

Time Value of Money Problems on a Texas Instruments TI-83¹

Before you start:

To calculate problems on a TI-83, you have to go into the applications menu, the blue “APPS” key on the calculator. Several applications may be loaded on your calculator. The “Finance” option should be the first one.

Steps:

- 1.) Press the blue “APPS” key.
- 2.) Select #1: Finance by highlighting and pressing “Enter”

You are now in the finance program. There are several options listed in this menu. Functions defined:

- 1.) 1: TVM Solver... is the main option that will be used to calculate these problems.
- 2.) 2:tvm_Pmt – to calculate a payment
- 3.) 3:tvm_I% – to calculate the interest percentage
- 4.) 4:tvm_PV – to calculate the present value
- 5.) 5:tvm_N – to calculate the number of payments
- 6.) 6:tvm_FV – to calculate the future value

Highlight “TVM Solver...” and press “Enter”

Listed are:

- 1.) N=
- 2.) I%=
- 3.) PV=
- 4.) PMT=
- 5.) FV=
- 6.) P/Y=
- 7.) C/Y=
- 8.) PMT: END BEGIN

I% (Interest) is ALWAYS entered as a percentage, not a decimal. “END” should always be highlighted unless you are calculating an annuity due. When you start a problem, make sure N, I%, PV, PMT, and FV are all set equal to zero. This ensures that you do not carry numbers over from previous problems. Whenever you are paying money out, it is a cash outflow, so that number will be negative. To make the number negative, you need to press the “(-)” key at the bottom of the calculator *before* you key in the number. P/Y and C/Y should always be the same value.

¹ These instructions prepared by Josh Heidenreich and Mike Laine, students at the Cameron School of Business, UNCW.

A. Sample Problem 1: Future Value for Single Deposit.

Given: What is the future value of \$1000 invested today at 8% per annum, compounded quarterly over 5 years?

Values: $N=5$ $I\%=8$ $PV=1,000$ $C/Y=4$ $P/Y=4$

NOTE: Five years covers 20 quarters so the N value is not 5 but 20, $(5*4)$

Calculator:

Press blue “APPS” key, highlight “Finance” and press “Enter.” Highlight “TVM Solver...” and press “Enter.”

Make sure all values have been set equal to zero to start off with. Key in each of these values:

$N=20$, or you can key $N=5*4$

$I\%=8$

$PV= -1,000$ (negative because you are putting the money up, so it is going out of your pocket)

$PMT=0$

$FV=0$

$P/Y=4$

$C/Y=4$

PMT : “END” should be highlighted because this is not an annuity due and payments are made at the end of a period, not the beginning.

Since you are calculating the Future Value (FV), scroll down and place the blinking cursor in the $FV=0$ position. Press the blue “APPS” again. Highlight “Finance” and press “Enter.” Scroll down to “tvm_FV” and press “Enter.” This takes you to the “TVM Solver...” screen and puts $FV=tvm_FV$ and press “Enter” again.

This yields an answer of \$1,485.95

B. Sample Problem 2: Sinking Funds or Retirement Plans.

A sinking fund is a series of payments leading to an accumulation. Examples are IRA and 401(K) programs. The payments will be negative (-) values; the Future Value will be positive (+), and the Present Value will be zero (0).

Problem:

You want to retire in 30 years. You are starting to invest in a growth income fund that promises an ambitious rate of 15%. You can put in \$200 per month. How much will you have in 30 years?

Values:

Set all values equal to zero in the "TVM Solver..." screen.

N=360 NOTE: The payments will be monthly over 30 years: $30 \times 12 = 360$, N=360.

I=15

PV=0

PMT= -200 (Payments are negative)

FV=0

P/Y=12

C/Y=12

PMT: "END" should be highlighted

Calculator:

Press blue "APPS," highlight "Finance" and press "Enter." Highlight "TVM Solver..." and press enter. Key in the values listed above. After keying in all the values listed above, we are calculating a Future Value (FV) so scroll down to FV and make sure blinking cursor is over "0." Press blue "APPS" key, highlight "Finance" and press "Enter." Scroll down to "tvm_FV" and press "Enter" again. This will take you back to the "TVM Solver..." screen and place FV=tvm_FV and you press "Enter" again.

This yields a Future Value of \$1,384,655.92

C. Sample Problem 3: Special Case of the Annuity Problem - Amortization

An amortization is a payment to pay down a loan that has been made in the present.

You have an opportunity to take on a 30 year \$100,000 mortgage at 7.5% interest.
What will your monthly payments be?

Values:

$N = 30$ $C/Y = 12$ $P/Y = 12$ $I\% = 7.5$ $PV = 100,000$ $PMT = 0$

$FV = 0$ PMT : "END" should be highlighted

{NOTE: The payments will be monthly over 30 years: $30 * 12 = 360$. $N = 360$ }

Calculator:

Bring up the "TVM Solver..." menu again. Set all values equal to zero.

Key in all of the values listed above in this screen.

