination:

Using Standard Method 2540 C for total dissolved solids the acceptance criteria for the LCS is +/- 15%. The laboratory LCS known concentration is 25 mg/L.

Which of the following LCS samples meets the acceptance criteria?

a. 29.1 mg/L

b. 22.3 mg/L

c. 21.05 mg/L

d. 32.23 mg/L

Answer: b. 22.3 mg/L

Step 1: We find our formula (the % calculation from Chapter 2.)

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

Step 2: We determine what parts of the formula we know and what we don't know:

% = 15%

Part = unknown

Whole = 25

Step 3: We plug our numbers into the equation.

$$15\% = \frac{\text{Part}}{25} \times 100$$

Step 4: We make sure our unknown is on one side of the equation. Since it's not, we work to cancel items out from one side to the other.

$$25 \times 1\ 5\% = \frac{\text{Part}}{\cancel{25}} \times 100 \times \cancel{25}$$

$$\frac{375\ \text{mg/L}\ \%}{100} = \frac{\text{Part} \times \cancel{100}}{\cancel{100}}$$

Part = 3.75

Therefore, 15% of 25 is 3.75

To determine + 15% of 25, we add 3.75:
25 + 3.75 = 28.75

To determine - 5% of 50, we subtract 2.5:
25 – 3.75 = 21.25

b. 22.3 mg/L is between 28.75 and 21.25, thus it would qualify as meeting the +/- 15% criteria

Unit 8 Exercise:

1. In order to produce a trend chart, data needs to be entered into a computer spreadsheet contained in a graphical package such as Excel.

a. True

b. False

Answer: a. True

2. A standards curve is a graph of known concentrations that can be used to determine the concentrations of the unknown.

a. True

b. False

Answer: a. True

3. The permit limit for a particular NPDES permit parameter is 1.0. Using EPA rounding principals, is a calculated parameter of 1.06 a violation?

a. Yes, because it rounds to 1.1

b. No, because it rounds to 1.0

Answer: a. Yes

4. A duplicate analysis of a sample found results of 3 mg/L and 5 mg/L. What is the relative percent difference of these results?

a. 50%

b. 0.08%

c. 80%

d. 0.05%

Answer: a. 50%

5. The standard method for a contaminant has an acceptance criteria for the LCS of +/- 5 %. If the known value of the LCS is 30 mg/l, which of the following LCS sample results meets the acceptance criteria?

a. 36 mg/l

b. 35 mg/l

c. 29 mg/l

d. 25 mg/l

Answer: c. 29 mg/L

Step 1: We find our formula (the % calculation from Chapter 2.)

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

Step 2: We determine what parts of the formula we know and what we don't know:

% = 5

Part = unknown

Whole = 30

Step 3: We plug our numbers into the equation.

$$5 = \frac{\text{Part}}{30} \times 100$$

Step 4: We make sure our unknown is on one side of the equation. Since it's not, we work to cancel items out from one side to the other.

$$30 \times 5\% = \frac{\text{Part}}{\cancel{30}} \times 100 \times \cancel{30}$$

$$\frac{150 \text{ mg/L } \%}{100} = \frac{\text{Part} \times \cancel{100}}{\cancel{100}}$$

Part = 1.5

Therefore, 5% of 30 is 1.5

To determine + 5% of 30, we add 1.5:
30 + 1.5 = 31.5

To determine - 5% of 30, we subtract 1.5:
30 – 1.5 = 28.5

c. 29 mg/l is between 31.5 and 28.5, thus it would qualify as meeting the +/- 5% criteria

Unit 9

Unit 9 Answer Key:

Unit 9 Exercise:

Multiple Choice: Choose one best answer unless otherwise indicated.

1. In most cases, DMRs for NPDES permits must be received by the applicable Pa. DEP Regional Office by the ______ day of the month following the monitoring period.

a. 1st

b. 10th

c. 28th

Ans: c. 28th

2. On the ____ day of each month as required by Chapter 109 of Title 25 of the Pennsylvania Code, all drinking water data is cleared from DWELR and passed to the PADWIS for monthly compliance processing.

a. 1st

b. 10th

c. 28th

Ans: b. 10th

Unit 10

Unit 10 Answer Key:

Unit 10 Exercise:

Multiple Choice: Choose one best answer unless otherwise indicated.

1. Unless otherwise specified in regulation, how long must records required under Chapter 252 be maintained?

a. 1 year

b. 3 years

c. 5 years

d. 10 years

Ans: c. 5 years

2. To avoid confusion, records should be edited in a way that the erases the original entry.

a. True

b. False

Ans: b. False

3. Records are to be kept electronically in an organized fashion, which allows laboratories to dispose of original handwritten records.

a. True

b. False

Ans: b. False

4. An environmental laboratory shall submit a corrective action report to the Department within *60 business days* from receipt of an onsite assessment report from the Pa. DEP where deficiencies have been found.

a. True

b. False

Ans: b. False (the correct answer is 60 calendar days)

5. Laboratory supply receipt records need be maintained and include which of the following:

a. Date received
b. Vendor
c. Amount received
d. Expiration date
e. a through d
f. c and d

Ans: e. a through d

6. Which of the following need to be recorded once a day for each day in use for all laboratory activities?

a. incubator temperatures

b. water bath temperatures

c. refrigerator temperatures

d. freezer temperatures

e. all of the above

Ans: e. all of the above

7. On April 5, 2013, Annette pulled an unopened laboratory chemical bottle off the shelves and saw it did not have an expiration date, but someone noted it had been purchased over 5 years prior during 1-2006; she went ahead and used it in her chemical analysis. Was this chemical considered too old to be used?

a. Yes
b. No

Ans: b. No (10 years is the limit for purchased chemicals)

8. The laboratory's QA plan should be readily available for inspection by auditors. On the other hand, the Standard Operating Procedures (SOPs) do not need to be available, since the auditors would never look at this information.

a. True
b. False

Ans: b. False (Both the laboratory's QA plan and appropriate Standard Operating Procedures (SOPs) should be readily available for inspection by auditors.)