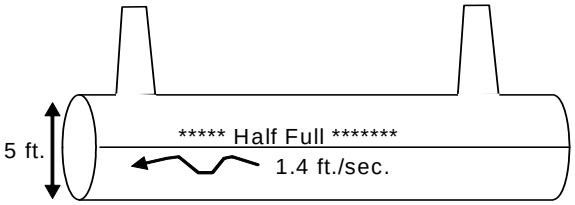
1) A 54 in. storm sewer flowing half full, at a velocity of 1.35 Ft./sec., will discharge how much flow into a creek in MGD?

[ ]	a)	13.85	MGD	
[ ]	b)	10.73	MGD	
[ ]	c)	1.85	MGD	
[X]	d)	6.92	MGD	**Right**

FORMULAS NEEDED;

Area of Pipe = D^2 x .785 $Ft^3/sec.$ = 1.55 x MGD



Calculate the Area of the Pipe; 54 in. pipe = 5 ft.

D^2 x .785

5 ft. x 5 ft. x .785 = 15.8963 ft^2

x 1.35 f/s ← **Multiply by the Velocity to get flow in ft^3/sec**

21.46 ft^3/sec

Divide ft^3/sec. by 1.55 to convert to MGD

$\frac{21.46\ ft^3/sec}{1.55}$ = 13.85 MGD ← This is the full pipe flow. This pipe is only half full. **Divide the flow in half.**

$\frac{13.85\ MGD}{2}$ = **6.92 MGD = "D"**

2) Shoring must protude _____ above the top of the excavation.

	[ ]	A)	3 feet
	[ ]	B)	24 inches
Right	[X]	C)	18 inches
	[ ]	D)	1 foot

3) A degreasing agent is added to a 16.0 ft. diameter wet well that is 18.4 ft. deep. 4.5 lbs. is required for every 1 ft^2 of surface area. If the degreaser weighs 8.5 lbs. per gallon and has a concentration of 13.8 mg/l , how many lbs. Of chemical must be added to the well?

	a) 16,639.5 lbs.
	b) 0.78 lbs.
	c) 6,764.3 lbs.
X	d) 904.3 lbs. **Right!.**

FORMULAS NEEDED;

area of a circle = D^2 x .785

1) Calculate the surface area of the well;

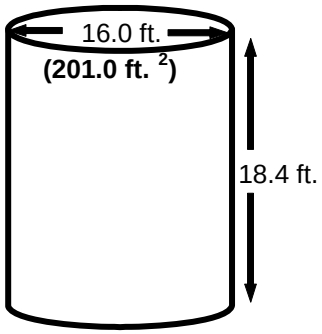
area of a circle = D^2 x .785

= 16.0 ft. x 16.0 ft. x x .785 = 201.0 ft^2

2) Multiply the required dosage by the surface area;

201.0 $ft.^2$ x 4.5 lbs./$ft.^2$ = **904.3 lbs.** **="D"**

None of the other information is needed



4) 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
Right	X	C) 25 feet
		D) 15 feet

5) What is the detention time in hours in a tank measuring 312 ft. x 97 ft. x 86 ft. , if the tank receives 945,023 GPH?

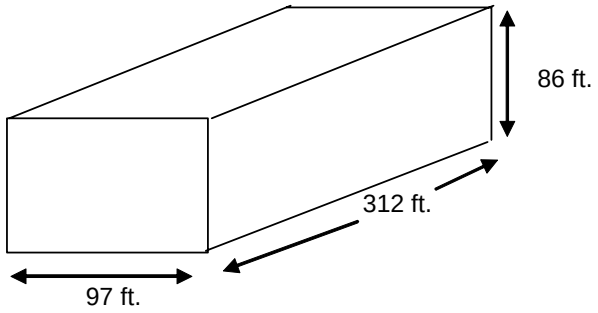
	a) 22.97 Hours
	b) 2.75 Hours
X	c) 20.60 Hours **Right**
	d) 12.36 Hours

FORMULAS NEEDED;

$1\ ft^3 = 7.48$ Gallons

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

945,023 Gal./Hr. → **or** → Inflow →



Convert from gallons to ft^3;

$$\frac{945{,}023\ \text{Gal./Hr.}}{7.48\ \text{gal./ft.}^3} = 126{,}340\ \text{cu.ft./hr.}$$

Calculate tank Volume;

Volume = L x W x H

= 312 ft. x 97 ft. x 86 ft.

= 2,602,704 ft. ^{3}

Use flow formula to calculate hours;

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

$$126{,}340\ \text{ft.}^3\text{/hr.} = \frac{2{,}602{,}704\ \text{ft.}}{\text{Time}}$$

$$\text{Time} = \frac{2{,}602{,}704\ \text{ft.}}{126{,}340\ \text{ft.}^3\text{/hr.}}$$

= 20.60 Hrs. "C"

6) Any excavation over _____ must have a ladder for the worker to get in and out of the trench

		A) 25 feet long
Right	X	B) 4 feet deep
		C) 8 feet deep
		D) 3 feet wide

7) A wet well is 9 feet deep by 21 feet in diameter. When the pump is not running, the water rises 33.4 in. in 3 min. 14 sec. If the level falls 4.5 in. in 10.3 min. while the pump is running, what is the pump rate in GPM?

	a) 2,135 Gal./Min.
X	b) 2,323 Gal./Min. **Right**
	c) 2,380 Gal./Min.
	d) 6,801 Gal./Min.

