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

		A) V=LxWxC
		B) V=WxAxP
Right	x	C) V=WxLxH
		D) V=WxHxD

Where,

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

2) 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
Right	x	C) Prevent water in discharge line from flowing back
		D) Regulate the rate of water flow through the discharge pipe

3) How does the area of a(n) 42 inch sewer compare to a(n) 21 inch sewer?

	a)	The	42 in.	area is	2.00	times larger than the	21 in. area.	
	b)	The	42 in.	area is	3.14	times larger than the	21 in. area.	
	c)	The	42 in.	area is	2.55	times larger than the	21 in. area.	
x	d)	The	42 in.	area is	4.00	times larger than the	21 in. area.	Right

Area of 42 in.

$= D^2 \times .785$

$= 42 \text{ in.} \times 42 \text{ in.} \times .785$

$= 1385 \text{ in}^2$

Area of 21 in.

$= D^2 \times .785$

$= 21 \text{ in.} \times 21 \text{ in.} \times .785$

$= 346.2 \text{ in}^2$

Compare the 2 areas

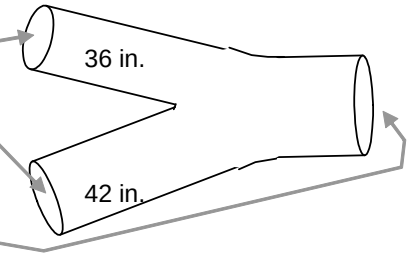
$$\frac{\text{Area of the 42 in.}}{\text{Area of the 21 in.}} = \frac{1385 \text{ in.}}{346 \text{ in.}} = 4.00 \text{ times larger}$$

4) 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"
Right	x	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 least 5 days

5) If a(n) 36 in. pipe and a(n) 42 in. pipe are running full and meet at a manhole, what minimum size outlet pipe will be required?

x	a) 56 inch	**Right**
	b) 44 inch	
	c) 71 inch	
	d) 78 inch	



Calculate the areas of both pipes, **Area = D^2 x .785**

Area of the 36 in. pipe = 36 in. x 36 in. x .785 = 1,017.4 in^2

Area of the 42 in. pipe = 42 in. x 42 in. x .785 = 1,384.7 in^2

Add the two areas together

(The outlet pipe area must be big enough for both pipes.)

1,017.4 in^2

\+ 1,384.7 in^2

2,402.1 in^2

Use the area formula to back out the diameter **Area = D^2 x .785**

D^2 x .785 = 2,402.1 in^2

$D^2 = \frac{2{,}402.1\ in^2}{.785}$

D^2 = 3,060.0 in^2

$D = \sqrt{3{,}060.0} = 55.32$ in.

If you round down the decimal, the pipe will be too small. YOU MUST ROUND UP THE DECIMAL.

56.0 inch

ALTERNATE METHOD;

Calculate the areas as if the pipe were square.
Using the method above, we multiplied the area by .785, only to take it back out again later. This step can be skipped, but only in certain situations. If you are not sure, use the method above.

36 in.	X 36 IN. =	1,296	$in.^3$
42 in.	X 42 IN. =	- 1,764	$in.^3$
	Total Area =	3,060	$in.^3$

$A = \sqrt{3{,}060.0} = 55.32$ in.

56.0 inch

6) 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.

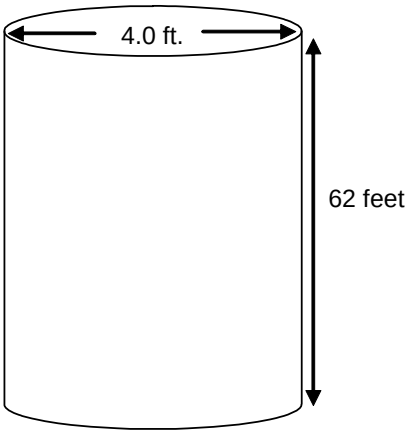
	A)	Dead fish
	B)	Fuel gas
	C)	Rotten cabbage
Right x	D)	Rotten eggs

7) What capacity blower is required to ventilate a manhole 48 in. in diameter and 62 feet deep, if 3 air change(s) is required every 6 minutes?

	a)	130	Ft^3/Min.	
x	b)	389	Ft^3/Min.	**Right**
	c)	2336	Ft^3/Min.	
	d)	934	Ft^3/Min.	

