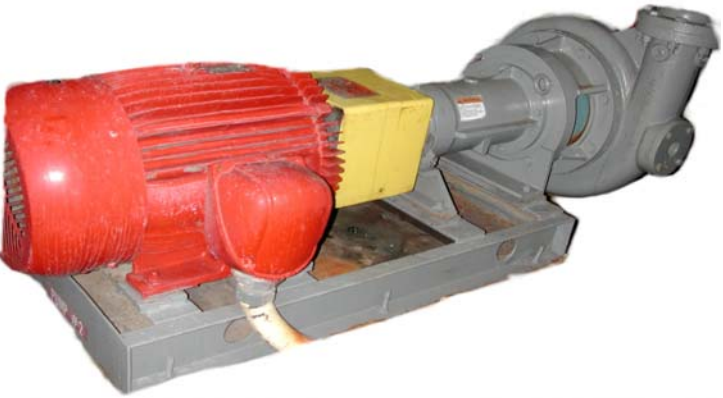
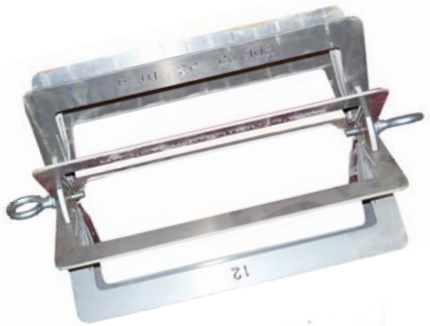
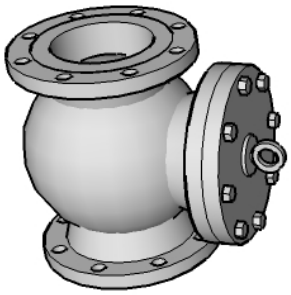
WASTEWATER COLLECTION REVIEW

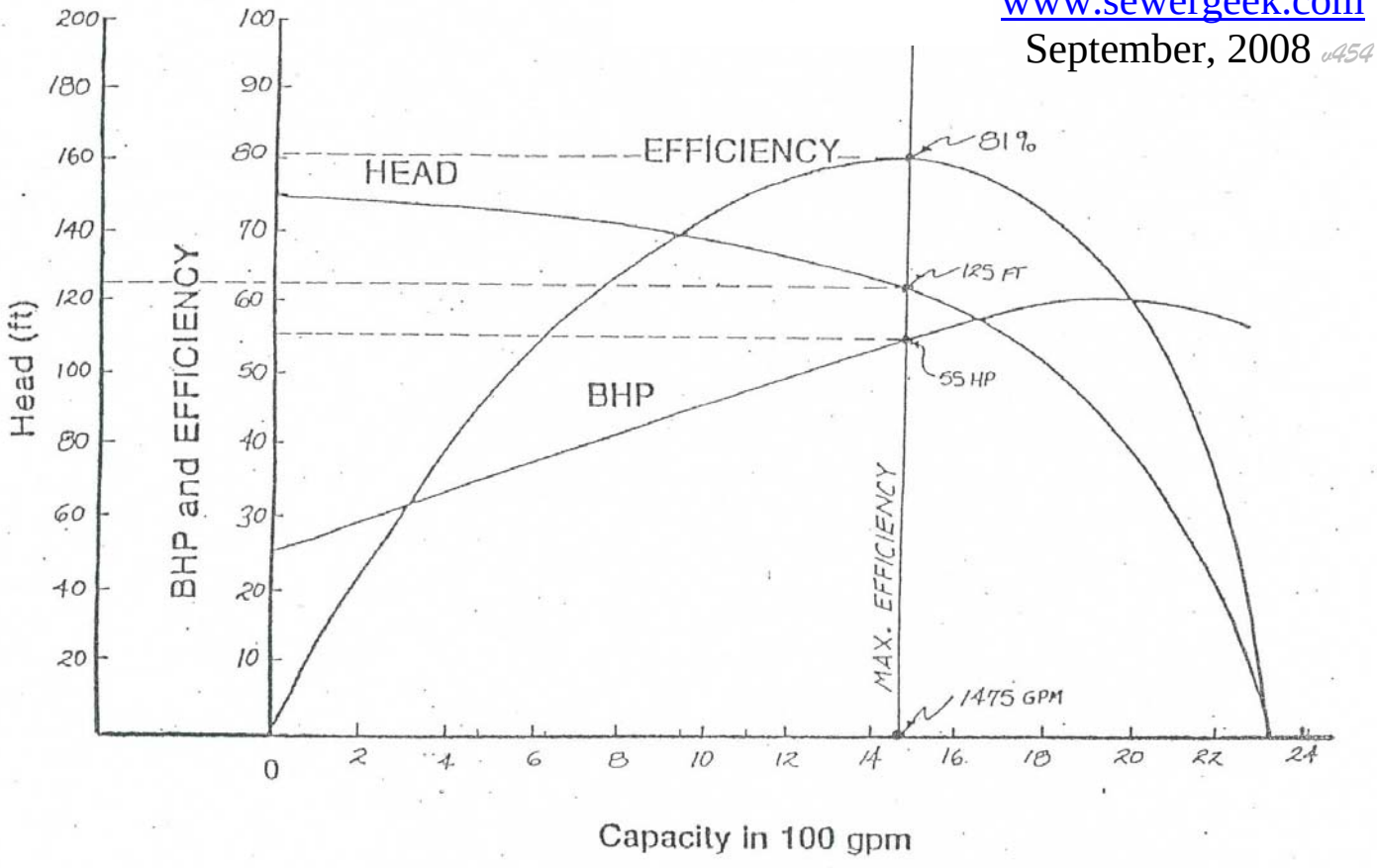
Q & A Examples & Sample Questions







EXAMPLE PUMP CURVE



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Wastewater Collection Formulas & Factors

(Bold items are important to remember, others are useful information)

Water & Flow

1 MGD = 1.55 $ft.^3$/sec.
1 ft. water depth = .433 PSI
1 gal. water = 8.34 lbs.
1 $ft.^3$ water = 7.48 gallons
(To avoid switching 8.34 & 7.48 remember, "**Weight is eight**")

Pipe Flow Formulas

Area of a circle = D^2 x .785 **Ft^3/sec. = MGD x 1.55**
Area of a Rectangle = L x W **Volume of a Rectangle = L x W x H**
Volume of a Cylinder = D^2 x .785 x L (or Depth)

Q = A x V **Q(flow) = $\frac{\text{Volume}}{\text{Time}}$** (*detention time formula*)
or **Flow = Area x Velocity**
or **Ft^3/sec. = $Ft.^2$ x Ft./sec.** **Velocity = $\frac{\text{Distance}}{\text{Time}}$**

Pump Information

1 HP = 746 watts **1 HP = .746 Kilowatts**
Watts = Amps x Volts

Total Dynamic Head (TDH) = Suction Head (ft.) + Suction Lift (ft.)

Water HP (output HP) = $\frac{\textbf{Flow (GPM) x TDH (Ft.)}}{\textbf{3960}}$ **(you may have to convert $\frac{PSI}{.433}$ to get feet)

Wire HP = Input HP = $\frac{\text{Input Watts}}{746}$

Brake HP = HP the motor delivers to the pump. ***Input HP x Efficiency% x PF = Water HP***
Water HP = output HP from the pump *or* HP required to move the water

Chemical Formulas

Lbs./day = mg/l* x MGD x 8.34 lbs./gal (If given a specific gravity other than water (1), Replace 8.34 with the given specific gravity** x 8.34)

Example: mg/l = 3, MGD = 22, Spec. Gravity (S.G.) = 1.03
8.34 x 1.03 = 8.59 New formula = mg/l x MGD x 8.59 lbs/gal.

*mg/l stands for milligrams per liter **specific gravity is the weight of a substance compared to water.

General Math Formulas

1 Mile = 5,280 feet **1 ton = 2,000 lbs.** **1 $yd.^3$ = 27 $ft.^3$**

Slope = $\frac{\text{Rise}}{\text{Run}}$ **$^0C = \frac{(^0F-32)}{1.8}$** **$^0F = (^0C \times 1.8) + 32$**

GPCD (Gallons per Capita per Day) **= 100** (unless given) *Meaning, each person uses about 100 gal./day.*

1 Day = 86,400 seconds or 1,440 minutes

HINTS FOR TEST TAKING

Before answering the question, SIMPLIFY IT!

Look at the units in the answer choices. Get rid of numbers you don't need and convert units to make the question less confusing.

1) A circular tank is 6ft. 6 inches in diameter and 25' deep. If the tank is completely full and a 300 GPM pump is supplied, how long will it take to remove 36" of water from the tank?

    a) 2.5 MIN
    b) 248 MIN
    c) .33 MIN
    d) 25 MIN

a. Because the problem gives a change in water depth of 36", the wet well depth is not needed. Cross it out to avoid accidentally using it later.
b. Convert inches to feet, and if you prefer, calculate the area before you start.
c. If its possible, DRAW THE PROBLEM!

6.5 feet (area= 6.5ft. x 6.5ft. x .785 = 33.17ft.^{2})

1) A circular tank is ~~6 ft 6 inches~~ in diameter ~~and 25' deep~~. If the tank is completely full and a 300 GPM pump is supplied, how long will it take to remove ~~36"~~ of water from the tank?

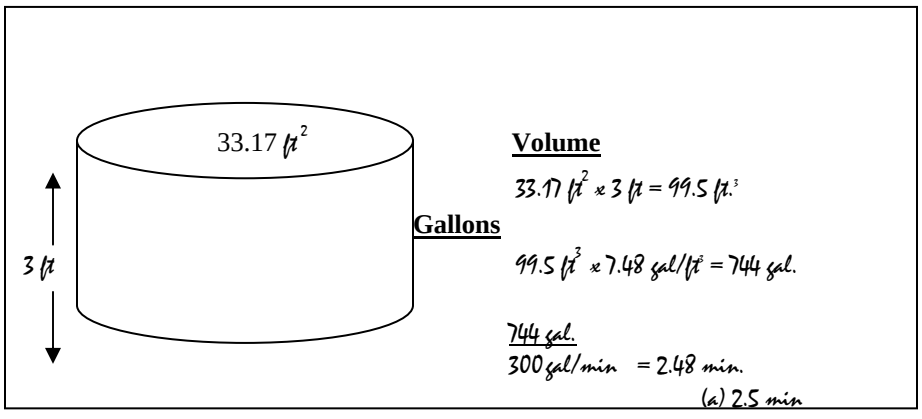
3 ft.

    a) 2.5 MIN
    b) 248 MIN
    c) .33 MIN
    d) 25 MIN

Now you have an easier question to deal with.

1) A circular tank has an area of 33.17 sq. ft. If 300 GPM pump is supplied, how long will it take to remove 3 ft. of water from the tank?

    a) 2.5 MIN
    b) 248 MIN
    c) .33 MIN
    d) 25 MIN



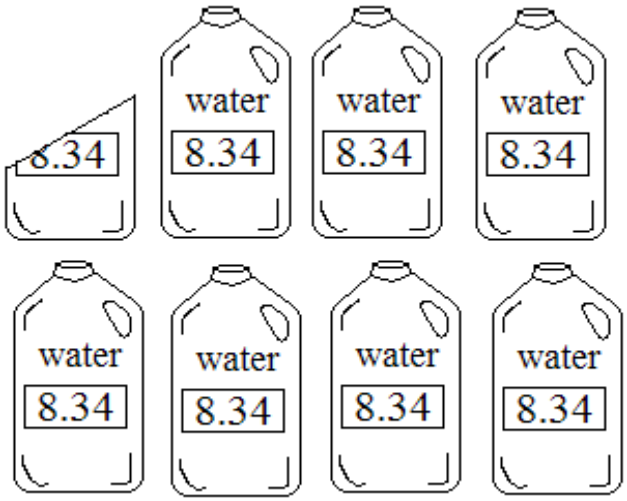
Make an educated guess to rule out some possibilities. The question below shows a 36" storm sewer flowing half full at 4.2 fps. You should see that "a" and "c" flows are much too high for a half full 36" pipe. (*Unless the slope is increased significantly*.) If you get these answers you should very carefully check your work. Also, if you look closer, b) 19.2 MGD is exactly twice as much as d) 9.6 MGD, this is done by the test maker so that if you forget to cut the full pipe flows in half when you are done you will pick "b". So before you even start calculating this one you should see that the answer is d) 9.6 MGD. All of the questions won't be this obvious, but many are.

2) A 36" storm sewer flowing half full at a velocity of 4.2 ft./sec. will discharge how much flow into a creek in MGD?

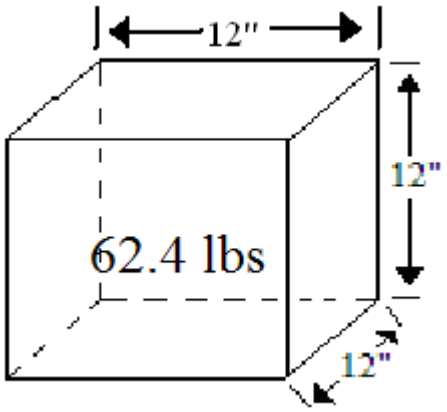
   ~~a) 29.7 MGD~~
   b) 19.2 MGD
   ~~c) 46 MGD~~
   d) 9.6 MGD

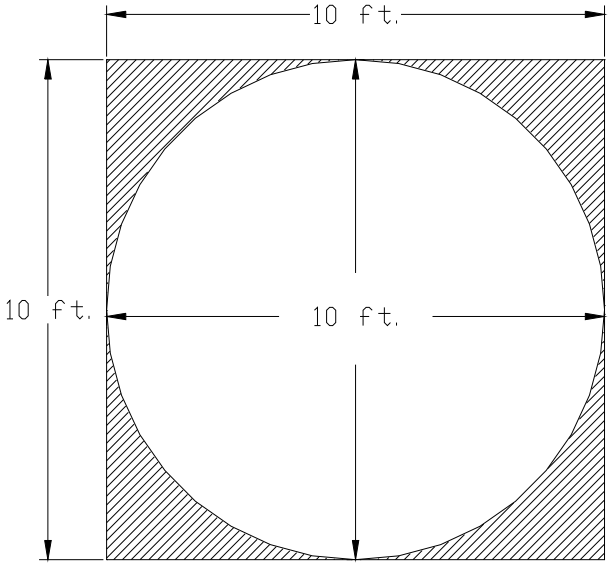
   In the example questions, I usually do not use these methods. I go through every step so you can see every part. But, if you simplify the problem first, it will be easier to understand and you will be less likely to forget something.

7.48 Gallons = $1ft^3$



7.48 gal. in a $ft.^3$
x 8.34 lbs./gal.
62.4 lbs./$ft.^3$



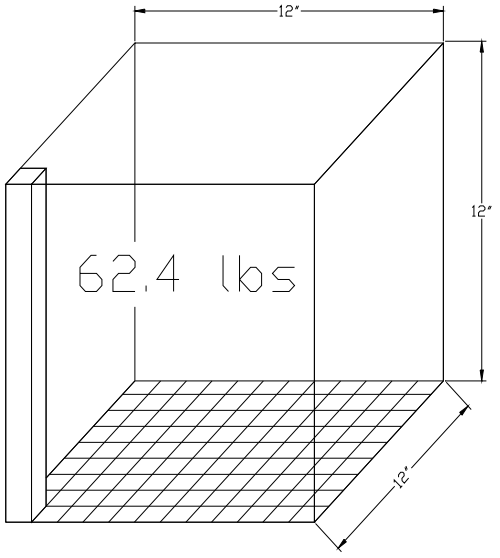


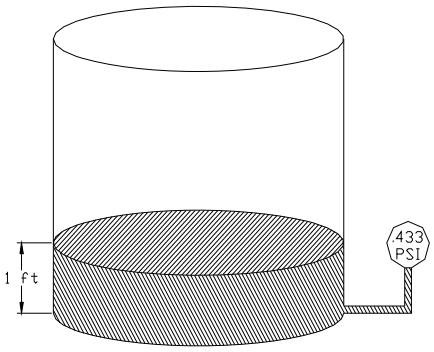
Area of a rectangle = length x width
10’ x 10’ = 100 ft.^{2}

Area of a circle =
78.5% of the area of the same size square
10’ x 10’ x 78.5% = 78.5’ sq.
(.785)

Area of a circle = D^2 x .785

D^2 (multiples L x H for the area of a square)
.785 (takes out corners to make it round)





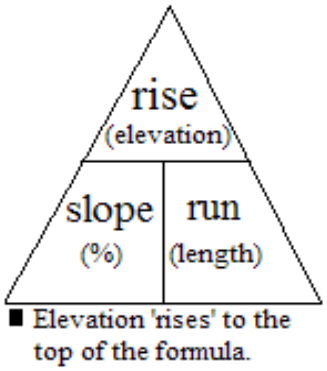
.433 lbs

(Estimate the water level to be a little more than twice the PSI)

<u>A 62.4 lb. cube</u>

12” W x 12” L = .433 lbs per square inch

Using Formula Triangles



■ Elevation 'rises' to the top of the formula.

Using the triangle at the left, insert the known variables in their correct spots.

The top variable = one bottom number x the other
Bottom number = the top number divided by the bottom number

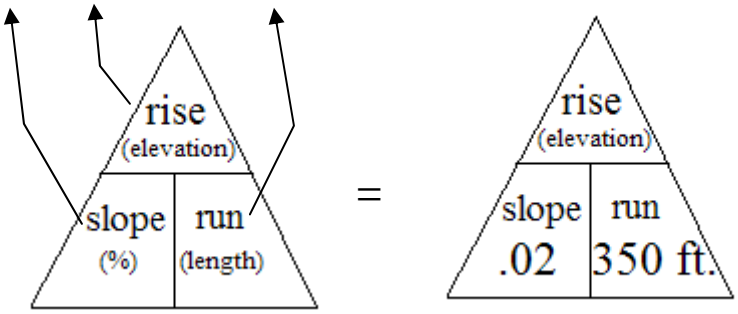
Simply cover the unknown variable & do the calculation.

Setting up triangles, the larger number goes on top, the other two go on the bottom – in any order. *see example(s) below.

Slope = 2% (.02) Run (M.II. Distance) = 350 ft.

What is the rise (elevation)

slope = rise OVER run



rise = .02 x 350 ft. = 7ft

Example question using the algebraic method, then the triangle method in solving the questions. Insert the known values in the proper triangle the solve for the unknown. If the unknown value is on the top of the triangle, simply multiply the two bottom values together. If the unknown value is on the bottom, divide the top value by the known value on the bottom. All of the answers to the sample questions will be done using the algebraic method. If you are unsure of your method, then refer to the sample triangles at the beginning of each section & use the triangle method.

It is important to develop your skills in arranging formulas without the triangles in order to move on to more difficult tests.

ALGEBRAIC METHOD

(30". ÷ 12"/ft. = 2.5 ft.)

1) A ~~30"~~ sanitary sewer carries a flow of 9 MGD, calculate the velocity of the flow in FPS.

Formula(s) needed: Flow = Area x Velocity or $Ft^3/sec. = Ft.^2 x Ft./sec.$, $Area=D^2 x .785$, CFS = MGD x 1.55

1) Convert the flow to CFS.
   CFS= MGD x 1.55
   CFS= 9 MGD x 1.55
   CFS= 13.9 ft^3/sec.
2) Calculate the area of the pipe.
   Area = D^2 x .785
   Area= 2.5 ft. x 2.5 ft. x .785
   Area= 4.9 ft^2
3) Calculate the velocity by rearranging the flow formula or by using it in a triangle.

$ft^3/sec. = ft.^2 x ft./sec.$

$15.5\ ft^3/sec. = 12.56\ ft^2 x$ **ft./sec.**

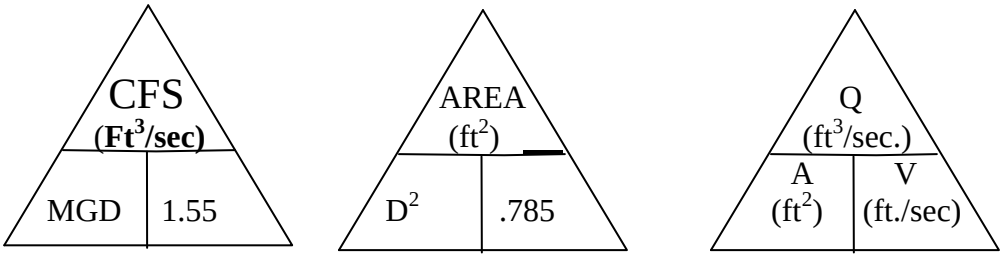
$$\frac{13.9\ ft^3/sec.}{4.9\ ft^2} = 2.85\ ft./sec.$$

TRIANGLE METHOD

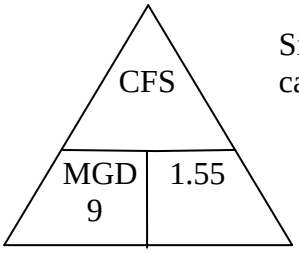
(30". ÷ 12"/ft. = 2.5 ft.)

1) A ~~30"~~ sanitary sewer carries a flow of 9 MGD, calculate the velocity of the flow in FPS.

Triangles needed:



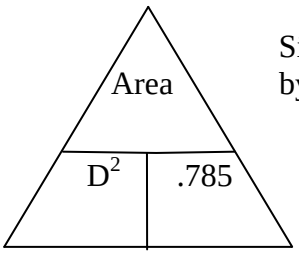
1) Convert the flow to CFS:



Since the unknown value, CFS is on the top, the CFS (ft^3/sec.) can be calculated by multiplying MGD x 1.55.

9 MGD x 1.55 = 13.9 ft^3/sec.

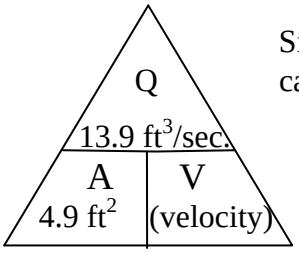
2) Calculate the area of the pipe. (Area is in ft^2)



Since the unknown value, Area is on the top, the area can be calculated by multiplying D^2 x .785. (D^2 = Diameter x Diameter)

2.5 ft. x 2.5 ft. x .785 = 4.9 ft^2

3) Calculate the velocity:



Since the unknown value, velocity is on the bottom, the velocity can be calculated by dividing Q ÷ **A**

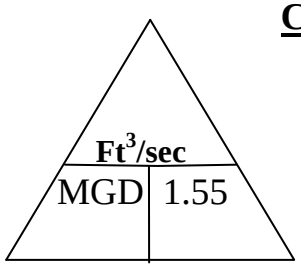
$$\frac{13.9\ ft^3/sec.}{4.9\ ft^2} = 2.85\ ft./sec.$$

WASTEWATER COLLECTION REVIEW

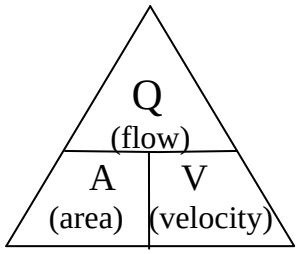
Flow Calculations Q&A

Flow Calculation Formulas & Definitions

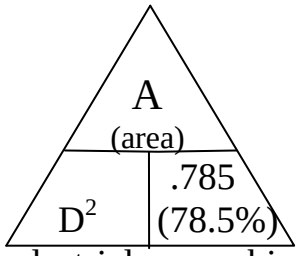
Converting MGD to Ft^3/sec.



$$\frac{\text{MGD} \times 1{,}000{,}000}{60 \text{ sec.} \times 60 \text{ min.} \times 24 \text{ hrs.} \times 7.48 \text{ gal./ft}^3} = 1.55 \times \text{MGD}$$

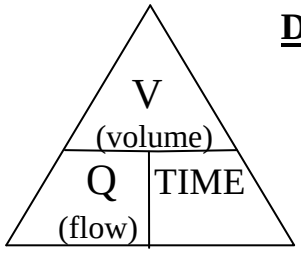


1 CFS = 1 Ft^3/sec = 7.48 gal./sec.



GPCD = Gallons Per Capita Per Day
* Usually given because it varies depending on residential, industrial or combined areas. If it is not given, use 100.

