

The Credit Card Dilemma

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This article is an updated version of a credit card problem encountered by one of my students, Kim Bowman. Here's Kim's explanation of the problem:

"As I near graduation and look forward to becoming a math teacher, I have become concerned with the debt that I have incurred. Most of my credit cards have become maxed out and I am wondering if I am going to be able to pay them off before I retire from teaching. This seems to be a common problem among college students. Credit card companies lure young students into debt with easy access to lines of credit and many of these students do not have any idea what they are getting into. The thought of purchasing just about anything your heart desires without having to shell out a handful of cash appeals to these newly independent young people. While the fact of the matter is that in the end these unsuspecting students will end up paying many times the original cost of their purchases."

When Kim realized that her credit card problems were compounded by the fact that she was being charged a monthly fee for being over her credit limit*, she decided it was time to stop using her credit cards and start paying off her debt. But how long would it take? And what should her monthly payments be?

Here's what Kim was facing with one of her two credit cards.

Debt:	\$2151.00
Credit limit:	\$1700.00
Annual percentage rate:	16.9%
Monthly "over credit limit" charge:	\$29.00

At first Kim felt that she could afford \$60 a month to pay off this credit card debt and \$60 a month for her other credit card debt. But when she used the sequence application on her calculator to figure out how long it would take to pay off her debt, she realized that she was in deep trouble.

* Shortly after Kim proposed this problem, credit card companies succumbed to the media criticism that their policies were taking advantage of financially unsophisticated college students. As a consequence, credit card companies no longer allow students to use their credit card when they are over credit limit.

To figure out how bad off Kim was, answer the following questions:

1. Without using a calculator or more than the equivalent of one side of a 3 by 5 index card, *guesstimate* how long it would take Kim to pay off the \$2151 debt at \$60 a month. Explain your reasoning.

An accurate answer is *not* required, nor expected, here. Just use a little mental arithmetic to come up with an intelligent guess at the answer and explain how you reached your guess.

2. Use the sequence application on your calculator to figure out how long it would take Kim to pay off the \$2151 debt at \$60 a month. Explain what you did and why.
3. How much would Kim eventually have to pay for the privilege of paying off her \$2151 debt at a rate of \$60 a month? Explain.
4. Help Kim out. She is adamant about not asking her parents for help with her credit card debts, but in six months she will have a real job as a high school math teacher and will be able to increase her contribution to her credit card debt. Unfortunately, teachers don't have high salaries and Kim has other college loans to pay off. But she figures she can at least afford to double her credit card payments.
 - a. Figure out a plan for Kim to pay off this credit card debt in a reasonable fashion. Explain.
 - b. How much would Kim eventually have to pay for the privilege of paying off her \$2151 debt using your plan? Explain.

Hint: The paradigm for constructing a sequence formula that calculates credit card balance is:

$$\text{New Balance} = \text{Old Balance} + \text{Change}.$$

It's up to you to figure out what constitutes the "change."

Answers and Explanations

1. Answers will vary. The question was asked for the sake of the shock value. If students are honest in reporting their initial guesses, all guesses will likely be gross underestimates. I would at least expect a student explanation of their guesstimate to mention that the fact that while Kim was over her credit limit, only \$31 of her \$60 a month payment was applied to paying off her debt.

2. **Answer:** 16 years and 10 months

In the sequence formula $\text{New balance} = \text{Previous balance} + \text{Change}$,

$$\text{Change} = \text{Interest} - \text{Payment} + \text{Other charges.}$$

When the "Previous balance" is combined with the monthly interest rate of $.169/12$, and the monthly payment of \$60 is inserted, we get:

$$\text{New balance} = \text{Previous balance} (1 + .169/12) - \$60 + \text{Other charges}$$

Since Kim has to pay a monthly charge of \$29 (Other charges) only while her balance is over \$1700, her "New balance" must be determined using two sequences. While Kim's balance is over \$1700, her monthly payment of \$60 combined with her \$29 "over limit" charge results in:

$$\text{New balance} = \text{Previous balance} (1 + .169/12) - \$31.$$

After her balance is below \$1700, we can use the formula:

$$\text{New balance} = \text{Previous balance} (1 + .169/12) - \$60.$$

3. **Answer:** \$9928.19

Kim made a total of 201 payments of \$60 and a last payment of \$19.19 for a total of \$12,079.19. Subtracting her debt of \$2151 gives \$9928.19, the amount she paid for the privilege of being in debt.