FORMULAS NEEDED;

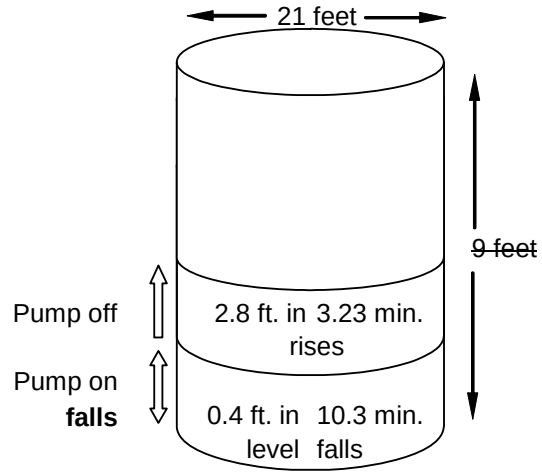
Volume of Cylinder = D^2 x .785 x Depth 1 ft.^{3} = 7.48 Gal.

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

Simplify;

33.4 in. **= 2.8 ft.**
4.5 in. **= 0.4 ft.**

$$3 \text{ min}, + \left\{\frac{14 \text{ sec.}}{60 \text{ sec/min}}\right\} = 3.23 \text{ min.}$$



Calculate inflow with the pump off;

Volume of Cylinder = D^2 x .785 x Depth
= 21 ft. x 21 ft. x .785 x 2.8 ft.
= 963.55 ft.^{3}
Convert to gallons;
= 963.55 ft.^{3} x 7. 48 gal/ft^3 = 7,207.34 Gal.

$$\text{Flow} = \frac{\text{Volume}}{\text{Time}} \qquad \text{Flow} = \frac{7{,}207.34 \text{ Gal.}}{3.23 \text{ min.}}$$

= 2,229 Gal./Min. (Inflow)

Calculate change in volume with the pump on;

Volume of Cylinder = D^2 x .785 x Depth
= 21 ft. x 21 ft. x .785 x 0.4 ft.
= 129.82 ft.^{3}
Convert to gallons;
= 129.82 ft.^{3} x 7. 48 gal/ft^3 = 971.05 Gal.

$$\text{Flow} = \frac{\text{Volume}}{\text{Time}} \qquad \text{Flow} = \frac{971.05 \text{ Gal.}}{10.30 \text{ min.}}$$

= 94 Gal./Min.

Add or subtract the change in volume to the inflo

The level falls when the pump is on.
This means the pump is keeping up add the
to the 2,229 GPM Inflow.

2,229 GPM
\+ 94 GPM
2,323 GPM = "B"

8) 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
Right	X	B) Pump #1 check valve stuck open.
		C) Either pump #1 or #2 is wired backwards
		D) Check valve on pump #3 is clogged.

9) Sewer “A” has 106,000 people at 95 GPCD. Sewer "B" has 94,875 people at 100 GPCD. Sewer “C” has 88,756 people at 90 GPCD. What percent of the flow is due to I&I if the total plant flow is 43.00 MGD?

- [ ] a) 43.1%
- [ ] b) 64.1%
- [ ] c) 51.2%
- [X] d) 35.9% **Right**

FORMULAS NEEDED:

GPCD = Gallons Per Capita Per Day

Add up known flows;

Sewer “A”		10,070,000 Gal./Day
Sewer "B"		9,487,500 Gal./Day
Sewer “C”	+	7,988,040 Gal./Day
		27,545,540 Gal./Day

Subtract know flows from the plant flow to get to get I & I;

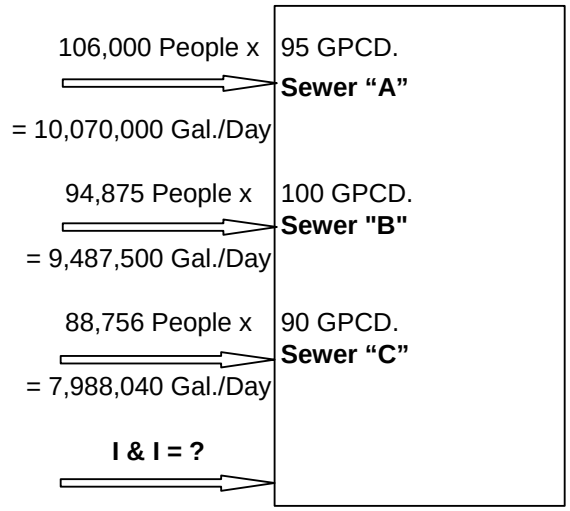
		43,000,000 Gal./Day
	-	27,545,540 Gal./Day
		15,454,460 Gal./Day (I & I)

Divide I & I flow by the plant flow & multiply by 100;

$$\frac{15{,}454{,}460 \text{ Gal./Day}}{43{,}000{,}000 \text{ Gal./Day}} \times 100 = \textbf{35.9\%} \quad \textbf{="D"}$$

** Before picking your answer, look at your I & I flows, does 15,454,460 Gal./Day I & I look like it might be 35.9% of 43,000,000 Gal./Day plsnt flow? If not, you probably divided by the wrong number.

Plant Flow = 43,000,000 Gal./Day (43.00 MGD)



10) An engineer must approve any trench shoring design above

- [ ] A) 4 feet deep
- [ ] B) A water line
- [ ] C) 50 feet in length
- Right [X] D) 20 feet deep

11) 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
Right X	D)	1 1/2:1

12) A certain town's household flow rate is measured at 90 GPCD. If the plant receives 34.25 MGD, but 12% of that is inflow & infiltration, then what is the population of the town?

