# **Filling the Pool**

A rope ladder with 8 rungs that are 9 inches apart is hanging over the side of a pool. The first rung is 9 inches from the bottom of the empty pool.

If we fill the pool at a rate of 1 foot per hour, how long will it take to reach the top rung of the ladder?

Grade Levels 3 - 5

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### Context

The sample student work was taken from a fourth grade class. This problem is challenging enough so most students find a need for drawing a diagram. It is interesting to see how students deal with the variety of units - time, distance (inches and feet) and distance/time. Those students who labeled their work also found it easier to understand what steps to take in their solution.

### What This Task Accomplishes

We often tell students that a diagram may help in solving problems, but rarely give a problem that is challenging enough. For many students, this problem may only be accessible through a diagram. Usually the more accurate the diagram the more successful the student is in working through their solutions. This task can be solved using different strategies. When the student is able to make connections, the solution is often more sophisticated.

### What the Student Will Do

Most students will draw a diagram. They will find that the time put into making an accurate and appropriate diagram will make solving the problem easier.

### **Time Required for Task**

45 minutes

### **Teaching Tips**

Encourage students having difficulty getting started to draw a diagram.

### **Suggested Materials**

Centimeter graph paper

## **Possible Solutions**

8 rungs x 9 inches apart = 72 inches to fill

72 inches/12 inches/foot = 6 feet to fill

At a rate of 1 foot/hour it will take 6 hours to fill the pool to the top rung.

## **Benchmark Descriptors**

#### Novice

This student is filling the pool to the top although there is no information in the problem as to how far the last rung is from the top of the pool. There is no explanation of the solution. The diagram is not labeled nor is it accurate. There is little use of mathematical language or notation.

#### Apprentice

This student uses a strategy that is partially useful. There is some use of appropriate mathematical representation. The diagram indicates s/he is counting by nines (keeping track of the rungs). S/he also is keeping track of the feet (the solution seems to indicate s/he knows that one foot means one hour of filling time). However, because their diagram is not accurate, s/he does not come out with a correct solution. S/he also incorrectly connects nine inches to nine minutes of filling time although their comment indicates s/he is not confident of this connection either.

#### Practitioner

The solution shows the student has a broad understanding of the problem and major concepts. The strategy of drawing a diagram leads to a solution. The mathematical reasoning is effective. There is a clear explanation of reasoning. The student also comments that if they filled the pool for an hour and measured how much was filled they could predict how long it would take to fill the pool. This is a good example of a student not stopping after solving a problem, but thinking about the task and making a comment about how this problem could be used in the real world.

#### Expert

This student shows a deep understanding of the problem and was able to identify the appropriate mathematical concepts necessary for the solution. The student uses an efficient strategy that leads directly to a solution. The first solution is verified using a second strategy. There is a clear and effective explanation detailing how the problem is solved. All of the steps are included so that the reader does not need to infer how and why decisions were made. The mathematical representation is accurate and actively used in communicating the second solution. The use of multiples and common multiples is a precise and sophisticated use of mathematical terminology.

### Novice



The student attempts to create a diagram although it is unclear how labels were determined.

The solution lacks communication about what was done to obtain a solution.

## Apprentice



### Practitioner

It will take 6 hours. I made a diag ram for the problem I drewa ladder with eight rugs. Each rung was gindes apart. I made sure they were equal. Chours 12 172 The diagram was easiest for me. I used it I measured every sinches, and every 1 Foot A 66 When I was dore If in ished with the Shours, 63 answer of 6 hours, Ididwhat I addes 60 57 didbecause Iwanted toget 4 hours-> 54 the problem done quickly. 51 48 The student clearly communicates 45 3 hours ? an approach that works. So what ... 42 39 If I had a pod. I could take 36 7 hour filling it. Then this could help me figure out how long 2,000 33 .30 29 it would take to fill it. -24 1 hour -> 21 12 - 18 The student's diagram is -15 accurate and appropriate. 12 The student obtains a correct solution.

## Expert



Expert

1st I read the directions so I'd know what to do. Then I said 9 multiplied by 8 because there's ginches between the rungs and the answer was 72 so I Knew the water had to go 72 inches to reach the top rung. I divided 72 by 12 because there's la inches in a foot and the answer was 6 hour And I decided to proove it a second way and this is how I did it. First I drew a ladder with 8 rungs then put a line under the ladder for the I Pool bottom and kobled if. Then on the rungs I put from the bottoms to the I wrote on the first rung I wrote tap Pinches then I smoltiples of 9 on the rungs. Then I wrote little marks between the inches because I had to find were my 12 inch would fall. I wrote on the first little dash 12 the did the multiples of three from there. Then I went back and marked water would be at every hour, of were the my second answer prooved that S answer Was right. My first The student verifies The student clearly communicates the solution by solving how the problem was solved. two different ways.