

# Using the Finance Solver on TI-*n*spire

The financial solver tool on the calculator can be very useful in calculating things related to compound interest and amortization (bank loans). As I type this, I don't actually know whether any of the things you will have to do on the IB Math A&A SL exam will require its use — I suspect not, but I'll let you know when I find out more.

To access the Finance Solver, from a calculator page, press Menu, then choose Finance, then Finance Solver...; notice the "Days between Dates" command in the Finance menu, perhaps the least-likely command on the entire calculator.

## Summary of the variables involved

Finance Solver	
N:	0.
I(%):	0.
PV:	0.
Pmt:	0.
FV:	0.
PpY:	1
CpY:	1
PmtAt:	END

Press ENTER to calculate  
Number of Payments, N

Once you've entered everything you have, put the cursor in the field for the value you'd like to determine, then hit Enter.

**N:** total number of compounding periods. For a 5-year loan with 12 payments for year, this would be 60; for a bank account paying interest quarterly for 10 years, it would be 40.

**I(%):** the annual interest rate, given as a percent, *not* changed to a decimal. For instance, 4% is entered as 4.

**PV:** the present value. For a loan, that's positive, because the money is going *to* you (to buy a home, for instance) today. For an investment, it's negative (because the money is coming *from* you).

**Pmt:** the amount of each payment. For an account in which you are only investing the money at the very beginning, the payment would be 0.

**FV:** the future value. For an investment, this will be positive; for a loan, it's zero.

**PpY:** payments per year. This defaults to being the same as compoundings per year.

**CpY:** compounding periods per year. For an investment, this is generally specified in the problem. For a loan, it's most often 12.

**PmtAt:** whether the payment is made at the beginning or end of the period. It defaults to End, and that is likely correct.

## Compound interest problems

### How much money is in the account after a period of time?

Leila invests ¥350,000 at 3.8% interest compounded monthly. How much money will her investment be worth in 4 years?

$$N = 4 \cdot 12 = 48 \text{ compounding periods}$$

$$I = 3.8$$

$PV = -350\,000$ . This is negative as she is paying the money out; it's a loss to her cash-on-hand.

$Pmt = 0$ . She is not making any additional monthly deposits (or withdrawals).

$FV$  is as yet unknown. Just tab past this field for now. It doesn't matter what's here at the moment.

$PpY$  and  $CpY$  are both 12. The choice of 12 for  $CpY$  seems obvious to me; the interest is compounded monthly.<sup>1</sup>

$PmtAt = \text{END}$ . The bank pays her the interest as each month elapses.

Once you've entered all of this in, continue to tab until you get back to the  $FV$  field. Hit Enter. There it is. At the end of four years, you should have found that her investment has a value of ¥407,358.<sup>2</sup>

<sup>1</sup> I have to admit that Payments per Year is not so obvious to me, but I've tried it both ways, and it needs to match Compoundings per Year for the answer to be correct. I have not looked up the formula the calculator is using. There's probably a good reason it has to match here.

<sup>2</sup> Yen (that's what ¥ is) is generally reported as a whole number. The currency's smaller subdivisions (sen, rin) have not been in circulation since the 1950s. ([https://en.wikipedia.org/wiki/Japanese\\_yen#Introduction](https://en.wikipedia.org/wiki/Japanese_yen#Introduction), accessed Oct. 14, 2019).

### ***How much do you need to start with to get a certain ending amount?***

**George projects that his business will need to replace its laser cutting machine in five years. If he can expect to earn 9% compounded quarterly on an investment, how much should he invest now to have the expected \$10,000 cost at the end of the five-year expected lifespan of the current device?**

This time the unknown is the PV. The FV is 10,000. Try it; you should get \$6,408.16. (Check at the end for the other input values if you don't get this result.)

### ***How long does it take to get to a particular accrued amount in the account?***

A typical question here is about how long it takes to double your money. **Tatiana has saved up \$30,000 toward a down payment on a house.<sup>3</sup> When she gets that up to \$60,000, she intends to buy a home. If she can invest her savings in a mutual fund that she expects to produce a return of 8.75% compounded annually, how long will it be before she can start shopping seriously?**

You're now looking for the value of N. Recall that the PV is negative, but the FV is positive. See the end for the answer.

