Groundwater Math Study Guide

Kentucky Division of Compliance Assistance
Certification and Licensing Branch

This study guide is intended to help students become more familiar with the variety of math equations within the Groundwater Treatment manual and exam.

Below is a chart of where math can be found in the training manual.

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Work through each problem introduced in each chapter and the math questions (if any) at the end of each chapter.

Class I & II

1. Calculate the specific Capacity of a well which has the following characteristics:
Well Yield: 300 gpm, Static Water level: 45 feet, Pumping level: 80 feet

A. 3.75 gpm/ft
B. 6.66 gpm/ft
C. 8.57 gpm/ft
D. 10.59 gpm/ft

2. What is the volume of a Stand pipe measuring 15 feet in diameter and 29 feet tall?

A. 3,532 gallons
B. 4,710 gallons
C. 26,423 gallons
D. 38,313 gallons

3. 55 psi is equivalent to how many feet of head?

A. 23.9 ft
B. 52.8 ft
C. 105.6 ft
D. 127.0 ft

4. A bucket contains 7.5 gallons of water. How much would the water weigh?

A. 56.1 lbs
B. 62.6 lbs
C. 75.0 lbs
D. 92.5 lbs

5. Three miles of new 3 inch PVS pipe needs to be disinfected using calcium Hypochlorite (70%). How many pounds of calcium hypochlorite will be needed?

A. 0.32 lbs
B. 2.33 lbs
C. 3.46 lbs
D. 350.3 lbs

6. Water flows through a 3 inch diameter pipe at 0.45 ft^3/s. What is the velocity of the water?

A. 9.18 ft/s
B. 12.34 ft/s
C. 15.25 ft/s
D. 18.45 ft/s

7. A water plant treats the water with 3.8 mg/l chlorine. When the residual chlorine is checked in the point furthest from the plant I the distribution system it is 0.35 mg/L. What is the demand in this distribution system?

A. 1.4 mg/l
B. 3.45 mg/l
C. 4.15 mg/l
D. 5.2 mg/l

8. The projected water use for a new industrial plant coming to town is 1.2 MGD. What is the flow in gallons per minute?

A. 79.0 gpm
B. 538.6 gpm
C. 833.4 gpm
D. 1728.0 gpm

9. If a chemical has a specific gravity of 1.15, what would 1 gallon of the chemical weigh?

A. 6.5 lbs
B. 7.3 lbs
C. 8.6 lbs
D. 9.6 lbs

10. A water plant treated 22,386,000 gallons during the month of February. Records indicate that the amount of water billed was 20, 345,670 gallons. What was the percent of non-revenue water or water loss for the plant?

A. 9.1%
B. 12.6%
C. 14.5%
D. 16.7%

11. The water plant treated 38,450 gallons of water during the last 24 hours using 1.5 pounds of chlorine. What is the dosage for that day?

A. 0.47 mg/l
B. 2.7 mg/l
C. 4.7 mg/l
D. 6.8 mg/l

12. Water from a well is being treated by a hypochlorinator, If the hypochlorinator is set at a pumping rate of 20 gallons per day and uses a 2% available chlorine solution, what is the chlorine dose if the well pump delivers 110 gpm?

A. 1.5 mg/l
B. 2.0 mg/l
C. 2.5 mg/l
D. 3.0 mg/l

13. A 50 gallon concentration tank is filled with 2 gallons of sodium hypochlorite (15% available chlorine) and 48 gallons of water. What is the % strength of this chlorine solution?

A. 0.6%
B. 1.1%
C. 1.6%
D. 2.2%

14. What is the flow rate of water moving through a 10 inch diameter pipe with a velocity of 2.5 feet per second?

A. 0.96 ft^3/sec
B. 1.35 ft^3/sec
C. 4.63 ft^3/sec
D. 196.5 ft^3/sec

15. When the well pump is running, Well #2 pumps 1.6 cu.ft/sec. The well drawdown has been measured at 47 feet. What is the specific capacity of Well #2?

A. 2.9
B. 8.6
C. 11.5
D. 15.3

16. The chlorine demand for your system is 2.6 mg/l. The operator treats 75,000 gallons of water with 3 pounds of chlorine gas. What will the chlorine residual be in the system?

A. 1.5 mg/l
B. 2.2 mg/l
C. 3.4 mg/l
D. 4.8 mg/l

17. A pump was found to deliver 15,748 gallons of water in 30 minutes into a cylindrical tank that measures 25 feet in diameter and stands 90 feet high. What is the pumping rate in gallons per minute?