FORMULAS NEEDED;

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



Convert inches to feet;

$$\frac{48 \text{ in.}}{12 \text{ in./ft.}} = 4.0 \text{ ft.}$$

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

4.0 ft. x 4.0 ft. x .785 x 62 ft. = 778.7 $Ft.^3$

Formula;

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

$$= \frac{778.7 \text{ Ft.}^3}{6 \text{ min.}}$$

$$= 129.8 \text{ Ft.}^3$$

Multiply ft3/min x Number of air changes required;

129.8 $Ft.^3$/Min x 3 Air Changes Req'd = 389 $Ft.^3$/Min

7) A pH of 6.0 is

Right x	A)	Acid
	B)	Alkaline
	C)	Neutral
	D)	Basic

8) If a sewer must have a flow rate of 33 MGD with a velocity between 1.09 ft./sec. and 2.25 ft./sec. What must the minimum size be?

x	a) 65 in.	**Right**
	b) 93 in.	
	c) 92 in.	
	d) 64 in.	

FORMULAS NEEDED;

$ft^3/sec. = 1.55 \times MGD$ Area $(ft^2) = D^2 \times .785$ $ft^3/sec. = ft^2 \times ft./sec.$ (Flow = Area x Velocity)

Convert MGD to $ft^3/sec.$

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

$= 1.55 \times 33 MGD$

$= 51.2 \ ft^3/sec.$

Decide which velocity you will use;

If the question asks for the minimum pipe size, you will need to design the pipe toward the HIGHEST velocity
If the question asks for the maximum pipe size, you will need to design the pipe toward the LOWEST velocity

In this case, it asks for the *minimum* velocity, so you will use the *2.25 ft./sec. velocity*

Use the formula, $ft^3/sec. = ft^2 \times ft./sec.$ To get the area;

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

$51.2 \ ft^3/sec. = ft^2 \times 2.25 \ Ft./Sec.$

$$\frac{51.2 \ ft^3/sec.}{2.25 \ Ft./Sec.} = 22.73 \ ft^2$$

Use the formula, Area $(ft^2) = D^2 \times .785$ To get the D^2

Area $(ft^2) = D^2 \times .785$

$22.73 \ ft^2 = D^2 \times .785$

$$\frac{22.73 \ ft^2}{.785} = D^2$$

$29.0 \ ft^2 = D^2$

Then squaere root the D^2, to get the Diameter

$D^2 =$ D (Diameter)

$29.0 \ ft^2 =$ 5.38 ft.

Convert to inches

$5.38 \text{ ft.} \times 12 \text{ in./ft.} = 64.6 \text{ in.}$

We are looking for the **minimum** velocity
64.0 in. would be too small & cause the velocity to rise above 2.25 ft./sec.

9) 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
Right x	C)	Cause jet action to aid in the hydraulic flushing of the sewer line
	D)	Reinforce (strengthen) the ball

10) A circular tank is 39 feet in diameter and 21 feet deep. If the tank is completely full and a 975 GPM pump is supplied, how long will it take to remove 11.5 feet of water from the tank?

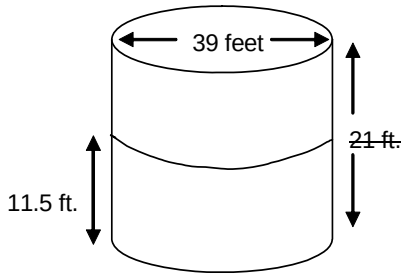
	a)	4	Hours,	23	Minutes
	b)	1	Hours,	57	Minutes
x	c)	1	Hours,	45	Minutes **Right**
	d)	1	Hours,	76	Minutes

FORMULAS NEEDED;

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

$1\ ft^3 = 7.48$ Gal.

Vol. of a Cylinder = $D^2 \times .785 \times$ Depth



Calculate the Cylinder Volume (ft^3)

Vol. of a Cylinder = $D^2 \times .785 \times$ Depth

= 39 feet x 39 feet x .785 x 12 ft. deep

= 13,730.83 $ft.^3$

Convert ft^3 to Gallons;

7.48 Gal./ft^3 x 13,730.83 $ft.^3$ = 102,706.59 Gallons

Calculate the Detention Time;

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

$$975\ \text{Gal./Min.} = \frac{102{,}706.59\ \text{Gallons}}{\text{Time}}$$

$$\text{Time} = \frac{102{,}706.59\ \text{Gallons}}{975\ \text{Gal./Min.}}$$

Time = 105.3 minutes

Convert Minutes to Hours, Minutes;

$$\frac{105\ \text{min.}}{60\ \text{min./hr.}} = 1.76\ \text{hrs.}$$

1 hrs. + (.76hrs. x 60) 45 min.

