The big picture

What is the true cost of buying a house?

Credit: fstop123 GettyImages

Buying a house often involves taking out a loan. The loan provider will charge interest on the money they lend. An amortizationcalculator tells you how much you will have to pay each month to repay your loan and pay the interest. There are many phone applications and internet-based calculators specifically for this purpose.

The same type of calculator can be used to work out the amounts for paying back credit-card and student loan debts on which interest is charged.

In this subtopic you will learn how to use the financial application on your calculator and spreadsheets to perform these calculations.

Overview (/study/ap 122- cid- 754029/

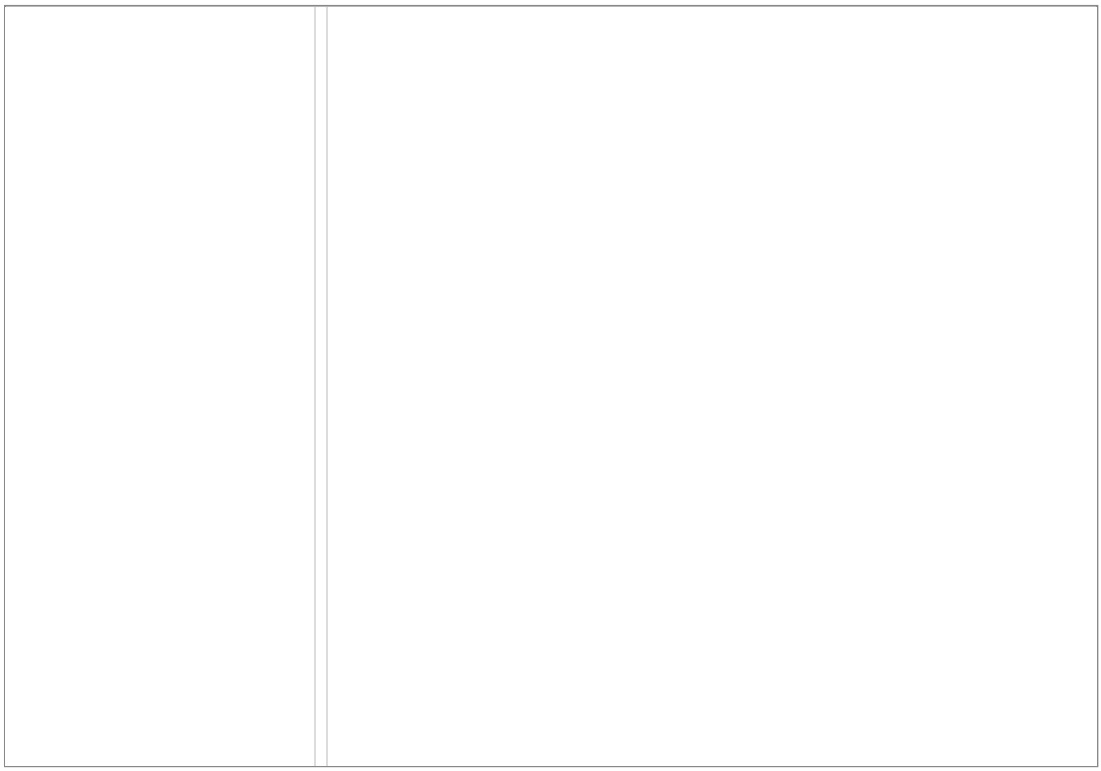
Concept

Modelling is used to create financial calculators that are used to predict outcomes. Consider any assumptions or simplifications that are made in the amortization and annuity models used in this subtopic. Can you be certain that the predictions made by these models are valid? Does the validity depend on the circumstances in which the models are applied?

Amortization

The process of repaying a loan on which interest is charged with regular payments is called amortization .

An amortization table can help you to work out the amount of each payment that you need to make to pay off the loan by a specific date.



Student view

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Interactive 1. An Amortization Table.

Credit: GeoGebra (https://www.geogebra.org/m/SwXUsM3w) Wolfe Wall

More information for interactive 1

Section Student (0/0) Feedback Print (/study/app/m/sid-122-cid-754029/book/the-big-picture-id-27389/print/) Assign

This interactive allows users to explore how loan amortization works by generating a customizable amortization table. Users begin by entering four key values: the total loan amount, the annual interest rate, the loan duration in years, and the number of payments per year. Once these values are submitted, the interactive calculates and displays a complete amortization schedule, showing how each payment is divided between interest and principal. For each payment period, the table lists the opening loan balance, the interest charged, the fixed payment amount, and the remaining balance after the payment is applied. As users review the table, they can observe how the interest portion of each payment decreases over time while the principal portion increases, reflecting the standard amortization process.

