

Financial Math Matters

A Jack and Jill Adventure

Instructor Notes

Goal: The primary goal of this activity is to help students understand the costs of financial decisions. Students explore financial decisions related to simple interest, compound interest, annual percentage rates, unearned interest, and amortization schedules. Students should walk away from this activity with a basic understanding of the total financial impact decisions have rather than just the short-term monthly impact of those decisions. For example, students should understand not just what a loan will cost each month, but also what it will cost over in total over the life of the loan. To help enhance that understanding, an emphasis is made on students using formulas to perform the calculations themselves. In many real-world scenarios involving amortization schedules, this might involve hundreds of calculations which are typically calculated using technology. This activity uses simplifications to provide students with intuition on how different variables impact the true costs of decisions without needing to do the dozens of intermediate calculations that might be necessary to calculate the true cost. (ie There are places that one could use monthly payments and develop amortization schedules for a multiyear loan, but instead we assume the interest is realized for the entire term on the original principal.) While this type of simplification is made in the body of the activity, the end of the activity does have students develop the first two months of an amortization schedule for a home purchase.

Helpful Formulas

(once a letter is defined, it will retain that meaning for any further formula as well)

- **Simple Interest**
 - $I = Prt$
 - $A = P(1 + rt)$
*I = interest amount, P = principal,
r = interest rate as a decimal, t = time in years
A = future value of investment*
- **Compound Interest**
 - $A = P \left(1 + \frac{r}{n}\right)^{nt}$
n = number of compoundings per year
- **Truth in Lending**
 - $h = \frac{\text{finance charge}}{\text{amount financed}} \cdot \100 then see table 5
- **Unearned Interest (Actuarial Method)**
 - $u = kR \left(\frac{h}{100+h}\right)$

R = regular monthly payment,
 k = remaining number of payments (after current payment)
 h = finance charge per \$100

- **Mortgages**

- $R = \frac{P\left(\frac{r}{12}\right)}{1 - \left(\frac{12}{12+r}\right)^{12t}}$

Table 5 Annual Percentage Rate (APR) for Monthly Payment Loans

Number of Monthly Payments (n)	Annual Percentage Rate (APR)																
	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%	10.0%	10.5%	11.0%	11.5%	12.0%
	Finance Charge per \$100 of Amount Financed (h)																
6	1.17	1.32	1.46	1.61	1.76	1.90	2.05	2.20	2.35	2.49	2.64	2.79	2.94	3.08	3.23	3.38	3.53
12	2.18	2.45	2.73	3.00	3.28	3.56	3.83	4.11	4.39	4.66	4.94	5.22	5.50	5.78	6.06	6.34	6.62
18	3.20	3.60	4.00	4.41	4.82	5.22	5.63	6.04	6.45	6.86	7.28	7.69	8.10	8.52	8.93	9.35	9.77
24	4.22	4.75	5.29	5.83	6.37	6.91	7.45	8.00	8.55	9.09	9.64	10.19	10.75	11.30	11.86	12.42	12.98
30	5.25	5.92	6.59	7.26	7.94	8.61	9.30	9.98	10.66	11.35	12.04	12.74	13.43	14.13	14.83	15.54	16.24
36	6.29	7.09	7.90	8.71	9.52	10.34	11.16	11.98	12.81	13.64	14.48	15.32	16.16	17.01	17.86	18.71	19.57
48	8.38	9.46	10.54	11.63	12.73	13.83	14.94	16.06	17.18	18.31	19.45	20.59	21.74	22.90	24.06	25.23	26.40
60	10.50	11.86	13.23	14.61	16.00	17.40	18.81	20.23	21.66	23.10	24.55	26.01	27.48	28.96	30.45	31.96	33.47

* *Mathematical Ideas* by Miller, Heeren, and Hornsby, 14th Edition (electronically accessible within MyMathLab)

Helpful Websites to Suggest to Students

Simple/Compound Interest =

<https://www.cuemath.com/commercial-math/simple-interest/>

Truth in Lending

<https://youtu.be/rJKetJbAZzl?si=rceCdlvd4qTFdfEJ>

Unearned Interest (Actuarial Method)

<https://www.youtube.com/watch?v=loBurO5r34c>

Mortgage Payments

https://youtu.be/_WWVxFSHCKs?si=0bF37dV1vWakxdzW

Prior Knowledge:

- The student should know how to comprehend and implement a variety of financial math formulas. These formulas are not provided explicitly in the activity, so the student should access this through previous class work or via research of other resources.
- The student should understand what the terms interest and loan mean.
- The student should know how their calculator handles mathematical functions like exponents, parentheses, fractions/division.