1 hrs., 45 min. = "C"

11) Your chlorinator room should have an exhaust vent installed

	A)	Near the ceiling.
Right x	B)	Near the floor.
	C)	Halfway up the wall.
	D)	At the chlorinator bell jar.

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

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

13) The flushing water pressure in a water-lubricated wastewater pump should be at least _____ the pump discharge pressure.

	A)	10 psi less than
	B)	5 psi less than
Right x	C)	5 psi more than
	D)	10 psi more than

14) A wet well is 10 feet deep by 17 feet in diameter. When the pump is not running, the water rises 31.0 in. in 2 min. 48 sec. If the level rises 5.2 in. in 16.0 min. while the pump is running, what is the pump rate in GPM?

	a) 1,612 Gal./Min.
x	b) 1,520 Gal./Min. **Right**
	c) 1,797 Gal./Min.
	d) 9,209 Gal./Min.

FORMULAS NEEDED;

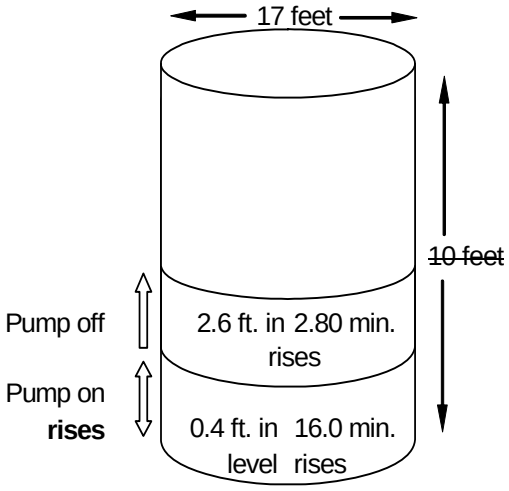
Volume of Cylinder = D^2 x .785 x Depth 1 $ft.^3$ = 7.48 Gal.

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

Simplify;

31.0 in. **= 2.6 ft.**
5.2 in. **= 0.4 ft.**

$$2 \text{ min}, + \left\{ \frac{48 \text{ sec.}}{60 \text{ sec/min}} \right\} = \mathbf{2.80 \text{ min.}}$$



Calculate inflow with the pump off;

Volume of Cylinder = D^2 x .785 x Depth
= 17 ft. x 17 ft. x .785 x 2.6 ft.
= 586.07 $ft.^3$
Convert to gallons;
= 586.07 $ft.^3$ x 7. 48 gal/ft^3 = 4,383.79 Gal.

$$\text{Flow} = \frac{\text{Volume}}{\text{Time}} \qquad \text{Flow} = \frac{4{,}383.79 \text{ Gal.}}{2.80 \text{ min.}}$$

= 1,566 Gal./Min. (Inflow)

Calculate change in volume with the pump on;

Volume of Cylinder = D^2 x .785 x Depth
= 17 ft. x 17 ft. x .785 x 0.4 ft.
= 98.31 $ft.^3$
Convert to gallons;
= 98.31 $ft.^3$ x 7. 48 gal/ft^3 = 735.35 Gal.

$$\text{Flow} = \frac{\text{Volume}}{\text{Time}} \qquad \text{Flow} = \frac{735.35 \text{ Gal.}}{16.00 \text{ min.}}$$

= 46 Gal./Min.

Add or subtract the change in volume to the inflo

The level rises when the pump is on.
This means the pump can not keep up subtract the
from the 1,566 GPM Inflow.

1,566 GPM
- 46 GPM
1,520 GPM = "B"

15) What factors should be considered when providing trench shoring?

	A)	Grade of sewer.
	B)	Pipe material.
Right	x C)	Structures or sources of vibration near trenches.
	D)	All of the above.

