

## AMORTIZATION TABLES AND GRAPHS WITH THE TI84 Family

An amortization table provides quick, easily interpreted numerical data about principal and interest amounts for each payment of a loan. Less familiar, but equally informative, an amortization graph gives the user a pictorial interpretation of the relative amounts of interest and principal. The following instructions explain how to set up both tables and graphs with the TI84 family of graphing calculators. The screenshots are from the TI84PlusCE.

### THE SITUATION:

You want to buy a home with a 30 year mortgage. You need to borrow \$300,000 and the interest rate will be 5%.

### YOUR TASKS

- A Determine how much your payments need to be, set up an amortization table and graph.
- B How much of your first payment goes towards principal, and how much towards interest?
- C After 10 years, how much of your payment goes towards principal and interest?
- D How much of the loan will you have paid off in the first 10 years? And what's the balance?
- E How long will it take before your payments are more than 50% principal?

Press **MODE**. Fix the decimal display to 2 digits and choose "Simul" Graph setting. (figure 1)

Open the FINANCE menu. (figure 2)

Press **APPS**, then select **1:Finance**.

Select the TVM (time-value-money) Solver by pressing **1** or **ENTER**. (figure 3) The variables stand for the following:

- N number of payment periods
- I% annual percentage rate
- PV Present value
- PMT= Payment amount
- FV Future value
- P/Y Payments per year
- C/Y Compounding periods per year
- PMT: Choose whether payments are made at the end or beginning of each period

For the given situation, since payments will be monthly, let  $N=30 \times 12$ ,  $I\%=5$ ,  $PV=-300000$  (this is negative to represent that it is a debt), PMT is skipped because this is what will be solved.  $FV=0$ ,  $P/Y=12$  Setting  $P/Y$  automatically sets  $C/Y$  to be the same. It can be overridden, but is not necessary for this case. (figure 4)

Move the cursor to PMT=. Press **ALPHA** **SOLVE**. (figure 5)

Your payments will be \$1610.46 per each month



FIGURE 1



FIGURE 2



FIGURE 3



FIGURE 4



FIGURE 5

Press **2nd** **QUIT** to return to the HOME screen.

Questions B, C, and D can be answered using the  $\Sigma\text{Prn}$  (sum of principal),  $\Sigma\text{Int}$  (sum of interest), and **bal**(balance) functions. These are found in the Finance menu. (figure 6)  
Principal and Interest are multiple argument functions. Balance requires only a single argument. The arguments are:

$\Sigma\text{Prn}(\text{first payment, last payment})$   
 $\Sigma\text{Int}(\text{first payment, last payment})$   
**bal**(number of payments made so far)

NOTE: Catalog (2<sup>nd</sup> function above 0 key) also lists arguments.

When looking for the amount of principal or interest for just one payment, let first payment and last payment be the same.

#### B. The First Payment.

From the HOME screen, go to the Finance menu and select  $\Sigma\text{Prn}$  by highlighting the number to its left, then pressing **ENTER**. For the principal paid in just the first payment, define the first and last payments to both be 1. Repeat with  $\Sigma\text{Int}$  (figure 7)

*\$1250 of the first payment goes to pay interest, while only \$360.46 goes towards the principal.*

#### C. The Payment after 10 years (the 120th payment)

Repeat the above steps, use 120 for the payment. (figure 8)

*After 10 years, you still pay mostly interest.*

#### D. How much has been paid off after 10 years? (How much is still owed?)

This can be done 2 ways, sum the principal for the first 120 payments, or calculate the balance after 120 payments. (figure 9)

*Less than \$56000 of the loan has been paid off.  
 \$244000 is still owed. Note the balance is negative, it indicates this amount is still owed.*

#### E. To find out when the loan payments are at least 50% principal, set up an amortization table or view a graph.

Press **Y=**. Enter the principal, interest, & balance functions in Y1, Y2, and Y3 (fig 10). Let Y3=-bal(x) so outputs are positive.

NOTE: Save keystrokes. The "last entry" recall feature for the home screen works in the Y= menu, too. Put the cursor at Y1=, then press **2nd** **ENTRY** repeatedly until  $\Sigma\text{Prn}$  appears. Then edit the arguments, replacing the numbers with X's.

Press **2nd** **TBLSET**. Set TblStart=0 and  $\Delta\text{Tbl}=1$ . (figure 11)

Press **2nd** **TABLE** to view the table. Press the up or down arrow keys to scroll up or down. (figure 12)

Jump quickly to any part of the table by returning to the TBLSET editor and choosing a different TblStart and/or  $\Delta\text{Tbl}$ .

