

## SIEMENS STEM DAY ACTIVITY

# CREDIT CARD DEBT

## OBJECTIVES

Students will be able to:

- **Understand** the benefits and tradeoffs of using credit.
- **Investigate** the rate credit card debt can increase when making minimum payments.
- **Develop** a plan to use a credit card responsibly.

## THIS LESSON FOCUSES ON

### Engineering Design Cycle

- Defining the Problem
- Designing Solutions
- Creating or Prototyping
- Refine or Improve
- Communicating Results

### 21st Century Skills

- Collaboration
- Communication
- Critical Thinking
- Creativity

## OVERVIEW

Students consider the benefits and tradeoffs of using credit and learn about the role interest plays in using credit cards. Students analyze different payment methods and calculate how long it takes to pay off a credit card balance before creating an equation that describes the length of time it takes to pay off a debt.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

## MATERIALS

- How Much Does It Really Cost? Handout—one per pair
- Computers with internet access
- Paying Off Debt Handout—one per pair
- General Terms Handout—one per pair

## HAVE YOU EVER WONDERED . . .

How can one have a credit card and avoid hefty fees and sky-high interest rates?

## MAKE CONNECTIONS!

### How does this connect to students?

In current society, credit is a part of everyday life. Renting cars, buying plane tickets, and booking hotel rooms all require credit cards. Therefore, using credit wisely is critical to maintaining financial health.

### How does this connect to careers?

**A credit monitoring manager** is responsible for checking charges on an account that do not fit the typical spending habits of the card holder. This role may involve contacting customers to discuss possible fraudulent charges. A credit monitoring manager may work for a credit card company or a bank.

A **Credit Counselor** is responsible for helping people get out of debt. This role may involve assisting consumers in refinancing debt, calling credit card companies and making settlement offers as well setting up payment plans for the consumer. A credit counselor may find themselves working for a non-profit or a for-profit company.

### How does this connect to our world?

**Credit card security** is becoming increasingly sophisticated. Some credit cards are including biometric data and two-factor authentications.

**Identity theft** accounts for hundreds of millions of dollars in losses each year. Credit card fraud is a type of identity theft. Learning to manage one's credit usage can reduce one's risk of falling victim to fraud.

## BLUEPRINT FOR DISCOVERY

- To engage students in what they will be learning, create a T-chart on the board where the left side is labeled "Benefits" and the right side is labeled "Tradeoffs." Facilitate a brain storming session in which students list potential benefits and tradeoffs of using credit. Examples might include:
  - Benefits: Able to buy items they do not have cash for now; No need to carry cash or checks; Efficient and convenient method of payment
  - Tradeoffs: Interest; Additional or "hidden" fees; Easy to slip into financial trouble or unmanageable debt; Increase in impulse buying/living beyond means
- Explain to students that credit cards charge **interest**, or a percentage of the standing balance that consumers are charged when they don't pay the balance in full each month. This makes it common for people to end up paying more than intended for items or experiences.

3. Instruct students to work with a partner to complete the **How Much Does It Really Cost?** Handout.
4. Tell students that they will now apply what they have learned about interest to calculate how long it will take to pay off a given debt. Distribute the **Paying Off Debt** handout to each pair. Walk around the room while students are working to answer questions and provide support.
5. Pass out **General Terms** handout. Direct each pair to develop an algebraic formula to determine the length of time to pay off a credit card balance given a fixed monthly payment.

- o *Note:* Students should discover the pattern using the following to assist them in the derivation as needed:

After n months, you have:

$$\text{Balance} = p*(1+i)^n - x*[(1+i)^{(n-1)} + (1+i)^{(n-2)} + (1+i)^{(n-3)} \dots + (1+i)^0]$$

Writing  $(1+i)^{(n-1)} + (1+i)^{(n-2)} + (1+i)^{(n-3)} \dots + (1+i)^0$  starting at zero and counting up we get

$$\text{Balance} = p*(1+i)^n - x*[(1+i)^0 + (1+i)^1 + (1+i)^2 \dots + (1+i)^{(n-1)}]$$

$$\text{Balance} = p*(1+i)^n - x*(1+i)^0 - x*[(1+i)^1 + (1+i)^2 \dots + (1+i)^{(n-1)}]$$

$$\text{Balance} = p*(1+i)^n - x - x*[(1+i)^1 + (1+i)^2 \dots + (1+i)^{(n-1)}]$$

$$\text{Balance} = p*(1+i)^n - [x + x(1+i)^1 + x(1+i)^2 \dots + x(1+i)^{(n-1)}]$$

This is  $\text{Balance} = p*(1+i)^n -$  the geometric series  $r = 1+i=1.015$ ,  $n =$  number of months,  $a_1 = x$ .

