Selected Math Problems for Collection and Distribution

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Math Problem Solving Strategy

1. Read the question carefully and underline what they are asking you to find.
2. Write down the formula you need to solve the problem. Look in the front of the test booklet if necessary.
3. Fill in everything you know. Sometimes filling in what you know might require you to find something else first like area or volume.
4. Check your units! Make sure they are correct for the formula and agree with each other.
5. Convert units where needed.
6. Put the new units into the formula.
7. Solve.
8. Check the units of your answer. Are they what the question asked for?
9. Convert units if necessary.

Starting Problems

1. Convert 35 cubic feet to gallons.

2. You are driving through Kansas at 90 mph. What is this in feet per second?

3. A pipe carries 2.3 mgd. How much is this in cfs?

4. A flow of 2500 gpm is equivalent to how many mgd?

5. The static pressure in a force main is 75 psi. How much head creates this pressure?

6. The following flows were recorded for the months of February, March, and April: Feb = 197.3 cfs, March = 100,182 gpm, Apr = 255.7 mgd. What was the average daily flow for this three month period?

7. A 12-inch diameter sewer line is evenly coated on the inside with 3-inches of grease all around. How much of the original carrying capacity of the pipe remains? Assume the pipe runs full at both diameters.

8. The diameter of a wet well is 13 feet. It is filled to a depth of 20 feet. How many gallons does it contain?

9. A wet well is 6 feet square. The low water level is 2 feet and the high water level is 14 feet. What is the working volume of the wet well in gallons?

10. A new, 18-inch diameter sewer line will be installed along a 400 foot block. The trench will be 400 feet long by 3 feet wide by 9 feet deep. Squeegee will be used to fill the trench for the first foot and then one foot above the pipe. How much fill dirt must be hauled away? If a dump truck holds 5 cubic yards, how many trucks will be needed?

11. How many yards of squeegee will be needed?

12. Water is entering a wet well at a rate of 50 gpm. The wet well is 10 feet in diameter and 8 feet deep. How long will it take to fill the wet well?

13. A wet well needs to be taken off-line for cleaning. It currently contains 2000 gallons of sewage. If a 35 gpm pump is used to drain the wet well, how long will it take?

14. If a 6-inch force main has a metered flow of 200,000 gpd, what is the average velocity through the force main in feet per second?

15. A force main necks down from 12-inches to 6-inches. The velocity in the 12-inch pipe was 2 fps. What will the velocity be in the 6-inch pipe?

16. A wet well has two lines coming into it. One is 8-inch diameter and the other is 12-inch diameter. Assume both pipes are running full. What diameter should the force main be if the flow velocity is the same entering and leaving the wet well?

17. A ball is dropped into a manhole. Two minutes and 18 seconds later, it is observed 500 feet away in the downstream manhole. What is the velocity of the flow in feet per second?

18. How much chlorine must be added daily to a flow of 2.3 mgd to achieve a dosage of 12 mg/L?

19. If 65% hypochlorite solution is used instead of chlorine, how many pound of hypochlorite solution will be needed?

20. A degreasing agent is added to an 11.5 foot diameter wet well that is 9.5 feet deep. A total of 4.5 pounds of degreasing agent is required for every square foot of surface area. If the degreaser weighs 9.5 pounds per gallon and has an active ingredient concentration of 61.4%, how many pounds of chemical must be added to the wet well?

21. Water is pumped from a wet well fifty feet uphill to the next gravity line. The pump rate is 50 gpm. The pump is 85% efficient and the motor is 90% efficient. Find the wire to water horsepower.

22. The pump in problem #13 runs for six hours each day. If electricity costs $0.07 per kwh, how much does it cost to run this pump for a month? Assume a month has 30 days.

23. A centrifugal pump delivers 1890 liters per minute against a head of 300 feet with a combined pump and motor efficiency of 70 percent. What is the cost of the electrical power required to operate the pump 12 hours per day for 2 months? Assume each month has 31 days. Electricity costs $0.09 per kWh.

24. A four cylinder positive displacement pump has a cylinder bore of 4.5 inches and a stroke length of 5.5 inches. The pump operates at 1700 rpm. How long will it take to empty a 72-inch diameter wet well, 33 feet deep, if it has an inflow of 2500 gpm?