4. Answers will vary. Using the plan that Kim will double her payment in 6 months and then double her payments each year after that, it would take Kim exactly 2 years to pay off the debt at a cost of \$944.20.

Answering Questions #2 and #3 Using the ClassPad 300

To access the Sequence application, use the stylus to tap **m** on the Icon panel at the bottom of the screen and then tap the Sequence application **H**, as illustrated in the first picture in Figure 1. If sequences are already defined in the Sequence editor, as in the second picture in Figure 1, tap **Edit** on the Menu bar and then tap **Clear All** in the drop-down menu. When requested to do so, tap **OK** to clear the Sequence editor, as illustrated in the third picture in Figure 1.

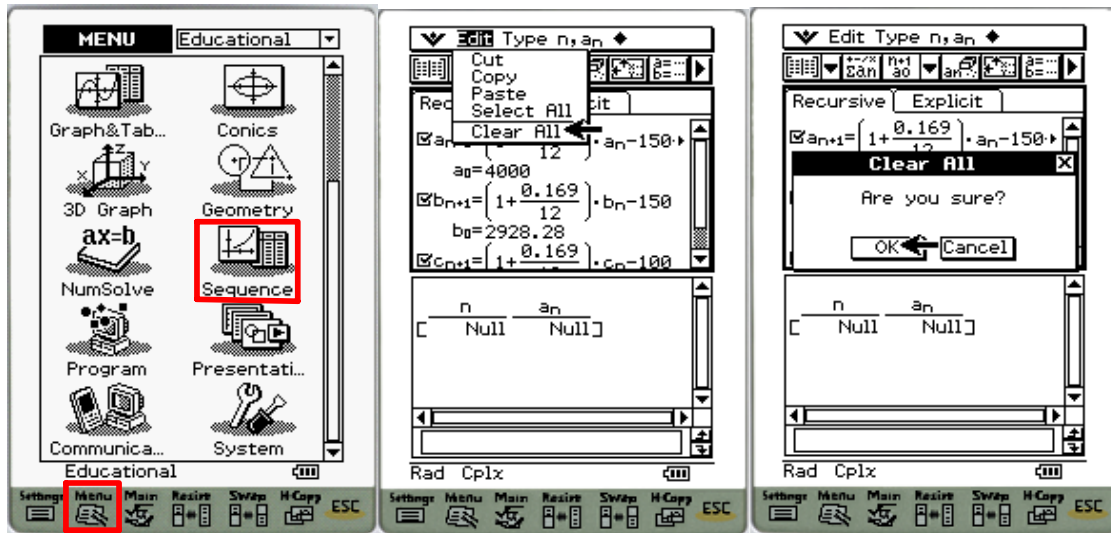
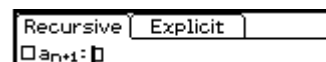


Figure 1

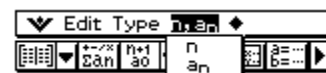
To enter the appropriate sequence formulas and solve the problems, follow these steps:

1. Enter the first formula **New balance = Previous balance (1 + .169/12) – \$31** for determining Kim's balance while she is over her credit limit. The following steps tell you how to do this:

Tap the box to the right of a_{n+1} .



Tap n, a_n on the Menu bar and then tap a_n in the drop down menu.