For example, if a user inputs a $10,000 loan at a 10% annual interest rate for 2 years with 5 payments per year, the interactive shows that the fixed payment amount would be $1,113.27 per period. The table given below then breaks down each of the 10 payments, helping users understand how the loan is gradually paid off.

Month	Opening Balance	Interest	Payment	Closing Balance
1	10000	200	1113.27	9086.73
2	9086.73	181.73	1113.27	8155.2
3	8155.2	163.1	1113.27	7205.04
4	7205.04	144.1	1113.27	6235.88
5	6235.88	124.72	1113.27	5247.33
6	5247.33	104.95	1113.27	4239.01
7	4239.01	84.78	1113.27	3210.53
8	3210.53	64.21	1113.27	2161.47
9	2161.47	43.23	1113.27	1091.44
10	1091.44	21.83	1113.27	0

This tool provides an intuitive and informative way to grasp how loan repayment works and offers valuable insight into financial planning and debt management.

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Overview (/study/ap 122-cid-754029/

Activity

Use the amortization table in the applet above to see how the payment amount is affected by

- amount borrowed
- yearly interest rate
- duration of the loan.

Note that the table in the applet is limited to a schedule of 120 payments.

In addition to using a spreadsheet you can also use the financial application on your calculator for amortization calculations.

Steps	Explanation
In these instructions you will see how to find the payment needed to pay off a $\$10000$ loan in three years using monthly payments if the bank charges 5% annual interest. This is the default setup in the applet above. To find this value, open the financial application, ...	

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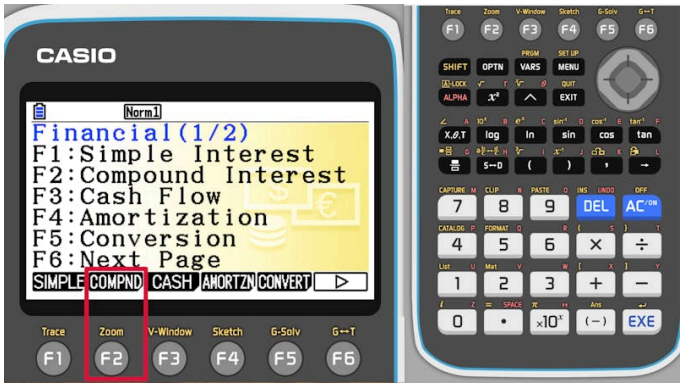
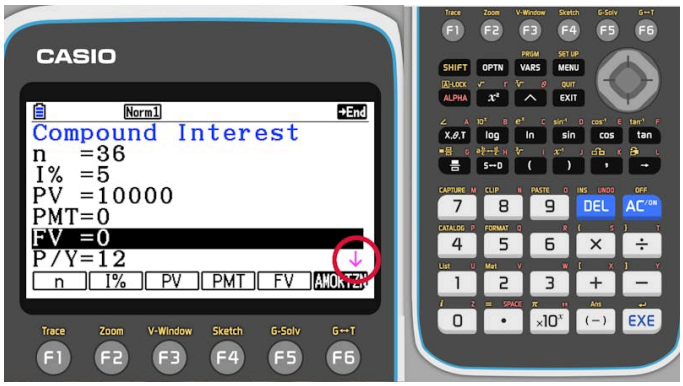
Steps	Explanation
... and press F2 to choose the compound interest option.	
You will need to give the necessary information to the calculator. • number of payments: $n = 12 \times 3 = 36$ (twelve monthly payments for three years) • annual interest rate: $I\% = 5$ • present value: $PV = 10000$ (this is the amount to be borrowed, positive, because we get the money) • payment (PMT): leave this for now, this is what we are interested in. • future value: $FV = 0$ (zero, because the loan is paid back in full) Scroll down to see the other options.	

