Activity Overview

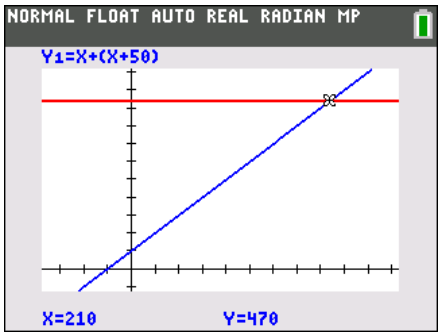
In this activity, students will use a variety of features of the TI-84 Plus to represent a problem situation. Students will look at the problem algebraically, graphically, verbally, and numerically.

Topic: Numbers

- Translating verbal sentences into mathematical equations
- Unit analysis
- Function zeros
- Solutions to systems of equations

Teacher Preparation and Notes

- Students will work with graphing equations, changing window settings, setting up a table, and using the equation solver.
- **To download the student worksheet, go to education.ti.com/exchange/rof**



This activity utilizes MathPrint™ functionality and includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-83 Plus, TI-84 Plus, and TI-84 Plus Silver Edition but slight variances may be found within the directions.

Compatible Devices:

- TI-84 Plus Family
- TI-84 Plus C Silver Edition

Associated Materials:

- The_Rule_of_Four_Student.pdf
- The_Rule_of_Four_Student.doc
-

Tech Tips:

- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Part 1 – Draining a Water Tank

The Rule of Four emphasizes that problem situations can be represented in four different ways. These multiple representations are: 1) verbal, 2) numerical (table), 3) analytic (algebraically), and 4) geometric (graphically).

Questions 1–3

In this problem, a water tank is being drained by two pipes. Use the following information to set up one way to solve this particular problem.

One pipe drains at a rate of 50 l/min faster than the other pipe. If they release 4,700 liters in 10 minutes, what is the drainage rate?

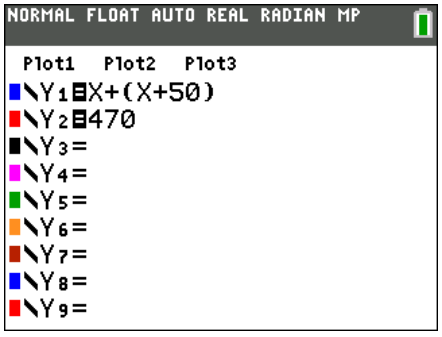
Students are first asked to translate the problem into a verbal sentence using variables.

- If the first pipe drains at x l/min, then the second drains at $x + 50$ l/min.
- Together the pipes drain 4700 l/10 min = 470 l/min.

So, $x + (x + 50) = 470$.

Students are to enter the expression for the drainage rate of both pipes working together in **Y1** and the unit rate in **Y2**.

Note: To enter X, press [X,T,Θ,n].

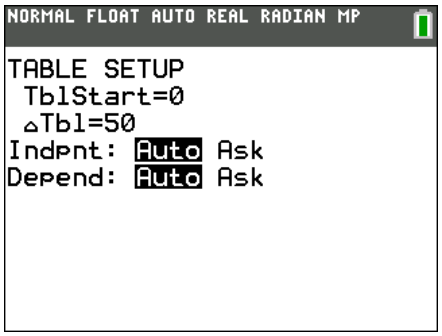


Questions 4–6

Students are to put together the expressions to form an equation and solve for x, algebraically.

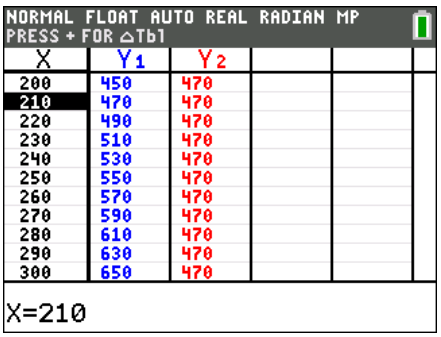
$$x + (x + 50) = 470$$
$$2x + 50 = 470$$
$$2x = 420$$
$$x = 210$$

Next, students will set up the table to find the value where both equations are equal. To access the table setup, press [2nd] [TBLSET]. Change the settings as shown at the right and then press [2nd] [TABLE] to view the actual table.



