Shortcut for Pipes and Cistern (Tank) Problems

On the surface of it, questions pertaining to Pipes and Cistern seem to be widely different from Time and Work questions. But as any keen observer will tell you, they are effectively the same concept, packaged differently. Which means that if you are an ace at solving Time and Work questions, Pipes and Cistern should be a cinch for you! And if you aren't? Well, don't worry. With this easy shortcut, you can easily solve Pipes and Cistern problems in less than a minute.

Problems containing pipes and cisterns fall broadly into one of two categories. The first category being one wherein questions are concerned with the time required to fill up a tank, with a combination of one or more pipes and cisterns. The second category, concerns itself with leakages and holes, requiring you to calculate the effective rate of the tank being filled or emptied.

Type 1: Pipes and Cistern (Tank)

In order to solve questions falling into the first category, imagine each of the pipes as a human doing some work. (Again, we are using a Work and Time reference here). The time taken by a single pipe to fill up the tank by itself, is the time taken by that human to do the entire work. Find out each pipe's (or human's) rate of doing work, with respect to each other. For instance, if Pipe A can fill the tank in 8 hours, and Pipe B can fill it in 4 hours, you know that the rate of B is twice as that of A.

Once, you have the rates of doing work, all you have to do is add them up to find out the overall rate of filling the tank by all the pipes together. Remember, rate is always inversely proportional to the time taken, so the rates you add up should be reciprocals of the time taken by each pipe.

An easy tip that helps, is to assign any one pipe's rate as 'x', and calculate the others' rate in terms of 'x'.

E.g. 1. Pipe A fills a tank in 3 hours whereas Pipe B fills the same tank in 10 hours.

Solution:

Since Pipe B takes more time, let us take 'x' as the rate at which B fills the tank.
Since time taken by B is 3 times the time taken by A, the rate of A will be 3 times faster than the rate of B. So the rate of A is '3x'.

REMEMBER: RATE, NOT TIME!!

Another advantage of using the rates, is that **rates** can be added up, not **time**. Which means that if two pipes take 4 and 8 hours respectively to fill up a tank, you can add the reciprocals of 4 and 8 to get the net rate. What you **cannot** do, is add 4 and 8 up, directly. That would result in a wrong answer.

The logic is simple. If you add 4 and 8 up, to find the time taken by both together to fill up the tank, you will get 12. But think, if one pipe takes 4 hours and the other takes 8 hours to fill up the tank, they couldn't possibly take 12 hours together!

So let us use the rates in the following example:

E.g. 2. Pipes P, Q, R and S can fill a certain tank in 3, 5, 6 and 10 hours, respectively. How much time will it take for the tank to be filled if all pipes are opened together?

Solution:

Let 'x' be the rate of Pipe S, which is the slowest. So the rates of all the pipes are as follows. Make sure to make as few calculations as possible – this is the trick to cracking your exam! Try the following method:

Pipe	Time Taken (in hours)	Efficiency (Inverse of time)
S	10	x (where x=1/10)
Q	5 (1/2 of 10)	2x
P	3 (1/3.33 of 10)	3.33 x
R	6 (2 times 3)	1.66x (1/2 of 3.33x)

So the total efficiency of the four pipes is: $x + 2x + 3.33x + 1.66x \approx 8x = 8 \times (1/10)$
Thus the total time taken for the four pipes working together to fill the tank would be:
10/8 hours = 1.25 hours = 1 hour 15 mins.

Shorten Your Calculations

By choosing the pipe taking the maximum time first and basing your calculations on that, you effectively bring down the number of reciprocal calculations you make. Of course, you need to pick and choose which pipe's efficiency to calculate next. Like in the example, after S, we chose Q because its time taken was a direct multiple of the time taken by S. This lets us calculate its reciprocal easily. Next, we were left with Pipes P and R, both of whose times are not multiples of the time taken by S. However, we all know that 10 is 3.33 times 3. So we use this to first find the efficiency of P. Next we know that 6 is two times 3. So clearly the efficiency of R is half of P.

To make such quick calculations, ensure that you are familiar with reciprocals of all numbers up to at least 20. You can check out tricks to remember them here:

Shortcuts to Remember Reciprocals of Numbers in PDF

Of course you won't make a table while solving the problem and waste your time. You just need to do the calculations mentally.

Type 2: Speed of Filling/Emptying

For the second category, take each pipe **filling** the tank as positive, and each hole, drain, outlet or leakage **emptying** the tank as negative. When you add these negative and positive rates together (being very careful with the signs), you get an equation giving you the net rate by which the tank is being filled up. If this figure is negative, that means the tank is being emptied, rather than filled up.

Once you have the net rate of the tank emptying or filling up, all you have to do is factor in the size of the tank, to find out the time it takes to empty or fill up. The size of the tank can be obtained from other information provided in the question. The question will either tell you how long the tank takes to empty through one hole, or it will give you the capacity of the tank. Either way, once you're at this point of the solving process, it should be easy to get to the end. Simple math will get you there!

E.g. 3. A pipe fills a tank in 3 hours, whereas an outlet can empty the filled tank completely in 12 hours. In what time will the tank be filled, if both the pipe and the outlet are opened simultaneously?

Solution:

Let 'x' be the efficiency of the outlet. However since it is emptying the tank, we always use a negative sign with it.
And efficiency of pipe = (12/3)x = 4x
∴ Total Efficiency = 4x – x = 3x
Since x = 1/12, we can say that the tank will be filled in time = 12/3 = 4 Hours.

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