

Doin' the TI Two-Step

by Suzanne Moyers

Time required

45-55 minutes

Activity Overview

In this activity, students solve two-step and multi-step equations using inverse operations. At first, they are guided through choosing which operation should be done first. They are even prompted to try an operation or two that is not necessarily an ideal first choice, to see what results. The objective of the activity is to enable students to decide the sequential order in which inverse operations should be carried out. Error correction is encouraged. Students are directed to record the steps of their work and their answers on the worksheet handout.

Concepts

- Solving two-step and multi-step linear equations of the form $ax+b=c$ and $(ax+b)/c=d$, where a , b , c , and d are integers, fractions or decimal forms of real numbers.
- Error correction when trials of inverse operations do not yield expected results, or result in necessitating more complex operations than called for in solving the equation.

Teacher Preparation

This activity is designed for use in an Algebra 1 classroom. It uses some trial-error techniques to help students discover error correction procedures on their own. These techniques do not lend themselves well to the use of manipulatives, since equations used in the activity include working with quotients and fractional or decimal coefficients.

Prior to the start of this activity, students should be able to perform equation-solving with one-step linear equations containing negative integer coefficients and constants, as well as fractional and decimal values.

- Two-step and multi-step linear equations with integer and rational coefficients and constants are included in the problem set.
- Each equation contains a different alphabetic variable, to promote ease of reference when discussing problems and recording results.
- Screenshots on the following pages include frames from the **TwoStep.tns** file, before it has been filled in by the student, AND frames from the **TwoStepAns.tns** file, which is completed as the student's submitted document.

Classroom Management

- This activity is intended to be completed **individually**, but with students arranged in pairs or small groups, to allow for discussion of procedure choices and student reasoning.
- A separate student worksheet is provided (.doc and .pdf formats for editing if desired): **Two-StepWorksheet.doc** or **Two-StepWorksheet.pdf**, for the student to record equation-solving steps as they progress through the activity.
- Students are directed to perform a **SAVE AS** operation at the completion of the activity, using **LASTNAME-2STEP** as their individual filenames, for ease of assessment.

TI-Nspire™ Applications

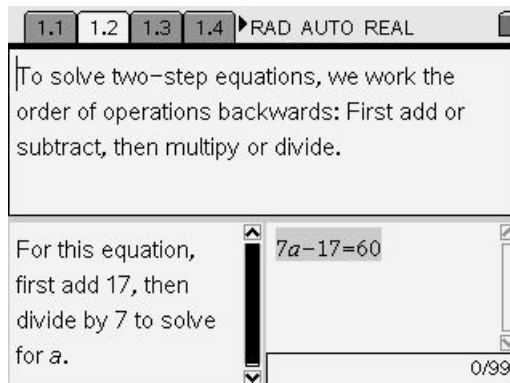
Calculator, Notes

Algebra 1 *TI-Nspire™ CAS* Solving Equations

Teacher Info: Solving two-step equations means that we must decide which inverse operation to do first, then which comes next. We must work our way backward through the order of operations, doing addition or subtraction first, then multiplication or division. Sometimes, we reverse these steps, depending on the type of equation we are solving.

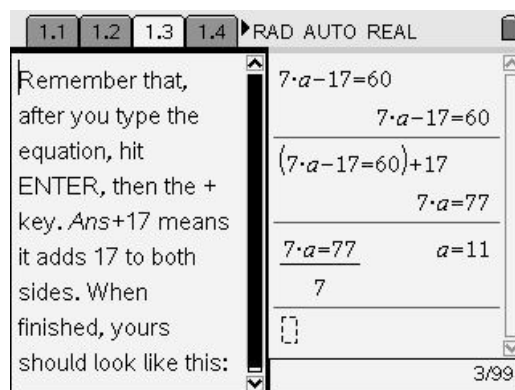
Problem Set 1 – Guided Problem Solving

Students begin by solving a 2-step equation, with guidance from directions given in the TI-Nspire file. They must Ctrl-Tab to the problem pane, place the cursor at the right end of the equation, then hit ENTER. This initial ENTER step must be used as they start the solution of each equation. When they hit the + key, *Ans*+ shows automatically, after which they enter 17. The CAS feature subtracts 17 from both sides of the equation. They'll repeat these steps with each equation.