16) Sewer “A” has 17,000 people at 95 GPCD. Sewer "B" has 13,800 people at 90 GPCD. Sewer “C” has 9,850 people at 85 GPCD. What percent of the flow is due to I&I if the total plant flow is 4.50 MGD?

	a)	21.5%
	b)	82.1%
	c)	65.7%
x	d)	17.9% **Right**

FORMULAS NEEDED;

GPCD = Gallons Per Capita Per Day

Add up known flows;

Sewer “A”	1,615,000 Gal./Day
Sewer "B"	1,242,000 Gal./Day
Sewer “C”	+ 837,250 Gal./Day
	3,694,250 Gal./Day

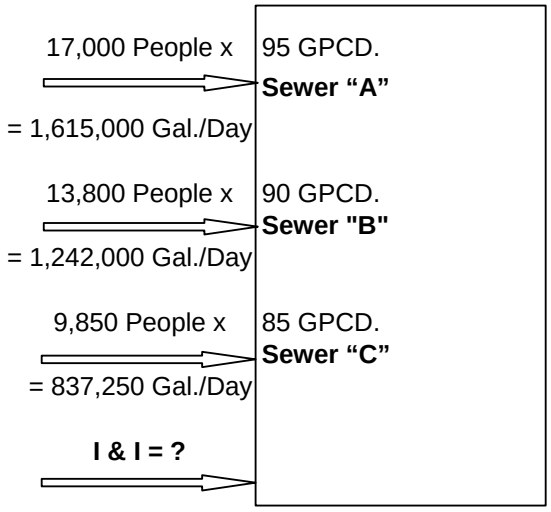
Subtract know flows from the plant flow to get to get I & I;

	4,500,000 Gal./Day
-	3,694,250 Gal./Day
	805,750 Gal./Day (I & I)

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

$$\frac{805{,}750 \text{ Gal./Day}}{4{,}500{,}000 \text{ Gal./Day}} \times 100 = \mathbf{17.9\%}$$

Plant Flow = 4,500,000 Gal./Day (4.50 MGD)



** Before picking your answer, look at your I & I flows, does 805,750 Gal./Day I & I look like it might be 17.9% of 4,500,000 Gal./Day plsnt flow? If not, you probably divided by the wrong number.

17 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.

18) Colored dye is dumped into a manhole. The dye first appears 4 min., 6 sec. later in a manhole 850 feet downstream and disappears 5 min. and 17 sec. after the dye was first dumped into the manhole. What is the velocity of the flow in the sewer?

	a) 2.68 Ft./Sec.
x	b) 3.02 Ft./Sec. **Right**
	c) 3.46 Ft./Sec.
	d) 0.66 Ft./Sec.

FORMULAS NEEDED;

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

Convert Min., Sec. To Seconds;

Dye first appears:

4 min., 6 sec. =

4 min. x 60 sec./min. = 240 sec.
+ 6 sec.
246 sec.

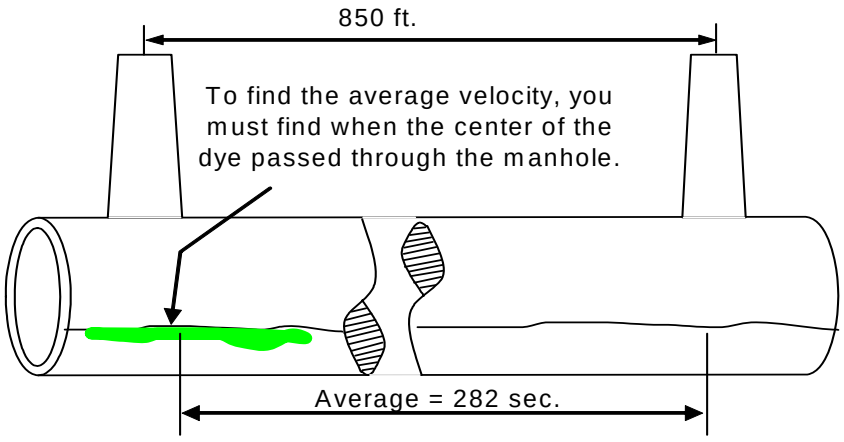
Dye disappears:

5 min., 17 sec. =

5 min. x 60 sec./min. = 300 sec.
+ 17 sec.
317 sec.

Average theStart & finish times;;

$$\frac{246 \text{ sec.} + 317 \text{ sec.}}{2} = 282 \text{ sec.}$$



Use the formula to calculate the velocity;

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

$$\frac{850 \text{ ft.}}{282 \text{ sec.}} = \mathbf{3.02 \text{ ft./sec.}} \quad \mathbf{= "B"}$$

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

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

20) 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
Right	x	C) Make sure all the torque is out of a broken rod
		D) Rod past dropped joints or through a crushed pipe

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

	a) 64.2 HP
	b) 2.0 HP
x	c) 20.6 HP **Right**
	d) 30.9 HP

FORMULAS NEEDED;

Watts = Amps x Volts, 1 HP = 746 Watts

Calculate Watts;

Volts x Amps = Watts

480 v x 32 a = 15,360 Watts

Convert Watts to HP;

1 HP = 746 Watts

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

= "C"

22) 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.