As students scroll down, they will notice that they "skip" 470 when x goes from 200 to 250. Engage them in a discussion about how you could include the numbers between 200 and 250 in the table.

Direct students to return to the table setup and adjust **ΔTbl** to be 10 instead of 50 and have them look at the table again. They should now find an exact match between Y1 and Y2 for 470 is at X = 210.



Note: Students can also press + while in the table to access **ΔTbl**.

Part 2 – Solving by a Different Method

Next, students will explore the same problem graphically and then using the solver.

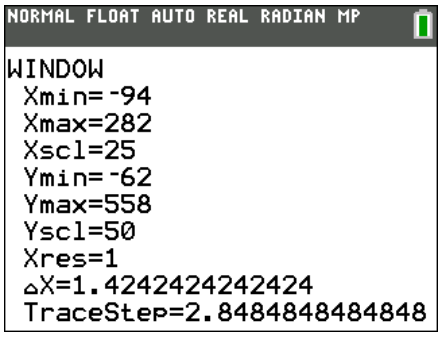
Questions 9–10

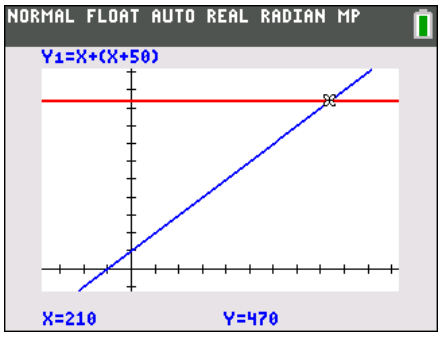
Have students check that their two equations are still in the Y= editor.

Students may need to adjust the window in order to actually see the graphs and the intersection of the graphs. Have them discuss what values might be appropriate for the window.

To adjust the window, press WINDOW. A suggested window is shown at the right.

Note: ΔX will automatically update when Xmin and Xmax are changed. Students should not change the ΔX value.



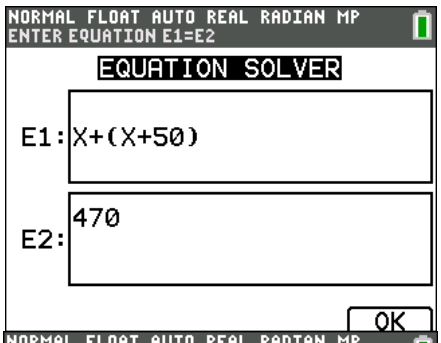


Part 3 – Using the Solver

Questions 11–12

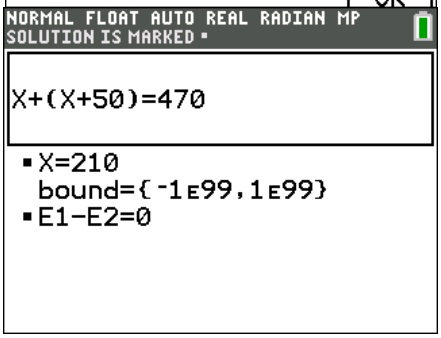
Finally, students will find the solution to the equation using the **Solver**. To access the solver, press MATH and select **B:Solver…**. The expression box should come up empty but if it does not, simply press CLEAR to remove any previous information.

Students will need to enter the left side of the equation into the E1 box and the right side of the equation into the E2 box. Then select **OK** or press [ENTER].



To solve the equation, make sure the blinking cursor is over the x value and press [ALPHA] [SOLVE]. The solution will appear next to **X=**.