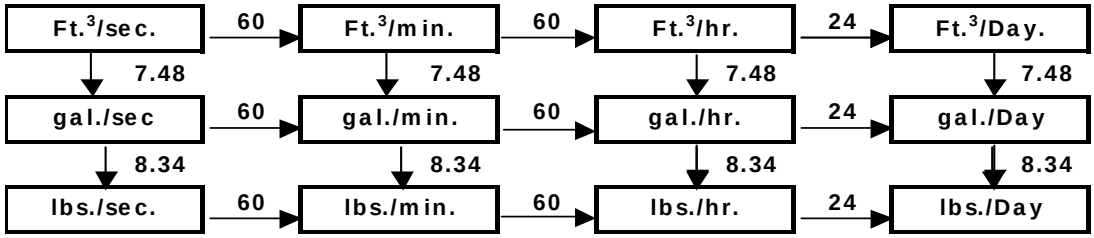
In wet well questions, if a wet well depth is given, IGNORE THE ORIGINAL WET WELL DEPTH!



Detention Time = How long it takes to fill or empty a tank.

GPCD = Gallons Per Capita Per Day
* Usually given because it varies depending

Box method (WATER FLOWS ONLY)



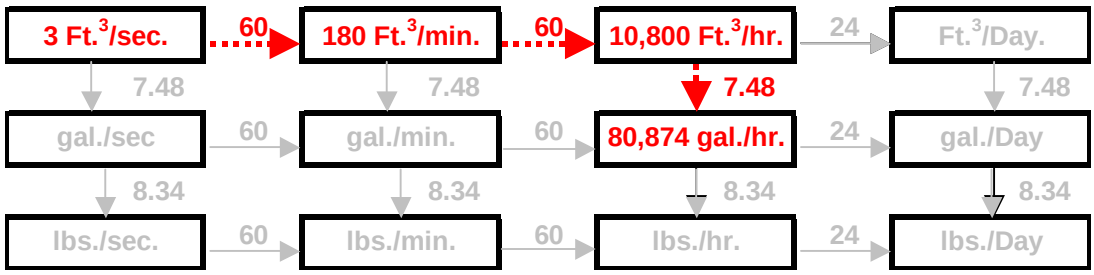
The diagram above can be easily memorized by drawing it by hand a few times. You will notice a pattern as you repeat it that will make it easy to remember. That can help in the short term. However, if you are practicing regularly, it should not take very long before you no longer need to use this.

THIS METHOD IS FOR CONVERTING WATER ONLY. IT WILL NOT WORK FOR ANY CHEMICAL OR MIXTURE WHICH HAS A SPECIFIC GRAVITY OTHER THAN 1.

Example;

If you are converting 3 ft^3/sec to gal./hr. - start with 3 in the box marked ft^3/sec then follow the arrows from that box to the box marked gal./hr. Multiply by the numbers between the boxes as you pass.

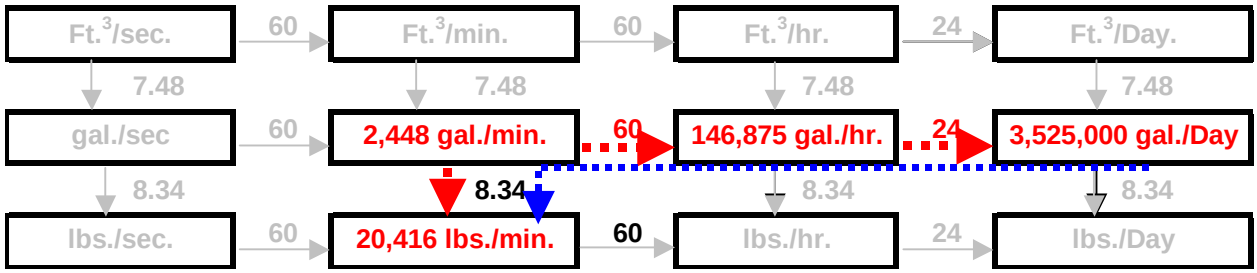
Box method (WATER FLOWS ONLY)



3 ft^3/sec x 60 x 60 x 7.48 = 80,874 gal./hr

When going backwards (against the arrows) you must divide by the number.
Try converting 3,525,000 gal./day to lbs./min.

Box method (WATER FLOWS ONLY)



3,525,000 gal./Day ÷ 24 hrs./day ÷ 60 min./hr. ÷ 8.34 lbs. gal = 20,416 lbs.min.

(As long as you follow the arrows, it does not matter which direction you take.)

1) Convert 42 ft^3/sec. to MGD

a) 2.71 MGD
b) 27.1 MGD
c) 65.1 MGD
d) 6.51 MGD

2) Convert 6.2 MGD to CFS.

a) 4.0 CFS
b) 96 CFS
c) 9.6 CFS
d) .40 CFS

3) How does the area of a 72" inch sewer compare to the area of a 36" sewer?

a) The 36" area is 50% smaller than the 72" area
b) The 72" area is 2 times larger than the 36" area
c) The 36" area is 1.5 times smaller than the 72" area
d) The 72" area is 4 times larger than the 36" area

4) If a 24" pipe and a 48" pipe are running full and meet at a manhole, what size outlet pipe will be required?

a) 54 INCH
b) 72 INCH
c) 48 INCH
d) 60 INCH

5) Rain falls for two hours on a parking lot that is 205 feet by 185 feet. The amount of rain that fell was measured at 2.5 inches. Calculate the amount of flow in GPM.

a) 1740 GPM
b) 549 GPM
c) 5,910 GPM
d) 492 GPM

6) A ball is dropped into a manhole, 2 min. 18 seconds later it is observed 500' away in a downstream manhole. What is the velocity of the flow in FPS?

a) 3.90 FPS
b) 3.62 FPS
c) 6.22 FPS
d) 1.59 FPS

7) What capacity blower is required to ventilate a manhole 60” in diameter and 53’ deep, if 3 air change(s) is required every 6 minutes?

a) 173 CFM
b) 520 CFM
c) 3,120 CFM
d) 1,248 CFM

8) A 42” storm sewer flowing half full, at a velocity of 2.5 ft./sec. will discharge how much flow into a creek in MGD?

a) 4.09 MGD
b) 18.6 MGD
c) 15.5 MGD
d) 7.75 MGD

9) A 48” sanitary sewer carries a flow of 10 MGD. Calculate the velocity of the flow in FPS.

a) 12.56 FPS
b) 1.9 FPS
c) .63 FPS
d) 1.23 FPS

10) If a plant receives a flow of 150 MGD, at a velocity of 3 feet per second, what minimum size pipe would be needed?

a) 72 INCHES
b) 48 INCHES
c) 120 INCHES
d) 10 INCHES

11) If a sewer must have a flow rate of 2.5 MGD with a velocity between 2.3 FPS and 2.8 FPS, what size must the sewer be?

a) sewer size 16”
b) sewer size 15”
c) sewer size 12”
d)) sewer size 18”

12) What is the detention time in hours in a tank measuring 150’ x 98’ x 55’, if the tank receives 700,500 GPH?

a) 5.1 HRS
b) 1.15 HRS
c) 8.63 HRS
d) 9.6 HRS

13) What is the detention time in hours and minutes in a tank measuring 50' x 150' x 20', given the tank receives 3 MGD?

a) 8 HRS 58 MIN
b) 13 HRS 46 MIN
c) 12 HRS 38 MIN
d) 8 HRS 98 MIN

14) A circular tank is 42' in diameter and 33' deep. If the tank is completely full and a 600 GPM pump is supplied, how long will it take to remove 9' of water from the tank?

a) 2 HRS 58 MIN
b) 3 HRS 30 MIN
c) 2 HRS 35 MIN
d) 9 HRS 28 MIN

15) If 400 GPM is entering a twenty-five by twenty-five foot wet well that is 15 feet deep, how long will a 750 GPM pump take to drop the wet well level two feet?

a) 26.7 MIN
b) 12.5 MIN
c) 93.5 MIN
d) 200 MIN

16) What is the pumping rate of a pump when water is flowing into a wet well 15' wide x 10' long x 12' deep, at 900 GPM and the water level is rising at 7.5" in 6 minutes?

a) 1,017 GPM
b) 375 GPM
c) 1,200 GPM
d) 783 GPM

17) A wet well is 20 feet deep by 15 feet in diameter. When the pump is not running, the water rises 36 inches in 4 minutes and 25 seconds. If the level falls 5 inches in 5 minutes while the pump is running, what is the pump rate in GPM?

a) 954.8 GPM
b) 1007 GPM
c) 787 GPM
d) 946 GPM

18) A wet well is 12 feet by 6 feet by 15 deep and the influent rate is 600 GPM. With the 2 pumps running, the level decreases 3' 9". In 18 minutes. If pump "A" has a pumping rate of 425 GPM, what is the pumping rate of pump "B"? (answer in GPM)

a) 175 GPM
b) 287 GPM
c) 488 GPM
d) 537 GPM

19) A certain town's household flow rate is measured at 85 GPCD. If the plant receives 3.0 MGD, but 15% of that is inflow and infiltration, then what is the population of the town?

a) 30,000 PEOPLE
b) 382,500 PEOPLE
c) 235,294 PEOPLE
d) 27,900 PEOPLE

20) Sewer "A" has 13,800 people at 90 GPCD; sewer "B" has 12,500 people at 85 GPCD. Sewer "C" has 8,000 people at 95 GPCD. What percent of the flow is due to I&I if the total plant flow is 4.0 MGD?

a) 44.50%
b) 55.49%
c) 59.33%
d) 23.40%

21) A wastewater treatment plant receives the following:

Pump Station = 900 GPM
Sewer "A" = 8,000people @ 95 GPCD
I&I = 35,000 gal/day
Ind. Waste = 30,000 gal/day
Sewer "B" = ?

If the plant receives 2.5 MGD, what percentage of the total flow is contributed by sewer "B"?

a) 41.6%
b) 32.8%
c) 84.8%
d) 15.2%

22) The interior of 750 ft of 24 in. pipe is uniformly coated with 1.5 inches of grease. How many gallons will this pipe hold when filled with water?

a) 13,487 gal.
b) 15,482 gal.
c) 17,165 gal.
d) 12,534 gal.

23) Colored dye is dumped into a manhole. The dye first appears 3 minutes and 18 seconds later in a manhole 600 feet downstream and disappears 4 minutes and 19 seconds after the dye was first dumped into the manhole. What is the velocity (FPS) of flow in the sewer?

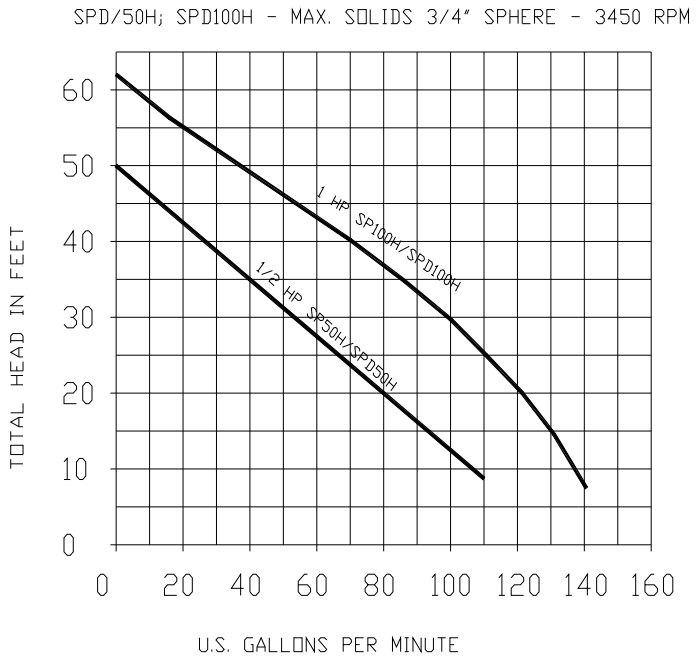
a) 1.58 FPS
b) 2.63 FPS
c) 3.27 FPS
d) 4.18 FPS

CHALLENGE QUESTIONS:

DIVISION PUMP STATION SUMP PUMP TEST

1) The sump well at a station is 3' in diameter and 3' deep. With both pumps off, the water level rose 3 inches in 1 minute 19 seconds. With the #1 pump on, the water rose 2.0 inches in 1 min. 3 sec. With the #2 pump on, (#1 off) the water level fell 6" in 1 minute 53 seconds. What is the GPM output of each pump if the TDH is 35'?

The pump model# is SPD50H. Look at the pump curve. Are the pumps performing above or below design? By how much?



2) Two pipes are running full at 1.6 ft./sec into a wet well that is 9 ft. wide by 25 ft. long by 22 feet deep. One pipe is 16" in diameter. With no pumps running, the water in the wet well is rising 12 inches every 31 seconds.

A) What size is the other pipe? (in inches)

B) How long will it take three 1,500 GPM pumps to lower the water level form 10 ft. to 3 ft.?

ANSWERS TO FLOW QUESTIONS

1) Convert 42 ft^3/sec. to MGD.

Formula(s) needed: MGD = ft^3/sec. ÷ 1.55

MGD = ft^3/sec. ÷ 1.55
MGD = 42 ft^3/sec. ÷ 1.55
MGD = 27.1 MGD **b) 27.1 MGD**

2) Convert 6.2 MGD to CFS.

Formula(s) needed: ft^3/sec. = MGD x 1.55

ft^3/sec. = MGD x 1.55
ft^3/sec. = 6.2 MGD x 1.55
ft^3/sec. = 9.6 ft^3/sec. **c) 9.6 CFS**

3) How does the area of a 72" inch sewer compare to the area of a 36" sewer?

Formula(s) needed: Area=D^2 x .785

(*Although 72" is twice as large as 36" notice that the area of a 72" pipe is much larger than a 36" pipe.)*

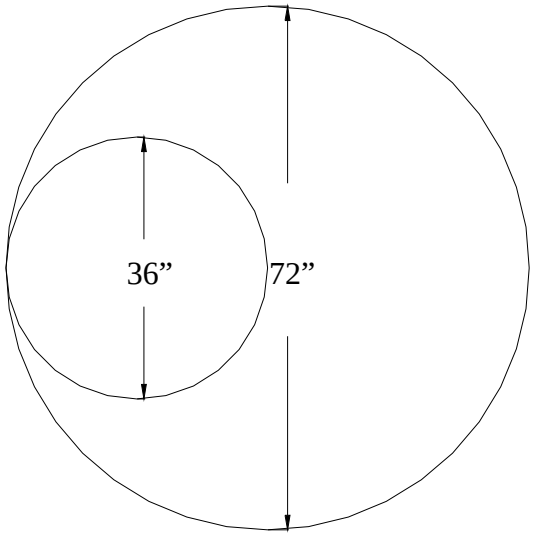


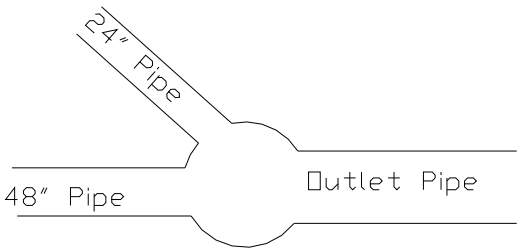
Figure the area of the 72" pipe, then divide it by the area of the 36" pipe

$\frac{72^2 \times .785}{36^2 \times .785} = \frac{4{,}069.44 \text{ in}^2}{1017.36 \text{ in}^2}$
= 4

d) The 72" area is 4 times larger than the 36" area

4) If a 24" pipe and a 48" pipe are running full, and meet at a manhole, what size outlet pipe will be required?

Formula(s) needed: Area=D^2 x .785



Calculate the area of both pipes coming into the manhole, add them up, then square root the results. (the area of the outlet must be at least the area of the 2 inlet pipes combined.)

$(24^2 \times .785) + (48^2 \times .785) = 2{,}260.80\ in^2$
(area of the outlet pipe)

In order to get the area of a pipe, you have to square the diameter, then multiply it by .785. To get the size, you divide by .785, then square root it.

$2{,}260.80\ in^2 \div .785 = 2{,}880\ in^2$

$\sqrt{2{,}880\ in^2} = 53.6$ inches **a) 54 INCH**

5) Rain falls for two hours on a parking lot that is 205 feet by 185 feet. The amount of rain that fell was measured at ~~2.5 inches~~. Calculate the amount of flow in GPM.

(2.5" ÷ 12"/ft. = .208 ft.)

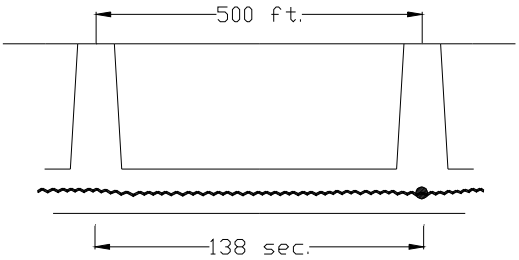
Formula(s) needed: Flow = Volume ÷ Time

1) Convert the rainfall from inches to feet.
   2.5" ÷ 12"/ft. = .208 ft.
2) Calculate the volume of water in ft^3 on the parking lot. (Length x Width x Depth)
   205 ft. x 185 ft. x .208 ft. = 7,888.4 ft^3
3) Multiply the cubic feet of water x 7.48 gallons per cubic foot.
   7,888.4 ft^3 x 7.48 gal/ft^3 = 59,005.2 gallons
4) Divide gallons by minutes to get Gallons Per Minute (GPM).
   59,005.2 gallons ÷ 120 minutes (2 hrs.) = 491.7 GPM

d) 492 GPM

6) A ball is dropped into a manhole. 2 min. 18 seconds later it is observed 500' away in a downstream manhole. What is the velocity of the flow in FPS?

Formula(s) needed: Velocity in FPS = feet ÷ seconds



1) Convert 2 min 18 seconds to seconds only.
   (2 min.) 120 sec. + 18 sec. = 138 seconds

2) Divide feet by seconds to get feet per second.
   500 ft. ÷ 138 min. = 3.62 FPS

b) 3.62 FPS

(60 in. ÷ 12"/ft. = 5 ft)

7) What capacity blower is required to ventilate a manh 60 in. in diameter an 53 feet deep, if 3 air change(s) is required ever 6 minutes?

	a)	173	Ft^3/Min.
	b)	520	Ft^3/Min.
	c)	3120	Ft^3/Min.
	d)	1248	Ft^3/Min.

FORMULAS NEEDED;

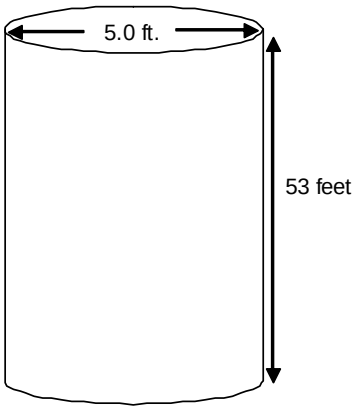
$$\frac{\text{Volume}}{\text{Time}} = \text{Flow}$$

Convert inches to feet;

$$\frac{60 \text{ in.}}{12 \text{ in./ft.}} = 5.0 \text{ ft.}$$

Volume of a Cylinder = D^2 x .785 x Depth

5.0 ft. x 5.0 ft. x .785 x 53 ft. = 1040.1 $Ft.^3$



Formula;

$$\text{Flow} = \frac{\text{Volume}}{\text{Time}}$$

$$= \frac{1040.1 \text{ Ft.}^3}{6 \text{ min.}}$$

$$= 173.4 \text{ Ft.}^3$$

Multiply ft3/min x Number of air changes required;

173.4 $Ft.^3$/Min x 3 Air Changes Req'd = 520 $Ft.^3$/Min **= "B"**

(42" ÷ 12"/ft. = 3.5 ft.)

8) A ~~42"~~ storm sewer flowing half full at a velocity of 2.5 ft./sec. will discharge how much flow into a creek in MGD?

Formula(s) needed: Flow = Area x Velocity or $Ft^3/sec. = Ft.^2 \times Ft./sec.$, $Area = D^2 \times .785$,
$MGD = ft^3/sec. \div 1.55$

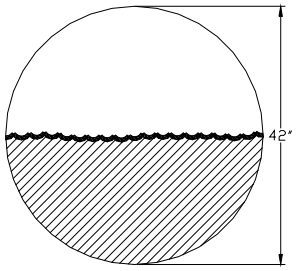
1) Velocity is given, so you only need to calculate the area in $Ft.^2$ to fill in the formula.

3.5 ft. x 3.5 ft. x .785 = 9.6 ft^2

2) $ft^3/sec. = 9.6\ ft.^2 \times 2.5 ft./sec$
$ft^3/sec. = 24\ ft^3/sec.$

3) $MGD = ft^3/sec. \div 1.55$
$MGD = 24\ ft^3/sec. \div 1.55$
MGD = 15.51 MGD

4) Divide the full pipe flow by two for the half pipe flow.
15.48 MGD ÷ 2 = 7.75 MGD



d) 7.75 MGD

(48". ÷ 12"/ft. = 4 ft.)

9) A ~~48"~~ sanitary sewer carries a flow of 10 MGD, calculate the velocity of the flow in FPS.

Formula(s) needed: Flow = Area x Velocity or $Ft^3/sec. = Ft.^2 \times Ft./sec.$, $Area = D^2 \times .785$,
CFS = MGD x 1.55

1) Convert the MGD flow to CFS.
CFS= MGD x 1.55
CFS= 10 MGD x 1.55
CFS= 15.5 $ft^3/sec.$

2) Calculate the area of the pipe.
Area = D^2 x .785
Area= 4 ft. x 4 ft. x .785
Area= 12.56 ft^2

3) Calculate the velocity by rearranging the flow formula or by using it in a triangle.
$ft^3/sec. = ft.^2$ x ft./sec.
15.5 $ft^3/sec. = 12.56\ ft^2$ x f**t./sec.**
$\frac{15.5\ ft^3/sec.}{12.56\ ft^2} = 1.23$ ft./sec.

d) 1.23 FPS

10) If a plant receives a flow of 150 MGD, at a velocity of 3 feet per second, what minimum size pipe would be needed?

Formula(s) needed: Flow = Area x Velocity or $ft^3/sec. = ft.^2 \times ft./sec.$, $Area = D^2 \times .785$, $MGD = ft^3/sec. \div 1.55$

1) Convert the MGD flow to CFS.

CFS= MGD x 1.55

CFS= 150 MGD x 1.55

CFS= 232.5 ft^3/sec.

2) Calculate the area of the pipe using the Q = A x V formula. (Ft^3/sec. = $Ft.^2$ x Ft./sec.)

$Ft^3/sec. = ft.^2 \times ft./sec.$

$232.5\ ft^3/sec. = ft.^2 \times 3\ ft./sec.$

$$\frac{232.5\ ft^3/sec.}{3\ ft./sec.} = 77.5\ ft.^2$$

3) Calculate the diameter in feet using the, Area = D^2 x .785 formula.

$Area = D^2 \times .785$

$77.5\ ft.^2 = D^2 \times .785$

$$\frac{77.5\ ft.^2}{.785} = D^2$$

$98.72\ ft.^2 = D^2$

Multiplying the square of the diameter by .785 'removes the area of the corners'. (see page 5) Dividing by .785 puts the corners back on. In the next step, we will square root the area of 98.72 $ft.^2$ in order to get the diameter in feet.

4) Square root the area to get the diameter in feet.

$$\sqrt{98.72\ ft.^2} = 9.94\ ft.$$

5) Convert the diameter in feet to inches.

9.94 ft. x 12"/ft. = 119.23 inches

c) 120 INCHES

11) If a sewer must have a flow rate of 2.5 MGD with a velocity between ~~2.3 FPS~~ and 2.8 FPS, what size must the sewer be?

Formula(s) needed: Flow = Area x Velocity or $ft^3/sec. = ft.^2 \times ft./sec.$, $Area = D^2 \times .785$, $MGD = ft^3/sec. \div 1.55$

For the same amount of flow, a smaller pipe size will cause a higher velocity (the fire hose effect) Pick the higher of the two velocities and that will be your minimum pipe size.
Use **2.8 ft/sec**. And cross out the lower velocity. (The lower velocity would be for the maximum pipe size)

Pipe Size for Maximum Velocity: (Minimum pipe size)

1) Convert the MGD flow to CFS.

CFS = MGD x 1.55

CFS = 2.5 MGD x 1.55

CFS = 3.9 ft^3/sec.

2) Calculate the area of the pipe using the Q = A x V formula. (Ft^3/sec. = $Ft.^2$ x Ft./sec.)
(using the maximum velocity of 2.8 FPS.)

Ft^3/sec. = $ft.^2$ x ft./sec.

3.9 ft^3/sec. = $ft.^2$ x 2.8 ft./sec.

$\frac{3.9\ ft^3/sec.}{2.8\ ft./sec.} = 1.4\ ft.^2$

3) Calculate the diameter in feet using the, Area = D^2 x .785 formula.