X	a)	334,889 People **Right**
	b)	45,667 People
	c)	3,699,000 People
	d)	256,875 People

FORMULAS NEEDED; GPCD = Gallons per capita per day

If you have 12% I&I, then 88% of the flow is from people (Assuming no industry)
34,250,000 Gal./Day x 88% = 30,140,000 Gal./Day (from People)

If each person uses 90 Gal./Day, then

$$\frac{30{,}140{,}000}{90\ \text{GPCD.}} = 334{,}889\ \text{People} = \text{'A'}$$

13) 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
Right x	D)	10 feet

14) What is the minimum distance from the edge of the spoils to the edge of the trench

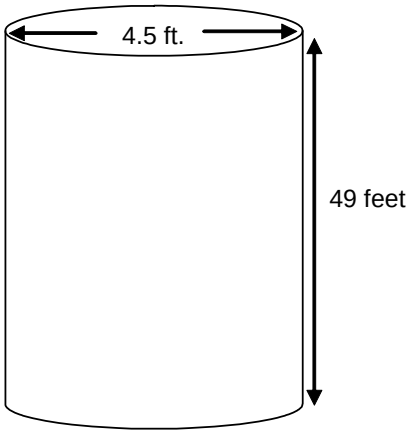
	A)	10 feet
	B)	18 inches
Right X	C)	2 feet
	D)	6 feet

15) What capacity blower is required to ventilate a manhole 54 in. in diameter and 49 feet deep, if 8 air change(s) are required every 60 minutes?

	a)	13	Ft^3/Min.	
X	b)	104	Ft^3/Min.	**Right**
	c)	6231	Ft^3/Min.	
	d)	249	Ft^3/Min.	

FORMULAS NEEDED;

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



Convert inches to feet;

$$\frac{54 \text{ in.}}{12 \text{ in./ft.}} = 4.5 \text{ ft.}$$

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

4.5 ft. x 4.5 ft. x .785 x 49 ft. = 778.9 $Ft.^3$

Formula;

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

$$= \frac{778.9 \text{ Ft.}^3}{60 \text{ min.}}$$

$$= 13.0 \text{ Ft.}^3$$

Multiply ft3/min x Number of air changes required;

13.0 $Ft.^3$/Min x 8 Air Changes Req'd = 104 $Ft.^3$/Min ="B"

16) A(n) _____ is required for any CSO outfall pipe.

	A)	Netting facility
Right X	B)	NPDES Permit
	C)	Outfall flow meter
	D)	Monthly inspection

17) Shoring must protude _____ above the top of the excavation.

	A)	3 feet
	B)	24 inches
	C)	1 foot
Right X	D)	18 inches

18) A wastewater treatment plant receives the following:

Pump Station	=	6,500 GPM	
Sewer "A"	=	70,000 People	@ 100 GPCD
I&I	=	50,000 gal/day	
Ind. Waste	=	92,000 gal/day	
Sewer "B"	=		

If the plant receives 21.5 MGD, what percentage of the total flow is contributedby sewer "B"?

	a) 69.7%
	b) 30.3%
	c) 76.8%
X	d) 23.2% **Right**

FORMULAS NEEDED;

GPCD = Gallons Per Capita Per Day

Add up known flows;

Pump Station		9,360,000 Gal./Day
Sewer "A"		7,000,000 Gal./Day
I&I		50,000 Gal./Day
Ind. Waste	+	92,000 Gal./Day
		16,502,000 Gal./Day

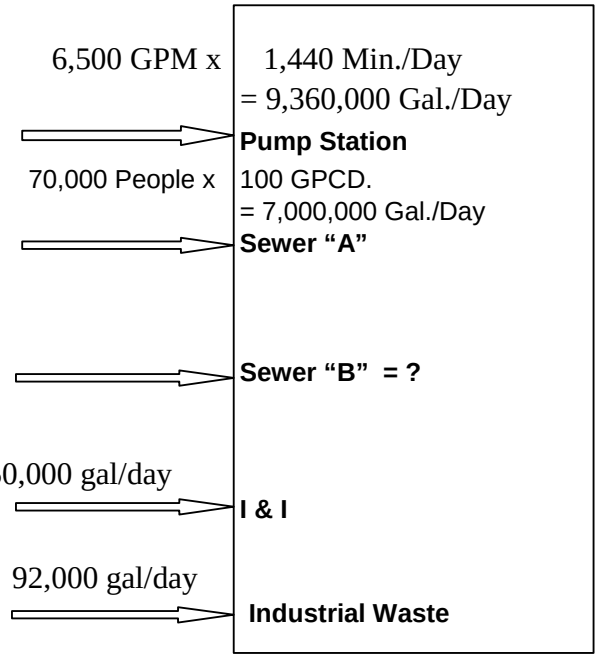
Subtract know flows from the plant flow to get to get Sewer 'B';

	21,500,000 Gal./Day
-	16,502,000 Gal./Day
	4,998,000 Gal./Day (Sewer "B")

Divide I & I flow by the plant flow & multiply by 100;

$$\frac{4{,}998{,}000 \text{ Gal./Day}}{21{,}500{,}000 \text{ Gal./Day}} \times 100 = \textbf{23.2\%} \quad \textbf{="D"}$$

Plant Flow = 21,500,000 Gal./Day (21.50 MGD)



** Before picking your answer, look at your I & I flows, does 4,998,000 Gal./Day I & I look like it might be 23.2% of 21,500,000 Gal./Day plsnt flow?
If not, you probably divided by the wrong number.

