DW Module 8:
Distribution
Answer Key

Unit 1:

Unit 1 Exercise

1. To become certified in distribution systems, a person must:
   a. Successfully complete the "Water Class E – Distribution System" certification examination.
   b. Meet work and educational experience qualifications.
   c. Submit an application along with a criminal background check to the Certification Board. The certification board will review the application and determine if the application should be approved.

2. Give an example of a process control decision that must be made by a certified operator or by another person following standard operating procedures written and approved by the certified operator for the system:

   If an operator wanted to divert more water flow in a system toward a tank, and as a result, they closed some valves to accomplish this objective. This action caused an increase in quantity of water in that particular section of main line and therefore is considered a process control decision.

3. Please determine whether a **certified operator**, **system owner, or Certification Board** is responsible for each of the following actions:

   Action:

   Approve a new application for certification: __Certification Board______________________

   Report any situations causing a violation to the system owner: __Certified Operator______

   A process control decision: ______Certified Operator ________________________________

   Respond to a certified operator report: ____System owner___________________________

Unit 2:

Example 2.2 – Pressure Head Calculation

How many feet of water would be in a tank if the pressure gauge at the base of the tank read 15 psi?

$$ft = \frac{2.31\ ft}{1\ \cancel{psi}} \times 15\ \cancel{psi}$$

$$= (2.31)\ (15)$$

$$= 35\ \text{Feet}$$

Example 2.3 – Pressure Head Calculation

What would the pressure head in psi be on a fire hydrant if a pressure gauge on that fire hydrant read 258 feet?

$$psi = \frac{1\ psi}{2.31\ \cancel{ft}} \times 258\ \cancel{ft} = 111.7\ psi$$

Example 2.4 – Pressure Head Calculation

What is the pressure (in psi) at a point 12 feet below the surface?

$$psi = \frac{1\ psi}{2.31\ \cancel{ft}} \times 12\ \cancel{ft} = 5.2\ psi$$

Unit 2 Exercise

1. Circle those items that are components of a distribution network.

   a. Pumps

   c. Storage Facilities

   d. Intake

   f. Pipes

g. Hydrants

h. Valves

j. Meters

Trench Safety fill-in-the-blank

2. OSHA requires a protective system for trenches 5 feet or greater.
3. Atmospheres containing oxygen levels below 19.5 % may be hazardous.
4. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for employees.

New main installation fill-in-the-blank

5. Haunching – the portion of the material placed in an excavation on either side of and under a pipe from the top of the bedding up to the springline or horizontal centerline of the pipe. This backfill layer extends from one trench sidewall to the opposite sidewall. This is the most critical area in providing support for a pipe.
6. To minimize settling, during a backfill operation, it is recommended that after every 12 inches of lift, material should be compacted.
7. The 4 crucial steps that are necessary before putting a new main in service:
    1. Disinfect
    2. Pressure Test
    3. Flush
    4. Perform Bacteriological Test

Valve Matching

Use word bank to fill in the blanks in questions 8-13 on the next page.

Butterfly valve	**Altitude valve**	**Gate valve**	**Pressure Reducing valve**
	Air release valves	**Check valves**	

8. Check Valves are used in distribution systems to prevent back flows.

9. Pressure Reducing Valves are used to create head loss and "break" pressure to keep system pressures less than the pressure ratings in pipes and to avoid other adverse impacts of high pressure.

10. Gate Valves are the most commonly used isolation valve.

11. Butterfly valves are a flow control valve that can be adjusted to allow various flows through piping.

12. Air release valves are used to eliminate air from a distribution network or to allow air into a distribution network.

13. Altitude valve is a type of valve used to control flow in and out of storage facilities based on water level.

Random Multiple Choice

14. Corporation stops are typically tapped at:
    a. 10:00 o'clock position
    b. 11:00 o'clock position
    c. 12:00 o'clock position
    d. 1:00 o'clock position

15. Rapid changes in flow velocity within a distribution network can result in:
    e. Water hammer
    f. Pipe bursting
    g. Failure of distribution network component
    h. All of the above

16. Commonly used as a customer service meter:
    i. Velocity
    j. Compound
    k. Displacement
    l. Proportional

17. A flow of _________________ can easily be identified if the top of the hydrant is painted blue.
    a. Below 500 gpm
    b. 500-9999 gpm
    c. 1000 -1499 gpm
    d. 1500 gpm or more

18. The pressure gauge at the bottom of the tank reads 12 psi. How many feet of water would you expect in the tank?
    a. About 2 feet
    b. About 5 feet
    c. About 28 feet
    d. About 60 feet

19. Thrust blocks or restraints should be used at _________ to avoid movements and leaks:
    a. Tees
    b. Bends
    c. Hydrants
    d. All of the above

20. List the five programs involved in routine maintenance of distribution networks.

    a. Pump Maintenance

    b. Valve Maintenance

    c. Meter Testing and Maintenance

    d. Fire Hydrant Maintenance

    e. Inspection and Monitoring

Unit 3:

Example 3.1 – Volume Calculation

A rectangular ground level storage facility is 100 feet long by 50 feet wide. The water level in the tank (measured from the bottom of the tank) is 10 feet. What is the volume (in gallons) of water in the tank?

