DW Module WDC Volume I **Answer Key**

Unit 1

Unit 1 Operator Certification and Training Requirements

Exercise I

1. What certificate is needed to become a water distribution system operator?

Class E

How much experience would be needed for a person with only a high school diploma before the board would grant a certificate to make process control decisions at this plant? **1 year**

2. What certificates would be needed to run a 50,000 gallon per day groundwater system that uses corrosion control and sodium hypochlorite disinfection? **Class D, Subclasses 7 and 12**

How much experience would be needed for a person with a high school diploma before the board would grant a certificate to make process control decisions at this plant? **1 year**

3. What certificates would be needed to run a groundwater system with 100 connections and 450 customers and treats with non-gaseous chemical disinfection? **Class Dc**

How much experience would be needed for a person with only a high school diploma before the board would grant a certificate to make process control decisions at this plant? **6 months**

Exercise II

Complete the following sentences by filling in the blanks.

1.   Class B operators must obtain **15** hours of continuing education during their first renewal cycle and **30** hours during all subsequent renewal cycles.

2. Owners, **operators**, non-certified operators and maintenance staff can be prosecuted for failing to comply with the Drinking Water and Wastewater Systems Operators Certification Act.

3. A **process control decision** is a decision, which maintains or changes the quality or quantity of water or wastewater in a water system that may affect the public health or environment.

4. An **appropriately certified operator** is defined as an operator having a certificate containing the class and subclass(es) matching the class and subclass(es) of the system that they operate.

5. If an owner directs a non-certified operator to make a process control decision, who may be in violation of the Operator's Certification Act?

    a) Owner
    b) Non-certified operator
    c) Both a and b
    d) Neither owner or non-certified operator

. . . .

Unit 2

Unit 2 – Source Development and Construction

Part 1 Exercise

1. If the static water level is 40 feet and the pumping water level is 200 feet, what is the drawdown in feet? **160 feet**

2. If the pumping level is 280 feet and the drawdown is 100 feet, what is the static water level? **180 feet**

3. The space between the well casing and the well hole is known as the **annual space.**

4. The distance from the center of the well to the outer edge of the cone of depression is:

    a) Zone of influence
    b) Drawdown
    c) Radius of influence
    d) Static water level

Part 2 Exercise

1. The purpose of a **well screen** is to allow the free flow of water into the well; but prevents sand from entering too.

2. Filling the bore hole with neat cement grout or concrete slurry to the surface refers to:

    a)   Well rehabilitation
    b)   Well drilling
    c)   Well abandonment

3. Wells are to be equipped with means to measure water level such as an access port with a removable cap that allows a measuring device to be lowered into the well.

    a)   True

    b)   False

4.   Well construction must conform to DEP guidelines for casing depth and grouting around the casing.

    a)   True

    b)   False

Unit 3 – Math Principles and Process Control Calculations

Explanation of diagonal movement and an example.

Example:

5X = 20

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

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

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

Answer:

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

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

FINAL ANSWER: 20 ÷ 5 = **4**

Example 2:

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

Question #1 regarding Example #2: Is the **X** in the numerator? **NO**
How do we move the **X** into the numerator?
Answer:

- Multiply both sides of the equation by **X**. Or, you could think of it as simply moving the **X** diagonally from the denominator into the numerator.

$$X(2.5) = \frac{1,000(X)}{X} \qquad \text{OR} \qquad X(2.5) = \frac{1,000}{X}$$

Question #2 regarding Example #2: Is the **X** alone on one side of the equation? **NO**
How do we use diagonal movement to place **X** alone on one side of the equation?

Answer:

- Divide by 2.5 on each side of the equation so that the **X** is alone, but the equation keeps the same value.

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

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

FINAL ANSWER: 400

Class Exercise Solving for X:

$$\frac{X}{200} = 2.4 \qquad\qquad\qquad 10 = \frac{3000}{X}$$

$$X = 2.4(200) \qquad\qquad\qquad \frac{X(10)}{(10)} = \frac{3000}{10}$$

$$X = 480 \qquad\qquad\qquad X = 300$$

Chlorine Demand = Chlorine Dose – Chlorine Residual

Practice Problem: Four mg/L of chlorine is used to disinfect a well that pumps at 25 gallons a minute. The chlorine residual is 0.3 mg/L after a 30-minute contact time. What is the chlorine demand of this well?

