Problem of the Day

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To check the velocity of flow through a stretch of sewer, a collection system operator dropped a float into the flow at the manhole where she stood. When she dropped the float, a coworker at the next downstream manhole started a stopwatch. The two manholes are 386 feet apart. It took 2 minutes and 56 seconds for the float to reach the coworker. Calculate the velocity of the flow in the sewer in feet per second.

Introduction

This kind of question has shown up on many Grade I and II certification exams. There are a lot of words in this problem, **but only two numbers**: 386 feet (386 ft) and 2 minutes 56 seconds (2 min 56 s). A lot of operators think they have to memorize a bunch of equations and piecharts to do math problems. While that is certainly one strategy, a lot of memorization, in WWTT's opinion, is a waste of time. The units tell you how to solve the problem.

Solution

The question asks to calculate velocity of the sewage moving between the two manholes in ft/s (feet per second). These units, as always, are entered between heavy vertical lines followed by an equals sign and the blank solution bridge.

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$$\left|\frac{\text{ft}}{\text{s}}\right| = \text{\_\_\_\_\_}$$

As I have been saying in past several Problems of the Day, I have recently been working with an operator who struggles terribly with "word problems." A lot of people do. He was telling me it's hard for him to even extract the "givens" out of the problem statement. I suggest that you underline each **number**, with units, given in the problem statement and any "descriptors" that go with each number. So today's problem might look like this with underlines:

> **Problem of the Day**: To check the velocity of flow through a stretch of sewer, a collection system operator dropped a float into the flow at the manhole where she stood. When she dropped the float, a coworker at the next downstream manhole started a stopwatch. The two manholes are 386 feet apart. It took 2 minutes and 56 seconds for the float to reach the coworker. Calculate the velocity of the flow in the sewer in feet per second.

Since these are math problems, the numbers in the problem statement are what are important to us; that's why we underline them. We all know problems sometimes give us numbers we don't need, but don't worry about picking up what you need and don't need as you list the information given in the problem statement. Each of the numbers has to be described in our list of givens. Here I recommend describing what the numbers are anyway you want to but take as much out of the problem statement descriptors that you've underlined as you can.

Before I do that, though, recall that I have said in precious Problems of the Day that mixed units, like 2 min 56 s, do not work well in the solution bridge. Whenever you see these kinds of units, WWTT recommends you immediately condense the mixed units to one set of units. With 2 min 56 s we have two options: convert to minutes or seconds.

The question is asking us to calculate velocity in feet per **second**, so should we convert 2 min 56 s to min or s?

Seconds, of course: 2 min 56 s = 120 s + 56 s = 176 s.

So, the list of givens is short:

1. Distance float traveled = 386 ft
2. Time it takes for float to travel = 2 min 56 s = 120 s + 56 s = 176 s

This is the absolute beauty of using the unit approach advocated by WWTT and others. The question asks to calculate velocity in ft per s. We have two numbers, one of them is in ft (No.1) and the other is in s (No. 2). Without knowing the equation for calculating velocity (by the way it is: velocity = distance ÷ time), the only way we can get the units in the correct order (numerator and denominator) needed in the answer

is to divide No. 1 by No. 2. We start with getting the units needed in the numerator of the answer in the numerator of the solution bridge by entering distance (No. 1) as shown in bold.

ft	=	386 **ft**	
s			

Now we want to enter the units s (only found in No. 2 of the list) in the denominator of the solution bridge because they are needed in the denominator of the answer.

ft	=	386 **ft**	
s			176 **s**

Because we have only the units needed in the answer in the solution bridge, **ft/s**,we know the solution bridge is complete and the arithmetic gives the **<u>answer</u>**.

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ft	=	386 **ft**	
s			176 **s**

386 ÷ 176 = **<u>2.2 ft/s</u>**.

Discussion

First of all, there is a lot about using units that makes the kinds of math problems water and wastewater operators have to do on the job and on certification exams easy. In today's problem, the units needed in the answer told us **exactly** how to do the problem; no question. It doesn't make sense to me that so many operators are reluctant to use units to do math problems. Because there are few numbers that we deal with that do **not** have units associated with them, just get in the habit of including units in your everyday conversations and writing. Instead of saying "8.34," say "8.34 pounds per gallon;" instead of saying "135 gpm," say "135 gallons per minute;" instead of saying "4.5 MGD," say "4.5 million gallons per day" or "4.5 Mgals per day."

Second, a velocity of 2 ft/s or greater is desired in gravity sewers. This is not something that is in the control of collection system operators, but it is still important because solids tend to settle out in sewers if the velocity is less than 2 ft/s, potentially leading to clogging and other maintenance issues.

Third, WWTT doesn't prepare Problems of the Day along the lines of different certification grade levels, no matter what state you're in. The sooner you develop a comfort level doing all the Problems of the Day, the sooner you will have success achieving higher levels of certification and on the job. If you think a problem is too hard for the grade level you are studying for, just try to understand how the problem is solved. The more you look at these problems and practice them, the easier you will find all math problems.

Happy calculating! Let us know, by leaving a comment, if you want us to do a specific problem, if you see a mistake, or if you have a question on any of the Problems of the Day you are looking at.