Area = D^2 x .785 Area = 1.4 ft^2

1.4 ft^2 = D^2 x .785

$D^2 = \frac{1.4\ ft^2}{.785} = 1.77 ft^2$

4) Square root the area to get the diameter in feet.

$\sqrt{1.77\ ft.^2} = 1.33$ ft.

5) Convert the diameter in feet to inches.

1.33 ft. x 12"/ft. = 15.98 inches

Minimum size = 15.98 inches

For the maximum velocity, this would be the minimum pipe size. Any smaller pipe & the velocity would speed up faster than 2.8 feet/sec.

a) sewer size 16"

12) What is the detention time in hours in a tank measuring 150' x 98' x 55', if the tank receives 700,500 GPH?

Formula(s) needed: Flow = Volume ÷ Time, 1ft^3 = 7.48 gal.

1) Calculate the volume of the tank in ft^3 (L x W x H)

150 ft. x 98 ft. x 55 ft. = 808,500 ft^3

2) Convert cubic feet to gallons

808,500 ft^3 x 7.48 gal./ft^3 = 6,047,580 gallons

3) Using the formula *Flow = Volume ÷ Time*, calculate the detention time of the tank.

Flow = Volume ÷ Time

700,500 gal./hr = 6,047,580 gal. ÷ Time

$\frac{6,047,580\ gal.}{700,500\ gal./hr.} = 8.63$ hrs

c) 8.63 hrs.

13) What is the detention time in hours and minutes in a tank measuring 50' x 150' x 20', given the tank receives ~~3 MGD~~? *(3,000,000 gal./day)*

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal.

1) Convert 3 MGD to Gal./hr.

   3 MGD = 3,000,000 gal./day

   $\frac{3{,}000{,}000 \text{ gal./day}}{24 \text{ hrs/day}}$ = 125,000 gal./hr.

2) Calculate the volume of the tank in ft^3 (L x W x H)

   50 ft. x 150 ft. x 20 ft. = 150,000 ft^3

3) Convert cubic feet to gallons

   150,000 ft^3 x 7.48 gal./ft^3 = 1,122,000 gallons

4) Using the formula *Flow = Volume ÷ Time,* calculate the detention time of the tank.

   Flow = Volume ÷ Time

   125,000 gal./hr = 1,122,000 gal. ÷ Time

   $\frac{1{,}122{,}000 \text{ gal.}}{125{,}000 \text{ gal./hr}}$ = 8.98 hrs

5) Convert decimal hrs. to HRS : MIN (convert .98 hrs to min. then add to the 8 hrs.)

   .98 hrs X 60 min./hr. = 58 min.

   8 hrs. 58 min.

a) 8 HRS 58 MIN

(not needed)*

14) A circular tank is 42' in diameter and ~~33' deep~~. If the tank is completely full and a 600 GPM pump is supplied, how long will it take to remove 9' of water from the tank?

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal., Area = D^2 x .785

**The tank depth is not important because we are only concerned with the depth of flow that we are pumping (9')*

1) Calculate the area of the tank.

   Area = D^2 x .785

   Area = 42 ft. x 42 ft. x .785

   Area = 1,384.74 ft^2

2) Multiply the area x depth to get the volume of water pumped.

   1,384.74 ft^2 x 9 ft. = 12,462.66 ft^3

3) Multiply the cubic feet of water x 7.48 gal./ft^3 to get gallons.

   12,462.66 ft^3 x 7.48 = 93,220.7 gallons

4) Calculate the flow rate in minutes, using the *Flow = Volume ÷ Time* formula.

   Flow = Volume ÷ Time

   600 gal/min. = 93,220.7 gal. ÷ Time

   $\frac{93{,}220.7 \text{ gal.}}{600 \text{ gal/min.}}$ = 155 min.

5) Convert minutes to hours, then to HRS : MIN.

   155 min. ÷ 60 min./hr. = 2.58 hrs

   2.58 hrs = 2 hrs. + (.58hrs x 60 min./hr.) = 2 hrs. 34 min.

c) 2 HRS 35 MIN

You should look at the 2.58 hrs & recognize that .58 hours is a little more than half an hour, so it should be a little more than 2 hrs. 30 min.

(not needed)*

15) If 400 GPM is entering a twenty-five by twenty-five foot wet well that is ~~15 feet deep~~, how long will a 750 GPM pump take to drop the wet well level two feet?

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal.

**The tank depth is not important because we are only concerned with the depth of flow that we are pumping (2')*

1) Calculate the volume of the water you are pumping.
   Volume = Length x Width x Depth
   Volume = 25 ft. x 25 ft. x 2 ft.
   Volume = 1,250 ft^3
2) Multiply the cubic feet of water x 7.48 gal./ft^3 to get gallons.
   1,250 ft^3 x 7.48 = 9,350 gallons
3) Determine the flow rate of water that is actually being removed from the tank.
   400 GPM entering – 750 GPM leaving = 350 gal./min. Actually removed
4) Calculate the flow rate in minutes, using the *Flow = Volume ÷ Time* formula.
   Flow = Volume ÷ Time
   350 gal/min. = 9,350 gal. ÷ Time
   $\frac{9{,}350 \text{ gal.}}{350 \text{ gal/min.}}$ = 26.7 min.

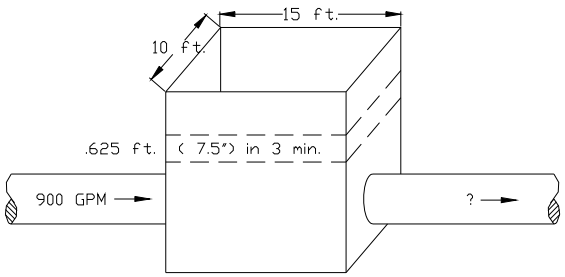
a) 26.7 Min

16) What is the pumping rate of a pump when water is flowing into a wet well 15' wide x 10' long x ~~12' deep~~, at 900 GPM and the water level is rising at ~~7.5"~~ in 6 minutes? *(not needed)* **(**7.5" ÷ 12"/ft. = .625 ft.)

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal.

The tank depth is not important because we are only concerned with the depth of flow that we are pumping (7.5")

BEFORE YOU START, THINK! – The water level is rising. The pump is not keeping up. Whatever the pump rate is, it's less than 900 GPM. Go back to the question and cross out any choices above 900 GPM.



1) Calculate the volume of the water you are pumping.
   Volume = Length x Width x Depth
   Volume = 15 ft. x 10 ft. x .625 ft.
   Volume = 93.75 ft^3
2) Multiply the cubic feet of water x 7.48 gal./ft^3 to get gallons.
   93.75 ft^3 x 7.48 = 701.25 gallons
3) Determine the flow rate of the rising water using the *Flow = Volume ÷ Time* formula.
   Flow = Volume ÷ Time
   $\frac{701.25 \text{ gal.}}{6 \text{ min.}}$ = 116.8 gal./min.
4) We have already determined that the pump is less than 900 GPM. We know by calculating the flow rate of the rising water, that it is 116.8 GPM less than 900 GPM.

900 GPM - 116.8 GPM = 783 GPM

d) 783 GPM

Simplify the question:

(not needed)

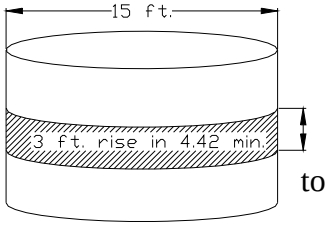
17) A wet well is ~~20 feet deep~~ by 15 feet in diameter. When the pump is not running, the water rises ~~36 inches~~ *(3 feet)* in 4 minutes and ~~25 sec.~~ *(4.42 min.)*. If the level falls ~~5 inches~~ *(.42 feet)* in 5 minutes while the pump is running, what is the pump rate in GPM?

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal., Area = D^2 x .785

This problem has to be done in two parts, 1) calculate the inflow, 2) Calculate the pumping rate.

CALCULATE THE INLET FLOW RATE:

1) Calculate the area of the wet well, then multiply x the depth of the rising water to determine the volume of the water coming into the well.



Area = D^2 x .785

Area = 15 ft. x 15 ft. x .785

Area = 176.625 ft^2 x 3 ft. (depth)

= 529.875 ft^3

2) Multiply the cubic feet of water x 7.48 gal./ft^3 to get gallons.

529.875 ft^3 x 7.48 = 3,963.5 gallons

3) Determine the flow rate of the rising water using the *Flow = Volume ÷ Time* formula.

Flow = Volume ÷ Time

$$\frac{3{,}963.5 \text{ gal.}}{4.42 \text{ min.}} = \textbf{896.7 gal./min.}$$

CALCULATE THE PUMPING RATE:

1) Calculate the area of the wet well, then multiply x the depth of the falling water to determine the volume of the water pumping out of the well.

Area = D^2 x .785

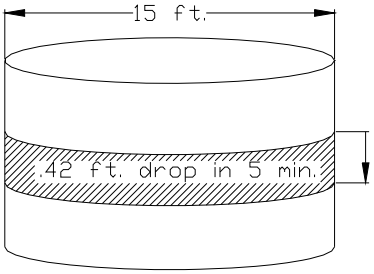
Area = 15 ft. x 15 ft. x .785

Area = 176.625 ft^2

x .42 ft. (depth) = 74.2 ft^3

2) Multiply the cubic feet of water x 7.48 gal./ft^3 to get gallons.

74.2 ft^3 x 7.48 = 555 gallons



3) Determine the flow rate of the falling water using the *Flow = Volume ÷ Time* formula.

Flow = Volume ÷ Time

$\frac{555 \text{ gal.}}{5 \text{ min.}}$ **= 111 gal./min**.

*Since the water level is **falling** with the pumps on, the pump is pumping more than the **896.7 gal./min. inlet flow rate** from part 1. Go to the choices below the problem on page 14 and eliminate any answers below 896.7 GPM.*

4) Part 2 determined that the pump dropped the level by 111 gallons per minute. **896.7 gal./min. + 111 gal./min. = 1,007.6 GPM**

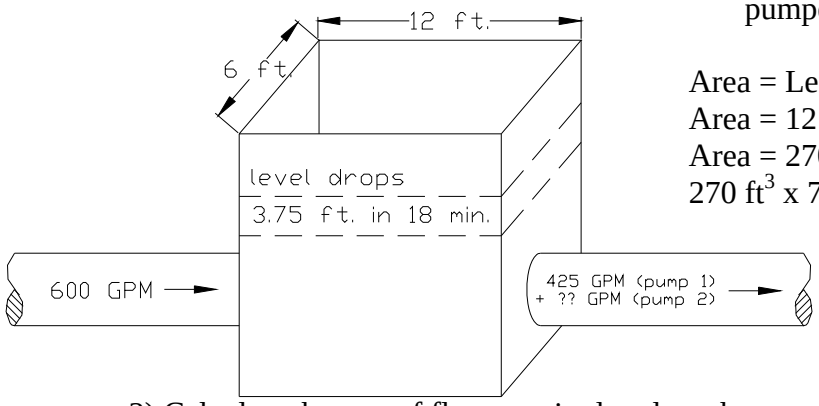
b) 1007 GPM

Simplify the question:

(not needed)

18) A wet well is 12 feet by 6 feet by ~~15 deep~~ and the influent rate is 600 GPM. With the 2 pumps running, the level decreases ~~3' 9"~~ *(3.75 ft.)*. In 18 minutes. If pump "A" has a pumping rate of 425 GPM, what is the pumping rate of pump "B"? (answer in GPM)

Formula(s) needed: Flow = Volume ÷ Time, $1ft^3$ = 7.48 gal.,



1) Calculate the volume of water that was pumped down in 18 min. & convert to gallons.

Area = Length x Width x Depth

Area = 12 ft. x 6 ft. x 3.75 ft.

Area = 270 ft^3

270 ft^3 x 7.48 gal./ft^3 = 2,019.6 gal.

2) Calculate the rate of flow required to drop the wet well 3.75 ft. in 18 min.

Using the formula, *Flow = Volume ÷ Time*

Flow = Volume ÷ Time

Flow = $\frac{2{,}019.6 \text{ gal.}}{18 \text{ min.}}$

Flow = 112.2 GPM

3) With 600 GPM entering the manhole & both pumps on, the water level is falling. That means; pump1 + pump 2 = more than 600 GPM. To determine how much more, add the flow from Step 2 to the 600 GPM influent rate.

Total flow of both pumps;

600 GPM + 112.2 GPM = 712.2 GPM

4) To find the flow of pump 2, subtract pump 1 from the total flow.

712.2 GPM - 425 GPM = 287.2 **b) 287 GPM**

19) A certain town's household flow rate is measured at 85 GPCD. If the plant receives ~~3.0 MGD~~ *(3,000,000 gal./day)* but 15% of that is inflow and infiltration, then what is the population of the town?

GPCD = (Gallons per Capita per Day)

1) If you have 15% I&I, then 85% of the flow is from people
(Assume no industry)
3,000,000 gal./day x 85% = 2,550,000 gal./day
(from people)

2) If each person uses 85 gal./day, then

$$\frac{2{,}550{,}000 \text{ gal./day}}{85 \text{ GPCD}} = \textbf{30,000 people}.$$

a) 30,000 PEOPLE

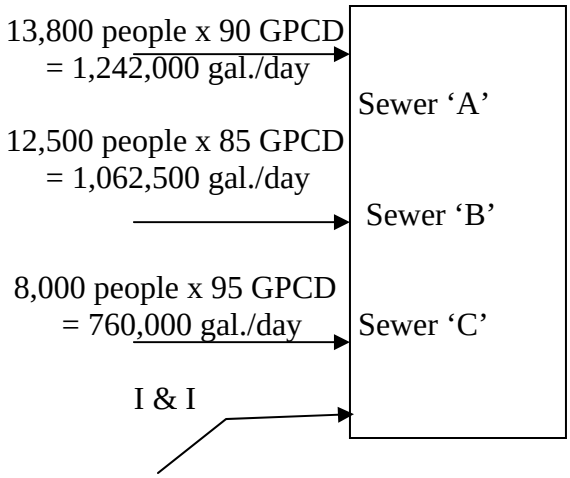
20) Sewer "A" has 13,800 people at 90 GPCD; sewer "B" has 12,500 people at 85 GPCD. Sewer "C" has 8,000 people at 95 GPCD. What percent of the flow is due to I&I if the total plant flow is 4.0 MGD *(4,000,000 gal./day)*?

GPCD = (Gallons per Capita per Day)

Plant flow = 4,000,000 gal./day

1) Add Known Flows:

1,242,000 gal./day
1,062,500 gal./day
\+ 760,000 gal./day
3,064,500 gal./day



2) Subtract from the total flow to get the I & I flow.

4,000,000 gal./day
\- 3,064,500 gal./day
935,500 gal./day

3) Divide I & I flow by total flow & multiply x 100.

935,500 gal./day ÷ 4,000,000 gal./day x 100 = 23.4% **d) 23.4%**

* Before picking your answer, look at your I & I flows & make sure they are reasonable. If you have a number higher than 50%, make sure your I & I flows are more than half. If not, you forgot step 2.

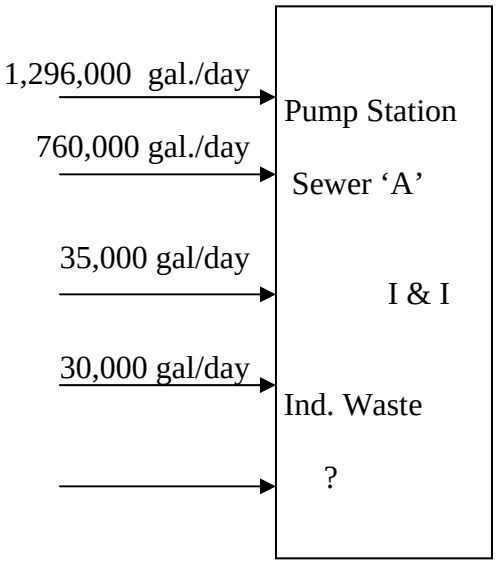
21) Rewrite the question with everything in the same units. Which units to use only depends on what is easiest for you. We will use gallons/day for this example.

A wastewater treatment plant receives the following:

Pump Station = 900 GPM *(900 gal./min. x 60 min./hr. x 24 hrs./day =* ***1,296,000 gal./day****)*
Sewer "A" = 8,000people @ 95 GPCD *(8,000 people x 95 GPCD =****760,000 gal./day****)*
I&I = 35,000 gal/day
Ind. Waste = 30,000 gal/day
Sewer "B" = ?

If the plant receives 2.5 MGD *(2,500,000 gal./day)*, what percentage of the total flow is contributed by sewer "B"?

Plant Flow - 2.5 MGD = 2,500,000 gal./day



1) Add Known Flows:

1,296,000 gal./day
760,000 gal./day
35,000 gal/day
\+ 30,000 gal/day
2,121,000gal./day

2) Subtract from the total flow to get the Sewer 'B' flow.

2,500,000 gal./day
\- 2,121,000 gal./day
379,000 gal./day

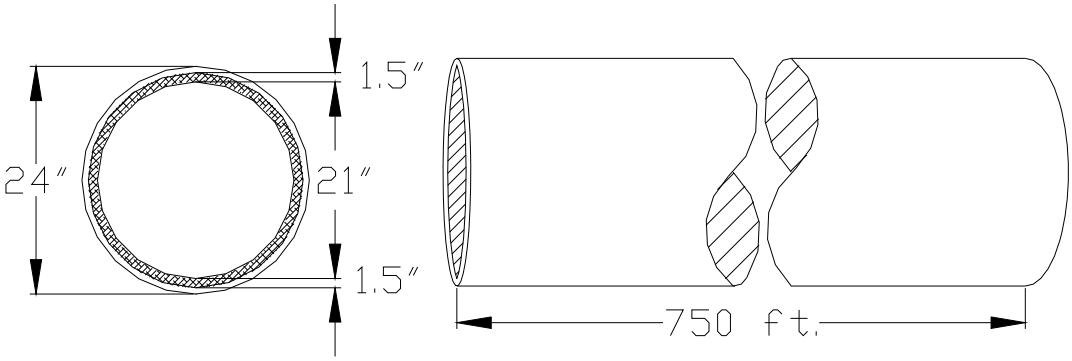
Sewer "B"

3) Divide I & I flow by total flow & multiply x 100.

379,000 gal./day ÷ 2,500,000 gal./day x 100 = 15.2% **d) 15.2%**

22) The interior of 750 ft of 24 in. pipe is uniformly coated with 1.5 inches of grease. How many gallons will this pipe hold when filled with water?

Formula(s) needed: $1ft^3 = 7.48$ gal., Area = $D^2 \times .785$



1) A 24” diameter pipe – 1.5” of grease all the way around leaves an inside diameter of 21inches *or* 1.75 ft. *(21”÷12in./ft. = 1.75”)*

2) Using the formula; *Area = $D^2 \times .785$*, calculate the area of the pipe. Then multiply time the pipe length to find the volume in ft^3.

Area = D^2 x .785
Area = 1.75 ft. x 1.75 ft. x .785
Area = 2.4 ft^2
2.4 ft^2 x 750 ft. = 1,803 ft^3

3) Convert cubic feet to gallons. *($1ft^3 = 7.48$ gal.)*
1,803 ft^3 x 7.48 gal./ft^3 = 13,487 gallons

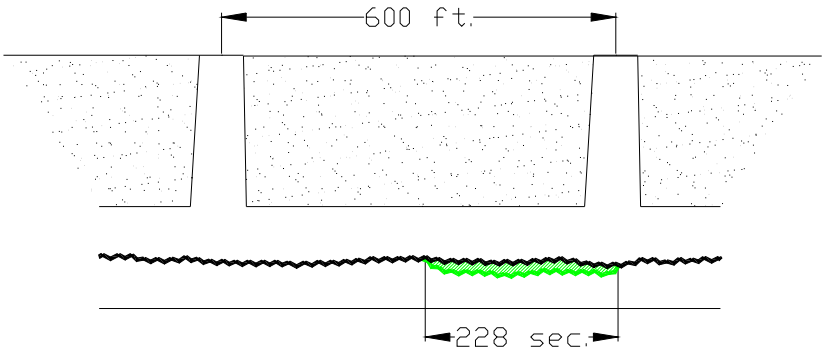
a) 13,487 gal.

23) **Simplify & re-write the question:**

Colored dye is dumped into a manhole. The dye first appears ~~3 minutes and 18 seconds~~ *(198 seconds)* later in a manhole 600 feet downstream and disappears ~~4 minutes and 19 seconds~~ *(259 seconds)* after the dye was first dumped into the manhole. What is the velocity (FPS) of flow in the sewer?

Formula(s) needed: $velocity = \frac{Distance}{time}$

1) To find the midpoint of when the dye was first seen and when it disappears, average the two times. $\frac{198 \text{ sec.} + 259 \text{ sec.}}{2} = 228.5 \text{ sec.}$



2) Using the formula, $velocity = \frac{Distance}{time}$ calculate the velocity.

$$\text{Velocity} = \frac{600 \text{ feet}}{228.5 \text{ sec}} = 2.63 \text{ ft./sec.}$$

b) 2.63 FPS

ANSWERS TO CHALLENGE QUESTIONS

DIVISION PUMP STATION SUMP PUMP TEST

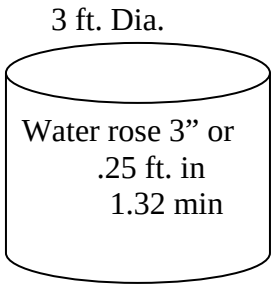
The sump well at Division is 3' in diameter and 3' deep. With both pumps off, the water level rose 3 inches (3"= .25ft.) in 1 minute 19 seconds. (= 1.32 min.) With the #1 pump on, the water rose 2.0 inches (2"= .167ft.) in 1 min. 3 sec. (= 1..05 min.) With the #2 pump on, (#1 off) the water level fell 6" (6"= .5ft.) in 1 minute 53 seconds. (= 1.88 min.) What is the GPM output of each pump if the TDH is 35'?

The pump model# is SPD50H. Look at the pump curve. Are the pumps performing above or below design? By how much?

Formula(s) needed: Flow = Area x Velocity or $ft^3/sec. = ft.^2 \times ft./sec.$, $Area = D^2 \times .785$,

$MGD = ft^3/sec. \div 1.55$, $Flow = \frac{Volume}{Time}$

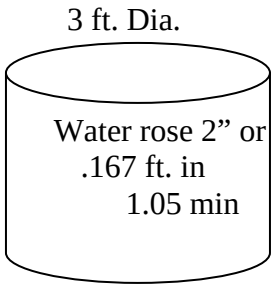
INFLOW =



$3^2 \times .785 \times .25$ ft. x 7.48 gal./ft = 13.215 gal.

$\frac{13.215 \text{ gal.}}{1.32 \text{ min.}} = 10$ gal./min.

PUMP #1 =

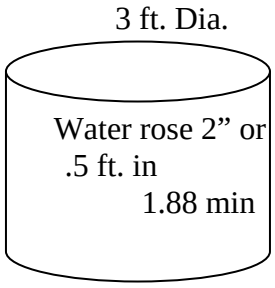


$3^2 \times .785 \times .167$ ft. x 7.48 gal./ft = 8.83 gal.

$\frac{8.83 \text{ gal.}}{1.05 \text{ min.}} = 8.4$ gal./min.

With pump #1 on, the water still rose 8.4 gal./min. This means Pump #1 is only pumping 1.6 gal./min. (10 gal./min. - 8.4 gal./min. = 1.6 gal./min.)

PUMP #2 =



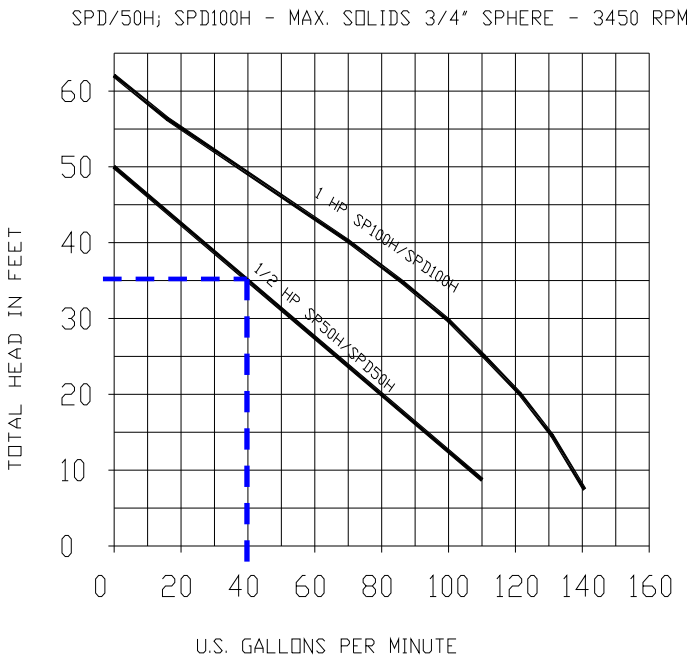
$3^2 \times .785 \times .5$ ft. x 7.48 gal./ft = 26.42 gal.