? Chlorine Demand = 4.0 – 0.3
= **3.7 mg/L**

Determining Length of Time to Fill a Storage Tank

Practice Problem: A well has the capacity to pump 300 gallons per minute. An operator has a daily water demand of 25,000 gallons a day. How many minutes is it necessary to operate the well pump to store a 1-day supply?

Step 1: Use unit cancellation step 1 to set up problem (? Unknown data with units)

? mins =

Step 2: Place known data with **same numerator unit** to position numerator unit.

NOTE: pump capacity data will need to be inverted

? mins = 1 min ◄——— Positions the numerator unit
        300 gal

Step 3: To cancel unwanted **denominator unit**, next place known data with those same units in the numerator of the next data set to cancel unwanted units

? mins = 1 min   X 25,0000 gal ◄——— Cancel unwanted units that match
        300 gal ◄———

Step 4: Do the math (divide numerator by denominator)

? mins = 25,0000 = **83.3 mins**
        300

OR One Step Calculation

? mins = Daily Water Demand = 25,000 = **83.3 mins**
        Pump capacity   300

Determining # of Days of Supply Based on Customer Demand (gal/hr)

Practice Problem: An operator loses power because of an ice storm. There are 9,000 gallons of water in the storage tank. The customer demand is 175 gallons per hour. Approximately how many days of supply are available?

Step 1: Use unit cancellation step 2 to place data with **same numerator unit** to position numerator

? days = 1 (day) ◄──── Positions the numerator unit
         24 hrs

Step 2: To cancel unwanted **denominator unit**, next place known data with those same units in the numerator of the next data set to cancel unwanted units

NOTE: pump capacity data will need to be inverted

? days = 1 day   X 1 hr ◄────
         24 hrs   175 gal ◄──── Cancel unwanted units that match

Step 3: To cancel unwanted **denominator unit**, next place known data with those same units in the numerator of the next data set to cancel unwanted units

? days = 1 day   X 1 hr   X   9,000 gallons
         24 hrs   175 gal ◄──── Cancel unwanted units that match

Step 4: Multiply the denominator values

? days = 9,000   = 9,000 days
         24 X 175   4,200

Step 5: Do the math (divide numerator by denominator)

? days = 9,000 = **2.14 days**
         4,200

Simplified Calculation

? days = Storage Tank Volume   =   **2.14 days**
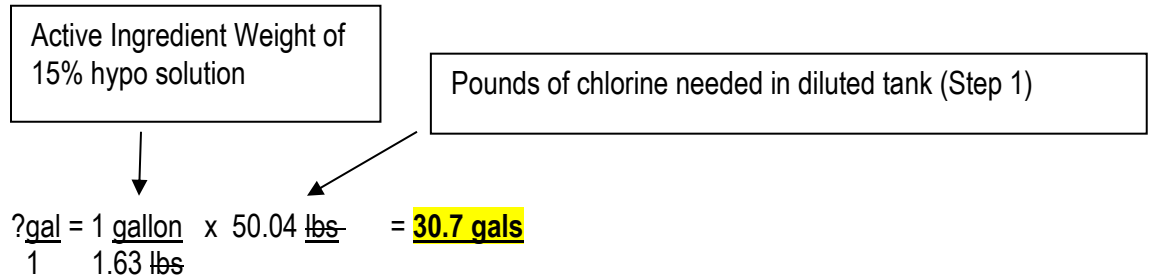   24 hrs X Pump Capacity (gal/hr)

Using "Active Ingredient" Weight to Dilute Solution for Day Tank

Practice Problem: How many gallons of 15% sodium hypochlorite solution does it take to mix a 6% chlorine solution in a 100-gallon tank? There are 1.63 lbs of chlorine per gallon of 15% sodium hypochlorite solution. (e.g., "active ingredient" weight)