19) Before any excavation can be done, you must notify_____.

		A) The Ohio EPA
		B) The Ohio Department of Transportation
		C) The County sewer Department
Right	X	D) The Ohio Utilities Protection Service

20) The bottom of a water line crossing above a sewer line must be_____ from the crown of the sewer.

Right	X	A) 18 inches
		B) 10 feet
		C) 24 inches
		D) 3 feet

21) 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.
Right	X	D) Records should be kept up-to-date and maintained as long as they are useful.

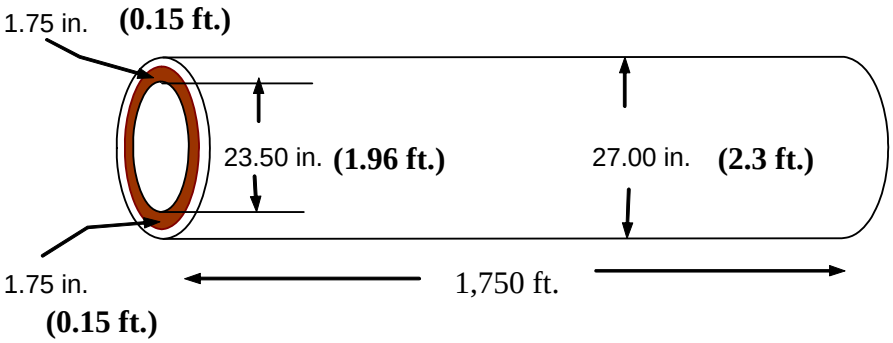
22) The interior of 1,750 ft. of 27 in. pipe is uniformly coated with 1.75 in. of grease. How many gallons will this pipe hold when filled with water?

X	a) 39,408 Gal.	**Right**
	b) 9,337,556 Gal.	
	c) 43,939 Gal.	
	d) 7,329,982 Gal.	

FORMULAS NEEDED;

1 FT.^{3} = 7.48 Gallons

Vol. Of a Cylinder = D^2 x .785 x L



Subtract the grease from the diameter for new diamerter;

(Because the grease is on both sides, it must be subtracted twice)

2.25 ft. - .15 ft. - .15 ft. = 1.96 ft.

Calculate the Volume of the Pipe:

Vol. Of a Cylinder = D^2 x .785 x L

= 1.96 ft. x 1.96 ft. x .785 x 1,750 ft. = 5,268.43 ft.^{3}

Convert ft^3 to Gallons;

1 FT.3 = 7.48 Gallons

5,268.43 ft. x 7.48 = **39,408 Gal.** **= "A"**

23) Colored dye is dumped into a manhole. The dye first appears 3 min., 32 sec. later in a manhole 975 feet downstream and disappears 7 min. and 55 sec. after the dye was first dumped into the manhole. What is the velocity of the flow in the sewer?

	a) 2.05 Ft./Sec.
X	b) 2.84 Ft./Sec. **Right**
	c) 4.60 Ft./Sec.
	d) 0.70 Ft./Sec.

FORMULAS NEEDED;

$$\text{velocity} = \frac{\text{Distance}}{\text{Time}}$$

Convert Min., Sec. To Seconds;

Dye first appears:

3 min., 32 sec. =

3 min. x 60 sec./min. = 180 sec.

+ 32 sec.

212 sec.

Dye disappears:

7 min., 55 sec. =

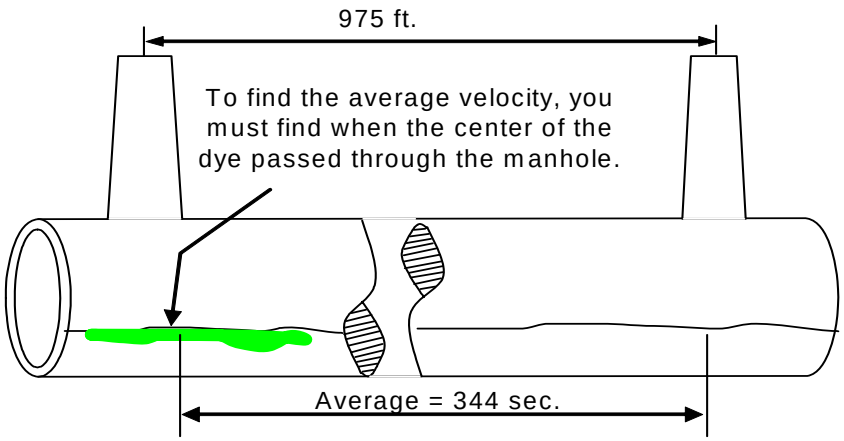
7 min. x 60 sec./min. = 420 sec.

+ 55 sec.

475 sec.

Average theStart & finish times;;

$$\frac{212 \text{ sec.} + 475 \text{ sec.}}{2} = 344 \text{ sec.}$$



Use the formula to calculate the velocity;

$$\text{velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\frac{975 \text{ ft.}}{344 \text{ sec.}} = 2.84 \text{ ft./sec.} \quad = \text{"B"}$$

24) 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

Right	X	A) 6
		B) 20
		C) 30
		D) 60

25) A tanker truck was involved in an accident a few 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?

Right [X] 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

26) A 480 v AC pump motor draws 27 amps, What is the horsepower output of the motor if the power factor is .77 and the pump efficiency is 81% ?