25. Two manholes are 400 feet apart. The pipe invert elevation in the first manhole is 5293.5 feet. The pipe invert in the second manhole is 5289.8 feet. What is the percent slope?

1. $\frac{35\,cf}{} \Big| \frac{7.48\,gal}{1\,cf} \Big| = 261.8$ gallons

2. $\frac{90\,miles}{hr} \Big| \frac{5280\,ft}{1\,mile} \Big| \frac{1\,hr}{60\,min} \Big| \frac{1\,min}{60\,sec} \Big| = 132\,\frac{ft}{s}$

3. HARD WAY

$\frac{2.3\,mg}{d} \Big| \frac{1000000\,gallons}{1\,mg} \Big| \frac{1\,cf}{7.48\,gal} \Big| \frac{1\,d}{1440\,min} \Big| \frac{1\,min}{60\,sec} \Big| = 3.56\,\frac{cf}{s}$

EASY WAY

$2.3\,mgd \Big| \frac{1.55\,cfs}{1\,mgd} \Big| = 3.565\,cfs$

this conversion factor is in the test book

4. $\frac{2500\,gal}{min} \Big| \frac{1440\,min}{1\,day} \Big| \frac{1\,MG}{1{,}000{,}000\,gal} \Big| = 3.6\,mgd$

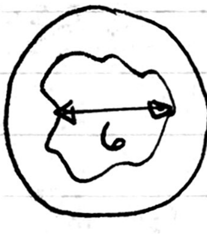
5. $75\,psi \Big| \frac{1\,ft}{0.433\,psi} \Big| = 173.2\,ft$

6. Before you can average – all flows must be in the same units.

$$\frac{197.3 \text{ cfs}}{} \left| \frac{1 \text{ mgd}}{1.55 \text{ cfs}} \right| = 127.2 \text{ mgd}$$

$$\frac{100{,}182 \text{ gal}}{\text{min}} \left| \frac{1 \text{ MG}}{1{,}000{,}000 \text{ gal}} \right| \frac{1440 \text{ min}}{1 \text{ day}} \right| = 144.26 \text{ mgd}$$

127.2 mgd
144.26 mgd
+ 255.7 mgd
527.16 mgd ÷ 3 = 175.72 mgd on average

7. 

Was a 12-inch pipe – but with 3-inches of grease all around, it is a 6-inch pipe.

AREA = (0.785)(diameter)^2
AREA = (0.785)(12 in)(12 in)
AREA = 113.04 in^2

vs.

AREA = (0.785)(6 in)(6 in)
AREA = 28.26 in^2

$$\frac{113.04}{28.26} = 4$$

four times more area in the bigger Pipe.
So 25% capacity now

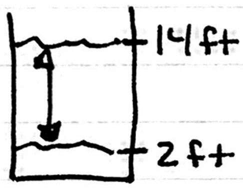
8. Volume = $0.785\,d^2h$

Volume = (0.785)(13 ft)(13 ft)(20 ft)

Volume = 2653.3 ft^3

$$2653.3\ ft^3 \left| \frac{7.48\ gal}{1\ ft^3} \right| = 19{,}847\ \text{gallons}$$

(rounded up)

9. 

working volume is 14 − 2 = 12 ft

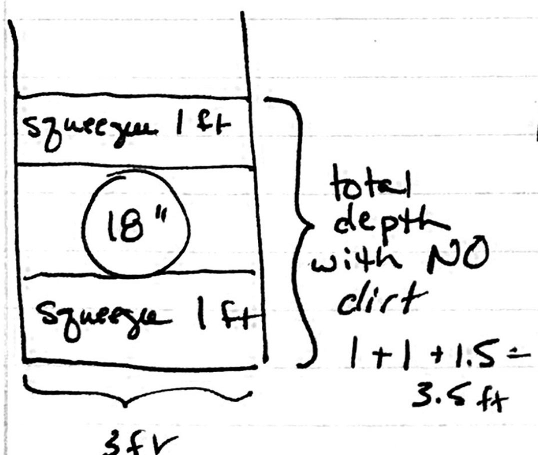
Volume = (LENGTH)(WIDTH)(HEIGHT)

Volume = (6 ft)(6 ft)(12 ft)

Volume = 432 ft^3

$$432\ ft^3 \left| \frac{7.48\ gal}{1\ ft^3} \right| = 3231\ \text{gallons}$$

10. DRAW A PICTURE!



Volume = (LENGTH)(WIDTH)(HEIGHT)

Volume = (400 ft)(3 ft)(3.5 ft)

Volume = 4200 ft^3

↑ ANSWER #1

10(cont) How many trucks?

$$4200 \text{ cf} \left| \frac{1 \text{ cy}}{27 \text{ cf}} \right| \frac{1 \text{ truck}}{5 \text{ cy}} \right| = 31.1$$

so
32 trucks
(can't have a
partial truck or overfill)

11. Volume of squeegee is the volume of fill dirt minus the volume of the pipe.

18 inch = 1.5 ft.