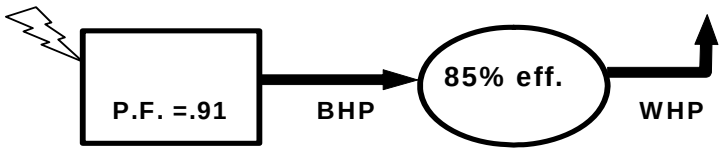
23) A 4,160 v motor draws 21 amps. What is the brake horsepower if the pump is 85% efficient and the motor power factor is .91?

	a) 90.6 HP
	b) 117.1 HP
	c) 5.1 HP
x	d) 106.6 HP Right

FORMULAS NEEDED;

1 hp = 746 Watts

Amps x Volts = Watts



1) 1) Calculate Watts;

Amps x Volts = Watts

21 a x 4,160 v = = 87,360 watts

2) Calculate Input (wire) HP;

1 hp = 746 Watts

$$\frac{87{,}360 \text{ watts}}{746 \text{ Watts / HP}} = 117.1 \text{ HP}$$

2) Calculate BHP;

117.1 HP x .91 = **106.6 HP**

= "D"

24) Which one of the following would not be considered a natural event?

Right	x	A) Explosion.
		B) Flood.
		C) Lightning.
		D) Tornado.

25) 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
Right	x	C) Signature of person who locked out the switch, who is the only person authorized to remove tag
		D) Time to unlock switch

26) Calculate the water horsepower if the pump it operates provides 875 GPM against 118 feet total dynamic head (TDH)?

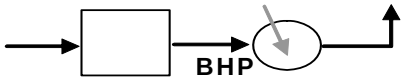
- [ ] a) 101 HP
- [ ] b) 55 HP
- [ ] c) 7 HP
- [x] d) 26 HP Right

27) If the pump in problem 26 is 79% efficient, then what is the brake HP?

- [x] a) 33.0 HP Right
- [ ] b) 70.2 HP
- [ ] c) 9.4 HP
- [ ] d) 43.8 HP

FORMULAS NEEDED;

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



Problem #26;

Calculate HP;

$$WHP = \frac{875\ GPM \times 118\ feet}{3960}$$

WHP = 26.1 HP 'D'

Problem #27;

Calculate BHP;

$$\frac{WHP}{Eff.} = BHP \qquad \frac{26\ HP}{.79} = 33.0\ HP = \text{"A"}$$

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

- Right [x] 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

29) 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
- Right [x] 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.

30) A pump has an efficiency of 91% and a motor has a power factor of .93. If the water horsepower is 334 HP and electricity has a cost of 11.0 cents per KWH, how much will it cost to run the pump for one month, (31 days) at 12.0 hrs./day?

x	a) $12,047.49 /mo.	Right
	b) $10,963.22 /mo.	
	c) $3,109.31 /mo.	
	d) $8,032.37 /mo.	

FORMULAS NEDED;

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

1) Convert WHP to Brake HP;

$\frac{334 \text{ HP}}{.91}$ = 367.0 HP

2) Convert BHP to Wire HP;

$\frac{367 \text{ HP}}{.93}$ = 394.7 HP

3) Convert Wire HP to KW (Kilowatts);

1 HP = .746 KW

394.7 HP x .746 KW per HP = 294.4 KW

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

294.4 KW x 12.0 hrs./day x .11 cents/KW x 31 days/month = **$ 12,047.49 per mo. = "A"**

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

	A) Bar	
x	B) Aluminum hydraulic	Right
	C) Truss	
	D) Sand	

32) 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	
x	D) You know what you are doing, are qualified, and are authorized	Right

33) 37 mg/l. of chlorine is required to treat a flow of 50.0 MGD. The solution available to you, however, is only 74% of chlorine. How many lbs./day of solution are requires to treat the flow?

	a) 85,403 lbs./day
x	b) 20,850 lbs./day **Right**
	c) 15,429 lbs./day
	d) 1,024,012 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

= 50 MGD x 37 mg/l. x 8.34

= 15,429 lbs./day

2) The solution is only 74% pure. You will need more;

How much more?

$$\frac{15{,}429 \text{ lbs./day}}{.74 \ (74\%)} = \textbf{20,850 lbs./day}$$

34) A venture meter measures quantity of fluid by

Right	x	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

35) 49 mg/l. of root control must be added to a 42 in. sewer that is 2,125 feet long. If the root control chemical is in a solution that consists of only 38% of the chemical, how many lbs. of the solution must be added to the sewer?