$\frac{26.42 \text{ gal.}}{1.88 \text{ min.}} = 14.05$ gal./min.

With pump #1 on, the water fell 14.05 gal./min. This means Pump #1 is pumping 24.05 gal./min. (10 gal./min. + 14.05 gal./min.= 24.05 gal./min.)

SINCE THE WATER LEVEL FELL, IT IS PUMPING 14.05 gal./min. PLUS THE 10 gal./min. INFLOW

On the pump curve follow the line from 35 feet of head across to the point on the pump curve that corresponds to the model number SPD50H. You will see that it should be pumping 40 GPM at 35 ft. of TDH. **Pump #2 is pumping at just over 50% capacity and pump #1 is basically broken.**



2) <u>SIMPLIFY THE QUESTION</u>

Two pipes are running full at 1.6 ft./sec into a wet well that is 9 ft. wide by 25 ft. long

by 22 feet deep. One pipe is ~~16"~~ *(16" = 1.33 FT.)* in diameter. With no pumps running, the water in the wet well is rising 12 inches every 31 seconds.

Formula(s) needed: Flow = Area x Velocity or $ft^3/sec. = ft.^2 \times ft./sec.$, $Area=D^2 \times .785$,
$MGD = ft^3/sec. \div 1.55$, $Flow = \frac{Volume}{Time}$

A) What size is the other pipe? (in inches)

1) Calculate the flow rate into the wet well

$$Flow = \frac{Volume}{Time} = \frac{225\ ft^3}{31\ sec.} = \mathbf{7.25\ ft^3/sec.\ (Total\ Flow)}$$

2) Calculate the area of the 16 *(16" ÷ 12"/ft. = 1.33 ft.)* inch pipe, using area formula,

$Area=D^2 \times .785$
$Area=1.33 \times 1.33 \times .785$
$Area= 1.4\ ft^2$

3) Calculate the flow from the 16" pipe, using the formula, *Flow = Area x Velocity or $ft^3/sec. = ft.^2 \times ft./sec.$*

$ft^3/sec. = ft.^2 \times ft./sec.$
$ft^3/sec. = 1.4\ ft.^2 \times 1.6\ ft./sec.$
$ft^3/sec. = 2.22\ ft^3/sec.$

4) Subtract the 16" pipe flow from the total flow to get the unknown pipes flow.

$7.25\ ft^3/sec. - 2.22\ ft^3/sec. = 5.03\ ft^3/sec.$

5) Using the Q = A x V formula from step 3, solve for the area of the unknown pipe.

$ft^3/sec. = ft.^2 \times ft./sec.$
$5.03\ ft^3/sec. = ft.^2 \times 1.6\ ft./sec.$

$$\frac{5.03\ ft^3/sec.}{1.6\ ft./sec.} = 3.14\ ft.^2$$

6) Solve for the unknown pipes size by using the area formula: *$Area=D^2 \times .785$*

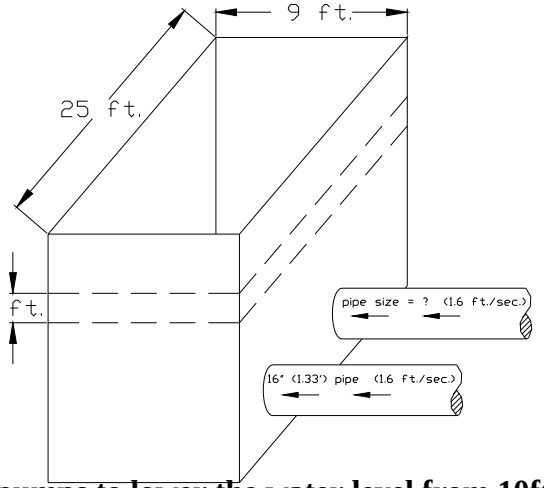
$Area = D^2 \times .785$
$3.14\ ft.^2 = D^2 \times .785$

$$\frac{3.14\ ft.^2}{.785} = D^2$$

$4\ ft. = D^2$

$\sqrt{4\ ft.} = D$

$2\ ft. = D =$ **24" pipe**



B) How long will it take three 1,500 GPM pumps to lower the water level from 10ft. to

3 ft.? *Formula needed; Flow = Volume / Time*

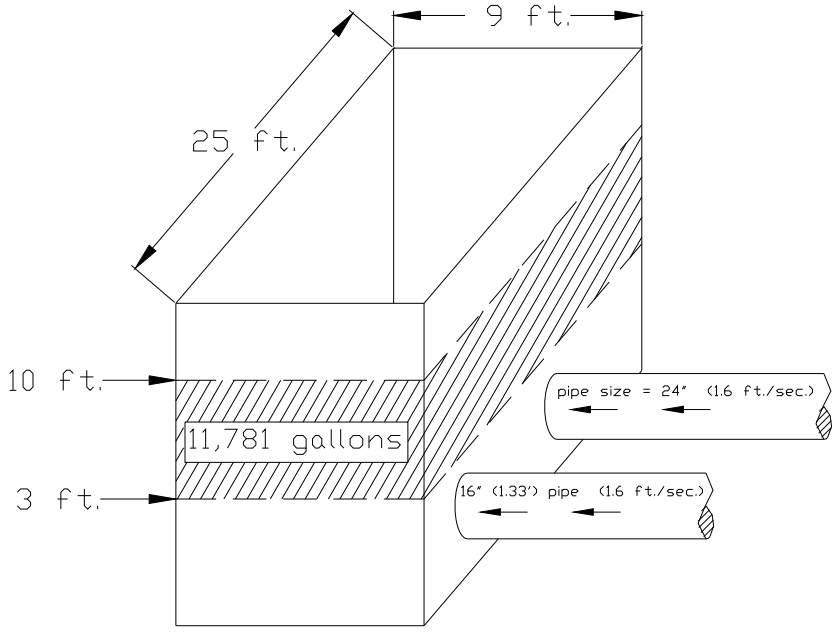
1) Determine the volume of the water to be pumped in gallons.
9 ft. wide x 25 long x 7 feet deep x 7.48 gal./ft^3 = 11,781 gallons
(10 ft – 3 ft = 7 ft.)

2) Convert total flow *(from part A, step 1)*, to gal./min., then calculate the 'effective pumping rate' by subtracting the total pumping capacity from the total flow.

Total Flow: 7.25 ft^3/sec. x 7.48 gal./ ft^3 x 60 sec./min. = 3,353 gal./min.
Three 1,500 GPM pumps = 4,500 GPM
4,500 GPM - 3,353 GPM = 1,147 GPM

3) Using the formula, *Flow = Volume / Time* calculate the detention time of the tank.

$$\text{Flow} = \frac{11{,}781 \text{ gal.}}{1{,}147 \text{ gal./min.}} = 10.27 \text{ min.}$$



WASTEWATER COLLECTION REVIEW

Pump Calculations Q&A

PUMP AND MOTOR FACTS

Pump Efficiency:

The percent of power used by the PUMP to move the water. The rest is wasted by water re-circulating inside the pump due to internal friction losses.

Motor Efficiency:

MOTOR efficiency, an efficiency of 80% means 80% of the power is available to drive the pump. The rest is lost to internal slippage and heat.

Power Factor:

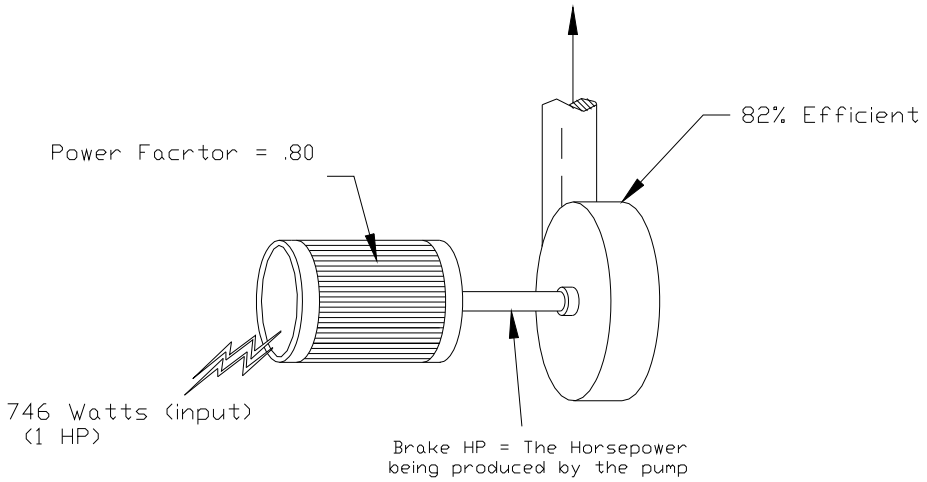
As the motor is rotated by the magnetic field in the windings. It generates an opposing magnetic field (counter EMF) that the motor must overcome. If the opposing field is 20% as strong as the input current, we can sat it has a power factor of .80 or 80% effective power.

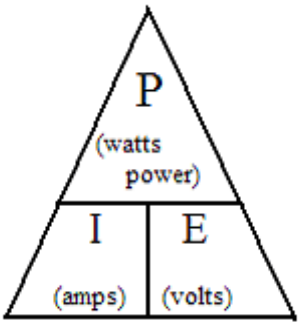
Wire to water efficiency = Power Factor x Pump Efficiency:

The MOTOR below has a power factor of .80 and an efficiency of 82%. That means that only 65.5% (.82 x 80%) is left to do work. It uses 1 HP (746 watts) to turn the motor, but due to friction losses and power factor (counter EMF) the output to the pump is only 65.5%

This leaves only .655 HP coming out of the motor to drive the pump. The remaining motor output HP is known as brake HP or BHP.

But inside of the pump housing, there are even more losses. Water re-circulates inside of the pump and because of friction losses, the pump is 88% efficient. This leaves only .572 HP (.656 HP x 88%) moving the water. These combined losses are called wire to water efficiency – the efficiency of the whole pump/motor assembly. In this example, only slightly more than ½ of the power (.572 HP) is used to actually pump water.





P (watts) = I(amps) x E(volts)
1 HP = 746 watts

WATER HP = (output hp)

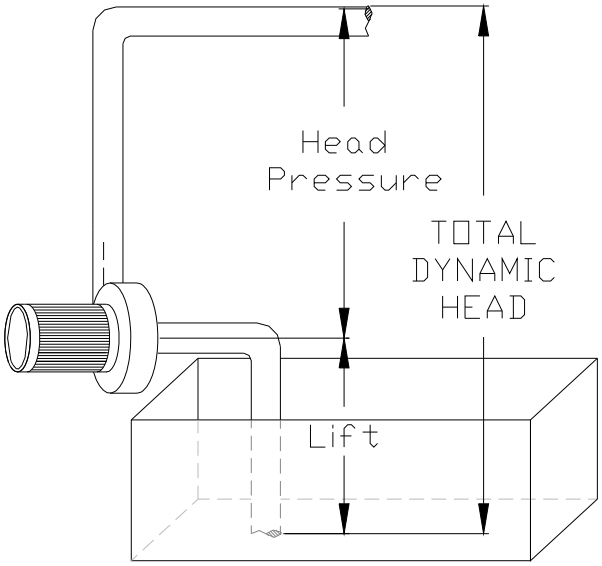
$$\text{WATER HP} = \frac{\text{FLOW (GPM) X TDH (ft.) x Specific Gravity(S.G.)}}{3960}$$

1 HP = 33,000 ft. lbs.

$$\frac{33{,}000 \text{ ft. lbs.}}{8.34 \text{ lbs/gal}} = 3960$$

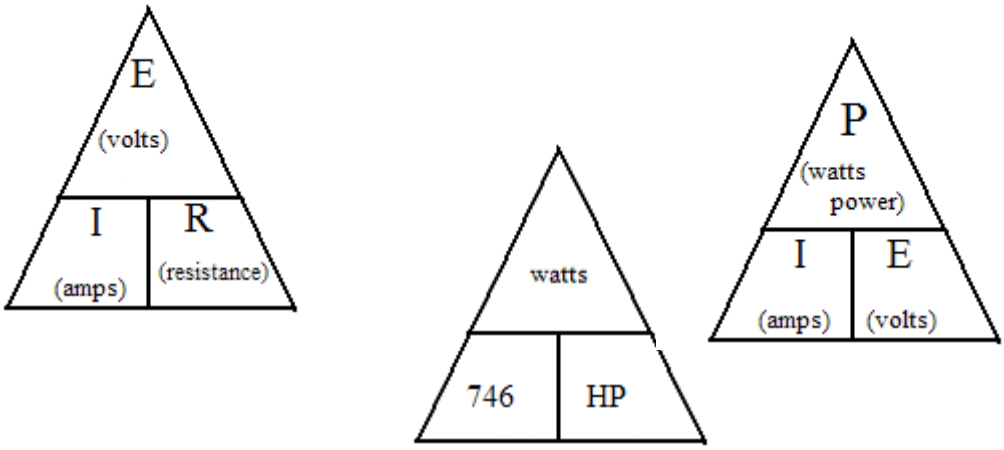
Watts = 746 x HP

TDH (total dynamic head) =
Suction head (lift) + head pressure



Pump formulas and facts

Water HP = $\frac{\text{FLOW (GPM) X TDH (ft.) x Specific Gravity (S.G.)}}{3960}$



Specific Gravity: the weight of a substance compared to the weight of the same volume of water.

If a problem gives you a specific gravity, multiply it and the top line of the water HP formula for example: spec. gravity = 1.03 Flow = 600 GPM
& TDH = 70 ft.

WATER HP = $\frac{\text{FLOW (GPM) X TDH (ft) X S.G.}}{3960}$

WATER HP = $\frac{\text{600 GPM X 70 ft. X 1.03}}{3960}$

WATER HP = 10.9 HP
****Reality check** – When specific gravity is given; a specific gravity greater than 1 should require *more* HP to move the fluid, since it is heavier than water.

24) If a pump discharges 8.2 MGD and the force main is 2,200 feet long, what is the total head loss assuming friction loss is .27 feet per 100 feet of pipe?

a) 594 feet
b) 2,206 feet
c) 72.4 feet

d) 2,227 feet

25) The power factor of a motor is .82 and the pump has an efficiency of 79%. If the motor consumes 12,000 watts, what is the water horsepower?

a) 2.9 HP
b) 2.17 HP
c) 19.6 HP
d) 10.4 HP

26) An electric motor is supplied by 480 volts and 32 amps, given no loss, what horsepower can the motor supply to the water?

a) 22.4 HP
b) 11.2 HP
c) 20.6 HP
d) 15.4 HP

27) A 480v AC pump motor draws 22 amps. What is the horsepower output of the motor if the power factor is .78 and the pump efficiency is 89%?

a) 12.41 HP
b) 9.83 HP
c) 11.04 HP
d) 7.33 HP

28) A 480v, 75 HP *(shaft HP)* **motor has a power factor of .80 and the pump is 89% efficient. How many amps will it draw?**

a) 93.3 AMPS
b) 146 AMPS
c) 8.00 AMPS
d) 38.6 AMPS

29) A 4,160 VAC motor draws 10 amps. What is the horse power output of the motor if the pump efficiency is 90% and the motor power factor is .88?

a) 49 HP
b) 366 HP
c) 329 HP

d) 65 HP

30) Calculate the water horsepower of a motor if the pump it operates provides 950 GPM against 121' total dynamic head (TDH)?

a) 65.5 HP
b) 154 HP
c) 7.8 HP
d) 29 HP

31) If the pump in problem 30 is 79% efficient, then what is the brake HP?

a) 36.7 HP
b) 10 HP
c) 82.9 HP
d) 195 HP

32) If a pump outputs 450 GPM against a total dynamic head of 600 feet, and the pump is 78% efficient, what is the brake HP?

a) 4.64 HP
b) 87.4 HP
c) 1.10 HP
d) 61.2 HP

33) The power factor of a motor is .74 and the pump has an efficiency of 73%. If the motor consumes 3,200 watts, what is the water horsepower?

a) 1.7 HP
b) 32.4 HP
c) 2.3 HP
d) 3.17 HP

34) What is the brake horsepower in problem 33?

a) 4.76 HP
b) 3.17 HP
c) 2.32 HP
d) 1.27 HP

35) What is the wire to water efficiency in problem 33?

a) 54%
b) 46%
c) 95%
d) 27%

36) A pump has an efficiency of 72% and a motor has a power factor of .77. If the water horsepower is 75 HP, and electricity has a cost of 11 cents per KWH, how much will it cost to run the pump for one month (30 days) at 8 hrs. per day?

a) $2,664.29
b) $2,051.50
c) $8,880.95
d) $1,918.29

CHALLENGE QUESTION:

3) In order to rebuild a pump station, you will need to install a temporary bypass pump. The pump you are using is 84% efficient and the motor has a power factor of .78. The wet well is 24 feet deep and the pump station must pump a maximum of 1,250 GPM to a gravity sewer that is 95 feet above the pumps. (Assume no additional friction loss through the pipes and elbows.)

If electricity costs $.09/kw, how much will it cost to run the pumps 10 hours a day during the 5 day repair?

ANSWERS TO PUMP QUESTIONS

(not needed)

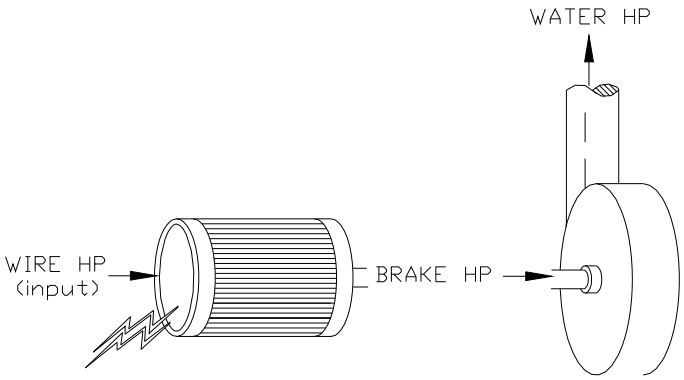
24) If a pump discharges ~~8.2 MGD~~ and the force main is 2,200 feet long, what is the total head loss assuming friction loss is .27 feet per 100 feet of pipe?

1) For every 100 ft. of pipe, add .27 ft. of pipe loss.
2,200 ft. of pipe x .27 ft./ft. = 6 ft.
2) Add that to the total pipe length.
2,206 ft. of pipe loss

b) 2,206 feet

25) The power factor of a motor is .82 and the pump has an efficiency of 79%. If the motor consumes 12,000 watts, what is the water horsepower?

Formulas needed: WATTS = 746 x HP



1)Convert watts to HP.

$\frac{12{,}000 \text{ watts}}{746 \text{ watts/HP}}$ = 16.08 HP Wire HP

2) Factor in losses.

(79%)

16.08 HP x .79 x .82 PF = 10.4 HP

d) 10.4 HP

26) An electric motor is supplied by 480 volts and 32 amps, given no loss, what horsepower can the motor supply to the water?

Formulas needed: Power (Watts) = Amps x Volts, WATTS = 746 x HP

1) Use the formula *Watts = Amps x Volts* to find watts.
Watts = Amps x Volts
Watts = 32 amps x 480v
Watts = 15,360w

2) Convert watts to HP.

$\frac{15{,}360\text{w}}{746 \text{ watts/HP}}$ = 20.6 HP Wire HP

c) 20.6 HP

27) A 480v AC pump motor draws 22 amps. What is the horsepower output of the motor if the power factor is .78 and the ~~pump efficiency is 89%~~ *(not needed)***?**

Formulas needed: Power (Watts) = Amps x Volts, WATTS = 746 x HP

1) 1) Use the formula *Watts = Amps x Volts* to find watts.

Watts = Amps x Volts
Watts = 22 amps x 480v
Watts = 10,560w

2) Convert watts to HP.

$$\frac{10{,}560\text{w}}{746 \text{ watts/HP}} = 14.15 \text{ HP Wire HP}$$

2) Factor in losses from counter EMF. *(power factor)*

14.15 HP x .78 PF = 11.04 HP **c) 11.04 HP**

*The question asks for horsepower output of the **motor,** pump efficiency is not needed.*

28) A 480v, 75 HP *(shaft HP)* **motor has a power factor of .80 and the pump is 89% efficient. How many amps will it draw?**

Formulas needed: Watts = Amps x Volts, WATTS = 746 x HP

1) Calculate input HP; $\frac{\text{BHP (Brake HP)}}{\text{Power Factor}} = \text{Input HP (wire HP)}$

$$\frac{75 \text{ HP}}{.80 \text{ (P.F.)}} = 93.75 \text{ HP}$$

2) 93.75 HP x 746 = 69,937 watts

2) Use the formula *Watts = Amps x Volts* to solve for Amps

Watts = Amps x Volts

69,937 watts = Amps x 480 volts

$$\frac{69{,}937 \text{ watts}}{480 \text{ volts}} = 145.7 \text{ Amps}$$

b) 146 AMPS

29) A 4,160 VAC motor draws 10 amps. What is the horse power output of the motor if ~~pump efficiency is 90%~~ *(not needed)* **and the motor power factor is .88?**

needed: Watts = Amps x Volts, WATTS = 746 x HP

1) Use the formula *Watts = Amps x Volts* to solve for watts.

Watts = Amps x Volts
Watts = 10 Amps x 4,160 Volts
Watts = 41,600 watts

2) Convert to HP *(WATTS = 746 x HP)*

$$\frac{41{,}600\text{watts}}{746 \text{ watts/HP}} = 55.8 \text{ HP}$$

3) Factor in losses.

55.8 HP x .88 PF = 49.07 HP *(Motor HP or Brake HP)* **a) 49 HP**

*The question asks for horsepower output of the **motor,** pump efficiency is not needed.*

30) Calculate the water horsepower of a motor if the pump it operates provides

950 GPM against 121' total dynamic head (TDH)?

Formulas needed: Water HP = Flow (GPM) x TDH (Ft.) / 3960

$$HP = \frac{\text{Flow (GPM)} \times \text{TDH (Ft.)}}{3960}$$

$$HP = \frac{950 \text{ (GPM)} \times 121 \text{ (Ft.)}}{3960} = 29.02 \text{ HP } \textit{(water HP)}$$

d) 29 HP

31) If the pump in problem 30 is 79% *(.79)* efficient, then what is the brake HP?

Instead of trying to remember whether to multiply or divide, just remember that you can never get more power out than you put in. According to the answer in problem 30 we got 29 HP out of our pump, the HP that we put in should be more than 29. If it is not, then you should have multiplied instead of dividing. ***(Input HP x Efficiency% x PF = Water HP)***

1) Input HP x Efficiency% ~~x PF~~ = Water HP

Input HP x .79 = 29 HP

$$\text{Input HP} = \frac{29 \text{ HP}}{.79}$$

Input HP = 36.7 HP a) **36.7** HP

32) If a pump outputs 450 GPM against a total dynamic head of 600 feet, and the pump is 78% efficient, what is the brake HP?

Formulas needed: Water HP = Flow (GPM) x TDH (Ft.) / 3960

1) Calculate the water HP.

$$HP = \frac{\text{Flow (GPM)} \times \text{TDH (Ft.)}}{3960}$$

$$HP = \frac{450 \text{ (GPM)} \times 600 \text{ (Ft.)}}{3960} = 68.2 \text{ HP } \textit{(water HP)}$$

2) Factor in losses.

$$\frac{29.02 \text{ HP}}{.78} = 87.4 \text{ HP}$$

b) 87.4 HP

33) The power factor of a motor is .74 and the pump has an efficiency of 73% *(.73)*. If the motor consumes 3,200 watts, what is the water horsepower?

needed: Watts = Amps x Volts, WATTS = 746 x HP

1) Use the formula *WATTS = 746 x HP* to solve for HP.