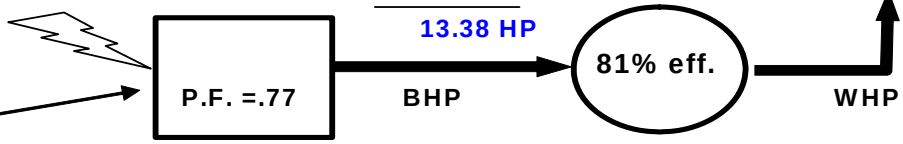
[ ] a) 10.84 HP
[ ] b) 14.07 HP
[X] c) 13.38 HP **Right**
[ ] d) 17.37 HP

FORMULAS NEEDED;
1 hp = 746 Watts
Amps x Volts = Watts

2) Calculate Watts;
Amps x Volts = Watts
27 a x 480 v = 12,960 Watts

3) Convert Watts to HP;
1 hp = 746 Watts
$\frac{12{,}960 \text{watts}}{746 \text{ Watts/HP}}$ = 17.4 HP

4) Calculate BHP
17.37 HP
x .77 P.F. ="B"
13.38 HP



27) What is the greatest distance at which manholes should be installed for an 8-inch sewer line?

[ ] A) 100 feet.
[ ] B) 200 feet.
Right [X] C) 300 feet.
[ ] D) 400 feet.

28) "Hz" stands for

Right [X] A) Cycles per second.
[ ] B) Hand control.
[ ] C) Horizontal phase.
[ ] D) Polyphase.

29) 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.
Right X	D) All of the above.

30) A pump has an efficiency of 80% and a motor has a power factor of .91. If the water horsepower is 213 HP and electricity has a cost of 12.3 cents per KWH, how much will it cost to run the pump for one month, (30 days) at 11.5 hrs./day?

X	a) $9,262.14 /mo.	Right
	b) $7,409.71 /mo.	
	c) $1,907.29 /mo.	
	d) $4,975.53 /mo.	

FORMULAS NEDED;

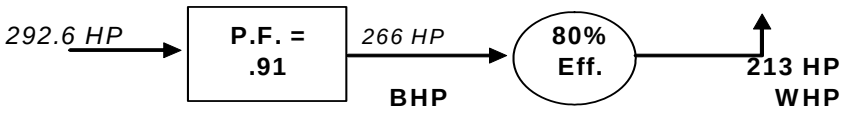
1 HP = 746 Watts *or* 1 HP = .746 KW

1) Convert WHP to Brake HP;

$\frac{213\ HP}{.80}$ = 266.3 HP

2) Convert BHP to Wire HP;

$\frac{266\ HP}{.91}$ = 292.6 HP



3) Convert Wire HP to KW (Kilowatts);

1 HP = .746 KW

292.6 HP x .746 KW per HP = 218.3 KW

3) To find the Cost, multiply KW x Hrs. x $/hr. x Days

218.3 KW x 11.5 hrs./day x .123 cents/KW x 30 days/month = **$ 9,262.14 per mo. = "A"**

31) Ideally, the pH meter should be standardized

Right X	A) Before each use
	B) Weekly
	C) Monthly
	D) Once

32) An automatic chemical feeder treats 67 MGD at a concentration of 73 mg/l. How many lbs./day of chemical is required?

	a) 5,453 lbs./day
	b) 36,585 lbs./day
X	c) 40,791 lbs./day **Right**
	d) 4,387 lbs./day

FORMULAS NEEDED;

lbs./day = MGD x mgl x 8.34

1) Use formula to Calculate lbs./day;

lbs./day = MGD x mgl x 8.34

= 67 MGD x 73 mg/l. x 8.34

= **40,791 lbs./day**

="C"

33) 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.
Right	X	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.

34) Emergency stoppages in pipelines may be cleared safely by use of

		A) Bar screens
Right	X	B) High velocity cleaners
		C) TV cameras
		D) All of the above

35) Which of the following are appropriate uses of closed-circuit television by wastewater collection system workers?

		A) Chemical addition
Right	X	B) Evaluating effectiveness of sewer cleaning & clearing techniques
		C) Removing sources of infiltration
		D) All of the above

36) 35 mg/l. of chlorine is required to treat a flow of 55.3 MGD. The solution available to you, however, is only 81% of chlorine. How many lbs./day of solution are requires to treat the flow?

	a) 97,802 lbs./day
X	b) 19,928 lbs./day **Right**
	c) 16,142 lbs./day
	d) 1,172,681 lbs./day

FORMULAS NEEDED;

lbs./day = MGD x mgl x 8.34

1) Use formula to Calculate lbs./day;

lbs./day = MGD x mgl x 8.34

= 55 MGD x 35 mg/l. x 8.34

= 16,142 lbs./day

2) The solution is only 81% pure. You will need more;

How much more?

$$\frac{16{,}142 \text{ lbs./day}}{.81 \ (81\%)} = 19{,}928 \text{ lbs./day}$$

="B"

37) 61 mg/l. of root control must be added to a 66 in. sewer that is 3,125 feet long. If the root control chemical is in a solution that consists of only 41% of the chemical, how many lbs. of the solution must be added to the sewer?

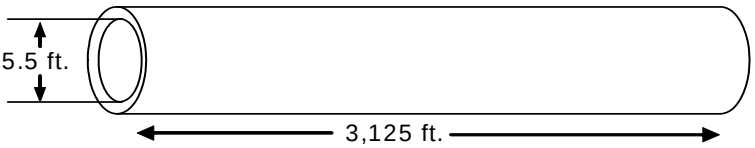
X	a) 688.75 lbs. **Right**
	b) 115.78 lbs.
	c) 767.93 lbs.
	d) 16,672.05 lbs.