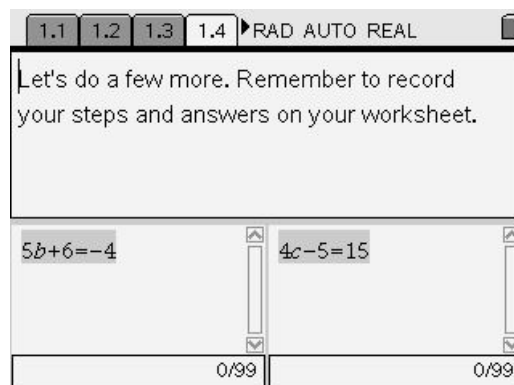


They are shown what their solution should look like. This may spark discussion among students, which is the purpose of the activity.

Note that the Calculator application shows dots for multiplication. Encourage questions at this point. On the next page they will work a few more equations, but on their own.



Students are reminded to record work and answers on their worksheets as they go along. Over-the-shoulder guidance may be needed, as some may find the CAS format rather intimidating, or even mind-boggling.



On page 1.5, students are prompted to break sequence and try doing what comes first: multiply. The CAS system then multiplies all terms by 8, resulting in large values. Then, they are coached in the UNDO procedure, to try again, but use subtraction instead. This allows them to see how to back up and start over and teaches the Ctrl-Z macro.

1.2 1.3 1.4 1.5 RAD AUTO REAL

Do we add, subtract multiply or divide first? See what happens if you multiply first. Then use *Ctrl Z* twice to undo. Now subtract.

$$\frac{d}{8} + 21 = 14$$

$$\frac{d}{8} + 21 = 14$$

$$\left(\frac{d}{8} + 21 = 14\right) \cdot 8$$

$$d + 168 = 112$$

2/99

On page 1.6, students are directed to try adding 15 first. They get unexpected results (see Two-Step Solutions section that follows).

Then, they are coached in using multiplication first and given a separate pane for the “do-over”. The tutorial nature of this page really gets them thinking. They are again reminded to record their work on student worksheets.

1.3 1.4 1.5 1.6 RAD AUTO REAL

In the top box, see what happens if you add 15. Not what we expected? Now, in the lower box, multiply by 9. Notice that -6 is also multiplied by 9. Finish it and record your work.

$$\frac{f-15}{9} = -6$$

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$$\frac{f-15}{9} = -6$$

0/99

On pages 1.7 through 1.9, students are solving equations independently. It is expected that discussion with partners or group members will arise, as well as requests for help from the teacher. Typically, questions are of a technical nature, rather than about equation solving procedures.

1.4 1.5 1.6 1.7 RAD AUTO REAL

Do this one on your own. Remember to record your steps and answer on the worksheet.

$$\frac{17-g}{4} = -10$$

0/99

Students may find some surprises about how the CAS Calculator application works from these last two problems in Problem Set 1. It likes to break numerators into separate fractions, which they may find alarming. It also tends to factor out negatives, forcing them to think about reversals and how negative coefficients work.

1.6 1.7 1.8 1.9 RAD AUTO REAL

Here are a few more. Think carefully on the second one! Be sure to write down each step and your answer on the worksheet.

$$\frac{-3j+4}{-6} = 12$$

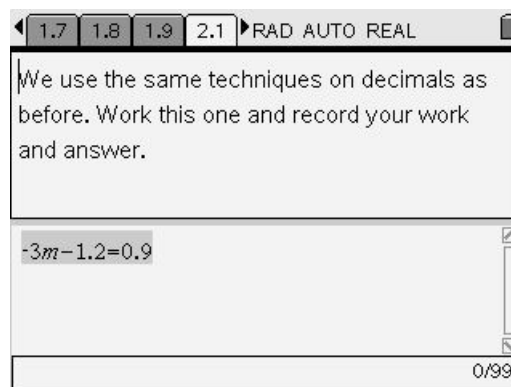
$$\frac{9k+4}{5} - 8 = 5.4$$

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Problem Set 2 - More Independent Work, But with Decimal Values

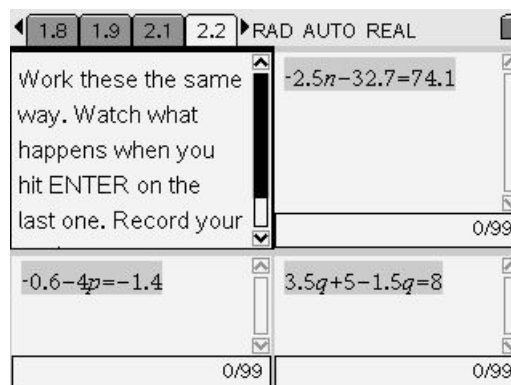
In this set, students perform more inverse operations, but with decimal coefficients and constants.