A. 524.9 gpm
B. 675.5 gpm
C. 778.4 gpm
D. 990.6 gpm

18. Calculate the Langelier's Index for water having an actual pH of 7.6 and a saturation pH (pHs) of 7.85.

A. + 0.25
B. -0.25
C. -2.5
D. +7.25

19. A 500,000 gallon storage tank is to be disinfected using a 50 ppm chlorine bleach solution (beach contains 5.25% available chlorine) with a specific gravity of 1.1. How many gallons of bleach will be required?

A. 24 gallons
B. 433 gallons
C. 476 gallons
D. 3971 gallons

20. The gauge at the bottom of an 80 foot tall standpipe reads 31 psi. What is the static head in feet?

A. 13.4 feet
B. 27.5 feet
C. 71.6 feet
D. 77.7 feet

Answer Key

1. C
2. D
3. D
4. B
5. C
6. A
7. B
8. C
9. D
10. A
11. C
12. C
13. A
14. B
15. D
16. B
17. A
18. B
19. B
20. C

Class III & IV

21. What is the motor horsepower of a pump that is pumping at a flow of 2.8 cu.ft/sec while overcoming 50 feet of head? The pump efficiency is 80% and a motor efficiency is 85%.

A. 16 MHP
B. 20 MHP
C. 23 MHP
D. 29 MHP

22. The meter on a well was reading 21,456,298 gallons. 30 days later the meter was reading 38,398,132. What was the average daily flow in gpm?

A. 0.547
B. 392.2
C. 564.7
D. 564,727

23. A ground storage tank 30 ft. tall and 50 ft. in diameter is currently 35% full. One pump is filling the tank at a rate of 450 gpm while another pump is emptying the tank at 200 gpm. How long will it be before the tank is completely filled?

A. 2.6 hours
B. 8.7 hours
C. 19.1 hours
D. 47.7 hours

24. A polyphosphate solution is being added at the water plant for corrosion control. One gall of this solution weighs 15 pounds. What is the specific gravity of this solution?

A. 0.75
B. 1.8
C. 2.0
D. 3.5

25. Water leaves the treatment plant at 300 gpm. If the water is flowing through a 4 inch line what is the flow rate in cubic feet per second?

A. 0.057 cu.ft/sec
B. 0.67 cu.ft/sec
C. 7.84 cu.ft/sec
D. 40.7 cu.ft/sec

26. A hypochlorinator lowers the level in a 36 inch diameter tank 16 inches in 4 hours. What is the hypochlorite feed rate?

A. 422 gpd
B. 565 gpd
C. 4,230 gpd
D. 697,570 gpd

27. What is the gauge pressure shown at the bottom of a tank 30 feet in diameter and 50 feet tall that is 75% full?

A. 9.7 psi
B. 16.2 psi
C. 21.7 psi
D. 27.1 psi

28. How long will it take to fill a 25,000 gallon tank if the pumping rate to fill the tank is 50 gpm?

A. 0.35 days
B. 0.75 days
C. 1.25 days
D. 2.75 days

29. A system has two wells pumping at the same time. Well #1 is pumping at 1.5 MGD and has a drawdown of 32 feet. Well # 2 is pumping at a rate of 1.8 cu.ft/sec and has a drawdown of 420 inches. What is the combined specific capacity?

A. 25.3 gpm/ft
B. 32.7 gpm/ft
C. 45.0 gpm/ft
D. 55.6 gpm/ft

30. A class 3 plant is adding 52 pounds of bleach at 7% available Chlorine to a flow of 950 gpm. What is the dosage?

A. 0.32 ppm
B. 0.67 ppm
C. 4.55 ppm
D. 7.56 ppm

31. What is the flow rate of water moving through a 6 inch pipe with a velocity of 2.2 feet per sec?

A. 0.43 cu.ft/min
B. 0.027 MGD
C. 193 gpm
D. 0.43 MGD

32. If the specific gravity of a bleach solution is 1.3, what will the weight of three gallons of this bleach be?

A. 8.3 pounds
B. 10.8 pounds
C. 25.0 pounds
D. 32.5 pounds

33. A plant is pumping water from a well in an 8 inch pipe. The pump is rated at 850 gpm and is running at 85% efficiency. The water is being treated wit 42 pounds HTH at 65% available chlorine. What is the chlorine dosage being added to this water?