1 HP = 746 watts

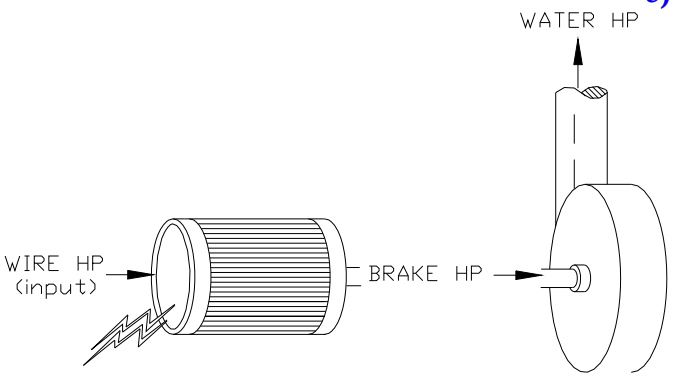
HP = $\frac{\text{3,200 watts}}{\text{746 watts/HP}}$

HP = 4.3 HP *(input HP)*

2) Factor in the losses.

4.3 HP x .74 PF x .73 efficiency = 2.31 HP *(Input HP)*

c) **2.3 HP**



34) What is the brake horsepower in problem 33?

1) Brake HP is between the pump and the motor, before the losses of the pump.
or Input HP x PF.

4.3 HP *(input HP)* x .73 PF = 3.14 HP

b) 3.17 HP

35) What is the wire to water efficiency in problem 33?

Wire to water efficiency = $\frac{\text{Output HP}}{\text{Input HP}} = \frac{\textbf{2.3 HP } \textit{(Output HP)}}{\text{4.3 HP } \textit{(Input HP)}}$

Problem 35) Alternate Method: W**ire to water efficiency is the combination of all of the efficiencies *or* pump efficiency x power factor.**

.73 x .74 = .5402 = 54.02%

a) 54%

36) A pump has an efficiency of 72% *(.72)* and a motor has a power factor of .77. If the water horsepower is 75 HP, and electricity has a cost of 11 cents per KWH, how much will it cost to run the pump for one month (30 days) at 8 hrs. per day?

1) Factor in for losses. *(Input HP should be more than output HP)*

$$\frac{75 \text{ HP}}{.72 \text{ efficiency x } .77 \text{ PF}} = 135.3 \text{ HP}$$

2) Use the formula *WATTS = 746 x HP* to solve for watts.

WATTS = 746 x 135.3 HP
WATTS = 100,798.5 watts

3) Convert to Kilowatts *(1 KW = 1,000 watts)*

$$\frac{100{,}798.5 \text{ watts}}{1{,}000 \text{ watts/KW}} = 100.8 \text{ KW}$$

4) To find cost, multiply KW x hrs x $/hr. x days.

KW x hrs x $/hr. x days

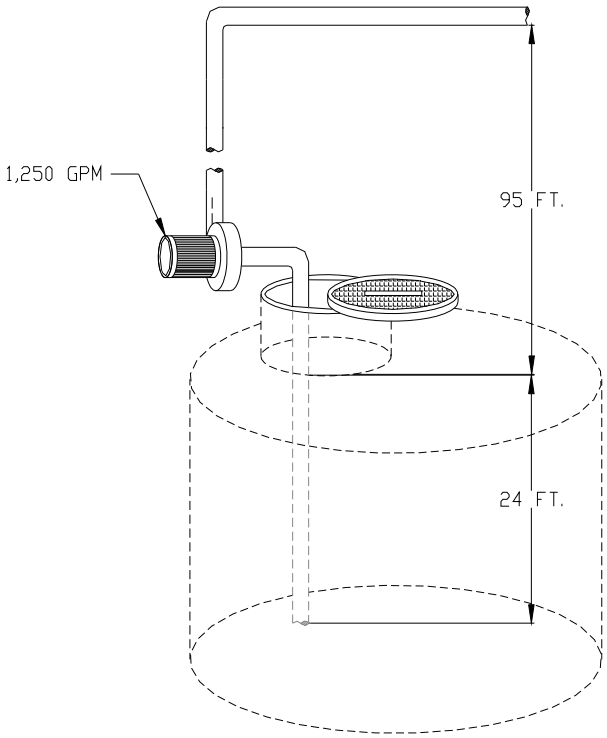
100.8 KW x 8 hrs./day x $.11 x 30 days = $ 2,664.29

a) $ 2,664.29

CHALLENGE QUESTION ANSWER:

3) In order to rebuild a pump station, you will need to install a temporary bypass pump. The pump you are using is 84% efficient and the motor has a power factor of .78. The wet well is 24 feet deep and the pump station must pump a maximum of 1,250 GPM to a gravity sewer that is 95 feet above the pumps. (Assume no additional friction loss through the pipes and elbows.)

If electricity costs $.09/kw, how much will it cost to run the pumps 10 hours a day during the 5 day repair?



Formula: $HP = \frac{GPM \times TDH}{3960}$

1) Find (TDH) Total Dynamic Head
24 ft. + 95 ft. = 119 ft.

2)Find the HP of the pump.

$HP = \frac{GPM \times TDH}{3960}$

$HP = \frac{1{,}250\ GPM \times 119\ ft.}{3960}$

HP = 37.6 HP

3) Factor in losses.

$\frac{37.6\ HP}{.84\ \text{pump efficiency} \times .78\ PF} = 57.4\ HP$

4) Convert HP to KW.

57.4 HP x .746 KW/HP = 42.8 KW

5) To find cost, multiply KW x hrs x $/hr. x days.

KW x hrs x $/hr. x days

42.8 KW x 10 hrs./day x $.09 x 5 days = **$ 192.65**

WASTEWATER COLLECTION REVIEW

Chemical Calculations Q&A

Chemical Questions – Facts and Review

There is sometimes confusion when solving chemical problems because of mixing standard U.S. measurements and metric units.
The base formula for collection system chemical problems is…..

X X =

$$\frac{\text{milligrams}}{\text{liter}} \quad \frac{\text{million gallons}}{\text{day}} \quad \frac{8.34 \text{ lbs}}{\text{gallon}} \quad - \quad \frac{8.34 \text{ lbs}}{\text{day}}$$

The milligrams per liter (mg/l) can be expressed as parts per million and the million gallons per day (MGD) can be expressed as parts per million, that's why the two units can be used together. To explain why it works the formula is broken down below to demonstrate how the units cancel……

$$\frac{\text{milligrams}}{\text{liter}} \times \frac{\text{million } \cancel{\text{gallons}}}{\text{day}} \times \frac{8.34 \text{ lbs}}{\cancel{\text{gallon}}} = \frac{8.34 \text{ lbs}}{\text{day}}$$

or

mg/l x MGD x 8.34 = lbs/day

a ratio of parts per million ***(milligrams per liter)***

converts units – parts/million to gallons

Converts units from gallons to lbs. by multiplying gal. x 8.34 lbs/gal.

If you see a percent in a chemical problem, ignore it until the end of the problem. Then multiply or divide it accordingly. ***(Always convert % to a decimal before using it. Ex: 15% = .15)***

A percent solution is ALWAYS going to mean will you need more solution. Since we can't have a solution that is more than 100% pure. Don't bother trying to remember when to multiply or divide, just remember that you would need more than if it was a 100% solution.

SPECIFIC GRAVITY (S.G.) : A specific Gravity can be looked at as a ratio compared to the weight of water. Some oils have a specific gravity of .9, meaning they are .9 times the weight of water. .9 x 8.34 lbs/gal, = 7.506 lbs./gal. (oil floats) If you see a specific gravity in a chemical problem, multiply it x 8.34, then replace 8.34 in the formula with your answer.
Ex: a Chemical has a S.G. of 1.03, 8.34 x 1.03 = 8.59, the formula would be….

Mg/l x MGD x 8.59 = lbs./day

37) An automatic chemical feeder treats 22 MGD per day at a concentration of 29 mg/l. how many lbs./day of chemical is required?

a) 711 LBS/DAY
b) 4,772 LBS/DAY
c) 5,321 LBS/DAY
d) 76.5 LBS/DAY

38) 21 mg/I of chlorine is required to treat a flow of 3.2 MGD. The solution available to you, however, is only 35% of chlorine. How many lbs./day of solution are requires to treat the flow?

a) 560.45 LB/day
b) 1,601.28 LB/day
c) 16.1 LB/day
d) 1,961.60 LB/day

39) **A chlorinator feeds 155 lbs./day to a tank treating 84 MGD. What is the concentration in mg/l?**

a) 15.39 mg/l
b) .42 mg/l
c) 1
d) .22 mg/l

40) An operator wishes to maintain a chlorine residual of 5 mg/l. The compound he is using is only 40% chlorine. If he uses 112 lbs./day, then how much flow is he treating daily, in MGD?

a) 8.04 MGD
b) 107.45 MGD
c) 1.07 MGD
d) 7.49 MGD

41) 20 mg/l of root control must be added to a 48" sewer that is 1,500 feet long. If the root control chemical is in a solution that consists of only 25% of the chemical, how many lbs. of the solution must be added to the sewer?

a) 94.02 lbs.
b) 31.34 lbs.
c) 104.83 lbs.
d) 119.78 lbs.

42) 22 mg/l of chemical was previously used to treat a flow of 3,500,000 gal./day. The chemical cost is $2.50 per pound. A chlorine residual test determined that 10 mg/l of chemical would be satisfactory. How much money would be saved per month by using the 10 mg/l dose instead of the 22 mg/l dose? (1 mo. = 30 days)

a) $23,562/mo.
b) $26,271/mo.

c) $48,163/mo.
d) $21,892/mo.

43) If a hypochlorite solution is 28% hypochlorite and 11 mg/l of hypochlorite is required at a flow rate of 12 MGD, what is the required GPH of hypochlorite solution if it's specific gravity is 1.0?

a) 29.46 GPH
b) 19.6 GPH
c) 7.86 GPH
d) 7.64 GPH

CHALLENGE QUESTION:

4) **Every 45 minutes a tank 250 ft. long by 27 ft. wide by 21 feet deep, is filled, treated with a 28 mg/l hypochlorite solution, then drained. How many pounds of solution per day would be used if the solution was diluted with 20% water?**

ANSWERS TO CHEMICAL QUESTIONS:

37) An automatic chemical feeder treats 22 MGD per day at a concentration of 29 mg/l. how many lbs./day of chemical is required?
Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) Solve for lbs./day using the formula; *mg/l x MGD x 8.34 = lbs./day*
mg/l x MGD x 8.34 = lbs./day
29 mg/l x 22 MGD x 8.34 = 5,321 lbs./day

c) 5,321 LBS/DAY

38) 21 mg/I of chlorine is required to treat a flow of 3.2 MGD. The solution available to you, however, is only ~~35%~~ *(.35)* of chlorine. How many lbs./day of solution are requires to treat the flow?
Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) Solve for lbs./day needed using the formula; *mg/l x MGD x 8.34 = lbs./day*
mg/l x MGD x 8.34 = lbs./day
21 mg/l x 3.2 MGD x 8.34 = 560.45 lbs./day

2) The solution is not 100 % pure. You will need more.

$$\frac{560.45 \text{ lbs./day}}{.35} = 1{,}601.28 \text{ lbs./day}$$

b) 1,601.28 LB/day

39) **A chlorinator feeds 155 lbs./day to a tank treating 84 MGD. What is the concentration in mg/l?**
Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) Solve for mg/l needed using the formula; *mg/l x MGD x 8.34 = lbs./day*
mg/l x MGD x 8.34 = lbs./day
mg/l x 84 MGD x 8.34 = 155 lbs./day

$$\text{mg/l} = \frac{155 \text{ lbs./day}}{84 \text{ MGD} \times 8.34}$$

mg/l = .22

d) .22 mg/l

40) An operator wishes to maintain a chlorine residual of 5 mg/l. The compound he is using is only ~~40%~~ *(.40)* chlorine. If he uses 112 lbs./day, then how much flow is he treating daily, in MGD?

Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) Solve for lbs./day needed using the formula; *mg/l x MGD x 8.34 = lbs./day*

mg/l x MGD x 8.34 = lbs./day
5 mg/l x MGD x 8.34 = 112 lbs./day

$$MGD = \frac{112 \text{ lbs./day}}{5 \text{ mg/l} \times 8.34}$$

MGD = 2.68 MGD

2) The solution is not 100 % pure. Factor in the percentage of solution.

2.68 MGD x .40 = 1.07 MGD

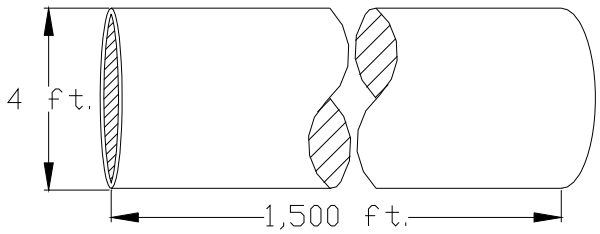
c) 1.07 MGD

At 100% solution, the operator would have treated 2.68 MGD. With only 40% solution, he can only treat 1.07 MGD.

41) 20 mg/l of root control must be added to a ~~48"~~ (4 ft.) sewer that is 1,500 feet long. If the root control chemical is in a solution that consists of only ~~25%~~ (.25) of the chemical, how many lbs. of the solution must be added to the sewer?

Formula(s) needed: mg/l x MGD x 8.34 = lbs./day, Area = D^2 x .785, 1ft^3 = 7.48 gal.

1) Calculate the area of the pipe.



Area = D^2 x .785
= 4^2 x .785
= 12.56 ft^2

2) Multiply area x length to find the volume in ft^3.

12.56 ft^2 x 1,500 ft. = 18,840 ft^3

3) Convert from ft^3 to gallons.

18,840 ft^3 x 7.48 gal./ ft^3 = 140,923 gallons

4) The formula, mg/l x MGD x 8.34 = lbs./day, calls for MGD.

$$\frac{140{,}923 \text{ gallons}}{1{,}000{,}000} = .141 \text{ MGD}$$

5) Solve for lbs./day needed using the formula; *mg/l x MGD x 8.34 = lbs./day*

mg/l x MGD x 8.34 = lbs./day
20 mg/l x .141 MGD x 8.34 = 23.52 lbs./day

6) The solution is not 100 % pure. You will need more.

$$\frac{23.52 \text{ lbs./day}}{.25} = 94.08 \text{ lbs./day}$$

a) 94.02 lbs.

42) 22 mg/l of chemical was previously used to treat a flow of ~~3,500,000 gal./day~~ (3.5 MGD). The chemical cost is $2.50 per pound. A chlorine residual test determined that 10 mg/l of chemical would be satisfactory. How much money would be saved per month by using the 10 mg/l dose instead of the 22 mg/l dose? (1 mo. = 30 days)
Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) To find how much money was saved. Find the cost of the amount no longer used.

22 mg/l - 10 mg/l = 12 mg/l not used

2) Solve for lbs./day needed using the formula; *mg/l x MGD x 8.34 = lbs./day*

mg/l x MGD x 8.34 = lbs./day
12 mg/l x 3.5 MGD x 8.34 = 350.28 lbs./day

3) Calculate the total cost of the unused chemical.

350.28 lbs./day x $2.50/lb. x 30 days = $26,271

b) $26,271/mo.

43) If a hypochlorite solution is 28% *(.28)* hypochlorite and 11 mg/l of hypochlorite is required at a flow rate of 12 MGD, what is the required GPH of hypochlorite solution if it's specific gravity is 1.0?

Formula(s) needed: mg/l x MGD x 8.34 = lbs./day

1) In the formula, mg/l x MGD x 8.34 = lbs./day, the 8.34 converts gallons to pounds. In this situation we don't want to convert to pounds. We can just drop the 8.34.

mg/l x MGD ~~x 8.34~~ = gal./day
11 mg/l x 12 MGD = 132 gal./day

2) Convert gal./day to gal./hr.

$$\frac{132 \text{ gal./day}}{24 \text{ hrs./day}} = 5.5 \text{ gal./hr.}$$

3) The solution is not 100 % pure. You will need more.

$$\frac{5.5 \text{ gal./hr.}}{.28} = 19.65 \text{ gal./hr.}$$

b) 19.6 GPH

NOTE: While specific gravity will affect the HP of a pump, changing the specific gravity will not affect the volume of a chemical needed.

CHALLENGE QUESTION ANSWER:

4) **) Every ~~45 minutes~~** *(.75 hrs.)* **a tank 250 ft. long by 27 ft. wide by 21 feet deep, is filled, treated with a 28 mg/l hypochlorite solution, then drained. How many pounds of solution per day would be used if the solution was diluted with ~~20%~~** ***(.20)*** **water?**

Formulas needed: lbs./day = mg/l x MGD x 8.34, 1ft3 = 7.48 gal., flow = $\frac{volume}{Time}$

1) Calculate the volume of the tank in gallons.

250 ft. x 27 ft. x 21 ft. = 141,750 $ft.^3$

141,750 ft. x 7.48 gal./ft^3 = 1,060,290 gal.

2) Calculate the number times the tank is filled per day, then multiply x gallons to find gal./day.

$\frac{24 \text{ hrs./day}}{.75 \text{ hrs/fill}}$ = 32 fills

32 fills x 1,060,290 gal. = 33,929,280 gallons

3) Divide by 1,000,000 to get MGD.

$\frac{33{,}929{,}280 \text{ gal.}}{1{,}000{,}000}$ = 34 MGD

4) Use the formula, *lbs./day = mg/l x MGD x 8.34*, to solve for lbs./day of 100% pure solution.

lbs./day = mg/l x MGD x 8.34
lbs./day = 28 mg/l x 34 MGD x 8.34
lbs./day = 7,939.68 lbs

5) The solution is not 100 % pure. The question states that the solution is diluted with 20% water, that means it is 80% *(.80)* hypochlorite. You will need more.

$\frac{7{,}939.68 \text{ lbs}}{.80}$ = **9,924.6 lbs./day**

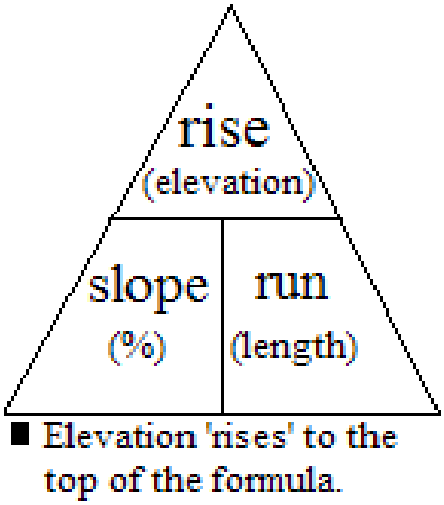
Be careful not to make the mistake of using a 20% hypochlorite when it is really 20% water & 80% hypochlorite.

WASTEWATER COLLECTION REVIEW

General Math & Budget Calculations Q&A

GENERAL MATH FORMULAS & FACTS:

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$



1 Mile = 5,280 ft.
1 ton = 2,000 lbs.
1 yd^3 = 27 ft^3
1 Day = 1,440 minutes
or 86,400 seconds

$$^{o}C = \frac{(^{o}F-32)}{1.8}$$

$$^{o}F = (^{o}C \times 1.8)+32$$

44) Convert 38 degrees Fahrenheit to Celsius

a) 100.4 ^{o}C
b) 20.2 ^{o}C
c) 3.0 ^{o}C
d) 38.9 ^{o}C

45) **Convert 190 degrees Celsius to Fahrenheit**

a) 310 ^{o}F
b) 374 ^{o}F
c) 88 ^{o}F
d) 81 ^{o}F

46) On Monday a flow totalizer read 11,356,587 Gallons. On Thursday the totalizer read 21,589,544 Gallons. What was the daily average flow?

a) 34 MGD
b) 2.56 MGD
c) 81 MGD
d) 3.41 MGD

47) If the grade of a sanitary sewer has a slope of 2% for 1,500 feet, what is the rise of the pipe?

a) 7.5 FEET
b) 30 FEET
c) .1 FEET
d) 750 FEET

48) A crew surveys a sewer from STA 8+75.25 to STA 19+98.00. If the elevation of the first manhole (closest to treatment plant) is 787 feet, what is the elevation of the second manhole if the grade is .0011 ft./ft.?

a) 7.00 feet
b) 788.24 feet
c) 790.16 feet
d) 1.24 feet

49) **A map with a scale of 1"=150' indicates that a manhole "A" is 9.25" from manhole "B". What is the actual distance between manholes? (Answer in feet)**

a) 1,152 feet
b) 1, 734feet
c) 1,388 feet
d) 1,396 feet

50) **) If a repair job can be done by 3 people in 19 hours, how long would it take 7 people to do a similar job?**

a) 6 hours, 20 min.
b) 44 hours, 20 min.
c) 13 hours, 18 min.
d) 8 hours, 9 min.

51) **A trench of 8' wide x 11' deep x 1725' long. A 27" sanitary sewer is going to be installed in this trench. 18 inches must be left out at the top for concrete. How much backfill will be required to fill the trench?**

a) 4,602 YDS^3
b) 13,805 YDS^3
c) 5,109 YDS^3
d) 4,095 YDS^3

52) **How many tons of backfill would there be in problem 51 if each the backfill material was 3,500 lbs./yd^3?**

a) 8,053 tons
b) 16,106 tons
c) 24,159 tons
d) 1,521 tons

53) **If a dump truck could carry 15 tons each, how many truck loads would be needed in problem 51?**

a) 536 TRUCKS
b) 1,074 TRUCKS
c) 537 TRUCKS
d) 101 TRUCKS

54) **A 5 foot wide 1,882 foot trench must be excavated and the spoil removed from The premises. The spoil weight is 2,900 LB/yd^3 and each truck can carry 12 tons. How many truck loads are required if the trench is 16 feet deep?**

a) 726 TRUCKS
b) 674 TRUCKS
c) 2,021 TRUCKS
d) 673 TRUCKS

55) **Given the following information, would it be less expensive to finish a job in two days, or finish the job in one day by paying the employees overtime?**

Actual job time is 11 hours
Travel time and set up time is 1.5 hrs./day
Average work day is 8 hours
Overtime is 1.5 times the normal hourly rate
All employees are paid the same hourly wage

a) Cheaper to have work done in two days
b) Cost is the same either way
c) Cheaper to have work done in one day
d) None of the above

56) **Estimate the total cost and cost per linear foot of a sewer construction project. The project consists of installing five manholes and 3,500 feet of 21" sewer. Costs are estimated as shown below:**

EXCAVATION AND BACKFILL-----$218.00 per foot
COST OF PIPE----------$26.00 per foot
MANHOLE + INSTALLATION---------$3,500.00 each

Cost per linear feet

a) $239.00
b) $249.00
c) $244.01
d) $197.00

Total Job Cost

a) $854,050
b) $836,500
c) $871,500
d) $689,500

57)) The average cost to have contractors clean the city sewers is $5.95 per foot for 1.6 miles of 12” pipe, $6.80 per foot for 1.8 miles of 15” pipe and $7.85 per foot of 1.7 miles of 18” pipe. The city is considering purchasing a $328,000 jet-vac and hiring a 3 man crew to operate it. Operator “A” makes $19.57/hour, operator “B” makes $18.59/hour and operator “C” makes $17.89/hour. The fringe benefits are 37% of wages. The cost/year of the jet vac will be $31,275 for 10 years. The time for the crew to clean 100 ft. of sewer is as follows:

12” sewer takes 1.50 hours
15” sewer takes 3.25 hours
18” sewer takes 4.00 hours

There will be .5 hours of non-productive time (travel, cleanup, ect.) for every hour spent cleaning the sewer.

Which is the least expensive option (contractor or in-house) and by how much over the 10 year period?

a) Cheaper to buy a jet-vac, cost savings over 10 years will be $625,505
b) Cheaper to buy a jet-vac, cost savings over 10 years will be $585,354
c) Cheaper to contract out, cost savings over 10 years will be $515,766
d) Cheaper to contract out, cost savings over 10 years will be $62,500

ANSWERS TO GENERAL MATH & BUDGET QUESTIONS:

44) Convert 38 degrees Fahrenheit to Celsius

Formula(s) needed, $^{o}C = \frac{(^{o}F-32)}{1.8}$

$$^{o}C = \frac{(^{o}F-32)}{1.8}$$

$$^{o}C = \frac{(38^{o}F-32)}{1.8}$$

$$^{o}C = 3.33$$

c) 3 ^{o}C

45) Convert 190 degrees Celsius to Fahrenheit

Formula(s) needed, $^{o}F = (C \times 1.8)+32$

$$^{o}F = (^{o}C \times 1.8)+32$$

$$^{o}F = (190^{o}C \times 1.8)+32$$

$$^{o}F = 374$$

b) 374 ^{o}F

46) On Monday a flow totalizer read 11,356,587 Gallons. On Thursday the totalizer read 21,589,544 Gallons. What was the daily average flow?