Student Learner Outcomes:

- *The student will compare different types of financial decisions.*
- *The student will explore financial decisions including the following: loan selection, down payment, finance charges, interest, payments, APR, unearned interest, amortization.*
- *The student will determine which formulas should be used for calculations.*
- *The student will calculate the following: simple interest, compound interest, down payment amount, finance charges, monthly payments, APR, unearned interest, amortization schedules, total cost.*
- *The student will justify which financing option is the better choice.*

Make sure to explain to the students the following:

- *They are not expected to know/remember every term.*
- *Researching what we don't know is itself application of concepts to real life.*
- *Asking themselves what they do know and what they are looking to find is a good place to start.*

Jack and Jill are looking at a car loan for a used Volkswagen Jetta. Loan A and Loan B are options below. Find the interest they will pay on each loan.

Loan A - This is a loan for \$5000 with a 4% simple annual interest rate for 3 years

Consider the following questions to assist students:

- *What is simple interest? How does it differ from compound interest?*
- *How do we use 4% within the simple interest formula? What is special that we need to remember?*
- *How is time measured in the simple interest formula? How is our time measured? Do we need to make any adjustments? Should it be days, months, years, etc?*
- *Does your answer make sense? Does it seem reasonable? How does the amount of interest compare to the amount borrowed?*

Loan B - This is a loan for \$5000 at 3.75% annual percentage rate and is compounded annually for 3 years

Consider the following questions to assist students:

- *What is compound interest? How does it differ from simple interest?*
- *How do we use 3.75% within the compound interest formula? What is special that we need to remember?*
- *How is time measured in the compound interest formula? How is our time measured? Do we need to make any adjustments? Should it be days, months, years, etc?*
- *What does it mean to compound annually?*

- *Does your answer make sense? Does it seem reasonable? How does the amount of interest compare to the amount borrowed?*

According to your answers above, which loan is the better deal for Jack and Jill? Why?

Consider the following questions to assist students:

- *How do we know what constitutes a ‘better loan’?*
- *What aspects of the loan should we consider when answering this question?*

After Jack and Jill pay off their car, they decide they want to go on a BIG vacation. Jack has just received a BIG commission check at work. They are looking into an Alaskan cruise in 18 months. How much would they need to save now at a 2% annual interest rate compounded quarterly if the trip will cost them \$8,000 (paid at the time of the trip)?

Consider the following questions to assist students:

- *Is this compound interest or simple interest? How do you know?*
- *What value does \$8000 represent? A or P? Why?*
- *Recall how time is measured for the formula you are using. How is the time measured in this preparation for the Alaskan cruise? Should it be days, months, years, etc?*
- *Does your answer make sense? Does it seem reasonable? How does the amount needed now compare to the final cost?*

Paying for a trip by saving in advance is not Jack & Jill’s only option. They could borrow money for their trip. Consider what this option would look like for Jack and Jill if they chose to put the full cost \$8000 on their credit card, which has an annual interest rate of 18% with the plan to pay it off in 18 months after the trip instead of saving for 18 months before the trip. After it was paid off, how much would this trip have cost Jack and Jill?

Consider the following questions to assist students:

- *Is this compound interest or simple interest? How do you know?*
- *What value does \$8000 represent? A or P? Why?*
- *Recall how time is measured for the formula you are using. How is the time measured in this preparation for the Alaskan cruise? Should it be days, months, years, etc?*
- *Does your answer make sense? Does it seem reasonable? How does the amount needed now compare to the final cost?*

Which option: saving or borrowing will cost Jack and Jill more money? By how much?

Consider the following questions to assist students:

- Why is A the amount that you pay when “borrowing”, but P is the amount you pay when paying “saving”?
- Does your answer make sense? Does it seem reasonable?

After their trip to Alaska, Jack and Jill find out that they are expecting their first baby! They are excited and run out to Babies-R-Us and buy baby furniture. They find the perfect bedroom set but realize that it will cost \$2500 for all the pieces they want to buy. The store is offering a deal. The couple can pay 10% down with 5% add-on interest for the next six months. In their flurry of excitement, they agree.

How much is their down payment?

Consider the following questions to assist students:

- What is a down payment?
- How can we find the down payment?
- Does your answer make sense? Does it seem reasonable? How does the downpayment compare to the initial cost?

How much will they be financing?

Consider the following questions to assist students:

- How is the amount being financed related to the down payment?
- Does the interest amount affect the amount they are financing?
- Does your answer make sense? Does it seem reasonable? How does the amount financed compare to the initial cost?

What will the finance charge be?

Consider the following questions to assist students:

- What is add-on interest?
- What would our value be for time in this scenario?
- If they paid it off in fewer (or more) months how does that affect their finance charge?