A. 2.7 ppm
B. 3.1 ppm
C. 4.6 ppm
D. 4.8 ppm

Answer Key

21. C
22. B
23. C
24. B
25. B
26. A
27. B
28. A
29. D
30. A
31. C
32. D
33. B

Class I & II Solved Equations

1. Formula used: *Specific Capacity = Flow, gpm ÷ Drawdown, ft*
   Calculate: drawdown – Drawdown = Pumping level, ft – Static water level, ft
   Drawdown, ft = 80 ft – 45 ft = 35 ft
   Specific Capacity = 300 gpm ÷ 35 ft = 8.57 gpm/ft

2. Formula used: *Volume, gal + 0.785 X Diameter, ft x Diameter, ft X Height, ft x 7.48 gal/ft* ^{3}
   Volume = 0.785 x 15 ft x 15 ft x 29 ft x 7.48 gal/ ft^3 = 38,313 gal

3. Conversion used: *1 psi = 2.31 ft of head*
   Going from unit on left of conversion chart to units on right so you multiply:
   55 psi x 2.31 ft of head = 127.0 ft of head

4. Conversion used: *1 gallon = 8.34 pounds*
   Going from unit on left of conversion chart to units on right so you multiply:
   7.5 gallons of water x 8.34 pound / gallon = 62.6 pounds

5. Formula used: *Pounds = (ppm x 8.34 x MG) ÷ % purity Use decimal equivalent (% purity 100)*
   Calculate the volume of the pipe in MG:
   Change inches to feet: 3 / 12 = 0.25 ft
   Volume, ft^3 = 0.785 x 0.25 ft x 0.25 ft x (3 miles x 5280 ft)
   Volume, ft^3 = .785 x 0.25 ft x 0.25 ft x 15,840 ft = 777.15 ft^3
   Volume, gal = 777.15 ft^3 x 7.48 gal / ft^3 = 5,813 gal ÷ 1,000,000 = 0.00581 MG
   Calculate pounds - Since this is new pipe regulations require it to be disinfected using 50 ppm:
   Pounds = (50 ppm x 8.34 x 0.00581 MG) ÷ 0.70 = 2.42 ÷ 0.70 = 3.46 pounds

6. Formula used: *Velocity (V) = Flow (Q) ÷ Area (A)*
   Find the area of the 3 in pipe: Convert inches to feet - 3 in ÷ 12 in = 0.25 ft
   A, ft^2 = 0.785 x 0.25 ft x 0.25 ft = 0.049 ft^2
   Calculate Velocity:
   V, ft/sec = 0.45 ft^3/sec ÷ 0.049 ft^2 = 9.18 ft/sec

7. Formula used: *Demand - Dosage - Residual*
   Demand, mg/L = 3.8 mg/L - 0.35 mg/L = 3.45 mg/L

8. Conversion used: *1 MGD = 694.5 gpm*
   1.2 MGD x 694.5 gpm = 833.4 gpm

9. Formula used: *Wt./gal = Specific Gravity x 8.34*
   Wt./gal = 1.15 x 8.34 = 9.59 or 9.6 lbs

10. Formula used:
    % water loss = (water lost, gallons ÷ water treated, gallons) x 100
    Find water loss: water treated, gallons – water billed, gallons
    Water loss = 22,386,000 gal – 20,345,670 gal = 2,040,330 gal
    % water loss = (2,040,330 ÷ 22,386,000) x 100 = 0.091 x 100 = 9.1%

11. Formula used: *mg/L = pounds ÷ (8.34 x Flow, MGD)*
    Convert flow to MGD: 38,450 gal ÷ 1,000,000 = 0.038 MGD
    Calculate mg/L: mg/L = 1.5 lbs. ÷ (8.34 x 0.038) = 1.5 lbs. ÷ 0.317 = 4.7 mg/L

12. Formula used: *mg/L = pounds ÷ (8.34 x Flow, MGD)*
    Calculate pound of Chlorine used:
    lbs. = 20 gal x 8.34 x 0.02 = 3.34 lbs.
    Convert flow to MGD: 1
    10 gpm ÷ 694.5 gpm/1 MGD) = 0.16 MGD
    Calculate mg/l:
    mg/L = 3.34 lbs. ÷ (8.34 x 0.16 MGD) = 3.34 lbs. ÷ 1.33 = 2.5 mg/L