FORMULAS NEEDED;

lbs./day = MGD x mgl x 8.34

Volume of a cylinder = D^2 x .785 x L

1 ft^3 = 7.48 Gallons



1) Calculate the Volume of Pipe, then convert to Million Gallons;

Volume of a cylinder = D^2 x .785 x L

5.5 ft. x 5.5 ft. x 3,125 ft. x .785 = 74,207 $ft.^3$

1 ft^3 = 7.48 Gallons

74,207 ft^3 x 7.48 gal./ft^3 = $\frac{555{,}069 \text{ gal.}}{1{,}000{,}000}$ = .56 MGD

2) Use formula to Calculate lbs./day;

lbs./day = MGD x mgl x 8.35

lbs./day = .56 MGD x 61 mg/l. x 8.34

lbs./day = 282 lbs./day

3) The chemical is only 41% pure. You will need more;

$$\frac{282 \text{ lbs./day}}{.41} = 688.75 \text{ lbs./day}$$

= "A"

38) Given the data below, what is the most 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
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
Right [X] D) Lead pump air-bound

39) 73 mg/l. of chemical was previously used to treat a flow of 85,500,500 gal./day. The chemical cost is $3.31 /lb. A chlorine residual test determined that 54 mg/l. of chemical would be satisfactory. How much money would be saved per month by using the 54 mg/l. dose instead of the 73 mg/l. dose? (1 mo. = 30 days)

[ ] a) $1,206,627.17 /mo.
[X] b) $1,345,357.04 /mo. **Right**
[ ] c) $5,169,003.35 /mo.
[ ] d) $3,823,646.31 /mo.

FORMULAS NEEDED;

lbs./day = MGD x mgl x 8.34

$$\frac{85{,}500{,}500 \text{ gal./day.}}{1{,}000{,}000} = 85.50 \text{ MGD}$$

1) Subtract the amount of chemical you are using from what you were previously using, to get the amount of chemical you are saving;

73 mg/l. - 54 mg/l. = 19 mg/l. (not used)

2) Use the chemical formula to determine how much the chemical "not used" would have costed;

lbs./day = MGD x mgl x 8.34
lbs./day = 85.50 MGD x 19 mg/l. x 8.34
lbs./day = 13,548.4 lbs./day

$$13{,}548.4 \text{ lbs./day} \times \frac{30 \text{ days}}{\text{Mo.}} \times \$3.31 \text{ /lb.} = \$\ 1{,}345{,}357.04 \text{ per month}$$

="B"

40) Important considerations when reviewing the plans for a lift station include:

Right [X] A) Access
[ ] B) Industrial development potential
[ ] C) Trench soil conditions and availability of suitable materials
[ ] D) All of the above

41) If the grade of a sanitary sewer has a slope of 0.80% for 445 feet, what is the rise of the pipe?

[ ] a) 448.6 Feet
[X] b) 3.56 Feet **Right**
[ ] c) 0.04 Feet
[ ] d) 0.36 Feet

FORMULAS NEEDED:

$$\text{SLOPE} = \frac{\text{RISE}}{\text{RUN}}$$

(Slope = 0.80% or .01)

$$.008 = \frac{\text{RISE}}{445 \text{ ft.}}$$

Slope =

.008 x 445 ft. = RISE
.008 x 445 ft. = **3.56 ft. = "B"**

42) What prevents any solution or water from backing up into the chlorine line?

[ ] A) Release valve
Right [X] B) Check valve
[ ] C) Auxiliary valve
[ ] D) Blow-off valve

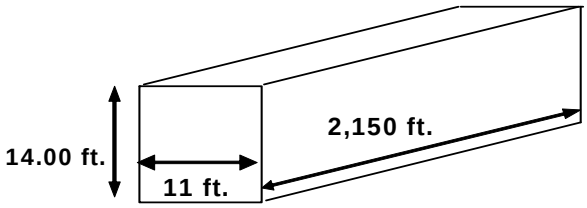
43) A(n) 11 ft. wide x 2,150 ft. long trench must be excavated and the spoils removed from the premises. The spoil weighs 2,344 lbs./cu. yd. and each truck can carry 13 tons. How many truck loads are required if the trench is 14.0 feet deep?

	a)	2,211 Trucks	
X	b)	1,106 Trucks	**Right**
	c)	3,316 Trucks	
	d)	1,105 Trucks	

FORMULAS NEEDED:

Volume of a rectangle = L x W x H

1 ton = 2,000 lbs. 1 $yd.^3$ = 27 $ft.^3$



1) Calculate the volume of the trench in (Yd^3);

Volume of a rectangle = L x W x H

Volume of a rectangle =

11 ft. x 14.00 ft. x 2,150 ft.

= 331,100 $ft.^3$

Convert to yd^3

$$\frac{331{,}100\ ft.^3}{27\ ft^3/yd^3} = 12{,}263\ \text{cu. yd.}$$

3) Calculate the wieght of fill in tons;

2,344 lbs./cu. yd x 12,263 cu. yds. = $\frac{28{,}744{,}385\ \text{lbs.}}{2{,}000\ \text{lbs./ton}}$ = 14,372.2 tons

4) Calculate the number of trucks;

$\frac{14{,}372.2\ \text{tons}}{13\ \text{tons/truck}}$ = 1,105.6 Trucks

You must round up to 1,106 Trucks or there will be .6 truckoads left over.