Volume = $0.785\, d^2 h$
Volume = (0.785)(1.5 ft)(1.5 ft)(400 ft)
Volume = 706.5 cf

4200 cf dirt removed
− 706.5 cf pipe volume
3493.5 cf of squeegee needed

12. $\text{time} = \frac{\text{Volume}}{\text{Flow}}$

Volume = $0.785\, d^2 h$
Volume = (0.785)(10 ft)(10 ft)(8 ft)
Volume = 628 ft^3

$$628\ ft^3 \left| \frac{7.48 \text{ gal}}{1\ ft^3} \right| = 4697.44 \text{ gallons}$$

12 (cont)

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

$$\text{time} = \frac{4697.44 \text{ gallons}}{50 \text{ gpm}}$$

time = 93.9 minutes

13.

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

$$\text{time} = \frac{2000 \text{ gallons}}{35 \text{ gpm}}$$

time = 57 minutes

14.

$$\text{velocity} = \frac{\text{flow, cfs}}{\text{area, sf}}$$

Find both pieces in the right units

$$200{,}000 \frac{\text{gal}}{\text{day}} \left| \frac{1 \text{ cf}}{7.48 \text{ gal}} \right| \frac{1 \text{ d}}{1440 \text{ min}} \left| \frac{1 \text{ min}}{60 \text{ sec}} \right| = 0.309 \text{ cfs}$$

6-inch = 0.5 ft

$$\text{Area} = 0.785 d^2$$

$$\text{AREA} = (0.785)(0.5 \text{ ft})(0.5 \text{ ft})$$

$$\text{AREA} = 0.19625 \text{ ft}^2$$

$$\text{VELOCITY} = \frac{\text{FLOW}}{\text{AREA}}$$

$$\text{VELOCITY} = \frac{0.309 \text{ cfs}}{0.19625 \text{ ft}^2}$$

VELOCITY = 1.57 ft/s

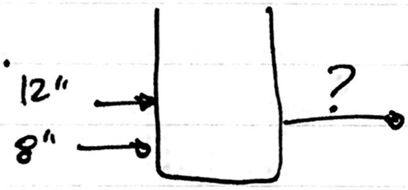
15. When diameter is cut in half, area goes down by a factor of 4.

Since $\text{velocity} = \frac{\text{flow}}{\text{area}}$

if area is 4 times smaller, velocity is 4 times faster, so

$2 \times 4 = 8$ ft/s

16.



area must be the same going in + out

Ⓐ $\text{AREA} = 0.785 d^2$
$\text{AREA} = (0.785)(12")(12")$
$\text{AREA} = 113.04 \text{ in}^2$

Ⓑ $\text{AREA} = (0.785)(8")(8")$
$\text{AREA} = 50.24 \text{ in}^2$

TOTAL AREA
IN = 113.04
+ 50.24
163.28 in²

$\text{AREA}_{\text{OUT}} = 0.785 d^2$
$163.28 \text{ in}^2 = 0.785 d^2$ — * divide both sides by 0.785

$163.28 / 0.785 = 0.785 d^2 / 0.785$

$\sqrt{208} = \sqrt{d^2}$ — * take the square root of both sides

$14.4" = d$

17. VELOCITY = $\frac{\text{FLOW}}{\text{DISTANCE}}$ and $\frac{\text{DISTANCE}}{\text{TIME}}$

VELOCITY = $\frac{500 \text{ ft}}{2\text{min } 18\text{sec}}$

VELOCITY = $\frac{500 \text{ ft}}{138 \text{ seconds}}$

$2 \times 60 + 18$

$120 + 18$

138sec

VELOCITY = 3.62 ft/sec

18. DOSE; lb/d = (mg/L)(Mgd)(8.34)

lb/d = (12 mg/L)(2.3 mgd)(8.34)

lb/d = 230.184

19. lb/d = $\frac{(\text{mg/L})(\text{mgd})(8.34)}{\text{\% available}}$

lb/d = $\frac{(12 \text{ mg/L})(2.3 \text{ mgd})(8.34)}{0.65}$

lb/d = 354

20. I need $\frac{\text{lbs chemical}}{\text{square feet of area}}$

AREA = $0.785 d^2$

AREA = (0.785)(11.5 ft)(11.5 ft)