If they pay the furniture off in 6 equal monthly installments, how much will each payment cost them?

Consider the following questions to assist students:

- What do Jack & Jill need to pay back as they pay their installments?
- If they paid it off in fewer (or more) months how does that affect their installments?
- Does your answer make sense? Does it seem reasonable? How does the amount paid each month compare to the amount financed?

What will be the total price (ignoring taxes) that they will pay for the furniture?

Consider the following questions to assist students:

- *What values do we need to include in this total price?*
- *What would happen if we added in taxes?*
- *Does your answer make sense? Does it seem reasonable? How does the total paid compare to the initial cost?*

After Jack's and Jill's baby, Joe Joe, is born, they decide they need a bigger car because after all, if Jill is going to be a soccer mom, she's going to need a minivan. They decide on a used Dodge Caravan with a purchase price of \$10,500. They are offered \$2500 trade-in for the Jetta they bought in problem number one. The loan they are offered is 6% add-on interest for 48 months.

How much are Jack and Jill going to finance?

Consider the following questions to assist students:

- *What constitutes the 'down payment' for this car?*
- *What is a trade-in?*
- *Does your answer make sense? Does it seem reasonable? How does the amount financed compare to the initial cost?*

What will be the finance charge on the minivan?

Consider the following questions to assist students:

- *What is add-on interest?*
- *What would our value be for time in this scenario?*
- *If they paid it off in fewer (or more) months how does that affect their finance charge?*
- *Does your answer make sense? Does it seem reasonable?*

Find the APR, to the nearest half-percent, for their loan.

Consider the following questions to assist students:

- *What methods have we discussed for finding the APR?*
- *Can you find any other options that yield a better approximation for the APR?*
- *What does the APR actually tell us about this loan?*

What will their regular payments be for the 48-month loan?

Consider the following questions to assist students:

- *What are regular payments?*
- *What components go into finding the amount of the regular payments?*
- *Does your answer make sense? Does it seem reasonable? How does the monthly payment compare to the amount financed?*

Jack has another BIG commission check at work 12 months into their loan. He decides to pay off the load early. What is the unearned interest on their loan.

Consider the following questions to assist students:

- *What is unearned interest?*
- *What options are we able to use to find the amount of unearned interest?*
- *Does your answer make sense? Does it seem reasonable? How does the unearned interest compare to the total interest?*

As Joe Joe turns two, Jill finds out baby #2 is on the way. Jack and Jill look around their two-bedroom apartment and decide it's time to move up and out into a house. Because of Jack's periodic large commission checks, they have been able to save some on their dream home. They negotiate a price of \$150,000 on their dream home. The credit union requires a 20% down payment on the home and will finance the remainder on a fixed rate mortgage with a 4% annual percentage rate for 15 years.

What is Jack and Jill's down payment amount?

Consider the following questions to assist students:

- *What is a down payment? What is a mortgage?*
- *How can we find the down payment?*
- *Does your answer make sense? Does it seem reasonable? How does the down payment compare to the initial cost?*

How much will Jack and Jill be financing?

Consider the following questions to assist students:

- *How is the amount being financed related to the down payment?*
- *Does the interest amount affect the amount they are financing?*
- *Does your answer make sense? Does it seem reasonable? How does the amount financed compare to the initial cost?*

Find the regular monthly payment needed to amortize the principal and interest.

Consider the following questions to assist students:

- *What do we need to know in order to find the regular monthly payment?*
- *What components of this formula look like those in other formulas you have used?*

Fill in the first two months of the following amortization schedule below.

Amortization Schedule

Payment Number	Total Payment	Interest Payment	Principal Payment	Balance of Principal
1	\$887.63	\$400	\$487.63	\$119,512.37
2	\$887.63	\$398.37	\$489.26	\$119,023.11

Consider the following questions to assist students:

- How are the columns in this table building off one another?
- What column remains the same value for the entire amortization schedule?
- What do you notice about the interest column?
- What do you notice about the principal payment column?
- Do your answers make sense? Does they seem reasonable?

Jill starts searching for homeowner's insurance and finds her best option will cost them \$1200 per year. She also finds that her taxes will cost her \$2000 per year. What will be the total monthly payment the couple will pay for their new home?

Consider the following questions to assist students:

- Are these estimations realistic for homeowner's insurance and taxes on a home costing around \$150,000.
- If we know the yearly cost, how can we find the corresponding monthly cost?
- What components need to be included when considering the monthly payment the couple needs?
- Does your answer make sense? Does it seem reasonable? How does the total monthly payment compare to the amortized monthly payment?