Step 1: Determine the # of pounds of chlorine that are needed for the diluted solution (6%) based on the volume of the day tank. (e.g., solute)

> ? ~~lbs~~ = 8.34 ~~lbs~~ X 100 ~~gal~~ (day tank volume) X 0.06 (6% as a decimal) = 50.04 lbs
> ~~gal~~

Step 2: Use "active ingredient" weight with unit cancellation steps to convert **lbs**/gal to **gals**

Active Ingredient Weight of 15% hypo solution

Pounds of chlorine needed in diluted tank (Step 1)

?~~gal~~ = 1 ~~gallon~~   x 50.04 ~~lbs~~   = **30.7 gals**
 1   1.63 ~~lbs~~

OR

?gal = lbs needed for diluted solution (calculated in Step 1)
           Active ingredient weight

Using "Active Ingredient" Weight to Determine "gal/day" Feed Rate (from lbs/day)

Practice Problem: A water plant uses sodium hypochlorite (12%) to disinfect the water which provides 1.2 lbs/gal of available chlorine ("active ingredient" weight). The required dosage is 2.5 mg/L. They treat 35,000 gallons per day. How many **gallons** of sodium hypochlorite will need to be fed?
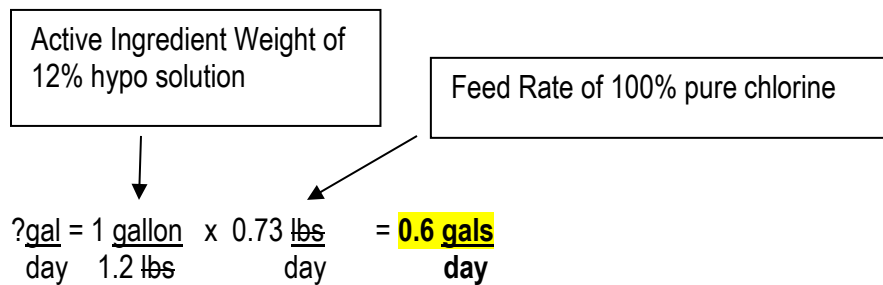
Step 1: Convert flow in gallons (per day) into MGD so that the feed rate (lbs/day) formula can be used.

? MGD = 1 MG   X   35,000 (gal) = 0.035 MGD
    1,000,000 gal   1   day

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

Using the formula pounds per day = flow x dose x 8.34 = (0.035)(2.5)(8.34) = 0.73 pounds of chlorine is required.

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

Active Ingredient Weight of 12% hypo solution

Feed Rate of 100% pure chlorine

?gal = 1 gallon   x 0.73 lbs   = **0.6 gals**
  day   1.2 lbs   day   **day**

OR

?gal = lbs of pure chlorine (Step 2)
       Active ingredient weight

Summary of Steps for Solving Feed Formula Calculations in <u>Gallons/Day</u> for % Strength (i.e., % Purity) Solutions

Example: An operator wishes to achieve a dose 2.0 mg/L. How many gallons per day of 12% sodium hypochorite must be used to treat 45,000 gallons per day flow rate? The 12% hypo solution has an active strength of 1.2 lbs of chlorine/gallon of 12% hypochlorite solution.

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

?MGD = <u>1 MG</u>   X   <u>volume of flow (g̶a̶l̶)</u> **OR**
           1,000,000 g̶a̶l̶   1 day

?MGD = <u>1 MG</u>   x <u>volume of flow (g̶a̶l̶)</u>   x   <u>1440 m̶i̶n̶</u>
           1,000,000 g̶a̶l̶   1 m̶i̶n̶   day

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

? <u>lbs</u> = Flow(MGD) x dose(mg/L) x 8.34 = pounds of chlorine that are required.
  day

     = 0.045 X 2 X 8.34 = 0.75 lbs/day

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

"Active Ingredient" Weight
of 12% hypo solution

Feed Rate of 100% pure chlorine

?<u>gal</u> = <u>1 gallon</u>   x 0.75 <u>l̶b̶s̶</u>   = **0.63 gals**
  day   1.2 l̶b̶s̶   day   **day**