V = (l) x (w) x (h), where h is the height of water in the tank

V = 100 ft x 50 ft x 10 ft

V = 50,000 cubic feet

There are 7.48 gallons in a cubic foot. Thus,

V = 50,000 cubic feet x 7.48 gallons/cubic foot

V = 374,000 gallons

Example 3.2 – Volume Calculation

An elevated tank has a diameter of 50 feet. The water level in the tank is 20 feet. What is the volume of water in the tank?

V = (A) x (h), where A = π x Radius $(r)^2$ or V = (0.785) x $(Dia)^2$ x H

V = (3.14 x 25^2) x 20 V = (0.785) x $(50)^2$ x 20

V = 39,250 cubic feet V = 0.785 x 2500 x 20 = 39,250 cubic feet

One cubic foot = 7.48 gallons, so we can calculate the volume to be:

V = 39,250 ft 3 x 7.48 = 293,590 gallons

Another example of distribution "storage" is the volume of water contained in the pipes themselves. The volume of water in a pipe can be calculated using the same formula as above:

vol = $(0.785)(dia)^2(length)(7.48gal/ft^3)$, substituting the length of pipe for the height of water

Example 3.3 – Volume Calculation

How many gallons of water are in a 400 foot section of main that has an 8 inch diameter?

First step:
Convert 8 inch to feet
Feet – $\frac{8\text{ in}}{12\text{ in}}$ = 0.67 feet

Second step:
Plug into volume formula
Vol = (0.785) x $(diameter)^2$ x (length)
= (0.785) x $(0.67\text{ feet})^2$ x 400 feet
= 141 ft^3

Third step:
Convert ft^3 to gallons
Gallons = 141 ft^3 x 7.48 = 1,055 gallons

Example 3.4 – Volume Calculation

The diameter of a tank is 60 feet. Without refilling of the tank, in one day, the water depth dropped from 25 feet to 21 feet, how many gallons of water were used that day?

First step:
Height = 25 ft – 21 ft = 4 ft

Second step:
V = (0.785) x (diameter)^2 x (height)
V = (0.785) x (60 ft)^2 x (4 ft) = 11,304 ft^3

Third step:
Convert ft^3 to gallons
Gallons = 11,304 ft^3 x 7.48 = 84,554 gallons

Unit 3 Exercise

1. List the three primary functions of distribution storage facilities.

   1) Equalize demand and pressures
   2) Fire Protection
   3) Emergency Supply

2. What are some advantages to using an elevated storage tank?

   Elevated storage facilities are typically used to boost pressure in distribution systems

3. Explain the procedures and methods used in controlling the filling and draining of a distribution storage facility that you are familiar with.

   [*Answer is as per the student's experience.*]

4. List three maintenance issues concerning distribution storage facilities.
   1) Painting
   2) Corrosion Control
   3) Water Quality

5. A new section of 12 inch diameter pipe is to be disinfected before it is put into service. If the length of pipeline is 2000 feet, how many gallons of water will be needed to fill the pipeline?

First step:
Convert 12 inch to feet
Feet – $\frac{12 \text{ in}}{12 \text{ in}}$ = 1 feet

Second step:
Plug into volume formula
Vol = (0.785) x (diameter)^2 x (length)
= (0.785) x (1 feet)^2 x 2000 feet
= 1,570 ft^3

Third step:
Convert ft^3 to gallons
Gallons = 1,570 ft^3 x 7.48 = **11,744 gallons**

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Unit 4:

Example 4.1 – Dosage Calculation

The chlorine residual is 0.7 mg/l, and the demand is 0.5 mg/l. What is the dose?

Dose = demand + residual = 0.7 + 0.5 = 1.2 mg/l

Example 4.2 – Dosage Calculation

The chlorine dose is 2.1 mg/l, and the demand is 0.9 mg/l. What is the residual?