1) Subtract the first reading from the last reading.
   21,589,544 gal - 11,356,587 gal. = 10,232,957 gal.
2) Divide by the number of days.
   $\frac{10,232,957 \text{ gal.}}{3 \text{ days}} = 3,410,985$ gal./day
   (do not count the day that the start reading was taken)
3) Divide gal./day by 1,000,000 to MGD
   $\frac{3,410,985 \text{ gal.}}{1.000,000} = 3.41$ MGD

d) 3.41 MGD

47) **If the grade of a sanitary sewer has a slope of ~~2%~~** *(.02)* **for 1,500 feet, what is the rise of the pipe?**

Formula(s) needed, Slope = $\frac{Rise}{Run}$

1) Use the formula, Slope = $\frac{Rise}{Run}$ to solve for the rise.

$$.02 = \frac{Rise}{1,500 \text{ ft.}}$$

$$1,500 \times .02 = 30 \text{ ft.}$$

b) 30 ft.

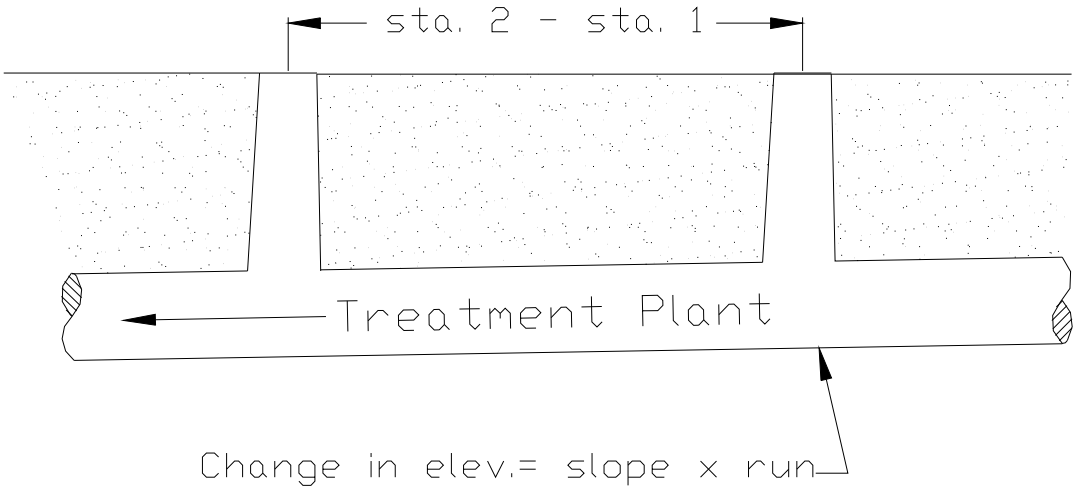
48) **A crew surveys a sewer from STA. ~~8+75.25~~ *(875.25 ft.)*to STA ~~19+98.00~~ *(1,998 ft.)*. If the elevation of the first manhole (closest to treatment plant) is 787 feet, what is the elevation of the second manhole, if the grade is .0011 ft./ft.?**

Formula(s) needed, Slope = Rise / Run

**The station numbers indicate the distance from the STARTING POINT of the sewer survey, which is usually station 0+00 feet. A new station is set up every 100 ft. (0+00, 1+00, 2+00, etc.*

Station 19+98.00 = 1,998.00 ft.
Station 8+75.25 = 875.25 ft.

The elevation of the first manhole (**closest to treatment plant**) is 787 feet. This means that the second manhole is at a higher elevation because it is farther from the plant. The answer to this problem must be more than 787 ft.



1) Subtract the stations to find the distance between them. (the RUN)

1,998.00 ft. - 875.25 ft. = 1,122.75 ft. *(RUN)*

2) Use the formula, Slope = Rise / Run to solve for the rise.

$$.0011 \text{ ft./ft.} = \frac{\text{Rise}}{1{,}122.75 \text{ ft.}}$$

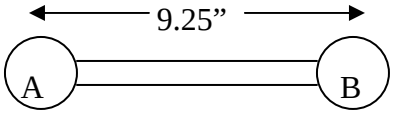
1,122.75 ft. x .0011 ft./ft. = 1.24 ft.

3) Add the rise to the elevation of the 1st manhole to get the elevation of the 2nd manhole.

787 ft. + 1.24 ft. = 788.24 ft.

b) 788.24 ft.

49) **A map with a scale of 1”=150’ indicates that a manhole “A” is 9.25” from manhole “B”. What is the actual distance between manholes? (Answer in feet)**



1) If 1 in. = 150 ft., then 9.25 in. = 9.25 x 150 ft.
9.25 x 150 ft. = 1,387.5 ft.

c) 1,388 ft.

50) **If a repair job can be done by 3 people in 19 hours, how long would it take 7 people to do a similar job?**

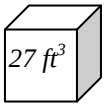
The easiest way to look at this problem is, if 3 people can do the job in 7 hrs., then 7 people can do it in 3/7ths of the time.

19 hrs x 3/7ths = 8.14 hrs. *(19 x 3 ÷ 7 = 8.14 hrs.)*
.14 hour x 60 = 8.4 minutes

d) 8 hrs. 9 min.

51) A trench of 8' wide x 11' deep x 1,725' long. A ~~27"~~ *(2.25 ft.)* sanitary sewer is going to be installed in this trench. ~~18"~~ *(1.5 ft.)* inches must be left out at the top for concrete. How much backfill will be required to fill the trench?

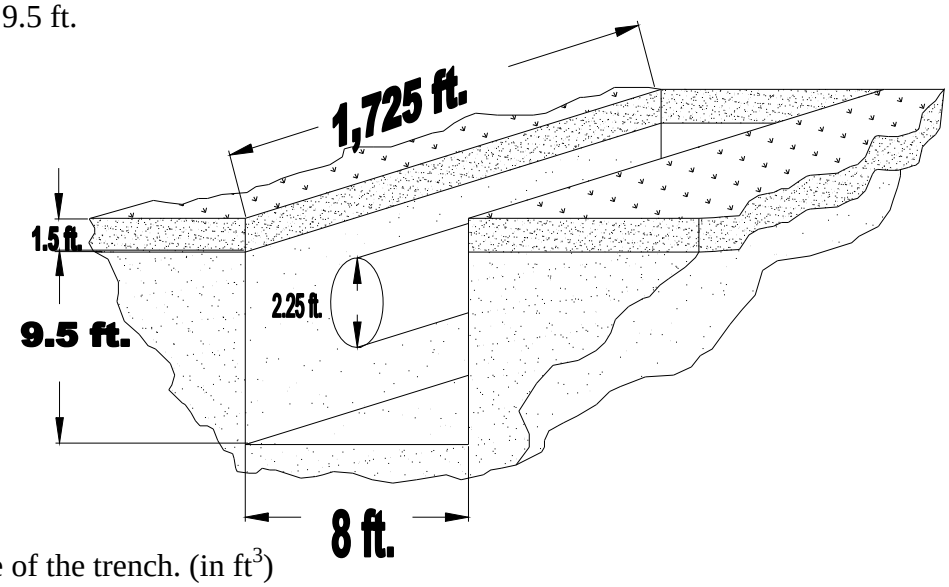
Formula(s) needed, Area of circle = D^2 x .785, 1 yd^3 = 27 ft^3



3' x 3' x 3'= 27 ft^3

1) Subtract concrete thickness from depth.

11 ft. – 1.5 ft. = 9.5 ft.



2) Calculate the volume of the trench. (in ft^3)

8 ft. x 9.5 ft. x 1,725 ft. = 131,100 ft^3

3) Calculate the area of the pipe. Then multiply x the length to get volume. (in ft^3)

Area = D^2 x .785

Area = 2.25 ft. x 2.25 ft. x .785 = 4 ft^2

4 ft^2 x 1,725 Ft = 6,855 ft^3

4) Subtract the volume of the pipe from the volume of the trench to find the volume of backfill in ft^3.

131,100 ft^3 - 6,855 ft^3 = 124,244 ft^3

5) Convert cubic feet to cubic yards (yd^3).

$$\frac{124{,}244 ft^3}{27\ ft^3./yd^3} = 4{,}602.65\ yd^3$$

a) 4,602 yd^3

52) **How many tons of backfill would there be in problem 51 if each the backfill material was 3,500 lbs./yd^3?**

Formula(s) needed, 1 ton = 2,000 lbs.

1) Multiply cubic yards from problem #52 times 3,500 lbs./yd^3.

4,602.65 yd^3 x 3,500 lbs./yd^3 = 16,107,000 lbs.

2) Divide the pounds of backfill by 2,000 lbs,/ton.

$$\frac{16{,}107{,}000 \text{ lbs.}}{2{,}000 \text{ lbs,/ton.}} = 8{,}053.5 \text{ tons}$$

a) 8,053 tons

53) **If a dump truck could carry 15 tons each, how many truck loads would be needed in problem 51?**

1) Divide The number of tons by 15 tons/truck.

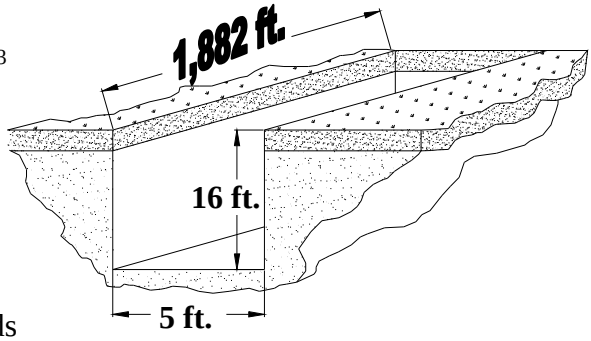
$$\frac{8{,}053.5 \text{ tons}}{15 \text{ tons/truck}} = 536.9 \text{ trucks*}$$

**Be sure to round up, since you will need another truck carry the decimal ton.*

c) 537 trucks

54) **A 5 foot wide 1,882 foot trench must be excavated and the spoil removed from The premises. The spoil weight is 2,900 lb/yd^3 and each truck can carry 12 tons. How many truck loads are required if the trench is 16 feet deep?**

Formula(s) needed, 1 ton = 2,000 lbs., 1 yd^3 = 27 ft^3



1) Calculate the volume of the trench in ft^3.
   1,882 ft. x 5 ft. x 16 ft. = 150,560 ft^3

2) Divide the cubic feet of spoils by 27 ft^3/yd^3.

$$\frac{150{,}560\ \text{ft}^3}{27\ \text{ft.}/\text{yd}^3} = 5{,}576\ \text{yd}^3$$

3) Multiply the cubic yards times the pounds per cubic yard.

   5,576 yd^3 x 2,900 lb/yd^3 = 16,170,400 lbs.

4) Divide pounds by 2,000 lbs./ton.

$$\frac{16{,}170{,}400\ \text{lbs.}}{2{,}000\ \text{lbs./ton}} = 8{,}085.2\ \text{tons}$$

5) Divide tons by tons/truck to find the number of trucks needed.

$$\frac{8{,}085.2\ \text{tons}}{12\ \text{tons/truck}} = 673.76\ \text{trucks}$$

b) 674 trucks

55) **Given the following information, would it be less expensive to finish a job in two days, or finish the job in one day by paying the employees overtime?**

Actual job time is 11 hours
Travel time and set up time is 1.5 hrs./day
Average work day is 8 hours
Overtime is 1.5 times the normal hourly rate
All employees are paid the same hourly wage

Calculate the cost for both ways:

1) Cost for completing the work in one day with overtime.

11 hrs (total job time)
+ 1.5 hrs. travel & set up
- 8 hrs. (strait time)
4.5 hrs. (paid at O.T.)

4.5 hrs. O.T. x 1.5 = 6.75 hrs. pay

6.75 hrs. pay + 8 hrs = 14.75 hrs. total pay

2) Cost for completing the work in two days with extra travel time.

11 hrs (total job time)
1.5 hrs. (travel & set up, day 1)
+ 1.5 hrs. (travel & set up, day 2)
14 hrs. total pay

a) Cheaper to have the work done in two days

56) **Estimate the total cost and cost per linear foot of a sewer construction project. The project consists of installing five manholes and 3,500 feet of 21" sewer. Costs are estimated as shown below:**

EXCAVATION AND BACKFILL-----$218.00 per foot
COST OF PIPE----------$26.00 per foot
MANHOLE + INSTALLATION---------$3,500.00 each

Total job cost:

1) Excavation and backfill of trench.
   $218.00 per ft. x 3,500 ft. = $763,000.00
2) Cost of pipe.
   $26.00 per ft. x 3,500 ft. = $91,000.00
3) Cost of manholes.
   5 manholes x $3,500.00 ea. = $17,500.00
4) Total cost.

$ 763,000.00
$ 17,500.00
+ $ 91,000.00
$ 871,500.00

c) $871,500

Cost per linear foot:

1) Divide total cost by linear feet to get cost/liner ft.

$ 871,500.00 = $249.00
3,500 ft.

b) $ 249.00/ft.

57)) The average cost to have contractors clean the city sewers is $5.95 per foot for 1.6 miles of 12” pipe, $6.80 per foot for 1.8 miles of 15” pipe and $7.85 per foot of 1.7 miles of 18” pipe. The city is considering purchasing a $328,000 jet vac and hiring a 3 man crew to operate it. Operator “A” makes $19.57/hour, operator “B” makes $18.59/hour and operator “C” makes $17.89/hour. The fringe benefits are 37% of wages. The cost/year of the jet vac will be $31,275 for 10 years. The time for the crew to clean 100 ft. of sewer is as follows:

12” sewer takes 1.50 hours
15” sewer takes 3.25 hours
18” sewer takes 4.00 hours

There will be .5 hours of non-productive time (travel, cleanup, ect.) for every hour spent cleaning the sewer.

Which is the least expensive option (contractor or in-house) and by how much over the 10 year period?

Answer is on next page.

Convert miles of sewer to feet .

size		miles		feet/mile		feet	
12 in.	=	1.6 miles	x	5280 ft./mile	=	8,448	ft.
15 in.	=	1.8 miles	x	5280 ft./mile	=	9,504	ft.
18 in.	=	1.7 miles	x	5280 ft./mile	=	8,976	ft.

CONTRACTOR COST/YEAR:

Convert feet of sewer cost.

feet	x	cost/ft.	=	total	
8,448	x	$ 5.95	=	$ 50,265.60	(12 in.)
9,504	x	$ 6.80	=	$ 64,627.20	(15 in.)
8,976	x	$ 7.85	=	$ 70,461.60	(18 in.)
				$ 185,354.40	**= TOTAL CONTRACTOR COST/YEAR**

IN HOUSE COST/YEAR

1) Calculate labor cost/hr.

Add wages of A,B & C operators.

A	=	$ 19.57	
B	=	$ 18.59	
+ C	=	$ 17.89	
		$ 56.05	(Total hourly rate)

hourly rate		travel & clean up		fringe benefits		Total labor Cost/hr.
$ 56.05	x	1.50 hrs.	x	1.37	=	$ 115.18

2) Set up grid to calculate in-house costs.

Size	ft. of pipe		100' sections	x	hrs. per 100 ft.	x	hourly rate	=	travel time pipe size	total cost/
12 in.	8,448	÷	100 ft. sections	x	1.50	x	$ 115.18	=	$ 14,595.96	
15 in.	9,504	÷	100 ft. sections	x	3.25	x	$ 115.18	=	$ 35,577.65	
18 in.	8,976	÷	100 ft. sections	x	4.00	x	$ 115.18	=	$ 41,355.21	

Total cost/year		$ 91,528.82
Jet-vac cost/year	+	$ 31,275.00
		$ 122,803.82

COMPARE COST/YEAR

	$ 185,354.40	IN HOUSE COST/YEAR
-	$ 122,803.82	CONTRACTOR COST/YEAR
	$ 62,550.58	Cheaper to do the work in-house

10 year cost difference

$ 62,550.58 x 10 = **$ 625,505.80**

a) $ 625,505.80

MISC ADD-ON MATH QUESTIONS: (These are questions from throughout the book with some twists and variations. Also some newer questions suggested by various people have been added)

58) Calculate the water horsepower if the pump it operates provides 950 GPM against 121 feet total dynamic head (TDH) & a spec. gravity of 0.92?

- [ ] a) 95.02 HP
- [ ] b) 26.71 HP
- [ ] c) 7.85 HP
- [ ] d) 58.73 HP

59) If the pump in previuos problem is 64% efficient, then what is the brake HP?

- [ ] a) 12.3 HP
- [ ] b) 91.8 HP
- [ ] c) 41.7 HP
- [ ] d) 37.6 HP

60) If a pump outputs 2 MGD against a total dynamic head of 168 feet, and the pump is 64% efficient, what is the brake HP if the fluid being pumped has a specific gravity of 1.30?

- [ ] a) 1,068 HP
- [ ] b) 107.4 HP
- [ ] c) 76.6 HP
- [ ] d) 119.7 HP

61) An automatic chemical feeder treats 4,900 GPM at a concentration of 23 mg/l. How many lbs./day of chemical is required? (the Specific Gravity of the chemical is 1.02.)

- [ ] a) 1,381 lbs./day
- [ ] b) 58 lbs./day
- [ ] c) 1,353 lbs./day
- [ ] d) 59 lbs./day

62) 37 mg/l. of chlorine is required to treat a flow of 4.30 MGD. The solution available to you, however, is only 61% of chlorine. If the S.G. of the chemical is 0.96, How many lbs./day of solution are required to treat the flow?

- [ ] a) 75,619 lbs./day
- [ ] b) 6,307 lbs./day
- [ ] c) 1,275 lbs./day
- [ ] d) 2,090 lbs./day

63) Prepare a cut sheet for a sewer laid on a .75 % grade with the given stake elevations and invert grade.

Station	Stake Elev.	Invert Grade	Cut
0 + 00	43.15	32.000	
0 + 50	43.78		
1 + 00	44.65		
1 + 50	43.65		
1 + 98	47.24		

64) Prepare a cut sheet for a sewer laid on a .69 % grade with the given stake elevations and invert grade. Consider a pipe thickness of 2.5 in. and assume the pipe will be installed on 1.5 ft. of bedding. What is your final cut at station 1 + 98?

Station	Stake Elev.	Invert Grade	Cut
0 + 00	67.28	18.00	
0 + 50	67.91		
1 + 00	68.13		
1 + 50	68.55		
1 + 98	69.69		

	A)	19.04
	B)	52.03
	C)	50.99
	D)	18.69

66) Operator "A" makes $18.88 per hour, operator "B" makes $17.91 per hour, operator "C" makes $16.50 per hour. Benifits cost 35% of wages .50 hours. of non-productive time (travel, cleanup, etc.) will be used for every hour spent cleaning sewers. What is the total cost per hour for the entire crew?

- [ ] a) $ 79.94 per./hr.
- [ ] b) $ 71.94 per./hr.
- [ ] c) $ 53.29 per./hr.
- [ ] d) $ 107.91 per./hr.

65) The average cost for contractors to clean the city sewers is $ 6.02 per foot for 1.75 miles of 12 in. pipe, $6.77 per foot for 3.10 miles of 15 in. pipe, and $ 7.44 per foot for 2.10 miles of 18 in. pipe, How much will it cost to contract out cleaning of the sewers for a(n) 10 year period?

- [ ] a) $ 1,216,883.05
- [ ] b) $ 248,930.88
- [ ] c) $ 4,609,405.50
- [ ] d) $ 2,489,308.80

67) The total cost per hour for a 3 man jet-vac crew, (including wages & benefits) is $ 107.91 per hr.
The time for the crew to clean 100 ft. of sewer is as follows:

12,500 feet of	12" sewer takes	2.25 hrs.	per 100 ft.
17,952 feet of	15" sewer takes	3.50 hrs.	per 100 ft.
8,976 feet of	18" sewer takes	4.00 hrs.	per 100 ft.

If it costs the city $ 23,000.00 per year to own & operate a jet-vac, how much will it cost to clean all of the sewers once per year?

- [ ] a) $ 24,598.96 per yr.
- [ ] b) $ 39,535.91 per yr.
- [ ] c) $ 159,895.71 per yr.
- [ ] d) $ 136,895.71 per yr.

68) A trench is dug at 8.0 ft. wide x 11.5 ft. deep x 1,884 ft. long. A 21 in. Sewer is going to be installed in this trench 16 in. must be left out of the top for concrete. How many trucks would be needed to bring backfill if the material weighed 3,724 lbs. per yd^3 and each truck carries 18.0 tons?

- [ ] a) 570 Trucks
- [ ] b) 15,383 Trucks
- [ ] c) 647 Trucks
- [ ] d) 569 Trucks

69) A sewer jet with a 1750 gallon tank has a 35 Gal./Min. pump. If the operator has to fill the truck 4 times in an 8 hour day, how much time is spent actually cleaning sewers during that day?

- [ ] a) 25 Hrs. .33 Min.
- [ ] b) 8 Hrs. 20 Min.
- [ ] c) 3 Hrs. 20 Min.
- [ ] d) 6 Hrs. 40 Min.

70) A city plans to purchase a chemical feed system to be installed 60 minutes from the maintenance office. They have a choice between a manually operated or an automatic system The manual system is $ 30,000 to purchase and $ 2,500 to install. It uses a 480v motor at 30 amps. It requires 1, A Operator(s) and 2, B Operator(s) to visit the site once a day, for 1.0 hr(s) to refill the tank and perform maintenance. The automatic feeder costs $ 41,000.00 to buy and $ 3,500 to install. It operates on 480v at 35 amps A site visit is needed every 7 day(s) by 1, A Operator(s) for 1.0 hr(s) per day. If both systems must to run 24 hr(s)/day, which syatem would be cheaper over a 2 year period?

Assume, Power costs $ 0.11 per KWH An "A" Operator makes $ 18.50 per hr.
A "B" Operator makes $ 17.10 per hr.

- [ ] a) Automatic feeder is cheaper by, $ 56,458.15
- [ ] b) Manual feeder is cheaper by, $ 80,735.53
- [ ] c) Automatic feeder is cheaper by, $ 70,572.69
- [ ] d) It costs about the same for the Automatic and the Manual Sytem

71) A(n) 30 in. force main that is 1.8 miles long, is supplied by a 1,675 gal./min pump. Once the pump is started, how long will it take to fill the force main? Assuming no head loss and the force main is empty.

- [ ] a) 3.00 hr(s). 47 min.
- [ ] b) 3.00 hr(s). 17 min.
- [ ] c) 3.00 hr(s). 28 min.
- [ ] d) 4.00 hr(s). 11 min.

72) The following flows were recorded for the months of February, March, and April, …

February, 187.2 cu. ft./sec. March, 94,722.2 Gal./Min. April, 156.1 MGD

What was the average daily flow for this three-month period?

- [ ] a) 4.6 MGD
- [ ] b) 413.3 MGD
- [ ] c) 120.8 MGD
- [ ] d) 3.7 MGD

COLLECTION THEORY STUDY GUIDE QUESTIONS

T1) The formula for calculating the volume of a rectangular wet well is

- A) V=LxWxC
- B) V=WxAxP
- C) V=WxLxH
- D) V=WxHxD

Where,

V= volume C=circumference
L= length P=perimeter
W= width D=diameter
A= area H= height

T2) You should never attempt to install, troubleshoot, maintain or replace electrical equipment panels, controls, wiring, or circuits unless

- A) A manhole is overflowing down a street
- B) A pump is unplugged
- C) You are receiving a lot of odor complaints
- D) You know what you are doing, are qualified, and are authorized

T3) Which of the following is not considered a confined space?

- A) Manhole
- B) Anaerobic digester
- C) Lift station wet well
- D) Operator control room

T4) A pump is delivering less than the expected rate of discharge. What can cause this to happen?

- A) Discharge head too low
- B) Discharge head too high
- C) Check valve open
- D) Pump is primed

T5) Wearing rings are installed in a pump to

- A) Concentrate wear on an economically replaceable part
- B) Hold the shaft in position
- C) Keep the impeller in place
- D) Wear out rings instead of sleeves

T6) A lantern ring is a

- A) Metal ring for lowering an explosive-gas detector candle into manholes and wet wells
- B) Shaft coupling that has been completely worn through in spots or that has “daylighted”
- C) Spacer ring in a pump packing gland to improve seat water distribution
- D) Type of coupling for joining pipes that will not be covered or put in the dark for at

T7) Check valves are used on the discharge side of centrifugal pumps to

A) Equalize the pressure on both sides of the impeller
B) Prevent water in the suction line from flowing back into the reservoir
C) Prevent water in discharge line from flowing back
D) Regulate the rate of water flow through the discharge pipe

T8) What information must be on a warning tag attached to a switch that has been locked out?