13. Formula used:
    SOS, % = (Gal, bleach x 8.34 x % purity (decimal)) ÷ ((gal, water + gal bleach) x 8.34) x100
    Calculate SOS, %:
    SOS, % = ((2 gal X 8.34 X 0.15) ÷ ((48 gal + 2 gal) x 8.34)) x 100
    SOS, % = (2.50 ÷ 417) x 100 = 0.006 x 100 = 0.6 %

14. Formula used: *Flow, Q = Area, A x Velocity, V*
    Calculate the area of the 10 inch pipe:
    Convert the 10 inches into feet: 10 in / 12 in = 0.83 ft
    Area, A = 0.785 x 0.83 ft x 0.83 ft = 0.54 ft^2
    Calculate the Flow:
    Flow, Q = 0.54 ft^2 x 2.5 ft/sec = 1.35 ft^3/sec

15. Formula used: *Specific Capacity = Flow, gpm ÷ Drawdown, ft*
    Convert flow from cu.ft/sec to gpm: 1.6 cu.ft/sec x 448.8 gpm = 718.08 gpm
    Calculate Specific Capacity of well:
    Specific Capacity = 718.08 gpm ÷ 47 ft = 15.28 or 15.3 gpm/ft

16. Formula used: *Residual = dosage – demand*
    Calculate the dosage in the system:
    3 lbs. ÷ (8.34 x 0.075 MGD) = 3 ÷ 0.626 = 4.79 or 4.8 mg/L
    Residual = 4.8 mg/L – 2.6 mg/L = 2.2 mg/L

17. Formula used: *Gallons pumped ÷ minutes pump runs = gpm*
    Pump rate, gpm = 15,748 gallons ÷ 30 minutes = 524.9 gpm

18. Formula used: *pH(A) – pH(S)* = Langelier's Index where, pH(A) is actual pH and pH(S) is calculated pH of Saturation:
    7.6 – 7.85 = -0.25

19. Calculate the number of pounds needed using the pounds formula:
    lbs. = (50 ppm x 8.34 x 0.5 MGD) ÷ 0.0525 = 208.5 ÷ 0.0525 = 3,971.43 lbs.

    Calculate the number of gallons by dividing the lbs. by the weight of 1 gallon:
    Gallons = 3,971.43 lbs. ÷ (8.34 x 1.1) = 3,971.43 lbs. ÷ 9.17 lbs./gal = 433.0 gallons

20. Convert PSI to feet of head:
    Feet of head = 31 psi x 2.31 feet of head/psi = 71.6 feet of head

Class III & IV Solved Equations

21. Formula used: *MHP = (Flow, gpm X head, feet) ÷(3960 x Pump efficiency, % x Motor efficiency, %)*
    Convert flow from cu.ft/sec to gpm:
    Flow, gpm = 2.8 cu.ft/s x 448.8 gpm/cu.ft/s =1,256.64 gpm
    Convert pump efficiency and motor efficiency to decimals:
    Pump efficiency = 80% ÷ 100 = 0.80
    Motor efficiency = 85% ÷ 100 = 0.85
    Calculate Motor Horsepower:
    MHP = (1,256.64 gpm x 50, feet) ÷ (3960 x 0.8 x 0.85) = 62,832 ÷ 2,672.4 = 23 MHP

22. Formula used: *(Ending flow – starting flow) ÷ number of days between readings = Avg. flow*
    Avg. Flow, gal/day = (38, 398,132 gal – 21,456,298 gal) ÷ 30 days = 16,941,834 gal / 30 days
    Avg. Flow = 564,727.8 gal/day ÷ 1,440 min/day = 392.2 gpm

23. Calculate the volume of the tank in gallons:
    Vol, gal = 0.785 x 50 ft x 50 ft x 30 ft x 7.48 gal/ft^3 = 440,385 gal
    Tank is 35% full so it is 65% empty, calculate the empty volume:
    Remaining volume = 440385 gal x .65 = 268,250.25 gal
    Flow coming in – flow going out: 450 gpm – 200 gpm = 250 gpm
    Remaining tank volume ÷ net flow = minutes until tank is full
    Minutes until filled = 286,250.25 gal ÷ 250 gpm = 1,145 minutes until filled
    Hours to fill = 1,145 minutes ÷ 60 min/hr = 19.08 or 19.1 hrs