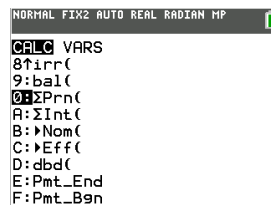


FIGURE 6

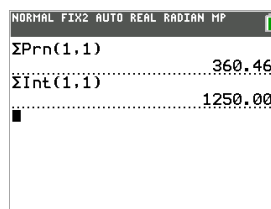


FIGURE 7

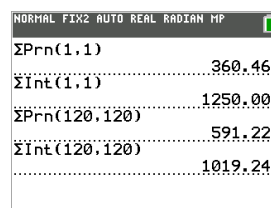


FIGURE 8

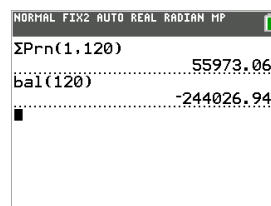


FIGURE 9

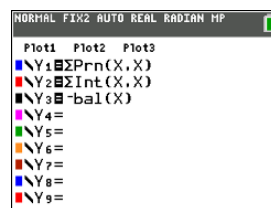


FIGURE 10

NOTE: Balance is entered with a (-) sign, so its table values are positive.



FIGURE 11

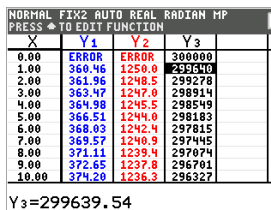


FIGURE 12

NOTE: Y1(0) and Y2(0) return ERROR messages because there was no "0th" payment. But Y3(0) does return the balance after 0 payments.

Part E can be answered by graphing the principal and interest amounts, and finding the intersection of the graphs.

Set up the viewing window seen in Figure 13.

NOTE: It is important that  $X_{\max} - X_{\min}$  be a multiple of 132 because the TI-84PlusCE screen has 132 “steps” between  $X_{\min}$  and  $X_{\max}$ . (it would need to be a multiple of 94 on the TI-84 Plus). The pixels are the only points evaluated by any function graphed in function mode; when  $X_{\max} - X_{\min}$  is a multiple of 132, then the pixels are integers. Since the functions in this exercise are defined only as positive integers, we must ensure that all the pixel values are positive integers. Using  $X_{\min}=0$  and  $X_{\max}=528$  means the distance between each column of pixels is  $528/132=4$ .

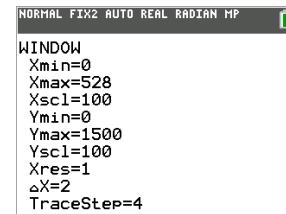


FIGURE 13

Press  $\boxed{Y=}$ . Deselect  $Y_3$  by moving the cursor to the "=" sign and pressing  $\boxed{ENTER}$ . Be sure you are in Simultaneous graphing mode (MODE menu) Then press  $\boxed{GRAPH}$ . (figure 14)

Be patient. The graph on a handheld device is slow to be drawn because it has a lot of calculating to do. If you want to speed up the graph, press  $\boxed{ON}$  to stop it, then press  $\boxed{WINDOW}$  and increase  $X_{\text{res}}$  from 1 to 4. Then press  $\boxed{GRAPH}$  again.

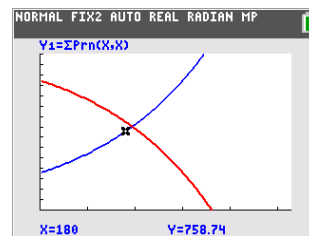


FIGURE 14

Press  $\boxed{TRACE}$ . Then use the left and right arrow keys to move along each function. Alternatively, jump to any desired  $X$  value by typing that value (when TRACE is active). Use the up and down keys to move between the functions. In this figure we see that after 15 years of making payments, the principal amount of the 180th payment is still less than half of the total payment, only \$758.74.

Answer part E graphically by finding the intersection of the two graphs.

NOTE: Because of the limited domain (only positive integers) of these functions, the CALCULATE menu cannot be used. But the intersection of the graphs can be approximated with the TRACE function. Since the distance between pixel columns is 4, this method will only approximate to the nearest 4th payment. For a more accurate solution, "ZoomIn" on the intersection, or use the Table for a numerical solution (figure 16)

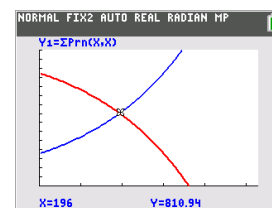


FIGURE 15

In this window, it's not until the 196th payment that more than 50% of the total go towards principal.

Press  $\boxed{TRACE}$ . Move the cursor near the intersection to find the first payment where the principal is larger than the interest. (figure 15)

NORMAL FIX2 AUTO REAL RADIAN MP				
PRESS + FOR <TBL>				
X	Y1	Y2		
180.00	790.95	819.59		
191.00	794.25	816.21		
192.00	797.56	812.90		
193.00	800.89	809.57		
194.00	804.22	806.24		
195.00	807.57	802.89		
196.00	810.94	799.52		
197.00	814.32	796.14		
198.00	817.71	792.75		
199.00	821.12	789.34		
200.00	824.54	785.92		
X=195				

FIGURE 16

Make quickly down the table by going to tblset and changing Tblstart. Precision in the graph in Figure 15 is limited to the nearest 4<sup>th</sup> payment, but here in the table we can change  $\Delta X$  to any value we choose. And we find it's actually the 195<sup>th</sup> payment where the principal reaches 50% of the total payment.