A) Direction for removing tag
B) Name of the nearest physician to call in case of an emergency
C) Signature of person who locked out the switch, who is the only person authorized to remove tag
D) Time to unlock switch

T9) Enclosed, open, and semi-closed are terms used for the designation and selection of

A) Impellers
B) Lantern rings
C) Sleeves
D) Stuffing Boxes

T10) Leakage of seal water around the packing on a centrifugal pump is required because it acts as a(n)

A) Adhesive
B) Coolant
C) Lubricant
D) Vapor Barrier

T11) Hydrogen sulfide is a toxic gas that smells like ____. At high concentrations of hydrogen sulfide, however, the sense of smell is deadened and no odor is detected.

A) Dead fish
B) Fuel gas
C) Rotten cabbage
D) Rotten eggs

T12) Why are gasoline and volatile solvents objectionable where present in a sewer?

A) They produce an explosion hazard
B) They tend to cause the solids to vaporize
C) They will coagulate floatables and cause stoppages
D) They represent wasted recourses

T13) Biological activity in long, sluggish-flow, flat-grade sewer lines will likely

A) Decrease line sediment
B) Create oxygen deficiency in the air in manholes, sewers, or wet wells
C) Stop toxic gas production
D) Increase the “carrying capacity” of the line

T14) Task least likely to be preformed by collection systems personnel is

- A) Cleaning sewer stoppages
- B) Making water connections
- C) Inspecting/testing manholes
- D) Maintaining collection systems equipment

T15) A pH of 6.0 is

- A) Acid
- B) Alkaline
- C) Neutral
- D) Basic

T16) Biological hazards in collection system operations include

- A) Noxious or toxic gases or vapors
- B) Oxygen deficiency
- C) Physical injuries
- D) Hepatitis A

T17) A pH of 7.0 is

- A) Acid
- B) Alkaline
- C) Basic
- D) Neutral

T18) What must be checked before entering a manhole?

- A) Atmosphere in manhole
- B) Safety equipment
- C) Proper barricades or warning devices around a manhole
- D) All of the above

T19) In sewer maintenance, what is a pig?

- A) A bullet shaped object passed through a force main
- B) A power rod
- C) Any foul smelling equipment
- D) The hydraulic rodding truck

T20) The purpose pf ribs on the outside of a Wayne Sewer Ball is to

- A) Allow the ball's weight to be closer to the ball's center
- B) Avoid patent infringement that would apply if a non-ribbed ball were used
- C) Cause jet action to aid in the hydraulic flushing of the sewer line
- D) Reinforce (strengthen) the ball

T21) Mechanical ventilation of a lift station is required to

- A) Ensure safe working access
- B) Reducing chlorine demand
- C) Reduce corrosion
- D) Increase dissolved oxygen (DO) in raw wastewater

T22) When opening a power rodder properly, do the following

- A) Push the rodding tool into an obstruction and hold it there
- B) Rotate rod in one position
- C) Make sure all the torque is out of a broken rod
- D) Rod past dropped joints or through a crushed pipe

T23) You should get out of the manhole as soon as

- A) Lower explosive level alarm activates
- B) H2S exceeds 5 ppm
- C) Flow increases slightly
- D) None of the above

T24) A common name appurtenance used to keep an accidental flow of wastewater from entering a building is called

- A) Barrel
- B) Cleanout
- C) Backwater valve
- D) Catch basin

T25) Which of the following is a type of shore?

- A) Bar
- B) Aluminum hydraulic
- C) Truss
- D) Sand

T26) The most important traffic safety consideration is the

- A) Time of day
- B) Size of the job
- C) Wearing of hard hats and safety vests
- D) Location of the job

T27) Which of the following first aid actions would you perform first if an operator inhales chlorine gas?

- A) Immediately remove victim from the contaminated area
- B) Immediately calla physician or paramedic
- C) Immediately begin appropriate treatment
- D) Do nothing because chlorine gas is nontoxic

T28) Which of these chemicals may be used for odor control in sewers?

- A) Chlorine
- B) Muriatic acid
- C) Potassium chloride
- D) Sodium chloride

T29) Sources of excessively clear water in a collection system include

- A) A problem at the wastewater treatment plant
- B) A sanitary sewer leak
- C) Exfiltration from a high water table
- D) Infiltration from a high water table

T30) What information would you consider while clearing a stoppage in a sewer?

- A) Nothing-start adding pressurized water to clear the stoppage
- B) Cause of stoppage
- C) Time of day
- D) Staffing requirements

T31) With the completion of a sewer cleaning job, which one of the following must be done at the manhole?

- A) Complete and sign timesheets
- B) Wash down the truck
- C) Wash down street around work area, making sure the wash water is broomed into the M.H.
- D) None of the above

T32) Lift station failures include _____ failure.

- A) dip tube
- B) electrical system
- C) inverted siphon
- D) All of the above

T33) A kilowatt (KW) is equivalent to

- A) .67 amperes at a voltage of 120
- B) 746 watts
- C) 1.34 horsepower
- D) 1,000 megacycles

T34) Infiltration my result from

- A) Bad joints
- B) Improper closed circuit television operation
- C) Poor ventilation
- D) Direct downspout and drain connections

T35) Grease in sewers is mechanically removed by

- A) High-pressure jets
- B) Sawing
- C) Not usually a problem in sewers
- D) Power rodders

T36) The most important reason for washing hands thoroughly after taking a wastewater sample is to

- A) Avoid being infected by pathogenic bacteria
- B) Avoid contaminating BOD bottles
- C) Avoid smudging BOD bottles
- D) Avoid accidentally dropping any glassware

T37) Roots can enter collection systems through

- A) Air gaps
- B) Manhole covers
- C) Pipe cracks
- D) Inflatable dams

T38) Which one of the following is a property of chlorine gas?

- A) Heavier than air
- B) Harmless to humans
- C) Highly flammable
- D) Lighter than air

T39) What is a mechanical means to remove material from a sewer?

- A) Herbicides
- B) Cutting
- C) Pumping
- D) Sweeping

T40) The purpose of a lift station sign-in log is to

- A) Budget lift station visits
- B) Identify who makes changes in station operation
- C) Track employee movement for disciplinary actions
- D) All of the above

T41) What tools are used with a power rodder?

- A) Finger grips
- B) Pruning shears
- C) Spring blades
- D) Videotape camera

T42) Which of the following should be inspected when responding to a lift station alarm?

A) Amount of screenings and trash removals
B) Wet well inlet velocities
C) Operation of gas masks
D) Motor control center and power panel

T43) The minimum scouring velocity normally used for sanitary collection lines is

A) 1.0 ft/sec
B) 2.0 ft/sec
C) 5.0 ft/sec
D) 10.0 ft/sec

T44) Tools used for sewer rodding include

A) Lag screw
B) Porcupine
C) Wildebeest
D) Set screw

T45) What equipment is effective in removing an emergency stoppage?

A) Strip chart recorder
B) Ultrasonic meter
C) Front-end loader
D) Hand rodder

T46) Employers must provide employees with information about possible health effects from contact with hazardous materials. This is called "right-to-know" legislation. Which document provides "right-to-know"?

A) Material Safety Data Sheet
B) NPDES permit
C) Sewer ordinance
D) Clean Water Act

T47) Who must review plants for final approval before a new sewer can be constructed?

A) County commissioner
B) City sewer Inspector
C) Ohio EPA
D) Water Commission

T48) What will happen if the discharge valve on a centrifugal pump is partially closed?

A) Amperage will increase, discharge head will increase
B) Amperage will decrease, discharge head will increase
C) Amperage will decrease, discharge head will remain constant
D) Amperage will decrease, discharge head will decrease

T49) As the impeller wears on a pump, the pump efficiency will

- A) Decrease
- B) Improve
- C) Increase
- D) Not change

T50) "Schedule 40" refers to pipe

- A) flow capacity
- B) friction loss
- C) tubing strength
- D) wall thickness

T51) Centrifugal pump parts include

- A) diaphragm
- B) piston
- C) rotor
- D) volute

T52) When packing a centrifugal pump, the-packing gland should be tightened

- A) slowly over a period of several hours
- B) to 20 ft-lb
- C) with wrench and then backed off a quarter turn
- D) none of the above

T53) A venturi meter measures quantity of fluid by

- A) difference in pressure between a constricted and a full-size portion
- B) electronic measurement
- C) velocity of the fluid past a given point
- D) weight of the fluid

T54) The gas most commonly associated with septic wastewater is

- A) carbon dioxide
- B) carbon monoxide
- C) hydrogen sulfide
- D) methane

T55) When sewer line grades are too flat, an odor problem is likely to result. The most likely cause of the odor problem is decreased velocity, which

- A) Allows decomposable solids to settle
- B) Decreases the treatment time in the lines
- C) Increases the treatment time of inorganic solids
- D) None of the above

T56) Hydrogen sulfide gas smells like,

A) Dead fish
B) Fuel gas
C) Rotten Cabbage
D) Rotten eggs

T57) Why are gasoline and volatile solvents objectionable when present in a sewer?

A) They produce an explosion hazard.
B) They tend to cause the solids to vaporize.
C) They will coagulate floatables and cause stoppages.
D) None of the above.

T58) The formula for calculating the volume of a cylinder is;

A) V = L x W x H
B) V = Distance/time
C) $V = D^2 \times .785 \times D$
D) $V = D^2 \times 746 \times D$

T59) Biological activity in long, sluggish-flow, flat-grade sewer lines will likely cause

A) Concrete and metal corrosion
B) Oxygen deficiency in the air in manholes, sewers or wet wells.
C) Toxic gas production.
D) All of the above.

T60) Tasks performed by a collection system operator include

A) Cleaning local treatment plants.
B) Maintaining collection system equipment.
C) Making water connections.
D) None of the above.

T61) One cubic foot per second flow is equal to _____ gallons per hour.

A) 2,794
B) 3,500
C) 6,000
D) 26,928

T62) On floors where water or chemicals are commonly spilled, cover the floors with

A) Catwalks.
B) Linoleum.
C) Tile.
D) Wood.

T63) You should never attempt to install, troubleshoot, maintain repair or replace electrical equipment panels, controls, wiring or circuits unless

- A) A manhole is overflowing down the street.
- B) A pump is plugged.
- C) You are receiving lots of odor complaints.
- D) You know what you are doing, are qualified, and are authorized.

T64) Employee hazards in collection system operations include

- A) Noxious or toxic gasses or vapor.
- B) Oxygen deficiency.
- C) Physical injuries.
- D) All of the above

T65) GPM means gallons per

- A) Mile.
- B) Milliliter.
- C) Minute.
- D) Month.

T66) Leakage of seal water around the packing on a centrifugal pump is required because it acts as a(n)

- A) Adhesive.
- B) Coolant.
- C) Lubricant.
- D) Vapor barrier.

T67) What must be checked before entering a manhole?

- A) Atmosphere in manhole.
- B) Equipment.
- C) Proper barricades or warning devices around manhole.
- D) All of the above.

T68) In sewer maintenance, what is a pig?

- A) A ball forced through a sewer line.
- B) A power rod.
- C) Any foul smelling equipment.
- D) The hydraulic rodding truck.

T69) The purpose of ribs on the outside of a Wayne Sewer Ball is to

- A) Allow the ball's weight to be closer to the ball's center.
- B) Avoid patent infringement that would apply if a non-ribbed ball was used.
- C) Cause jet action to aid in the hydraulic flushing of the sewer line.
- D) Reinforce (strengthen) the ball.

T70) A pump is delivering at less than the expected rate of discharge. What will not cause this to happen?

A) Check valve stuck or clogged.
B) Discharge head too low.
C) Impeller clogged.
D) Pump not primed.

T71) Wearing rings are installed in a pump to

A) Concentrate wear on an economically replaceable part.
B) Hold the shaft in position.
C) Keep the impeller in place.
D) Wear out rings instead of sleeves.

T72) A lantern ring is a

A) Ring for lowering an explosive-gas detector candle into manholes and wet wells.
B) Shaft coupling that has been completely worn through in spots or that has "daylighted."
C) Spacer ring in a pump packing gland to improve seal water distribution.
D) Type of coupling for joining pipes that will not be covered or put in the dark for at least 5 days.

T73) Mechanical ventilation of a lift station is required to

A) Lower temperatures to reduce production of hydrogen sulfide.
B) Reduce chlorine demand.
C) Reduce corrosion.
D) Increase d.o. in raw wastewater.

T74) To properly operate a power rodder

A) Do not jam rodding tool into an obstruction.
B) Do not rotate the rod in one position for extended periods.
C) If a rod should break, make sure all the torque is out of it before handling it.
D) All of the above.

T75) Check valves are used in connection with centrifugal pumps in order to

A) Equalize the pressure on both sides of the impeller.
B) Prevent water in the suction line from flowing back into the reservoir.
C) Prevent water in the discharge line from flowing back.
D) Regulate the rate of water flow through the discharge pipe.

T76) You should get out of a manhole as soon as you start feeling

A) Thirsty.
B) Sick to your stomach.
C) Like sneezing.
D) Dirty.

T77) What information must be on a warning tag attached to a switch that has been locked out?

- A) Directions for removing tag.
- B) Name of nearest physician to call in case of emergency.
- C) Signature of person who locked out switch and who is the only person authorized to remove tag.
- D) Time to unlock switch.

T78) Enclosed, open and semi-closed are terms used for the designation and selection of

- A) Impellers.
- B) Lantern rings.
- C) Sleeves.
- D) Stuffing boxes.

T79) What is (are) used to remove grease?

- A) Bar screens
- B) Biological treatment.
- C) Chemicals.
- D) All of the above.

T80) A Parshall flume is a type of

- A) Orifice.
- B) Submerged nozzle.
- C) Venturi.
- D) Weir requiring free-fall discharge.

T81) Which of these chemicals should be used for odor control in sewers?

- A) Chlorine
- B) Muriatic acid.
- C) Potassium chloride.
- D) Sodium chloride.

T82) Which of the following are types of shores?

- A) Bar.
- B) Hydraulic.
- C) Sand
- D) All of the above.

T83) Important traffic safety considerations include

- A) Routing pedestrians around a job site.
- B) Routing traffic around job site.
- C) Wearing of hard hats and safety vests.
- D) All of the above.

T84) Which of the following first aid actions would you perform first if an operator inhales chlorine gas?

A) Immediately remove patient from contaminated area.
B) Immediately call physician or paramedic.
C) Immediately begin appropriate treatment.
D) Do nothing, as chlorine gas is non-toxic.

T85) Flatter sewer line grades may cause added sewer maintenance expense and odor nuisance. The problem is most likely caused by

A) A decrease in velocity allowing gases to be released from the wastewater.
B) A decrease in velocity allowing organic and inorganic solids to settle out.
C) A decrease in velocity which increases the treatment time of the inorganic solids.
D) And increase in velocity which decreases the treatment time in the lines.

T86) Sources of excessive clear water in a collection system include

A) A problem at the wastewater treatment plant.
B) An interceptor sewer leak.
C) Exfiltration from a high water table.
D) Infiltration from a high water table.

T87) What items would you consider when selecting a solution to clear a stoppage in a sewer?

A) Adding a solution to the upstream manhole to clear the stoppage.
B) Cause of stoppage.
C) Time of day.
D) Staffing requirements.

T88) With the completion of a sewer cleaning job, which of the following is not necessary to be done at the manhole?

A) Load the debris on the truck.
B) Sweep up the debris around the manhole.
C) broomed into the manhole.
D) Wash down the truck.

T89) The static pressure in a pipeline is 24 psi. How much head, in feet would create that much pressure.

A) 5ft.
B) 55ft.
C) 10ft.
D) 90ft.

T90) A pH of 7.0 is

A) Acid.
B) Alkaline.
C) Neutral.
D) None of the above.

T91) Infiltration is caused by

A) Cracked pipes.
B) Improper closed circuit TV operation.
C) Poor ventilation.
D) All of the above.

T92) The main reason for chlorinating wastewater in sewers is for ___ ____ control.

A) BOD
B) Odor
C) Pathogen
D) Suspended Solids

T93) The most important reason for washing hands thoroughly after taking a wastewater sample is to

A) Avoid being infected by pathogenic bacteria.
B) Avoid contaminating the BOD bottles.
C) Avoid smudging the BOD bottles.
D) Get the slime off your hands so you won't accidentally drop any glassware.

T94) Roots can enter collection systems through

A) Air gaps.
B) Manhole covers.
C) Pipe cracks.
D) All of the above.

T95) Which of the following is a property of chlorine gas?

A) Can be compressed into liquid form.
B) Harmless to humans.
C) Highly flammable.
D) Lighter than air.

T96) What is a mechanical means to remove material from a sewer?

A) Brushing.
B) Cutting.
C) Pumping.
D) Sweeping.

T97) The purpose of a lift station sign-in log is to

A) Budget lift station visits.
B) Identify who makes changes in station operation.
C) Track employee movement for disciplinary actions.
D) All of the above.

T98) What tools are used with a power rodder?

A) Finger grips.
B) Pruning shears.
C) Spring blades.
D) Videotape camera.

T99) Which one(s) of the following items should be inspected when responding to a lift station alarm at night?

A) Amount of screenings and other trash removal.
B) Motor control center and power panel.
C) Operation of gas masks.
D) All of the above.

T100) A PH of 6.0 is

A) Acid.
B) Alkaline.
C) Neutral.
D) None of the above.

T101) Tools used for sewer rodding include all but the

A) Lag screw.
B) Porcupine.
C) Root saw.
D) Square bar cork screw.

T102) Area subject to higher than normal vandalism are usually

A) Along heavily traveled streets.
B) Secluded, out-of-the-way buildings.
C) Well-lighted, visible areas.
D) None of the above.

T103) How does an emergency service crew try to remove a stoppage?

A) Balling.
B) Flushing.
C) Hand rods.
D) Parachutes.

T104) The amount of oxygen that may become dissolved in a given amount of water is <u>most</u> related to

A) Hardness.
B) Total Dissolved Solids
C) Temperature.
D) Turbidity.

T105) The gas most commonly associated with septic wastewater is

A) Carbon dioxide.
B) Carbon monoxide.
C) Hydrogen sulfide.
D) Methane.

T106) What determines the amount of hydrogen sulfide produced in a sewer?

A) BOD concentration.
B) DO concentration.
C) pH
D) SS concentration.

T107) Four conditions are necessary to create an explosion. Three of these conditions are: combustible gas, adequate oxygen and sufficient heat. What is the fourth?

A) Constant supply of combustible gas.
B) Enclosed area that will hold the gases.
C) Proper mixing of gas and oxygen.
D) None of the above.

T108) The lack of an unpleasant odor in a manhole, lift station or other structures does not always mean that no dangerous gases are present because

A) Some dangerous gases have no odor.
B) Oxygen may still be lacking.
C) Some gases deaden the sense of smell
D) All of the above.

T109) As the impeller wears on a pump, the pump efficiency will

A) Decrease.
B) Improve.
C) Increase.
D) Not change.

T110) How closely an instrument measures the actual value of the process variable being measured is called its

A) Accuracy.
B) Calibration.
C) Precision.
D) Standardization.

T111) Items that must be examined when inspecting manholes include

- [ ] A) Corrosion.
- [ ] B) Cracks.
- [ ] C) Elevation of lid.
- [ ] D) All of the above.

T112) Vibrations in pumps may be caused by improper motor-pump

- [ ] A) Alignment.
- [ ] B) Curves.
- [ ] C) Piping.
- [ ] D) Power factor.

T113) Advantages of a video tape recording system include

- [ ] A) Ability to see what's happening when camera is under water.
- [ ] B) Cheaper than a Polaroid camera.
- [ ] C) Length and severity of defective areas can be recorded.
- [ ] D) Visitors are impressed.

T114) The most widely used type of prime mover in a pumping plant is

- [ ] A) Diesel engine.
- [ ] B) Electric motor.
- [ ] C) Gas engine.
- [ ] D) Steam engine.

T115) "Schedule 40" refers to

- [ ] A) Flow capacity.
- [ ] B) Friction loss.
- [ ] C) Tubing strength.
- [ ] D) Wall thickness.

T116) Hazards that my damage a TV camera going through a sewer include

- [ ] A) Deep water that submerges the camera
- [ ] B) Fogging of optical lens.
- [ ] C) Offset joints.
- [ ] D) All of the above.

T117) Centrifugal pump parts include

- [ ] A) Diaphragm.
- [ ] B) Piston.
- [ ] C) Rotor.
- [ ] D) Volute.

T118) When packing a centrifugal pump, the packing gland should be tightened

A) Slowly over a period of several hours.
B) To 20 foot pounds.
C) With wrench and then backed off 1/4 turn.
D) None of the above.

T119) What factors should be considered when providing trench shoring?

A) Grade of sewer.
B) Pipe material.
C) Structures or sources of vibration near trenches.
D) All of the above.

T120) Construction defects that cause problems in wastewater collection systems include

A) Improper grade of sewers.
B) Improper taps.
C) Structure failure of manholes.
D) All of the above.

T121) A venturi meter measures quantity of fluid by

A) Difference in pressure between a constricted and a full-size portion.
B) Electronic measurement.
C) Velocity of the fluid past a given point.
D) Weight of the fluid.

T122) How can the members of a bailing crew communicate with each other?

A) Hand signals.
B) Shouting down the sewer.
C) Telegraph.
D) Writing.

T123) Which of the following is the <u>most</u> common factor leading to the generation of hydrogen sulfide in sewers?

A) Anaerobic conditions.
B) Constantly high velocity of flow in sewers.
C) Low concentrations of ferrous sulfide.
D) Presence of highly soluble fats and oils.

T124) When sewer line grades are too flat, an odor problem is likely to result. The <u>most likely cause of the odor problem is decreased velocity which</u>

A) Allows decomposible solids to settle.
B) Decreases the treatment time in the lines.
C) Increases the treatment time of inorganic solids.
D) None of the above.

T125) After a collection system problem has been solved, you should

- A) Wait until tomorrow to fill out the report forms.
- B) Take a break.
- C) Go home.
- D) Evaluate the effectiveness of the results.

T126) Why must you always know where a cleaning tool is in a sewer?

- A) So the tool can find its way back.
- B) So you can locate it when resuming work after and interruption.
- C) So you know where obstructions or difficulties are encountered.
- D) None of the above.

T127) Improper connections can be detected through

- A) DO tests.
- B) Soundings.
- C) TV inspection.
- D) All of the above.

T128) When curing a concrete slab, which of the following tools is used to compact the concrete and bring a cement film to the surface for finishing?

- A) Grasshopper.
- B) Tamper.
- C) Trowel.
- D) Vibrator.

T129) Emergency stoppages in pipelines may be cleared safely by use of

- A) Hand rods.
- B) High velocity cleaners.
- C) Power rodders.
- D) All of the above.

T130) Mark the correct equation for determining the amount of chlorine required for a dosage of 10 mg/L in 500,000 gallons of flow.

- A) 0.05 x 7.34 x 10 = 1b $C1_2$
- B) 0.05 x 8.34 x 10 = 1b $C1_2$
- C) 0.5 x 7.34 x 10 = 1b C12
- D) 0.5 x 8.34 x 10 = 1b $C1_2$

T131) Your chlorinator room should have an exhaust vent installed

- A) Near the ceiling.
- B) Near the floor.
- C) Halfway up the wall.
- D) At the chlorinator bell jar.

T132) Rodents and insects can be controlled by

A) Aeration.
B) Spraying manholes with an approved pesticide.
C) Vacuum filtration.
D) All of the above.

T133) What is a mechanical means to remove material from a sewer?

A) Brushing.
B) Pumping.
C) Scraping.
D) Sweeping.

T134) Hydrogen peroxide controls odors by

A) Decreasing the DO.
B) Neutralizing pH.
C) Oxidizing sulfide components.
D) Providing a source of hydrogen ions.

T135) Which of these pH readings indicates an acidic wastewater?

A) 3
B) 7
C) 9
D) 12

T136) The record log of a hydraulic cleaning operation should include

A) Type and amount of material removed from downstream manhole.
B) Feet of rod used.
C) Camera malfunctions.
D) All of the above.

T137) What type of pump is <u>not</u> seriously damaged if the discharge valve is closed for a short time while the pump s running?

A) Centrifugal pump.
B) Diaphragm pump.
C) Piston pump.
D) Plunger pump.

