Activity Overview

In this activity, students will be asked some exam-like questions to introduce separable differential equations. Students will use the **deSolve** command to find general and particular solutions to differential equations. They will also graphically view the family of particular solutions to a differential equation.

Topic: Differential Equations

- Differential equations solved algebraically
- Solutions shown graphically

Teacher Preparation and Notes

- The syntax for **deSolve** is **deSolve(*y'*=f(*x,y*),*x,y*)** where *x* is the independent and y is the dependent variable. The **deSolve** command can be found in the HOME screen by pressing F3 and selecting **C: deSolve(**. This activity will help students see the application of differential equations, the process of solving separable differential equations, and how to use the TI-89 to check or find the solution to differential equations.

- **To download the student worksheet, go to education.ti.com/exchange and enter "12368" in the keyword search box.**

Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

- Differential Equations (TI-Nspire™ CAS technology) — 8998
- Logistic Growth, Differential Equations, Slope Fields (TI-89 Titanium) — 5514
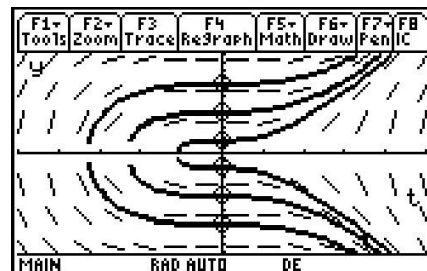
This activity includes screen captures taken from the TI-89 Titanium.

Compatible Devices:
- TI-89 Titanium

Associated Materials:
- ChargedUp_Student.pdf
- ChargedUp_Student.doc
- Diffq1.89d
- Diffq2.89i

Click HERE for Graphing Calculator Tutorials.

Part 1 – Separable Differential Equations Introduced

For Questions 1 and 2, students are asked exam-like questions about differential equations. These foundational (practically review) questions can serve as an introduction to separable differential equations. Teachers can use question 2 to formatively assess how well students are making the connection to their previous knowledge. If students appear to be struggling, teachers can use the opportunity to state the following steps: STEP 1 separate variable, STEP 2 integrate both sides, STEP 3 apply initial conditions to solve for the constant of integration and find a particular solution, STEP 4 answer the question.

Differential equations are applicable for all sorts of physical phenomena, including radioactive decay, economics, biology, chemistry, population growth, and electric circuits with capacitors.

The steps for solving a separable differential equation are outlined and reinforced. Some students may need help with the algebra involved in the steps.

The **deSolve** command is used to check the solution. The syntax of **deSolve** is explained so that students can use this as a tool to explore several other differential equations.
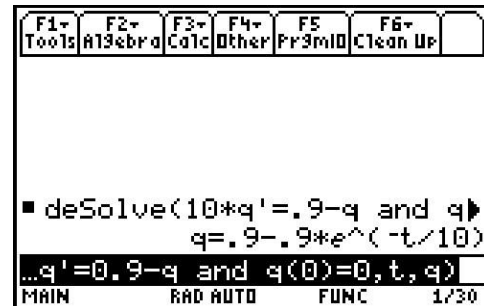
Student Solutions

1. $\dfrac{dq}{dt} = kq$

2. $\displaystyle\int dy = \int \sin(x)\cos^2(x)\,dx \Rightarrow y = -\dfrac{1}{3}\cos^3(x) + C$ and

    since $\cos\left(\dfrac{\pi}{2}\right) = 0$, $y(0) = -\dfrac{1}{3}$.

3. $\dfrac{dq}{0.0009 - q} = \dfrac{1}{10}dt \Rightarrow -\ln|0.0009 - q| = \dfrac{1}{10}t + C \Rightarrow \ln|0.0009 - q| = -\dfrac{1}{10}t + C$

4. $|0.0009 - q| = e^{-\frac{1}{10}t + C} = e^{-\frac{1}{10}t}e^{C}$. Let $C_1 = \pm e^{C}$, $0.0009 - q = C_1 e^{-\frac{1}{10}t}$ and with $q = 0$ when

    $t = 0$, $C_1 = 0.0009$

    $q(t) = 0.0009\left(1 - e^{-\frac{1}{10}t}\right)$

5. They are equivalent. In the solution using **deSolve**, the 0.0009 was distributed

6. $y = c \cdot x$

   If $y(1) = 1$, $c = 1$, so the particular solution is $y = x$.

Part 2 – Homework/Extension – Practice with deSolve and Exploring DEs

Students first use **deSolve** to find the general solution to four DEs. The fourth situation can also be viewed graphically. To view the graph of the family of functions, students should first enter **RclGDB diffq1** on the **HOME** screen, and then press [GRAPH].

On the worksheet students will write the solution to each DE. You may wish for students to algebraically show their work and use **deSolve** check their answers.
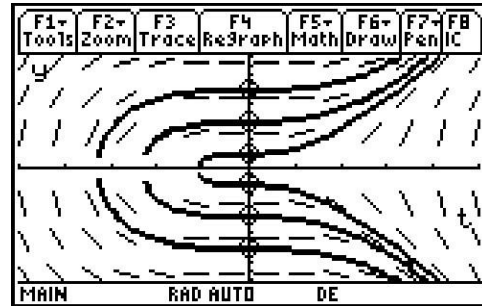
A non-separable differential equation is solved with **deSolve**. The particular solution can also be viewed graphically by entering **RclPic diffq2** on the HOME screen. The slope field and the particular solution are shown on the screen.
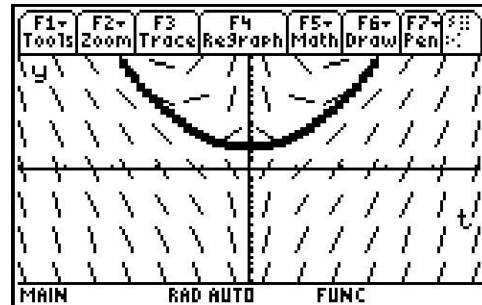
Finally, **deSolve** is used to find the particular solution for three differential equations with initial conditions. Students are asked to solve for *y*. With the TI-89, this can be done with **solve()**. Again, students may show their work and use **deSolve** to check their answers.

Another extension/exploration activity would be to have students come up with their own DE and find the general solution. Have them discuss solutions that surprised them.

Student Solutions

1. $y = Ce^{kx}$

2. $y^2 = x^2 + C$

3. $y^3 = 3x^2 + C \rightarrow y = (3x^2 + C)^{1/3}$

4. $y^2 = 2x^3 + C$

5. It looks like a parabola because $y = x^2 + \dfrac{C}{x} + 2$ is $y = x^2 + 2$ when $c = 0$.

6. $1 - \dfrac{1}{y} = \dfrac{x^2}{2} \Rightarrow y = \dfrac{-2}{x^2 - 2}$

7. $\tan^{-1}(y) - \dfrac{\pi}{4} = x \rightarrow y = \tan\left(x + \dfrac{\pi}{4}\right)$

8. $y = e^{7x}$