24. Formula used: *weight of solution ÷ weight of same quantity of water = Sp.Gr.*
    Sp.Gr. = 15 /8.34 = 1.8

25. Convert flow rate from gpm to ft^3/s – Ignore the 4 inch pipe
    Flow, ft^3/s = 300 gpm ÷ 448.8 gpm/ft^3/s = 0.67 ft^3/s

26. Calculate volume of liquid pumped in gallons in 4 hours
    Convert inches to feet
    Volume pumped, gal = 0.785 x 3 ft x ft x 1.33 ft = 9.4 ft_3 x 7.48 gal/ft^3 = 70.31 gallons/4 hrs
    Gals/24 hr = 70.31 x 6 = 421.9 or 422 gpd

27. Calculate height of water in the 50 ft tank that is 75% full:
    Height = 50 x 0.75 = 37.5 feet
    Convert feet of head to psi:
    Psi = 37.5 feet of head x 0.433 = 16.2 psi

28. Calculate time required in minutes then convert to days:
    Time, min = 25,000 gal ÷ 50 gpm = 500 minutes
    Convert to days:
    Time, days = 500 min ÷ 1440 min/day = 0.347 or 0.35 days

29. Formula used: *Specific Capacity = Flow, gpm ÷ Drawdown, feet*
    First, convert the flow from each well to gpm –
    Well #1 Flow, gpm = 1.5 MDG x 694.5 gpm/MGD = 1,041.75 gpm
    Well #2 = 1.8 cu.ft/s x 448.8 gpm / cu.ft/s = 807.84 gpm

    Calculate the drawdown for each well:
    Well #1 Drawdown, ft = 32 ft (no conversion needed)
    Well #2 Drawdown, feet = 420 in ÷ 12 in/ft = 35 ft

    Calculate the specific capacity for each well and add them together:
    Specific Capacity, Well #1 = 1,041.75 gpm ÷ 32 ft = 32.55 gpm/ft
    Specific Capacity, Well #2 = 807.84 gpm /35 ft = 23.08 gpm/ft
    Combined Specific Capacity = Specific Capacity, Well #1 + Specific Capacity, Well #2
    Combined Specific Capacity = 32.55 + 23.08 = 55.64 or 55.6 gpm/ft

30. Formula used: *ppm = (lbs., added x %purity) ÷ (8.34 x flow, MGD)*
    First convert flow to MGD – Flow, MGD = 950 gpm ÷ 604.5 gpm/MDG = 1.37 MGD

    Calculate the dosage, ppm:
    ppm = (52 lbs. x 0.07) ÷ (8.34 x 1.37 MGD) = 3.64 lbs. ÷ 11.42 = 0.32 ppm

31. Formula used: *Q = A x V, where Q = flow, A = Area of pipe and V = Velocity of the water*
    Calculate the area of the 6 inch pipe. 6 inches = 0.5 feet
    Area, ft^2 = 0.782 x 0.5 feet x 0.5 feet = 0.196 ft^2

    Calculate the flow:
    Flow, ft^3/s = 0.196 ft^2 x 2.2 ft/s = 0.43 ft^3/s
    Convert the flow to gpm and MGD to find the right answer since 0.43 ft^3/s is not one of the answers:
    Flow, MGD = 0.43 ft^3/s x 1.55 MGD/ft^3/s = 0.67 MGD
    Flow, gpm = 0.43 ft^3/s x 448.8 gpm/ft^3/s = 193 gpm

32. Formula used: *lbs. = gal x 8.34 x Sp.Gr.*
    lbs. = 3 gal x 8.34 lbs./gal x 1.3 = 32.5 lbs.

33. Formula used: ppm = *(lbs., added x %purity) ÷ (8.34 x flow, MGD)*
    Calculate flow in MGD – Flow, MGD = (85 gpm x 0.85) ÷ 694.5 = 722.5 ÷ 694.5 = 1.04 MGD

    Calculate dosage, ppm:
    Ppm = (42 lbs. x 0.65) ÷ (8.34 x 1.04) = 27.3 lbs. ÷ 8.67 = 3.14 or 3.1 ppm

Questions or Concerns?

The Kentucky Operator Certification Program provides training and issues certifications to ensure that individuals engaged in performing many of Kentucky's critical environmental activities are qualified and capable to perform their duties. DCA staff are available to provide on-site assistance and training.

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