Important thing to remember: In every case in which you are investing or saving money, the money is leaving you to come back later. That makes the present value negative for you, and the future value positive.

## **Amortization (loan) problems**

### ***How much will each loan payment be?***

**Pat wants to buy a new car. She found a Toyota Camry XLE that she loves for \$28,700. If she can finance it at 4.9% APR for 60 months, what will her monthly payment be?**

This is a pretty typical amortization problem. This time the present value is positive, and it's the amount of money being borrowed: \$28,700. The future value is \$0, because at the end of the loan, the car has been paid off. The *PpY* and *CpY* are 12 because her payments are monthly. Put your cursor in the *Pmt* field and hit enter after you've input all the other values. Check the end to see if you got the right payment amount.

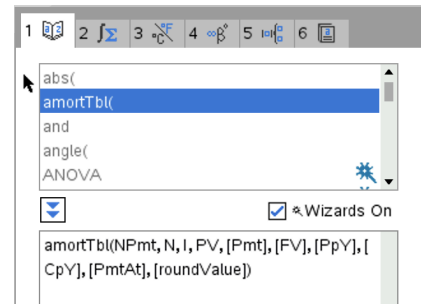
### ***What's an amortization table, and how do you make one?***

One of the things the calculator is really quick at that is highly annoying to do by hand is an amortization table, which shows, at the time of each payment, how much of that payment goes toward interest, how much reduces the principal, and how much you still owe on the loan. It can be very illuminating. It's hard to imagine just how little of your payment actually reduces what you owe initially until you see the numbers. When you get a loan, every month you have to pay all of the interest you owe so far; any payment above the interest owed reduces the principal.

**Tatiana (same woman from two problems back) has saved up her down payment now, and she's going to get a mortgage for the other \$224,900. She found one that she can qualify for that is a 20-year fixed rate loan with a rate of 3.70%. Make an amortization table for the first two years of payments.**

For this one, you're using a different command entirely. Hit Escape to get out of the Finance Solver, and this time choose Amortization Table from the Finance menu. Actually, that's not the most helpful way to get there if you don't already know how to use it. Instead, go to the catalog (the book menu), and choose `amortTbl`( in the list. At the bottom of the screen, you'll see the list of arguments that it takes. The ones in square brackets are optional, but you still put in the commas if you want to skip them.

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<sup>3</sup> Initially I wrote the Tatiana-buys-a-house problems in Canadian dollars, denoted CAD. I got tired of typing it. 'Murica!

$NPmt$  is the number of payments you'd like to see. In this case, that's 24.  $PmtAt$  is 0 for End, 1 for Beginning, and defaults to 0.  $RoundValue$  is the number of decimal places you want in your answer. I'll go with two.

Unfortunately, in order to fill in that list of things, we need the payment amount first. So escape out of this and go back to the Finance Solver to get the payment. I'll wait.

Did you get \$1327.56? Me, too! Here is the amortization command and the result.

`amortTbl(24,20,12,3.7,224900,-1327.56,0,12,12,,2)`

The double comma there was because I skipped the  $PmtAt$  but needed to put in the 2 still. Recall that the payment amount is negative, because it's leaving your pocket. (The first time I made it positive; it was like Tatiana was borrowing that amount more every month. She ended up owing more every month. Not good.)

0	0.	0.	224900.	8	-679.63	-647.93	219772.	17	-661.42	-666.14	213850.
1	-693.44	-634.12	224266.	9	-677.63	-649.93	219122.	18	-659.37	-668.19	213182.
2	-691.49	-636.07	223630.	10	-675.63	-651.93	218470.	19	-657.31	-670.25	212512.
3	-689.53	-638.03	222992.	11	-673.62	-653.94	217816.	20	-655.24	-672.32	211839.
4	-687.56	-640.	222352.	12	-671.6	-655.96	217160.	21	-653.17	-674.39	211165.
5	-685.58	-641.98	221710.	13	-669.58	-657.98	216502.	22	-651.09	-676.47	210488.
6	-683.61	-643.95	221066.	14	-667.55	-660.01	215842.	23	-649.01	-678.55	209810.
7	-681.62	-645.94	220420.	15	-665.51	-662.05	215180.	24	-646.91	-680.65	209129.
				16	-663.47	-664.09	214516.				