Use the Keypad to multiply a_n by $(1 + .169/12)$ and to subtract the \$31 payment (\$60 minus the \$29 over-limit charge). Then press \mathbb{E} .

$$\begin{aligned} \text{a}_{n+1} &= a_n \cdot \left(1 + \frac{0.169}{12}\right) - 31 \\ a_0 &= 0 \end{aligned}$$

The cursor highlights the 0 after a_0 . Use the Keypad to enter the initial balance of \$2151 and then press \mathbb{E} .

$$\begin{aligned} \text{a}_{n+1} &= a_n \cdot \left(1 + \frac{0.169}{12}\right) - 31 \\ a_0 &= 2151 \\ b_{n+1} &= 0 \end{aligned}$$

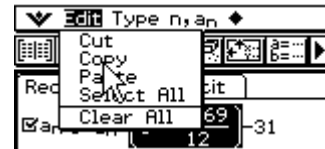
2. Enter the next formula **New balance = Previous balance $(1 + .169/12) - \$60$** for determining Kim's balance while she is below her credit limit. Here's how you do this:

Tap n, a_n on the Menu bar and then tap b_n .

$$\begin{aligned} a_0 &= 2151 \\ b_{n+1} &= b_n \end{aligned}$$

To multiply b_n by $(1 + .169/12)$ you can enter it from the Keypad or cut and paste it from the formula for a_{n+1} .

To cut and paste, place the stylus on the left parenthesis and then drag the stylus until the contents of the parentheses is highlighted. Then tap **Edit** on the Menu bar and tap **Copy** in the drop down menu. Tap to the right of b_n and then tap **Edit** and then tap **Paste**.



Use the Keypad to subtract the \$60 payment and then press \mathbb{E} . Since you don't yet know the exact value Kim owes once she is below her credit limit, leave b_n equal to zero. You will change this value later.

$$\begin{aligned} b_{n+1} &= b_n \cdot \left(1 + \frac{0.169}{12}\right) - 60 \\ b_0 &= 0 \end{aligned}$$

3. Determine how long it takes Kim to get below her \$1700 credit limit and determine how much she owes once she is below this level.

To see how much Kim owes each month while she is over her credit limit, tap # on the label of the first drop down menu on the Toolbar.



Tap and drag the Scroll bar on the right until you find that Kim's balance is below \$1700. Tap n at the bottom of the Scroll bar to fine tune your view.

n	a_n	b_n
164	1703.8	-37960
165	1696.8	-38554
166	1689.7	-39157
167	1682.5	-39769
168	1675.2	-40389

To see exactly how much Kim owes after she is below her credit limit, tap the value that is below \$1700 and to display the exact value at the bottom of the screen.

n	a_n	b_n
164	1703.8	-37960
165	1696.8	-38554
166	1689.7	-39157
167	1682.5	-39769
168	1675.2	-40389

1696.856926911

Take note that it took Kim 165 payments to get below her \$1700 credit limit. Also take note that when she was finally below that limit, she owed \$1696.85.

4. Determine how long it takes Kim to pay off her debt once she is below her \$1700 credit limit. To do this, follow these steps:

Tap on the top screen and then tap to the left of the 0 entry for b_n and drag to highlight that entry. Then enter 1696.85 and press \mathbb{E} .

$b_n = 0$
 $b_n = 1696.85$
 $c_{n+1} = 0$

Tap # on the label of the first drop down menu on the Toolbar. Use the Scroll bar to determine when Kim has paid off her debt.

n	a_n	b_n
34	2120.4	136.17
35	2119.3	78.088
36	2118.1	19.197
37	2116.9	-40.54
38	2115.8	-101.1

Take note that after Kim was below her credit limit, it took her 36 more full payments of \$60, and one last payment (rounded) of \$19.19.

Conclusions: Kim made a total of $165 + 37 = 202$ payments; 201 at \$60 and the last at \$19.19. 202 divided by 12 gives a quotient of 16 and a remainder of 10. So it would take Kim 16 years and 10 months to pay off her debt at \$60 a month. Since 201 of these payments are \$60 and the last is \$19.19, the cost to Kim for carrying this debt is

$$201 \times 60 + 19.19 - 2151 = \$9928.19.$$

To do these calculations on the ClassPad, tap \mathbb{M} on the Icon panel at the bottom of the screen.

202/12 = 16.83333333
 $202 - 12 \times 16 = 10$
 $201 \times 60 + 19.19 - 2151 = 9928.19$