AREA = 103.8 ft^2

26. (cont.) $\dfrac{103.8\ ft^2 \mid 4.5\ lbs}{\mid 1\ ft^2} = 467.2$ lbs chemical

all other info given is not needed.

21. $HP_{MOTOR} = \dfrac{(gpm)(TDH, ft)}{(3960)(E_p)(E_m)}$

$HP_{MOTOR} = \dfrac{(50 gpm)(50 ft)}{(3960)(0.85)(0.90)}$

$HP_{MOTOR} = 0.825$

22. $\dfrac{6\ hrs}{day} \Big| \dfrac{30\ days}{1\ month} = \dfrac{180\ hrs}{month}$

$0.825\ HP \Big| \dfrac{0.746\ kw}{1\ HP} = 0.615\ kw$

$(180\ hrs)(0.615\ kw) = 110.7\ kwh$

$110.7\ kwh \Big| \dfrac{\$0.07}{1\ kwh} = \$7.75$

23. $\frac{1890 \text{ Liters}}{\text{min}} \Big| \frac{1 \text{ gal}}{3.785 \text{ L}} \Big| = 499 \frac{\text{gal}}{\text{min}}$

$$HP = \frac{(gpm)(TDH, ft)}{(3960)(E_p)(E_m)}$$

$$HP = \frac{(499 \text{ gpm})(300 \text{ ft})}{(3960)(0.70)}$$

$HP = 54$

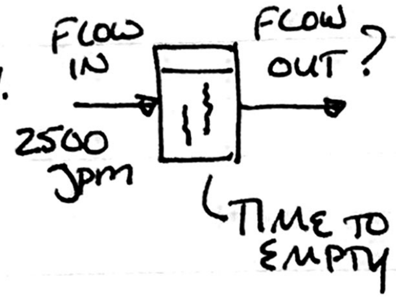
$54 \text{ HP} \Big| \frac{0.746 \text{ kw}}{1 \text{ HP}} \Big| = 40.3 \text{ kw}$

$\frac{12 \text{ hrs}}{\text{day}} \Big| \frac{31 \text{ days}}{1 \text{ month}} \Big| 2 \text{ months} \Big| = 744$ hrs run time

$(40.3 \text{ kw})(744 \text{ hrs run time}) = 29,983.2 \text{ kwh}$

$29,983.2 \text{ kwh} \Big| \frac{\$0.09}{1 \text{ kwh}} \Big| = \$2698.49$

24.



4.5 inch | 1 ft / 12 in | = 0.375 ft

5.5 inch | 1 ft / 12 in | = 0.458 ft

72. inch | 1 ft / 12 in | = 6 ft

VOLUME PUMP BORE = $0.785 d^2 h$

= (0.785)(0.375 ft)(0.375 ft)(0.458 ft)

= $0.0506\ ft^3$

× 4 (4 bores in pump)

= 0.202 cf/stroke

0.202 cf/stroke | 1700 strokes / 1 min | = 343 cfm = FLOW OUT

2500 gal/min | 1 cf / 7.48 gal | = 334 cfm = FLOW IN

Net flow is FLOW OUT − FLOW IN

343 − 334

9.57 cfm drop in wet well volume

time = Volume / flow

time = 932.58 cf / 9.57 cfm

time = 98 minutes

$V = 0.785 d^2 h$

V = (0.785)(6 ft)(6 ft)(33 ft)

V = 932.58 cf

25. $\% \text{slope} = \frac{\text{rise}}{\text{run}} \times 100$

$\% \text{slope} = \frac{(5293.5\text{ft} - 5289.8\text{ft})}{400\text{ft}} \times 100$

$\% \text{slope} = \frac{3.7\text{ ft}}{400\text{ ft}} \times 100$

$\% \text{slope} = 0.925$