My calculator is set for 6 significant figures, so we're not seeing the cents in the last column, but I don't think it matters. The first column is the payment number. The second is the amount of each payment that is applied to the interest and the third column shows what's applied to the principal. Notice that it's not until month 16 that more is going to principal than interest. In a 30-year mortgage on the same terms otherwise, it takes until month 136, after more than 11 years of payments, to reach the same point, but the payments are smaller.

If you were to look at the 20th year of Tatiana's payments, you'd see this:

229	-48.15	-1279.41	14336.9	233	-32.3	-1295.26	9179.69	237	-16.25	-1311.31	3958.58
230	-44.21	-1283.35	13053.5	234	-28.3	-1299.26	7880.43	238	-12.21	-1315.35	2643.23
231	-40.25	-1287.31	11766.2	235	-24.3	-1303.26	6577.17	239	-8.15	-1319.41	1323.82
232	-36.28	-1291.28	10475.	236	-20.28	-1307.28	5269.89	240	-4.08	-1323.48	0.34

As you might guess from the \$0.34 balance at the end, the very last payment on a loan is often just a little different from the others; the bank generally has to tell you how much to pay at the end.

### ***How long will it take to pay off a loan if you overpay each month?***

If you can afford it, it's a great idea to pay somewhat more than your payment amount each month, as the extra payment comes straight off the principal. **What if Tatiana were to pay \$1500 each month instead of the \$1327.56 she promised to pay?** Back to the Finance Solver for this one. You're solving for  $N$ . Check at the end to see if you got the right answer.

### ***How much should be saved from every paycheck?***

**Trenton wants to buy a new MacBook Air when he graduates from high school in 19 months. If the computer lists for £1099 (including the VAT of £184)<sup>4</sup>, how much money should he invest from his lawn maintenance business every month at 5.45% interest in order to have enough to cover the cost?**

This is an example of an amortization that is an annuity; you invest a certain amount each period. A common place you see these things is for retirement plans. Save up, kids, compound interest is a big deal!

In the Finance Solver, you know the values of  $N$ ,  $I$ ,  $FV$ , and the "per year" variables. We'll start with a present value of 0, since he hasn't yet started saving, and his lawn service customers pay him at the end of every month. Calculate the value of  $Pmt$ . You can check it at the end.

<sup>4</sup> <https://www.apple.com/uk/shop/buy-mac/macbook-air>, accessed Oct. 14, 2019. Trenton lives in the UK.

That's all I've got. I think I've hit all of the high points. Let me know if there's a type of problem you would like to have seen here, but do not find.

**Answers:**

George's laser cutter:  $N = 5 \cdot 4 = 20$ ;  $I = 9$ ,  $Pmt = 0$ ,  $FV = 10\,000$ ,  $PpY = CpY = 4$ ;  $PmtAt = END$

Tatiana's house:  $I = 8.75$ ,  $PV = -30\,000$ ,  $Pmt = 0$ ,  $FV = 60\,000$ ,  $PpY = CpY = 1$ ,  $PmtAt = END$ ; it will take her about 8.26 years, but with interest only compounded yearly, that really works out to 9 years.

Pat's car:  $N = 60$ ,  $I = 4.9$ ,  $PV = 28\,700$ ,  $FV = 0$ ,  $PpY = CpY = 12$ . The payments are \$540.29 each. Maybe she should look for a cheaper car?

Tatiana's quicker mortgage payoff: With payments entered as  $-1500$ ,  $N$  comes out to 201.5 or so, which means it would take 202 payments. That's more than three years quicker, and in the end she'd save more than \$16,300 in interest. (I got that by subtracting 201.5 payments of \$1500 from 240 payments of \$1327.56.)

Trenton's savings: £55.51 a month ought to do it.