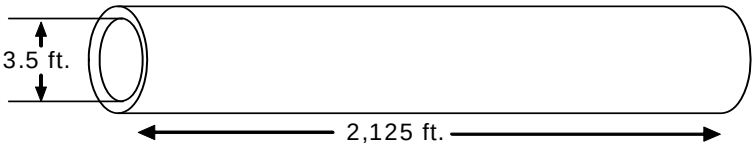
x	a) 164.38 lbs.	Right
	b) 23.74 lbs.	
	c) 183.28 lbs.	
	d) 3,418.02 lbs.	

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

3.5 ft. x 3.5 ft. x 2,125 ft. x .785 = 20,435 $ft.^3$

1 ft^3 = 7.48 Gallons

20,435 ft^3 x 7.48 gal./ft^3 = $\frac{152,850 \text{ gal.}}{1,000,000}$ = .15 MGD

2) Use formula to Calculate lbs./day;

lbs./day = MGD x mgl x 8.35

lbs./day = .15 MGD x 49 mg/l. x 8.34

lbs./day = 62 lbs./day

3) The chemical is only 38% pure. You will need more;

$\frac{62 \text{ lbs./day}}{.38}$ **= 164.38 lbs./day**

= "A"

36) On Monday A flow totalizer read 11,156,800 gal. On Thursday the totalizer read 114,081,002 gal. What was the daily average flow?

	a) 114.08 MGD	
	b) 25.73 MGD	
	c) 40.03 MGD	
x	d) 34.31 MGD	Right

1) Subtract the two readings to determine how many gallons passed through;

114,081,002 gal.
- 11,156,800 gal.
102,924,202 gal.

1) Divide by the number of FULL days that passed;

$\frac{102,924,202 \text{ gal.}}{3 \text{ Days}}$ **= 34.31 MGD**

= "B"

⇇ **Monday**
⇇ Tuesday
⇇ Wednesday
⇇ **Thursday**
⇇ Friday
⇇ Saturday
⇇ Sunday
3 Days

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

Right [x] A) Impellers
[ ] B) Lantern rings
[ ] C) Sleeves
[ ] D) Stuffing Boxes

38) If the grade of a sanitary sewer has a slope of 0.50% for 350 feet, what is the rise of the pipe?

[ ] a) 351.8 Feet
[x] b) 1.75 Feet **Right**
[ ] c) 0.02 Feet
[ ] d) 0.18 Feet

FORMULAS NEEDED;

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

(Slope = 0.50% or .01)

$$.005 = \frac{\text{RISE}}{350 \text{ ft.}}$$

Slope =

.005 x 350 ft. = RISE
.005 x 350 ft. = **1.75 ft. = "B"**

39) What must be checked before entering a manhole?

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

40) A crew surveys a sewer from STA. 9+ 54.00 to STA 32+ 65.25 If the elevation of the manhole (farthest to the traetment plant) is 742.6 feet,what is the elevation of the second manhole if the grade is 0.0017 FT/FT,

	a) 3.9 Feet	
x	b) 738.7 Feet	Right
	c) 746.5 Feet	
	d) 7.4 Feet	

FORMULAS NEEDED;

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

1) Convert survey station numbers into feet, then Calculate Run;

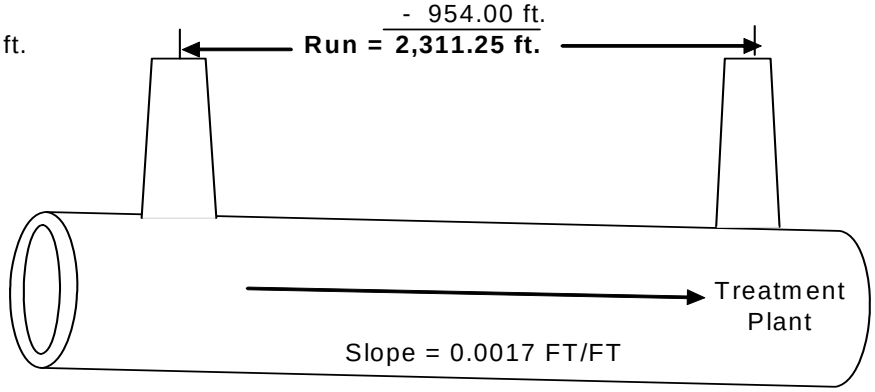
STA 32 + 65.25 = 32 hundred + 65.25 = 3,265.25 ft.
STA 9 + 54.00 = 9 hundred + 54.00 = 954.00 ft.