T138) Yokes, rollers, jacks, swivels, pull in machine and loader are accessories used in

A) Catch basin cleaning.
B) Jet rodding.
C) Power-bucket machine cleaning.
D) Power rodding.

T139) Sources of excessive clear water in a collection system include

A) A problem at the wastewater treatment plant.
B) A water distribution main construction project.
C) Evaporation.
D) Infiltration from a high water table.

T140) What should be your most important concern after a chemical spill?

A) Aquatic life.
B) Clean-up procedures.
C) Health-related effects
D) Odors.

T141) A sewer-use ordinance should specify the personnel performing

A) Cleaning of the main lines.
B) Monitoring.
C) Repairing of broken pipes.
D) Sealing of leaky joints.

T142) What factor must be considered when obtaining an easement for construction and maintenance of a collection system?

A) Compaction.
B) Deposition of out materials.
C) Revegatation costs.
D) Manhole headroom.

T143) Sewers which are located adjacent to a ground storage reservoir are required to be located at least 10 feet from the structure and be constructed of water main-type materials for a distance of at least 50 feet from the storage reservoir. What is the reason for this requirement?

A) Prevent a high ground water table adjacent to the reservoir.
B) Protect the storage reservoir from contamination.
C) Reduce infiltration into the sewer.
D) Vitrified-clay sewer pipe is easily broken.

T144) Sewer maps should be kept up-to-date for several reasons. Which of the following is the least appropriate reason?

A) So a TV inspection program can be planned and scheduled effectively.
B) So that census canvassers can determine data on standards of living.
C) So that new house services can be connected with minimum difficulty.
D) To permit development of better plans and specifications for street improvement projects.

T145) The temperature versus DO relationship for wastewater is such

A) Higher the temperature, the higher the DO saturation level.
B) Higher the temperature, the lower the DO saturation level.
C) Lower the temperature, the lower the DO saturation level.
D) None of the above.

T146) The gas most commonly associated with fresh wastewater is

A) Carbon dioxide.
B) Carbon monoxide.
C) Hydrogen sulfide.
D) Oxygen.

T147) Sources of harmful radioactive isotopes in wastewater collection systems include

A) Hospitals.
B) Research labs.
C) Tracer studies.
D) All of the above.

T148) "Hz" stands for

A) Cycles per second.
B) Hand control.
C) Horizontal phase.
D) Polyphase.

T149) When a fire hydrant is operated, it should be

A) Just opened enough to have a flow.
B) Opened fully.
C) Opened halfway.
D) Regulated to flow required.

T150) Results obtained from pipe roughness coefficient tests can indicate whether or not

A) Contamination is entering the pipe.
B) The ability of the pipe to transmit flow is being hindered.
C) The quality of the wastewater in the pipe is deteriorating.
D) The size and number of leaks are increasing.

T151) Anaerobic wastewater is frequently corrosive to materials it contacts, especially

A) Coal tar enamel.
B) Concrete.
C) Copper.
D) Plastic.

T152) The electrical disconnect for a pumping station motor can trip out under which one(s) of the following

A) Clogged pump inlet.
B) Low temperature.
C) Strike by lightning.
D) Worn packing.

T153) One of the electric motors in the facility has overheated and caught fire. Select the correct sequence of steps you would take.

1 extinguish fire
2 test
3 repair
4 shut off power
5 remove tags and locks
6 ascertain cause
7 tag and lock out power

A) 1, 2, 5, 4, 7, 3, 5
B) 1, 4, 6, 7, 2, 3, 5
C) 4, 1, 7, 6, 3, 5, 2
D) 4, 6, 1, 7, 3, 5, 2

T154) How can a closed circuit television unit with video tape help to evaluate the condition of a wastewater collection system?

A) Chemicals can be applied for root control.
B) To study the effectiveness of cleaning techniques under various conditions in collection system.
C) Service lines to homes can be inspected
D) TV camera can remove stoppages.

T155) Pipe materials that are the least susceptible to corrosion by acids formed from gases generated in sewers are

A) ACP
B) CIP
C) RCP
D) VCP

T156) A chlorine gas mask should be provided

A) Just outside the chlorine room door.
B) Just inside the chlorine room door.
C) In the plant superintendent's office.
D) In a locked tamper-proof container.

T157) Chlorine cylinders should be stored

A) Below ground level.
B) In a clean, dry location.
C) On their side.
D) With the protective caps off.

T158) Waste flowing at 15 percent of design flow through a 60-inch interceptor may allow

A) photosynthesis to take place in the collection system.
B) Combined sewers to relieve the waste load.
C) The waste to scour the collection system.
D) The waste to turn septic.

T159) At a pumping station equipped with centrifugal pumps, what caused the discharge pressure to suddenly increase and the discharge quantity to suddenly decrease?

A) A discharge valve was closed.
B) A suction valve was closed.
C) The pump amperage was decreased.
D) The voltage was suddenly increased.

T160) To reduce infiltration into the existing wastewater collection system, you should

A) Enforce ordinances that require roof drains to be discharged to street gutters or storm drains.
B) Insert plastic liners into sewer pipes.
C) Replace multi-holed manhole covers with no-hole covers.
D) Use higher pressures in force mains.

T161) Which chemical may be used for odor control in a septic sewer system?

A) Calcium chloride.
B) Hydrogen peroxide.
C) Oxidized aluminum.
D) Sodium chloride.

T162) Liners are installed in sewers to correct problems caused by

A) Grade alignment.
B) Grease.
C) Grit.
D) Infiltration.

T163) To sample for pH, you should collect a

A) Composite sample.
B) Continuous sample.
C) Grab sample
D) Regulated sample.

T164) You have been directed to examine and review the plans and specifications for a new wastewater pump station prior to the advertising or construction bids. Which of the following is of <u>least</u> significance to your

- A) The clearance around and above pumps, motors, valves and control switch gear.
- B) The provisions for ingress and egress for both wet well and dry well.
- C) The size and geometry of the wet well
- D) The specific colors for all piping.

T165) Which one(s) of the following items should be inspected when responding to a lift station alarm at night?

- A) Dry well.
- B) motor control center and power panel.
- C) Operation of ventilation equipment.
- D) All of the above.

T166) What affects the flow capacity of an installed sewer line?

- A) Backfill material, manhole spacing, pipe size.
- B) Burial depth, size, manhole spacing.
- C) Pipe material, invert elevation, pipe size.
- D) Pipe size, pipe material, grade.

T167) When litmus paper is immersed in an acid solution, the paper turns

- A) Blue
- B) Red
- C) Violet.
- D) Yellow.

T168) What is the <u>greatest</u> distance at which manholes should be installed for an 8-inch sewer line?

- A) 100 feet.
- B) 200 feet.
- C) 300 feet.
- D) 400 feet.

T169) Which of the following types of information should be recorded during TV inspection of a sewer?

- A) Amount of material removed in cubic feet.
- B) Distance from manhole to recorded observations.
- C) Volume of water used.
- D) All of the above.

T170) Disaster planning is

- A) Having manuals ready so they can be read if a disaster occurs.
- B) Something that, if properly done, will not need to be revised.
- C) Useful in reducing confusing in the event of a disaster.
- D) None of the above.

T171) The best discipline is

- A) Authoritarian.
- B) General supervisory.
- C) Self-discipline.
- D) Theocratic.

T172) Duties assigned to an industrial waste section include

- A) Attempting to locate and/or identify sources of wastes that upset water treatment plants.
- B) Collect data and make recommendations regarding sewer-use ordinance violations by industries.
- C) Inspecting discharges into collection system.
- D) All of the above.

T173) Staffing a new system should be viewed primarily as the function of

- A) Every operator.
- B) Personnel department.
- C) They employee.
- D) The supervisory management.

T174) Organization charts are helpful to show

- A) How the collection system is organized.
- B) How to locate sewers
- C) The structure of an agency
- D) The way to select solutions to problems.

T175) Decentralization of organization refers to

- A) Nominating new supervisors
- B) Looking at all positions, and possibly redelegating authority.
- C) Firing all employees and hiring new ones.
- D) Eliminating some departments.

T176) Which one of the following would not be considered a natural event?

- A) Explosion.
- B) Flood.
- C) Lightning.
- D) Tornado.

T177) A worker notices that a necessary piece of equipment is defective. The current job needs to be finished as soon as possible. The worker should

- A) Consult with the other employees and reach a consensus agreement on what to do.
- B) Continue the job but be cautious while using the defective equipment.
- C) Report the defect but hold off completing the job until the equipment is repaired of replaced.
- D) Stop all work and wait for the boss to come by the job site and make a decision.

T178) The essence of control is

A) Written records.
B) Testing.
C) Evaluation.
D) Action.

T179) While evaluating an applicant for employment, which of the following may enter into your decision?

A) Age.
B) Education level.
C) Minority classification.
D) All of the above.

T180) Public relations are important because we

A) Like our jobs.
B) Need lots of training.
C) Want to finish our work in a hurry
D) Work for the public.

T181) The best way to record all work done is through

A) closed circuit TV.
B) Polaroid system.
C) Tape recorder.
D) Work order system.

T182) The most important function of record-keeping is

A) They record how much money was budgeted and how much we spent.
B) They record the past and provide a sound basis on which to plan the future.
C) The record what was done and when it was done.
D) They record where we've been and how we got where we are today.

T183) The presence of hydrogen sulfide in a collection system is usually caused by the

A) Bacterial oxidation of sulfur in the presence of dissolved oxygen.
B) Bacterial reduction of methane in the absence of dissolved oxygen.
C) Bacterial reduction of methane in the presence of dissolved oxygen.
D) Bacterial reduction of sulfate compounds in the absence of dissolved oxygen.

T184) Which of the following rules apply to the operation of gas or electric welding equipment?

A) Adequate fire protection must be provided.
B) Operators must be thoroughly trained.
C) Protection of other personnel must be provided and used.
D) All of the above.

T185) Upon investigating a complaint of bad odors around a catch basin, you find that the trap and water level appear to be in good order. The proper next step is to

A) Add 7.5 to 10 lbs of quicklime to the basin daily until the odor diminishes.
B) Ask residents to stay away from the catch basin area.
C) Flush the basin with fresh water.
D) Rod and then ball the connection from the catch basin to the sewer.

T186) Which of the following is <u>not</u> typical of a "submersible" pump?

A) Can be installed in a crooked hole.
B) Minimizes vandalism.
C) Quieter operation.
D) Requires water lubrication.

T187) Possible types of atmospheric hazards found in manholes include

A) Explosion.
B) Oxygen deficiency.
C) Toxic gas.
D) All of the above.

T188) The flushing water pressure in a water-lubricated wastewater pump should be _____the pump discharge pressure.

A) 10 psi less than
B) 5 psi less than
C) 5 psi more than
D) 10 psi more than

T189) Given the following data, what is the <u>most</u> likely cause of the mechanically cleaned bar screen problem?

DATA:
Above normal water differential across bar screen.
Drive motor shaft turning.
Drive sprocket, chain, rake not moving.
Less than normal flow on bar screen downstream side.
Bar screen mode selector in automatic position.
Normal seasonal flow (influent) coming into bar screen.
Alarm systems operating normally.

A) Low influent (incoming) level.
B) Raw wastewater pumping units out of service.
C) Sheared pin or disengaged clutch on drive unit.
D) None of the above.

T190) Given the data below, what is the most likely cause of the lift station problem?

DATA: Wet well inlet is normal for dry weather flow
Wet well is alternating between excessively high & low levels.
Lead pump starts at right level, level continues to rise, pump stops at right level
Lead pump check valve arm remains stationary in lowered position when pump starts & stops
Lag pump check valve arm rises when lag pump starts & lowers when it stops.
Force main pressure remains the same when lead pump runs, but increases when lag pump runs. Level drops when lag pump runs.
Low-level pressure switch normal
High-level pressure switch normal
Electrical controls are all in automatic.

A) Lead pump clogged
B) Force main pressure too high
C) Lag pump is air-bound
D) Both Pumps clogged

T191) Given the data below, what is the most likely cause of the lift station problem?

DATA: Wet well inlet has increased because of rain.
Wet well drops normally from for weather conditions, but rises much more rapidly than normal.
Lead pump cycles on & off at right levels, but faster than normal.
Lag pump cycles on & off at right levels, but faster than normal.
Lag pump motor shaft turns backwards when off.
Force main pressure increases with both pumps on & drops very low when lead pump runs.
Level system is reading correctly.
Electrical controls are all in automatic.

A) Check valve on lag pump is clogged.
B) Lag pump check valve stuck closed.
C) Lead pump check valve stuck closed.
D) Check valve on lead pump is clogged.

T192) Given the data below, what is the most likely cause of the lift station problem?

DATA: Wet well inlet has normal dry weather flow.
Wet well is erratic with alternating excessively high & low levels.
Lead pump starts & stops erratically.
Lag pump starts & stops erratically.
Lead & lag pumps both have normal flow rates.
Force main pressure is erratic with alternating high & low pressures.
Lead air compressor running.
Low-level pressure switch is erratically opening & closing.
Malfunctioning high level pressure switch is erratically opening & closing.
Electrical controls are all in automatic.

A) Malfunctioning air bubbler system is casing erratic wet well influent.
B) Malfunctioning level control is casing pumps to run constantly.
C) Malfunctioning level control is casing pumps to run out of phase.
D) Malfunctioning level control is casing lead-lag sequence switch to be broken.

T193) Which of the following are accepted means for applying herbicides to control roots in wastewater collection

- A) Aeration
- B) Foaming
- C) Stem injection
- D) All of the above.

T194) Velocity may be sensed

- A) Electrically
- B) Hydraulically
- C) Mechanically
- D) All of the above

T195) Using water on a gas chlorine leak will

- A) Form sodium hypochlorite, which can explode.
- B) Make the leak worse.
- C) Neutralize the chlorine.
- D) Sop the leak.

T196) What prevents any solution or water from backing up into the chlorine line?

- A) Release valve
- B) Check valve
- C) Auxiliary valve
- D) Blow-off valve

T197) Important considerations when reviewing the plans for a lift station include:

- A) Access
- B) Industrial development potential
- C) Trench soil conditions and availability of suitable materials
- D) All of the above

T198) Given the data below, what is the <u>most</u> likely cause of the problem?

DATA: Wet well inlet is normal for dry weather flow
Lead pump amperage is lower than normal
Lead pump starts at right level, level continues to rise.
Lead pump check valve arm remains stationary in lowered position when pump starts & stops
Lag pump check valve arm rises when lag pump starts & lowers when it stops.
Force main pressure remains the same when lead pump runs, but increases when lag pump runs.
Level drops when lag pump runs.
Rattling noise coming from lead pump
Low-level pressure switch normal
High-level pressure switch normal
Electrical controls are all in automatic.

- A) Lag pump clogged
- B) Force main pressure too high
- C) Lag pump is air-bound
- D) Lead pump air-bound

T199) Which of the following are appropriate uses of closed-circuit television by wastewater collection system workers?

A) Chemical addition
B) Evaluating effectiveness of sewer cleaning & clearing techniques
C) Removing sources of infiltration
D) All of the above

T200) Emergency stoppages in pipelines may be cleared safely by use of

A) Bar screens
B) High velocity cleaners
C) TV cameras
D) All of the above

T201) Which of the following would be the safest action to take in the event of a major chlorine container leak?

A) Call the fire department to hose down the container.
B) Notify local police or sheriff.
C) Roll the container so that liquid, rather than gas escapes.
D) Submerge the container in a basin or stream if feasible.

T202) Ideally, the pH meter should be standardized

A) Before each use
B) Weekly
C) Monthly
D) Once

T203) In the steps of the decision-making process, which step utilizes outside influences, such as experience, the most?

A) Analyzing the problem
B) Defining the problem
C) Defining alternatives
D) Selecting one alternative

T204) If you were in charge of a large operation with four foremen, three whose work was exceptionally good and a fourth whose work was substandard, what should you do?

A) Demote the substandard Forman and bring up a replacement from the ranks
B) Discuss the problem with the substandard Forman and offer to help before any other action is taken.
C) Find a replacement, then fire the substandard Forman.
D) Wait to see if the substandard Forman does better.

T205) Which of the following items is not to be considered in the budget for a utility?

A) Anticipated costs due to labor & maintenance.
B) Anticipated revenues
C) Costs of street maintenance.
D) Insurance

T206) Which of the following are reasonable or valid objectives of a cost accounting program for a wastewater utility?

A) Identify methods or measures for controlling increases in operating costs.
B) Provide data for budget development and preparation.
C) Provide data that helps in making decisions about making repairs verses replacement of equipment.
D) All of the above.

T207) When Brian asks a question in class, you should,

A) Insult him behind his back. He does kind of smell.
B) Throw things at him!
C) Yell out the wrong answer!
D) Shut up unless he says your name.

T208) There are two components involved with the managerial functions and reporting to a higher authority.

A) Performing all of the managerial functions and reporting to a higher authority.
B) Performing all of the managerial functions and possessing authority.
C) Performing all of the managerial functions is the only requirement.
D) Possessing authority is the only requirement.

T209) Scientific decision-making tends to refer to

A) Using computer techniques on quantifiable information
B) Problem-solving in a particular order.
C) Experimentation.
D) Consulting a scientist.

T210) Which of the following is <u>not</u> part of a good public relations program?

A) Concise and easy to understand billing.
B) Encouraging visits to the plant.
C) Prompt response to consumer complaints.
D) Referring all complaints to the manager.

T211) Getting the facts is the first step in what part of the process?

A) Development of alternatives
B) Problem analysis
C) Problem definition
D) Selection of alternatives

T212) When an employee breaks the rules and requires discipline, who is responsible for administering it?

A) Fellow employees
B) Personnel office
C) Supervisor
D) Upper management

T213) In order to budget a certain number of personnel, an operator should know the amount of "backlog" work, the rate at which it increases, and how to apply _____ to determine total.

A) Job standards
B) Pay scales
C) Time
D) Work orders

T214) You are notified that a semi-truck was involved in an accident 5 miles upstream from the treatment plant. Storm water inlets to the combined wastewater collection system are receiving a large quantity of an unknown chemical. What is the first action that would be taken?

A) Determine type of chemical from shipper
B) Evacuate all homes in the vicinity of the sewer
C) Immediately instruct treatment plant to start bypassing wastewater.
D) Warn downstream treatment plant

T215) A mechanical ventilation system for the wet well portion of a lift station which operates continuously should be able to exchange the air in the wet well_____ times an hour

A) 6
B) 20
C) 30
D) 60

T216) Proper selection of an emergency lighting unit for a particular location requires careful consideration of

A) Costs
B) Lighting requirements
C) Types of batteries
D) All of the above

T217) In keeping records,

A) Every test result should be included in an annual report.
B) Poor records are better than no records
C) Records should be destroyed every two years.
D) Records should be kept up-to-date and maintained as long as they are useful.

T218) Collection system maintenance programs include _____

A) Emergency
B) Operation
C) Public
D) None of the above

T219) Recruiting of new utility employees falls within which category?

A) Directing
B) Organizing
C) Planning
D) Staffing

T220) O.U.P.S. must be notified_____ before a sewer excavation can begin

- A) 48 hours
- B) 30 days
- C) 10 days
- D) 24 hours

T221) The managerial function which includes the guiding, teaching, motivating and supervising of treatment plant shift operators is

- A) Staffing
- B) Planning
- C) Organizing
- D) Directing

T222) The bottom of a water line crossing above a sewer line must be_____ from the crown of the sewer.

- A) 18 inches
- B) 10 feet
- C) 24 inches
- D) 3 feet

T223) A trench above_____ must have proper shoring

- A) 5 feet deep
- B) 6 feet deep
- C) 50 feet long
- D) a gas line

T224) Before any excavation can be done, you must notify_____.

- A) The Ohio EPA
- B) The Ohio Department of Transportation
- C) The County sewer Department
- D) The Ohio Utilities Protection Service

T225) A(n) _____ is required for any CSO outfall pipe.

- A) Netting facility
- B) Outfall flow meter
- C) NPDES Permit
- D) Monthly inspection

T226) What is the minimum distance from the edge of the spoils to the edge of the trench

- A) 10 feet
- B) 18 inches
- C) 2 feet
- D) 6 feet

T227) According to "Ten State Standards" When a sewer is installed parallel to a water line, it must be a minimum of _____ away (measured from the outside diameters)

- A) 6 feet
- B) 48 inches
- C) 36 inches
- D) 10 feet

T228) All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of

- A) 1:1
- B) 4 feet
- C) 20 feet
- D) 1 1/2:1

T229) An engineer must approve any trench shoring design above

- A) 4 feet deep
- B) A water line
- C) 50 feet in length
- D) 20 feet deep

T230) Given the data below, what is the most likely cause of the lift station problem?

DATA: Wet well inlet is normal
Well drops normally when pump #1 is running
Well level rises slowly when pump #2 or pump #3 is running
Run amperage is the same for all three pumps
One of the pump motors turn backwards when off.
Level system is reading correctly.
Electrical controls are all in automatic.

- A) Pump #1 & #2 are air-bound
- B) Pump #1 check valve stuck open.
- C) Either pump #1 or #2 is wired backwards
- D) Check valve on pump #3 is clogged.

T231) Any excavation over _____ must have a ladder for the worker to get in and out of the trench

- A) 25 feet long
- B) 4 feet deep
- C) 8 feet deep
- D) 3 feet wide

T232) In a trench deep enough to require a ladder(s), the worker must not be required to travel more than _____ to get to the ladder

- A) Three steps
- B) 10 feet
- C) 25 feet
- D) 15 feet

T233) Shoring must protude _____ above the top of the excavation.

- A) 3 feet
- B) 24 inches
- C) 18 inches
- D) 1 foot

T234) A device used to test the percent deflection in a sewer pipe between manholes is known as what?

- A) Mandrel Assembly
- B) Poly Pig
- C) Air Plug
- D) Laser

T235) What is not the cause of grease build up in a sewer?

- A) Inorganic wastewater
- B) Dip in pipe
- C) Low velocity
- D) Bad Grade

T236) What will not solve an odor problem in a sewer?

- A) Sulfuric Acid
- B) Hydrogen Peroxide
- C) Chlorine
- D) Aeration

T237) What is the purpose of a mandrel?

- A) Hydrostatic test
- B) Manhole test
- C) Deflection test
- D) Sewer taps

T238) What would be the best pipe material to use for sewer flows containing sulfuric acid?

- A) Vitrified clay
- B) Poly-ethelyne pipe
- C) Concrete lined pipe
- D) Cast iron pipe

T239) xxx

- A) x
- B) x
- C) x
- D) x

T240) xxx

- [ ] A) x
- [ ] B) x
- [ ] C) x
- [ ] D) x

T241) xxx

- [ ] A) x
- [ ] B) x
- [ ] C) x
- [ ] D) x

T242) xxx

- [ ] A) x
- [ ] B) x
- [ ] C) x
- [ ] D) x

T243) xxx

- [ ] A) x
- [ ] B) x
- [ ] C) x
- [ ] D) x

Math Answer Key

1) B
2) C
3) D
4) A
5) D
6) B
7) B
8) D
9) D
10) C
11) A
12) C
13) A
14) C
15) A
16) D
17) B
18) B
19) A
20) D
21) D
22) A
23) B
24) B
25) D
26) C
27) C
28) B
29) A
30) D
31) A
32) B
33) C
34) B
35) A
36) A
37) C
38) B
39) D
40) C
41) A
42) B
43) B
44) C
45) B
46) D
47) B
48) B
49) C
50) D
51) A
52) A
53) C
54) B
55) A
56) B,C
57) A

Add-on Math

58) B
59) C
60) D
61) A
62) D
63) X
64) B
65) D
66) D
67) C
68) A
69) C
70) A
71) C
72) A
73) D
74) B
75) B
76) A
77) D
78) D
79) A
80) B
81) B
82) D
83) C
84) C
85) B
86) D
87) D
88) A
89) B
90) C
91) B
92) A
93) A

Challenge Questions

C1) B
C2) C
C3) D
C4) A
C5) D
C6) B
C7) B

Theory Answer Key

T1) C
T2) D
T3) D
T4) B
T5) A
T6) C
T7) C
T8) C
T9) A
T10) C
T11) D
T12) A
T13) B
T14) B
T15) A
T16) D
T17) D
T18) D
T19) A
T20) C
T21) A
T22) C
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T24) C
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T26) C
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T28) A
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T210) D
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T212) C
T213) A
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T215) A
T216) D
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T228) D
T229) D
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T231) B
T232) C
T233) C
T234) A
T235) A
T236) A
T237) C
T238) B
T239) B
T240) B
T241) B
T242) B
T243) D

NOTES