1,106 Trucks = 'C'

44) Estimate the total cost and cost per linear foot of a sewer construction project.
The project consists of installin 7 manholes and 3,275 feet of 36 inch sewer
Costs are estimated as shown below:

EXCAVATION AND BACKFILL_____	$	420.00	per foot
COST OF PIPE_____	$	397.23	per foot
MANHOLE + INSTALLATION_____	$	4,725.00	each

TOTAL JOB COST:

	a)	$	1,408,972.23	
	b)	$	1,334,003.25	
	c)	$	2,681,153.25	
X	d)	$	2,709,503.25	**Right**

COST PER LINEAR FOOT:

	a)	$407	
	b)	$819	
X	c)	$827	**Right**
	d)	$430	

TOTAL JOB COST;

1) Excavation and backfill of trench.
420.00 per ft. x 3,275 ft. = $ 1,375,500.00
2) Cost of pipe.
397.23 per ft. x 3,275 ft. = $ 1,300,928.25
3) Cost of manholes.
7 manholes x 4,725 ea. = $ 33,075.00

4) Total cost.
$ 1,375,500.00 *(Excavation)*
$ 1,300,928.25 *(pipe)*
$ 33,075.00 *(Backfill)*
$ 2,709,503.25 = "D"

COST PER LINEAR FOOT;

1) Divide the total job cost by linear feet of pipe.

$$\frac{\$\ 2,709,503.25}{3,275\ \text{ft.}} = \$\ 827.33 \text{ per ft.} = \text{'C'}$$

45) The average cost for contractors to clean the city sewers is $ 5.30 per foot for 2.20 miles of 12 in. pipe, $ 6.25 per foot for 2.25 miles of 15 in. pipe, and $ 7.89 per foot for 1.75 miles of 18 in. pipe, The city is considering purchasing a new jet & vac truck for $ 312,750 and hiring a 3 man crew to operate it. Operator "A" makes $18.43 per hour, operator "B" makes $19.67 per hour, operator "C" makes $20.49 per hour. Health care & benefits cost 37% of wages.

The cost/year of the jet truck will be $ 39,093.75 for 10 years. The time for the crew to clean 100 feet of sewer is as follows:

12" sewer takes 1.80 hours.
15" sewer takes 3.00 hours.
18" sewer takes 4.25 hours.

.50 hours. of non-productive time (travel, cleanup, etc.) will be used for every hour spent cleaning sewers

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

X	a)	Cheaper to buy a jet-vac, cost savings will be $541,983.87	**Right**
	b)	Cheaper to contract out, cost savings will be $435,755.03	
	c)	Cheaper to buy a jet-vac, cost savings will be $54,469.38	
	d)	Cheaper to contract out, cost savings will be $53,656.40	

SEE NEXT PAGE FOR SOLUTION

Convert miles of sewer to feet .

size		miles		feet/mile		feet
12 in.	=	2.20 miles	x	5,280 ft./mile	=	11,616 ft.
15 in.	=	2.25 miles	x	5,280 ft./mile	=	11,880 ft.
18 in.	=	1.75 miles	x	5,280 ft./mile	=	9,240 ft.

CONTRACTOR COST/YEAR:

Convert feet of sewer cost.

feet	x	cost/ft.	=	total	
11,616 ft.	x	$ 5.30	=	$ 61,506.72	(12 in.)
11,880 ft.	x	$ 6.25	=	$ 74,250.00	(15 in.)
9,240 ft.	x	$ 7.89	=	$ 72,903.60	(18 in.)
				$ 208,660.32	= **TOTAL CONTRACTOR COST/YEAR**

IN HOUSE COST/YEAR

1) Calculate labor cost/hr.

Add wages of A,B & C operators.

	$18.43	*(Operator A)*
	$19.67	*(Operator B)*
+	$20.49	*(Operator C)*
	$58.59	(Total hourly rate)

hourly rate	travel & clean up		fringe benefits		Total labor Cost/hr.
$58.59	x 1.50 hrs.	x	1.37	=	$120.40

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
12 in.	=	11,616	÷	100 ft. sections	x	1.80	x		$ 120.40	=	25,174.71
15 in.	=	11,880	÷	100 ft. sections	x	3.00	x		$ 120.40	=	42,911.43
18 in.	=	9,240	÷	100 ft. sections	x	4.25	x		$ 120.40	=	47,282.04

In-house labor cost	=	115,368.18
Jet-vac cost/year	=	39,093.75
Total cost/year	=	154,461.93

COMPARE COST/YEAR

$208,660.32	*CONTRACTOR COST/YEAR*
- $154,461.93	*IN HOUSE COST/YEAR*
$54,198.39	Cheaper to do the work in-house

10 year cost difference

$ 54,198.39 x 10 = **$541,983.87**

= "A"

46) 32 mg/l. of chlorine is required to treat a flow of 4.44 MGD. The solution available to you, however, is only 66% of chlorine. If the S.G. of the chemical is 0.94, How many lbs./day of solution are requires to treat the flow?

	a) 74,619 lbs./day
	b) 6,223 lbs./day
	c) 1,115 lbs./day
X	d) 1,689 lbs./day **Right**

Multiply 8.34 x S.G. & use it instead of 8.34 lbs/gal.

8.34 lbs/gal. x 0.94 = 7.84 lbs/gal.

Enter the data into the formula:

lbs./day = MGD x mg/l x 7.84 lbs/gal.

= 4.44 MGD x 32 mg/l. x 7.84 lbs/gal.