OR
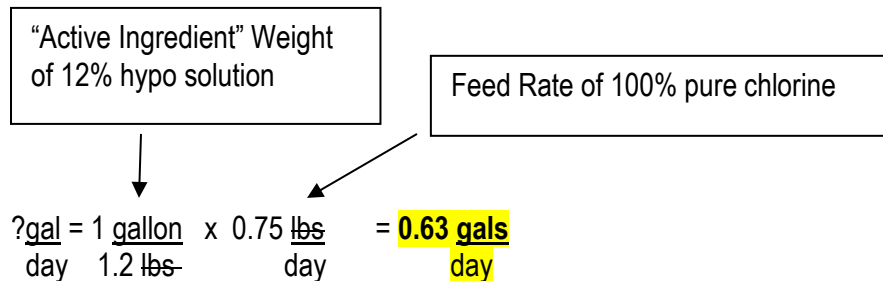
?gal = <u>lbs of pure chlorine</u> (Step 2)
          Active ingredient weight

Refilling a Day Tank Based on a Daily Feed Pump Rate

Practice Problem: A water plant operator mixes 4 gallons of 12.5% hypochlorite solution in a 30-gallon day tank. If the feed pump uses 10 gallons of the solution in a 24-hour period, how many gallons of 12.5% solution must be added with water to refill the day tank to its 30-gallon capacity?

Step 1: Create the ratio of <u>Original mixing volume (gals)</u> =   <u>X(Unknown volume)</u>
                              Day Tank volume (gals)   Feed Pump Usage in a day

$\frac{4}{30} = \frac{X}{10}$

Step 2: To get "X" alone, multiply 4 X 10 = <mark>40</mark> (in the numerator)

Step 3: Then divide numerator (40) by denominator (30) = <mark>**1.33 gal**</mark>

$\frac{40}{30}$ = <mark>**1.33**</mark> gal

Unit 3 Exercise – Process Control Calculations

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

   a) <mark>**MGD or MG**</mark>

   b) gpm or gallons

   c) gpd or gallons

   d) All of the above units can be used

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

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

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

   c) <mark>**Multiply gpm x 1440 and divide by 1,000,000**</mark>

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

3. If you have a flow in gal/day, what calculation do you use to convert it to MGD?

   a) Divide flow in gpd by 100

   b) Divide flow in gpd by 10,000

   c) Divide flow in gpd by 100,000

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

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

   a) **? gals = 1 gal   X   "lbs"** (needed to dilute day tank solution or as a % solution feed rate)
      1.63 lbs

   b) ? gals = 1.63 lbs X "lbs" (either needed to dilute day tank solution or as a % solution feed rate)
      gal

Unit 4 Exercise – State Act and Regulations

1. The barium level in your treated water has exceeded the MCL of 2 mg/L.

   a. Are you in violation? **YES**

   b. Are you required to notify DEP within 1 hour? **YES**

   c. Name the tier type of the public notice you must issue? **Tier 2 PN** (Options: Tier 1, Tier 2, or Tier 3 PN)

   d. In what timeframe is this public notice required? **30 days**

2. Under the Lead and Copper Rule, where should the first-draw lead and copper tap sample be collected?

   a) Outside spigot
   b) Kitchen hot water tap
   c) Kitchen cold water tap
   d) Laundry sink

3. Indicate where the samples are collected (entry point or distribution) for the following contaminants:

Total coliform samples	**Distribution**
Nitrate samples	**Entry Point**
Arsenic samples	**Entry Point**
VOCs	**Entry Point**
IOCs	**Entry Point**
SOCs	**Entry Point**
TTHM/HAA5 samples	**Distribution**

4. In a Tier 1 PN, how long should customers boil their water?

   a) 30 seconds
   b) 1 minute
   c) 2 minutes
   d) 5 minutes

5. When collecting a total coliform sample, the collector should leave air space at the top of the container.

   a) True
   b) False