Most students will be working independently through this set.



Students will be surprised that the CAS Calculator application automatically combines like terms, as in the third equation on page 2.2.

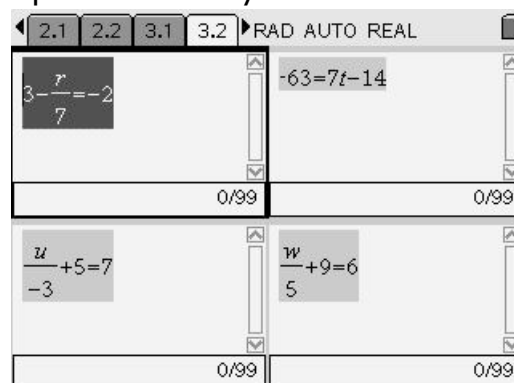
Don't be surprised if they ask: "Can we use these calculators all the time?".

**Problem Set 3 – And More Independent Work: Mixed Equation Types**

In Set 3, students work a mixture of types of equations. They should be working with confidence by now. Students who are finished should be reminded to record work and answers on their worksheets.

There are seven equations in Problem Set 3.

Remind them to hit Ctrl and the HOME key to go to TOOLS, then File, then SAVE AS. If they simply SAVE, their work will overwrite the original Two-Step document. The original (without student work) will have to be reloaded to the handheld.



TwoStepAns.tns

Completed Student Document (page 1)

1.1 1.2 1.3 1.4 ▶ RAD AUTO REAL

To solve two-step equations, we work the order of operations backwards: First add or subtract, then multiply or divide.

For this equation, first add 17, then divide by 7 to solve for a.

$$7 \cdot a - 17 = 60$$

$$7 \cdot a - 17 = 60$$

$$\frac{\text{Ans} + 17}{7}$$

1/99

----->

1.1 1.2 1.3 1.4 ▶ RAD AUTO REAL

To solve two-step equations, we work the order of operations backwards: First add or subtract, then multiply or divide.

For this equation, first add 17, then divide by 7 to solve for a.

$$(7 \cdot a - 17 = 60) + 17$$

$$7 \cdot a = 77$$

$$\frac{\text{Ans} / 7}{7}$$

2/99

1.1 1.2 1.3 1.4 ▶ RAD AUTO REAL

To solve two-step equations, we work the order of operations backwards: First add or subtract, then multiply or divide.

For this equation, first add 17, then divide by 7 to solve for a.

$$\frac{7 \cdot a = 77}{7} \quad a = 11$$

3/99

----->

1.1 1.2 1.3 1.4 ▶ RAD AUTO REAL

Remember that, after you type the equation, hit ENTER, then the + key. *Ans*+17 means it adds 17 to both sides. When finished, yours should look like this:

$$7 \cdot a - 17 = 60$$

$$7 \cdot a - 17 = 60$$

$$(7 \cdot a - 17 = 60) + 17$$

$$7 \cdot a = 77$$

$$\frac{7 \cdot a = 77}{7} \quad a = 11$$

3/99

1.1 1.2 1.3 1.4 ▶ RAD AUTO REAL

Let's do a few more. Remember to record your steps and answers on your worksheet.

$$\frac{5 \cdot b = -10}{5} \quad b = -2$$

$$(4 \cdot c - 5 = 15) + 5$$

$$4 \cdot c = 20$$

$$\frac{\text{Ans} / 4}{4}$$

3/99 2/99

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1.2 1.3 1.4 1.5 ▶ RAD AUTO REAL

Do we add, subtract multiply or divide first? See what happens if you multiply first. Then use *Ctrl Z* twice to undo. Now subtract.

$$\frac{d}{8} + 21 = 14$$

$$\frac{d}{8} + 21 = 14$$

$$\left(\frac{d}{8} + 21 = 14\right) \cdot 8$$

$$d + 168 = 112$$

2/99

1.2 1.3 1.4 1.5 ▶ RAD AUTO REAL

Do we add, subtract multiply or divide first? See what happens if you multiply first. Then use *Ctrl Z* twice to undo. Now subtract.

$$\frac{d}{8} + 21 = 14$$

$$\left(\frac{d}{8} + 21 = 14\right) - 21$$

$$\frac{d}{8} = -7$$

2/99

----->

1.2 1.3 1.4 1.5 ▶ RAD AUTO REAL

Do we add, subtract multiply or divide first? See what happens if you multiply first. Then use *Ctrl Z* twice to undo. Now subtract.

$$\left(\frac{d}{8} + 21 = 14\right) - 21$$

$$\frac{d}{8} = -7$$

$$\left(\frac{d}{8} = -7\right) \cdot 8 \quad d = -56$$

3/99

TwoStepAns.tns

Completed Student Document (page 2)

1.3 1.4 1.5 1.6 RAD AUTO REAL

In the top box, see what happens if you add 15.
Not what we expected?