2) Calculate Slope;

$$\frac{\text{RISE}}{2{,}311.25 \text{ ft.}} = 0.0017 \text{ ft/ft}$$

RISE = .0017 ft/ft x 2,311.25 ft.
RISE = 3.93 ft.

3,265.25 ft.
- 954.00 ft.
Run = 2,311.25 ft.



3) Add or Subtract the 'rise' to get the other Elevation;

The manhole farthest is at 742.6 ft.
So, the other manhole must be LOWER.

You SUBTRACT the 'rise' from 742.6 ft.

742.60 ft.
- 3.93 ft.
738.67 ft. = "B"

742.6 ft. (Higher Elevation)

(Lower Elevation)

41) Which of the following is not typical of a "submersible" pump?

	A) Can be installed in a crooked hole.	
	B) Minimizes vandalism.	
	C) Quieter operation.	
x	D) Requires water lubrication.	Right

42) A map with a scale of 0.625 in.= 100 feet indicates that manhol"A" is 7.50 in. from manhole "B" What is the actual distance between manholes?

	a)	4.7 ft.
	b)	8.3 ft.
x	c)	1,200.0 ft. **Right**
	d)	83.3 ft.

$$\frac{\text{Scale factor x Measurement}}{\text{Scale}} \text{ '= Actual Diatance}$$

$$\frac{7.50 \text{ in. x } 100 \text{ ft.}}{0.625 \text{ in.}} = \mathbf{1,200.0 \text{ feet,}}$$

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

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

44) If a repair job can be done by 14 people in 17 hours, how long will it take for 5 people to do a similar job?

	a)	12 Hours, 0 min.
	b)	47 Hours, 6 min.
	c)	6 Hours, 4 min.
x	d)	47 Hours, 36 min. **Right**

1) Set up the problem;

If a repair job can be done by 14 people in 17 hours,

then it would take 5 people, $\frac{14}{5}$ of the time.

So, $17 \text{ hrs.} \times \frac{14}{5} = 47.6 \text{ hrs.}$

2) Convert Decimal Hours yo Hours, Minutes;

47.6 hrs. = 47 hrs. + (.60 hrs. x 60 sec./hr.) = 36 min.

= 47 hrs., 36 min. = "D"

45) Biological hazards in collection system operations include

	[ ]	A) Noxious or toxic gases or vapors
	[ ]	B) Oxygen deficiency
	[ ]	C) Physical injuries
Right	[x]	D) Hepatitis A

46) A trench is dug at this trench. 13 ft. wide x 9 ft. deep x 1,654 ft. long. A 21 in. Sewer is going to be installed in 16 in. must be left out of the top for concrete. How much backfill will be required to fill the trench?

x	a)	5,958 Yd^3	**Right**
	b)	17,875 Yd^3	
	c)	160,872 Yd^3	
	d)	7,020 Yd^3	

47) How many tons of backfill would there be in problem 51 if the backfill material weighed 3,724 lbs./cu. yd.?

x	a)	11,094 Tons	**Right**
	b)	33,283 Tons	
	c)	299,544 Tons	
	d)	13,071 Tons	

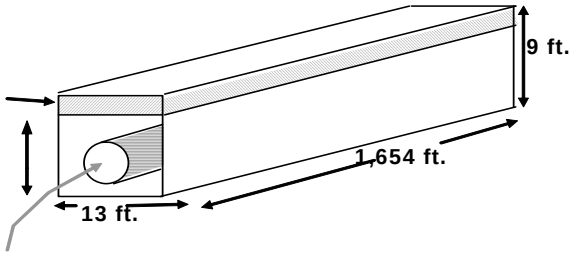
48) If a loaded dump truck could haul 18 tons each, how many truck loads would be needed in problem 47?

	a)	616 Trucks	
	b)	727 Trucks	
x	c)	617 Trucks	**Right**
	d)	16,642 Trucks	

FORMULAS NEEDED;

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

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



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

16 in. = **1.33 ft.**

Volume of a rectangle = L x W x H
Volume of a rectangle = 9 ft. - 1.33 ft. = **7.67 ft.**
= 1,654 ft. x 13 ft. x 7.67 ft.
= 164,849 $ft.^3$

Convert to yd^3

$$\frac{164{,}849\ ft.^4}{27\ ft^3/yd^3} = 6{,}106\ \text{cu. yd.}$$

21 in. = **1.75 ft.** Diameter

2) Calculate the volume of the pipe (in Yd^3);

Volume of a cylinder = D^2 x .785 x L
= 1.75 ft. x 1.75 ft. x .785 x 1,654 ft.

$$= \frac{3{,}976.3\ \text{cu. ft}}{27\ ft^3/yd^3} = 147\ \text{cu. yd.}$$

3) Subtract pipe volume from trench volume;

This will give you the volume of fill.