Once students have found this result, encourage them to use the formula to find the sum of a Finite Geometric series

$$S_n = \frac{a_1(1-r^n)}{1-r}, r \neq 1$$

This will result in the formula  $(p*(1+i)^n) - (a_1*(1-(1+i)^n)/(1-(1+i)))$

The students can compare the formula to the table results by adding a third column to the excel spreadsheet (Column C) with the formula

$$=(\$B\$1*(1+(\$B\$3/12))^A6)-((\$B\$2*\$B\$1)*(1-(1+(\$B\$3/12))^A6)/(1-(1+(\$B\$3/12))))$$

Where A6 is the cell holding the number of months.

6. Conclude the lesson by facilitating a discussion about what students feel to be the best method for paying off debt. Encourage them to provide examples from their learning as support.

## TAKE ACTION!

- Students can research how a credit score is calculated and present to peers actions that they can take to improve their credit and maintain a positive credit rating.

## NATIONAL STANDARDS

Mathematical Practice	<a href="#">Common Core</a> HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
Financial Literacy	<a href="#">Council on Economic Educator</a> Using Credit.12.1: Consumers can compare the cost of credit using the annual percentage rate (APR), initial fees charged, and fees charged for late payment or missed payments.

# HOW MUCH DOES IT REALLY COST?

Joe wants to buy a new cell phone that costs \$650, but he does not have the cash on hand to pay for it. He decides to use a credit card that charges an annual interest rate of 19.85%

If Joe pays the minimum monthly payment of \$21.45		If Joe makes monthly payments of \$60	
How long will it take Joe to pay off his new cell phone?		How long will it take Joe to pay off his new cell phone?	
What is the total amount Joe will pay for his new cell phone?		What is the total amount Joe will pay for his new cell phone?	
How much extra did Joe pay because he used his credit card?		How much extra did Joe pay because he used his credit card?	

What conclusion can you draw by looking at the table above? What payment plan would you suggest to Joe? Use evidence from your table to support your suggestions.

# HOW MUCH DOES IT REALLY COST?

## ANSWER KEY

Joe wants to buy a new cell phone that costs \$650, but he does not have the cash on hand to pay for it. He decides to use a credit card that charges an annual interest rate of 19.85%

If Joe pays the minimum monthly payment of \$21.45		If Joe makes monthly payments of \$60	
How long will it take Joe to pay off his new cell phone?	<b>43 months</b>	How long will it take Joe to pay off his new cell phone?	<b>13 months</b>
What is the total amount Joe will pay for his new cell phone?	<b>\$909.54</b>	What is the total amount Joe will pay for his new cell phone?	<b>\$722.20</b>
How much extra did Joe pay because he used his credit card?	<b>\$259.54</b>	How much extra did Joe pay because he used his credit card?	<b>\$72.20</b>

What conclusion can you draw by looking at the table above? What payment plan would you suggest to Joe? Use evidence from your table to support your suggestions.

**Anticipated Responses:** Paying only the minimum payment takes longer and costs more overall. A suggested payment plan might include paying as much per month as you can afford or well over the minimum payment in order to pay off the purchase sooner and pay less overall.



# GENERAL TERMS

Given principal  $p=1000$ , monthly payment  $x=25$ , and monthly interest  $i=.015$

$$\begin{aligned}\text{Balance after Month 1} &= p * (1+i)-x \\ &= 1000(1+.015)-25 \\ &= 990\end{aligned}$$

$$\begin{aligned}\text{Balance after Month 2} &= [\text{balance after one month}] * (1+i)-x \\ &= [p * (1+i)-x] * (1+i) - x \\ &= p * (1+i)^2 -x*(1+i) -x \\ &= 1000 *(1+.015)^2 - 25*(1+.015)-25 \\ &= 979.85\end{aligned}$$

Use the above information to continue the pattern and find the formula for a given month's (n) balance.

Simplify the formula and find an equation for the remaining balance after n number of months of minimum payments.