= 1,113.85 lbs/day

The solution is only 66% You will need more, divide lbs/percent

$$= \frac{1{,}113.85 \text{ lbs/day}}{66\%}$$

= 1,687.65 lbs/day

= "D"

47) Prepare a cut sheet for a sewer laid on a .66 % grade with the given stake elevations and invert grade. Consider a pipe thickness of 2.3 in. and assume the pipe will be installed on 1.0 ft. of bedding.

	Station	Stake Elev.	Invert Grade	Cut
0 =	0 + 00	67.28	- 59.00 =	9.47
50 =	0 + 50	67.91	- 59.33 =	9.77
100 =	1 + 00	68.13	- 59.66 =	9.66
150 =	1 + 50	68.55	- 59.99 =	9.75
198 =	1 + 98	69.69	- 60.31 =	10.57

For Each row Calculate the RUN:

Run = 2nd station - 1st station

Run = 50 - 00 = 50

For Each row Calculate RISE:

Slope = $\frac{\text{Rise}}{\text{Run}}$ = 0.0066 = $\frac{\text{Rise}}{50}$

Rise = 0.330

Add the rise to the previous Invert Grade

59.00 + 0.330 = 59.330

For cut, subtract Stake Elev. - Invert grade
Then Add the pipe bedding and thickness

67.28 - 59.00 = 8.28

+ .188 ft. (2.3 in./ 12")

+ 1.0 ft. Beding

9.468 ft

Repeat steps for the other Rows

48) A trench is dug at 8.5 ft. wide x 10.8 ft. deep x 2,235 ft. long. A 27 in. Sewer is going to be installed in this trench. 18 in. must be left out of the top for concrete. How many trucks would be needed if the material weighed 3,146 lbs. per yd^3 and each truck carries 14.5 tons?

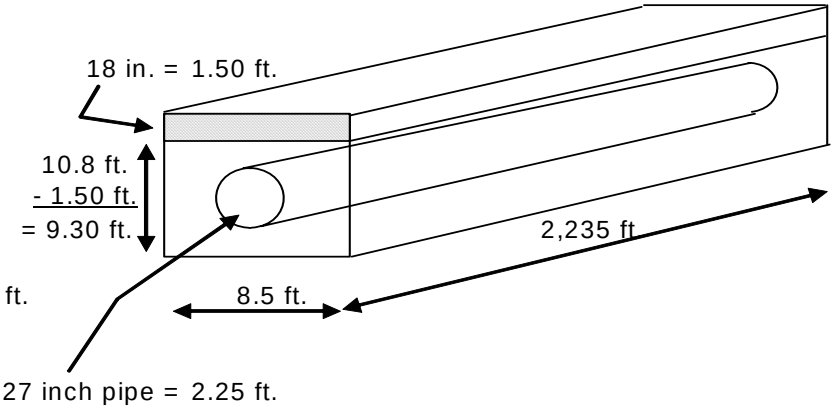
X	a)	675 Trucks	**Right**
	b)	18,203 Trucks	
	c)	789 Trucks	
	d)	674 Trucks	

Volume of Trench (ft^3):

L x W x H

9.30 ft. x 8.5 ft. x 2,235 ft.

= 176,677 $Ft.^3$



Volume of pipe (ft^3):

D^2 x .785 x Length

2.25 ft. x 2.25 ft. x .785 x 2,235 ft.

= 8,882 $Ft.^3$

Calculate Backfill Volume (ft^3):

176,677 $Ft.^3$

- 8,882 $Ft.^3$

167,795 $Ft.^3$

$$\frac{167{,}795 \text{ Ft.}^3}{27 \text{ ft}^3/\text{yd}^3} = 6214.6 \text{ yd}^3$$

Calculate Backfill Weight (Tons):

6214.6 yd^3 x 3,146 lbs. per cu. Yd. = $\frac{19{,}551{,}192}{2{,}000 \text{ lbs/yd}^3}$ = 9,775.6 Tons

Calculate Trucks:

$$\frac{9775.6 \text{ tons}}{14.5 \text{ tons/truck}} = 674.2$$

675 Trucks (A)

(Round up one truck to carry away the extra .2 tons)

49) Which of the following are accepted means for applying herbicides to control roots in wastewater collection

		A) Aeration
Right	X	B) Foaming
		C) Stem injection
		D) All of the above.

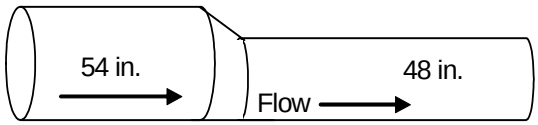
50) A(n) 54 in. sewer has a flow of 43.75 MGD at a velocity of 2.62 ft./sec. The sewer size changes to a(n) 48 in. sewer with the same slope and flow. Assuming no friction loss, what is the new velocity? *(Both sewers are flowing full.)*

	a)	5.08 ft./sec.
X	b)	5.40 ft./sec. **Right!.**
	c)	12.56 ft./sec.
	d)	3.48 ft./sec.

FORMULAS NEEDED;

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

$ft^3/sec. = MGD \times 1.55$



1) Convert MGD to $ft.^3/sec.$;

$ft^3/sec. =$ 43.75 MGD x 1.55

$ft^3/sec. =$ 67.81 ft^3/sec

2) Calculate the area of the new pipe size:

48 in. = 4.0 ft.

Area = $D^2 \times .785$

4.0 ft. = 4.0 ft. x 4.0 ft. x .785 = 12.56 $ft.^2$

3) Calculate the new velocity;

$$\frac{67.81\ ft.^3/sec.}{12.56\ ft.^2} = \mathbf{5.40\ ft./sec.}$$

= "B"