6,106 yd^3
- 147 yd^3
5,958 yd^3 **#51 ="A"**

3) Calculate the wieght of fill in tons;

5,958.2 x 3,724 lbs. cu. yd. = $\frac{22{,}188{,}467\ \text{lbs.}}{2{,}000\ \text{lbs./ton}}$ = **11,094 tons**

="A"

3) Calculate the wieght of fill in tons;

$\frac{11{,}094.2\ \text{tons}}{18\ \text{tons/truck}}$ = 616.3 Trucks

You must round up to 617.0 Trucks or there will be .3 truckoads left over.

617 Trucks = 'C'

49) Given the following information, would it be less expensive to finish the job in 2 days, or finish the job in one day by working overtime?

Actual job time = 15.00 hrs
Travel time & set-up time = 1.50 hrs
Average Work day = 8.00 hrs
Hourly pay rate = $ 18.25
Overtime is 1.50 times the normal hourly rate

	a) Cheaper to do the work with O.T.
x	b) Cheaper to do the work in two days **Right**
	c) Costs the same either way
	d) None of the above

CALCULATE THE COST BOTH WAYS

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

(Add up the total hours worked, then subtract 8.00 hours to determine hours paid at O.T.)

15.00 hrs *(Actual job time)*
+ 1.50 hrs *(Travel time & set-up time)*
- 8.00 hrs *(straight time)*
8.50 hrs *(paid at O.T. Rate)*

(Convert O.T. hours to straight time hours)

8.50 hrs ***O.T. x 1.50 =*** **12.75 hrs. pay**

(Add them together for total hours paid)

12.75 hrs. pay **+ 8.00 hrs =** 20.75 hrs. total pay

2) Cost for doing the work in two days

1.50 hrs *(Set-up, Day 2)*
1.50 hrs *(Set-up, Day 1)*
+ 15.00 hrs
18.00 hrs (Total pay)

50) The average cost for contractors to clean the city sewers is $ 5.95 per foot for 1.60 miles of 12 in. pipe, $ 6.80 per foot for 1.80 miles of 15 in. pipe, and $ 7.85 per foot for 1.70 miles of 18 in. pipe, The city is considering purchasing a new jet & vac truck for $ 284,318 and hiring a 3 man crew to operate it. Operator "A" makes $19.57 per hour, operator "B" makes $18.59 per hour, operator "C" makes $17.89 per hour. Health care & benefits cost 37% of wages. The cost/year of the jet truck will be $ 31,275.00 for 10 years. The time for the crew to clean 100 feet of sewer is as follows:

12" sewer takes	1.50 hours.
15" sewer takes	3.25 hours.
18" sewer takes	4.00 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 $625,505.80	**Right**
	b)	Cheaper to contract out, cost savings will be $502,906.66	
	c)	Cheaper to buy a jet-vac, cost savings will be $62,863.33	
	d)	Cheaper to contract out, cost savings will be $61,925.07	

See Next Page For Solution

Convert miles of sewer to feet .

size		miles		feet/mile		feet
12 in.	=	1.60 miles	x	5,280 ft./mile	=	8,448 ft.
15 in.	=	1.80 miles	x	5,280 ft./mile	=	9,504 ft.
18 in.	=	1.70 miles	x	5,280 ft./mile	=	8,976 ft.

CONTRACTOR COST/YEAR:

Convert feet of sewer cost.

feet	x	cost/ft.	=	total	
8,448 ft.	x	$ 5.95	=	$ 50,265.60	(12 in.)
9,504 ft.	x	$ 6.80	=	$ 64,627.20	(15 in.)
8,976 ft.	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.

	$19.57	*(Operator A)*
	$18.59	*(Operator B)*
+	$17.89	*(Operator C)*
	$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
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

In-house labor cost = 91,528.82

Jet-vac cost/year = 31,275.00

Total cost/year = 122,803.82

COMPARE COST/YEAR

$185,354.40	*CONTRACTOR COST/YEAR*
- $122,803.82	*IN HOUSE 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"