Students should quickly see that the same solution is obtained using this method as well.



Note: on the TI-84 Plus, the equation is entered as:

eqn: 0 = x + (x + 50) - 470

Solutions – Student Worksheet

Part 1: Draining a Water Tank

1. Translate the word problem above to a verbal sentence using variables.

   Answer: If the first pipe drains at *x* l/min, then the second drains at *x* + 50 l/min. Together the pipes drain 4700 l/10 min = 470 l/min. So, *x* + (*x* + 50) = 470.

2. Together, what is the unit rate that water drains from the tank? **Answer: 470 l/min**

3. Enter the combined expression for the rate the water drains in Y1. Enter the unit rate in Y2. To access Y1, press [Y=]. What are these expressions? **Answer: Y1 = *x* + (*x* + 50); Y2 = 470**

4. Write an equation where the left side is Y1 and the right side is Y2. **Answer: *x* + (*x* + 50) = 470**

5. What value of *x* will make the left side of this equation equal to 470? **Answer: 210**

6. Use ▲ and ▼ to scroll through the table looking for when Y1 is equal to Y2. What do you find?

   Answer: Students should observe that with the initial window settings, they "skip" past the point where 470 would appear in both lists. They need to make the changes in the table step smaller to find where 470 appears in both lists.

7. Adjust the table values as needed to find an exact answer. What value makes the two sides equal?

   Answer: 210

8. At what rate does each pipe drain? **Answer: 210 l/min, 260 l/min**

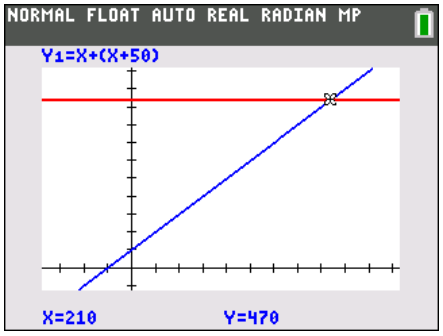
Part 2: Solving by a Different Method

9. Another way to solve this equation is by looking at a graph. You have already entered the left and right side in Y1 and Y2. The point on the graph you are interested in is where the two lines intersect. Press [WINDOW] to adjust the viewing window to an appropriate setting. Then press [GRAPH]. Use the **Trace** feature ([TRACE]) to find the intersection point. Are you able to find the exact intersection for the lines?

   Answer: (210, 470); Yes, the exact intersection can be found.

10. Draw your graphs on the screen at the right and indicate the intersection point.

    Find the answer in the screen to the right.



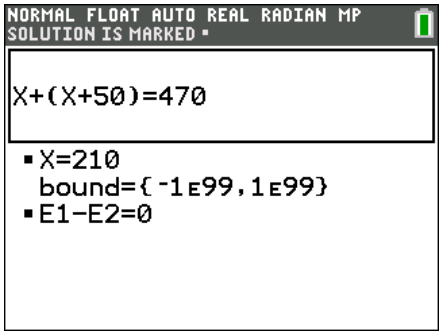
Part 3: Using the Solver

11. Finally, use the SOLVER to find a numerical solution to the equation. To access the solver, press MATH and select **B:Solver…**.

    Enter the left side of the equation in the E1 box and the right side of the equation in the E2 box.

    Press **OK** or ENTER when done.

    Find the answer in the screen to the right.



12. Place the blinking cursor over the value of X. Press ALPHA [SOLVE]. What value is returned for *x*? **Answer: 210**

13. How does this value compare to the value you found as the intersection of the graphs?

    Answer: It is the same.

14. How does this value compare to the value you found using the table?

    Answer: It is the same.

15. What are the advantages or disadvantages to the different ways of solving equations?

    Answer: Answers will vary. Students should see that there could be limitations with finding an "exact" intersection on a graph. This is not the "best" method of solving an equation but it can give you a visual idea of where the intersection is. Students may also conclude that the table could have the same limitation.