Now, in the lower box, multiply by 9. Notice that -6 is also multiplied by 9.
Finish it and record your work.

$$\frac{f}{9} + \frac{40}{3} = 9$$

$$\left(\frac{f}{9} + \frac{40}{3}\right) \cdot 9$$

$$f - 15 = -54$$

2/99



1.3 1.4 1.5 1.6 RAD AUTO REAL

In the top box, see what happens if you add 15.
Not what we expected?

Now, in the lower box, multiply by 9. Notice that -6 is also multiplied by 9.
Finish it and record your work.

$$\frac{f}{9} + \frac{40}{3} = 9$$

$$\left(\frac{f}{9} + \frac{40}{3}\right) \cdot 9$$

$$f - 15 = -54$$

$$(f - 15 = -54) + 15$$

$$f = -39$$

2/99

3/99

1.4 1.5 1.6 1.7 RAD AUTO REAL

Do this one on your own. Remember to record your steps and answer on the worksheet.

$$(-(g-17)=-40)-17$$

$$-g=-57$$

$$(-g=-57) \cdot -1$$

$$g=57$$

4/99



1.5 1.6 1.7 1.8 RAD AUTO REAL

Do this one on your own. Think about what to do first. Record your work.

$$\left(6 - \frac{h}{5} = 31\right) - 6$$

$$\frac{-h}{5} = 25$$

2/99

1.6 1.7 1.8 1.9 RAD AUTO REAL

Here are a few more. Think carefully on the second one! Be sure to write down each step and your answer on the worksheet.

$$3 \cdot j = 76$$

$$\frac{3 \cdot j = 76}{3} \quad j = \frac{76}{3}$$

$$\left(\frac{9 \cdot k + 4}{5} = 13.4\right) \cdot 5$$

$$9 \cdot k + 4 = 67$$

$$(9 \cdot k + 4 = 67) - 4$$

4/99

3/5



1.7 1.8 1.9 2.1 RAD AUTO REAL

We use the same techniques on decimals as before. Work this one and record your work and answer.

$$-3 \cdot m = 2.1$$

$$-3$$

$$m = -.7$$

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1.8 1.9 2.1 2.2 RAD AUTO REAL

Work these the same way. Watch what happens when you hit ENTER on the last one. Record your

$$-2.5 \cdot n = 106.8$$

$$-2.5$$

$$n = -42.72$$

3/99

$$-4 \cdot p = -.8$$

$$p = .2$$

$$\frac{2 \cdot q = 3}{2} \quad q = \frac{3}{2}$$

1/3

1/3



1.9 2.1 2.2 3.1 RAD AUTO REAL

The following pages have a collection of mixed types of problems. Work each of them and record your work and answers.

When you are finished, SAVE this document, using LASTNAME-2STEP as the file name. Ask for help if you need it.

Algebra 1 *TI-Nspire™ CAS* Solving Equations

TwoStepAns.tns

Completed Student Document (page 3)

TI-Nspire CAS interface showing four equations and their solutions:

- Equation 1: $\left(\frac{-r}{7} = -5\right) \cdot -7$ with solution $r = 35$
- Equation 2: $\frac{-49 = 7 \cdot t}{7}$ with solution $-7 = t$
- Equation 3: $\left(\frac{-u}{3} = 2\right) \cdot -3$ with solution $u = -6$
- Equation 4: $\left(\frac{w}{5} = -3\right) \cdot 5$ with solution $w = -15$

Each equation is displayed in a separate window with a scroll bar and a page indicator (3/99).

TI-Nspire CAS interface showing two equations and a save prompt:

- Equation 5: $\frac{3 \cdot x = -18}{3}$ with solution $x = -6$
- Equation 6: $\left(\frac{-y}{7} = 1.8\right) \cdot -7$ with solution $y = -12.6$

Below the equations, a prompt reads: "Record your work, then SAVE as: LASTNAME- 2STEP." The page indicator is 4/99.