You want to calculate the amount of the payment, so after all values have been input into the "TVM Solver ..." menu, scroll down and place the cursor in the $PMT=0$ display. Press the blue "APPS" key, highlight "Finance" and press "Enter." Scroll down to "tvm_PMT" and press "Enter." This takes you back to the "TVM Solver ..." screen and you will see $PMT=tvm_PMT$ and press "Enter" again.

This yields the answer $PMT = -\$699.21$

D. Sample Problem 4: Annuity Due

An annuity is any terminating stream of fixed payments over a specified period of time.

In an annuity it is assumed that the first payment would be made at the end of the year, which is typical. However, what if you plan to make (or receive) the first payment today? This changes the cash flow from a regular annuity into an annuity **due**. (normally the calculator is working in the END mode which assumes that payments will be made at the end of the period)

Problem:

Suppose that you are planning to send your child to college in 18 years. Furthermore, assume that you have determined that you will need \$100,000 at that time in order to pay for tuition, room and board, etc. If you believe that you can earn an average annual rate of return of 8% per year, how much money would you need to invest at the **beginning** of each year (starting today) to achieve your goal?

Values:

$N = 18$ $C/Y = 12$ $P/Y = 12$ $I\% = 8$ $PV = 0$ $PMT = 0$ $FV = 100,000$ $PMT:$
 “BEGIN” should be highlighted (to do this look at the first step under the calculation explanation)

{NOTE: The payments will be monthly over 18 years: $18 * 12 = 216$. $N = 216$ }

Calculator:

First you must change the calculator to calculate the payment at the beginning of each period. (This is what makes a calculation an annuity due) Bring up the “TVM Solver...” and set all values to zero, go the bottom of the solver where you see END and BEGIN use your right arrow to select “BEGIN” and press “ENTER.” Now enter the values you were given in the problem. After entering the data and making sure you selected the “BEGIN” function, scroll down to place the cursor beside $PMT=$ and then press the blue “APPS” key, highlight “Finance” and press “Enter.” Scroll down to “tvm_PMT” and press “Enter.” This takes you back to the “TVM Solver ...” screen and you will see $PMT=tvm_PMT$ and press “Enter” again.

This yields the answer $PMT = -\$2,472.42$

* That is about \$200 per year less than if you make the first payment a year from now because of the extra time for your investments to compound.

Be sure to switch back to End Mode after solving the problem. Since you almost always want to be in End Mode.

E. Solving for the Interest Rate

Solving for the interest rate is exactly like solving for any other variable in “TVM Solver...”
Be sure to watch the signs you enter for numbers in the TVM keys, as it will affect results.

Problem:

Suppose that you make an investment that will cost \$1000 and will pay you interest of \$100 per year for the next 20 years. Then at the end of the 20 years, the investment will pay \$1,500. If you purchase this investment, what is your compound average annual rate of return?

$N = 20$ $C/Y = 1$ $P/Y = 1$ $I\% = 0$ $PV = -1000$ $PMT = 100$ $FV = 1500$

PMT: “END” should be highlighted

{NOTE: The payments will be monthly over 20 years: $20 * 12 = 240$. $N = 240$ }

Calculator:

Bring up the “TVM Solver ...” and set all values to zero. Now enter the values you were given in the problem. After entering the data scroll down to “I%=” and press the blue “APPS” key, highlight “Finance” and press “Enter.” Scroll down to “tvm_I%” and press “Enter” again.

This yields the answer $I\% = 10$

* This investment will return an average of 10% per year. This particular problem is an example of solving for the yield to maturity (YTM) of a bond.

F. Sample Problem 5: Amortizing a Loan

A loan which is fully amortized (or fully amortizing) is one which the required payments will pay it off in full by the end of the term of the loan.

Problem:

Prepare an amortization schedule for a three-year loan of \$24,000. The interest rate is 16 percent per year, and the loan calls for equal annual payments. How much interest is paid in the third year? How much total interest is paid over the life of the loan?

To prepare a complete amortization schedule, you must amortize each payment one at a time:

Values:

$N = 3$ $C/Y = 1$ $P/Y = 1$ $I\% = 16$ $PV = -24000$ $PMT = 0$ $FV = 0$ $PMT:$
 “END” should be highlighted

{NOTE: The payments will be annually over 3 years: $3 * 1 = 3$. $N = 3$ }

Calculator:

Bring up the “TVM Solver...” and set all values to zero. Now enter the values you were given in the problem. After entering the data scroll to “PMT” and press “Apps” select “TVM Solver...” and click enter. This takes you back to the “TVM Solver ...” screen and you will see “tvm_Pmt” and press “Enter” again, this will compute the payments for the loan. To begin the amortization table, press “2nd” then “Quit” to take you to the main screen of the calculator. Press “Apps” and select “TVM Solver...” scroll down to “9: bal(“ and hit “Enter.” To find the balance for year one enter a “1” and close the parenthesis. You should now see “bal(1)” hit “Enter” and the calculator will compute the answer. To find year 2 or 3 insert a 2 or 3 in place of the 1. To find the Principal go back into the “TVM Solver” and select “0: SumPrn(“ hit “Enter.” For year 1 enter “1,1” and close that parenthesis. It should look like SumPrn(1,1), hit “Enter” to compute. For year 2 or 3 you will enter(2,2) or (3,3). To find the total Principal for the three years you can enter (1,3). To find interest go back to the “TVM Solver...” and select “A: SumINT(“ hit “Enter.” To find the interest for year 1, 2, or 3 or to find the total interest for years 1-3, follow the same procedure as for Principal.