Rearrange = Chlorine Residual = Chlorine Dosage – Chlorine Demand

2.1 - 0.9 = 1.2 mg/l

Example 4.4 – Dosage Calculation

A system has repaired the storage facility. They need to disinfect it before putting it back in service. They are going to use 25 mg/l of chlorine. How many pounds of 65% calcium hypochlorite are required if the storage facility has a 50 foot diameter and is 75 feet tall?

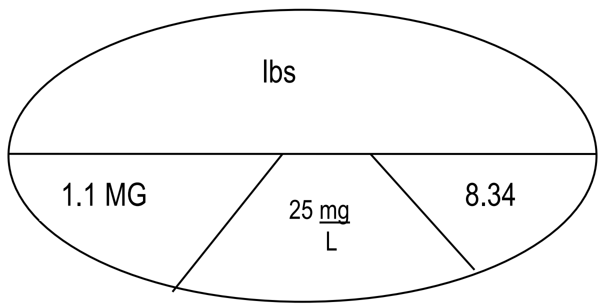
First step:
Plug into volume formula
Vol = (0.785) x (diameter)^2 x (length)
= (0.785) x (50 feet)^2 x 75 feet
= 147,188 ft^3

Second step:
Convert ft^3 to gallons
Gallons = 147,188 ft^3 x 7.48 = 1,100,963 gallons

Third step:
Now, convert the 1,100,963 gallons to a MGD unit by dividing by 1,000,000 gallons

$$\frac{1,100,963 \text{ gal}}{1,000,000 \text{ gal}} = \quad = 1.1 \text{ MGD}$$

Fourth step:
Plug into "pounds formula"
Pounds/day = flow(MG) dose(mg/l)(8.34)
= (1.1)(25)(8.34)
= 229 pounds



Last step:
Calculate the amount of 65% calcium hypochlorite needed factoring in the purity:

$$\frac{229}{0.65} = 353 \text{ pounds}$$

Unit 4 Exercise

1. Write the two immediate steps required after a bacteria test is positive for total coliform:

   a. <u>The laboratory will analyze for *E. coli* bacteria</u>

   b. <u>The system will collect check samples</u>

2. Select the best response to complete the following true statement. Chlorine is added to a water system and is maintained throughout the distribution system to:

   a. Protect public health.

   b. Prevent corrosion.

   c. Reduce public confidence.

   d. Increase taste and odor.

3. The initial chlorine demand of the impurities in a source of water is 1.5 mg/l. What is the chlorine dosage required to produce a chlorine residual of 2.0 mg/l?

   3.5 mg/l

4. What is the recommended minimum water velocity when flushing water distribution piping?

   5 fps

5. List five problems associated with stagnation of water due to dead ends:

   a. Depleted disinfectant residual

   b. Bacteriological issues

   c. Turbidity

   d. Color/tastes/Odor Issues

   e. Iron/Manganese Sediment

6. A system has replaced 350 feet of 12 inch water main. They are going to use 50 mg/l of chlorine for 24 hours to disinfect the line. How many pounds of 65% calcium hypochlorite are required?

   First step:
   Convert 8 inch to feet
   Feet – $\frac{12 \text{ in}}{12 \text{ in}}$ = 1 foot

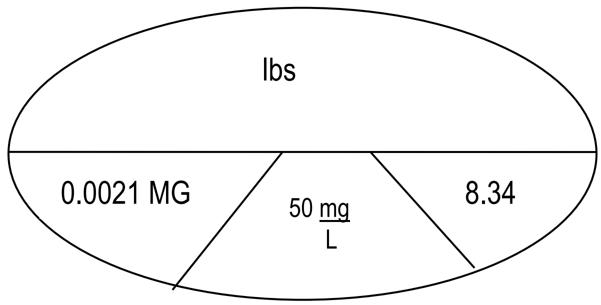
Second step:
Plug into volume formula
Vol = (0.785) x (diameter)^2 x (length)
= (0.785) x (1 feet)^2 x 350 feet
= 275 ft^3

Third step:
Convert ft^3 to gallons
Gallons = 275 ft^3 x 7.48 = 2055 gallons

Fourth step:
Now, convert the 527 gallons to a MGD unit by dividing by 1,000,000 gallons

$$\frac{2055 \text{ gal}}{1{,}000{,}000 \text{ gal}} = 0.0021 \text{ MGD}$$

Fifth step:
Plug into "pounds formula"
Pounds/day = flow(MG) dose(mg/l)(8.34)
= (0.0021)(50)(8.34)
= 0.9 pounds



Last step:
Calculate the amount of 65% calcium hypochlorite needed factoring in the purity:

$$\frac{0.9}{0.65} = \mathbf{1.3 \text{ pounds}}$$