When you compute interest for year 3 the answer will be: \$1,473.96

The total interest for the life of the loan will be: \$8,058.57

G: Sample Problem 6: Capital Budgeting

Problem:

- ❖ The total depreciable costs (Installed Costs) are as follows:
 - Equipment: \$200,000
 - Shipping: \$10,000
 - Installation: \$30,000
 - Total Installed Cost: \$240,000
- ❖ Changes in Net Working Capital are as follows:
 - Inventories will rise by \$25,000
 - Accounts Payable will rise by \$5,000
- ❖ Effect on Operations are as follows:
 - New Sales: 100,000 units per year @ \$2.00 per unit = \$200,000
 - Variable Costs: 60% of sales = .6 * 200,000 = \$120,000
 - Operating Cash Flow: 200,000-120,000 = \$80,000
- ❖ Life of the project
 - Economic Life: 4 years
 - Depreciable life: MACRS 3-year class
 - Salvage Value: \$25,000
- ❖ Tax Rate: 40%
- ❖ WACC: 10%

Solution

Cost = \$240,000
 Change in NWC: 25,000-5,000 = \$20,000
 Initial Outlay: 240,000 + 20,000 = 260,000

Change in Sales: 100,000*2 = \$200,000
 Change in COGS: (0.60)(200,000) = \$120,000
 EBDT: 200,000 – 120,000 = \$80,000

Determine the annual depreciation expense:

<u>Year</u>	<u>Rate</u>	<u>X</u>	<u>Basis</u>	<u>=</u>	<u>Depreciation</u>
1	0.33	X	\$240,000	=	\$79,200
2	0.45	X	\$240,000	=	\$108,000
3	0.15	X	\$240,000	=	\$36,000
4	0.07	X	\$240,000	=	\$16,800
	1.00				\$240,000

We are depreciating the installed cost. In the MACRS 1/2 yr convention, a 3-year asset is depreciated over 4 years.

TVM Appendix B: Using the TI-83/84

Next fill out this table. Values that have been calculated already or have been given are in blue.

	Year 1	Year 2	Year 3	Year 4	Notes
EBDT	80,000	80,000	80,000	80,000	GIVEN
- Depr	79,200	108,000	30,000	16,800	Calculated above and should = \$240,000
= EBT	800	<28,000>	44,000	63,200	EBDT-Depr
- tax (40%)	320	<11,200>	17,600	25,300	(EBT)(.40)
= EAT	480	<16,800>	26,400	37,900	EBT-tax
+ Depr	79,200	108,000	30,000	16,800	Calculated above and should = \$240,000
=ATC/F	\$79,680	\$91,200	\$62,400	\$57,720	EAT+Depr

Terminal Net Cash Flow

Recovery of NOWC	\$20,000
Salvage Value	25,000
Tax on SV (40%)	-10,000
Terminal CF	<u>\$35,000</u>

Proposed project's I_0 , $ATCF_t$ time line:

Year	0	1	2	3	4
	-260,000	79,680	91,200	62,400	57,720
					+35,000
					<u>92,720</u>

Calculator:

To calculate NPV on a TI-83, the formula is as follows:

$Npv(\text{WACC} \%, -\text{Initial Outlay}, \{\text{cash flow from year 1}, \text{cash flow from year 2}, \text{cash flow from year 3}, \text{cash flow from year 4}\}, \{\# \text{ of years depreciated}, \# \text{ of years depreciated}, \# \text{ of years depreciated}, \# \text{ of years depreciated}\})$

Press the blue "APPS" key, highlight "Finance," press "Enter." Scroll down to "7↓npv(" and press "Enter." This takes you to the home screen with "npv(" on the screen. For this problem the following should be keyed in at this point:

$Npv(10,-260000,\{79680,91200,62400,57720\},\{1,1,1,1\})$ and press "Enter."

This yields the correct Net Present Value of -\$25,886.16. It would not be smart to invest in this project because the NPV value is negative.

To calculate IRR on a TI-83, the formula is as follows:

$Irr(-\text{Initial outlay}, \{\text{cash flow from year 1}, \text{cash flow from year 2}, \text{cash flow from year 3}, \text{cash flow year 4}\}, \{\# \text{ of yrs depreciated}, \# \text{ of years depreciated}, \# \text{ of years depreciated}, \# \text{ of years depreciated}\})$

TVM Appendix B: Using the TI-83/84

Press the blue “APPS” key, highlight “Finance,” press “Enter.” Scroll down to “8↓irr(“ and press “Enter.” This takes you to the home screen with “irr(“ on the screen. For this problem the following should be keyed in at this point:

$\text{Irr}(-260000, \{79680, 91200, 62400, 57720\}, \{1, 1, 1, 1\})$ and press “Enter.”

This yields the correct Internal Rate of Return of 4.999407.