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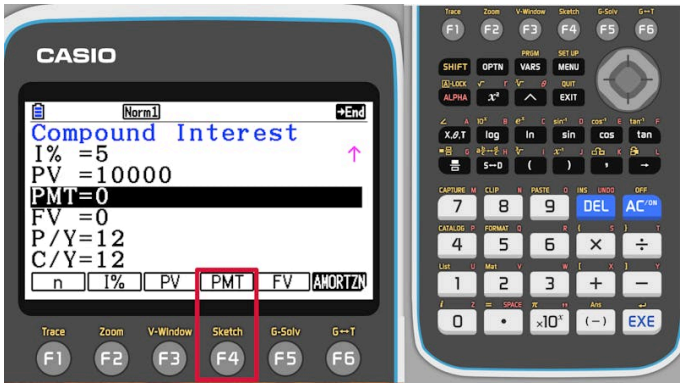
Steps	Explanation
• number of payments per year: $P/Y = 12$ (monthly payment means twelve payments in a year) • number of compounding periods: $C/Y = 12$ (unless the question specifically tells otherwise, C/Y is the same as P/Y) Once you are done setting all values, press F4 to ask the calculator to find the amount of monthly payments (PMT) needed.	
The negative sign in front of the payment means, that we are giving the money, not receiving it. Note, that the sign of PV and PMT is different. This indicates that the loan is coming **from** the bank, but the payment is going **to** the bank. Note, that there are five important parameters here: $$n, I, PV, FV, PMT$$ This application can solve for any of these if the other four and P/Y and C/Y are given.	

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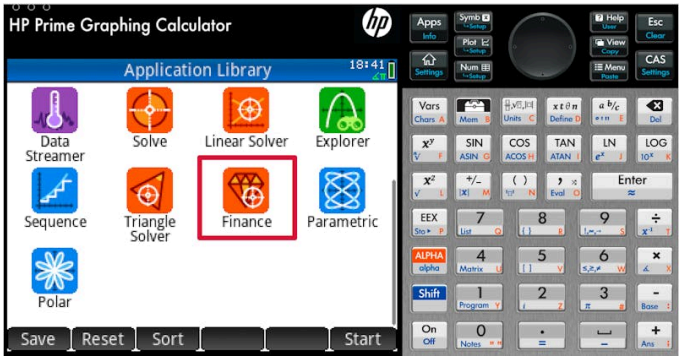
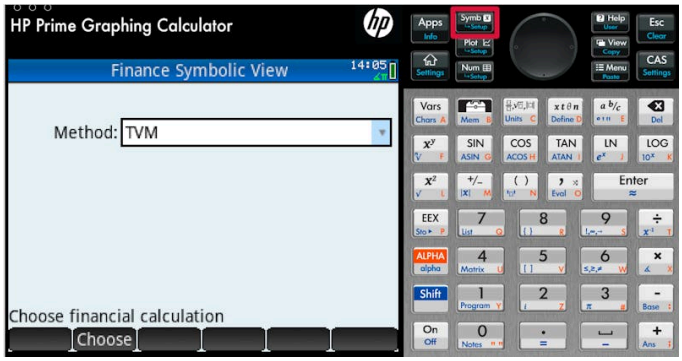
Steps	Explanation
In these instructions you will see how to find the payment needed to pay off a $\$10000$ loan in three years using monthly payments if the bank charges 5% annual interest. This is the default setup in the applet above. To find this value, open the finance application, ...	
... and in symbolic view choose the TVM (Time Value of Money) method.	

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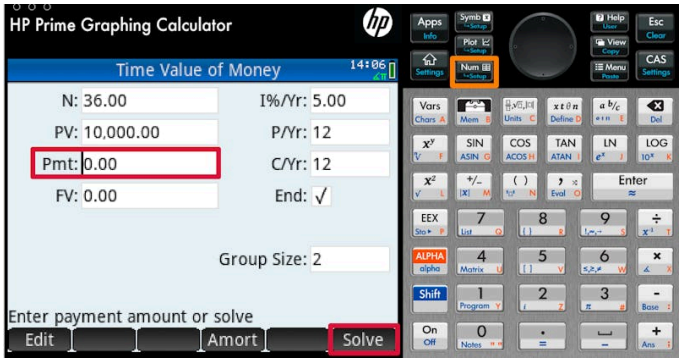
Steps	Explanation
You can give the necessary information to the calculator in numeric view. • number of payments: $N : 12 \times 3 = 36$ (twelve monthly payments for three years) • annual interest rate: $I\%/Yr : 5$ • present value: $PV : 10000$ (this is the amount to be borrowed, positive, because we get the money) • payment (Pmt): leave this for now, this is what we are interested in. • future value: $FV : 0$ (zero, because the loan is paid back in full) • number of payments per year: $P/Yr : 12$ (monthly payment means twelve payments in a year) • number of compounding periods: $C/Yr : 12$ (unless the question specifically tells otherwise, C/Yr is the same as P/Yr) • The tick indicates payment at the end of the period. Keep it like this unless the question tells otherwise. Once you are done setting all values, move to the line of the payment and tap on solve to ask the calculator to find the amount of monthly payments (Pmt) needed.	

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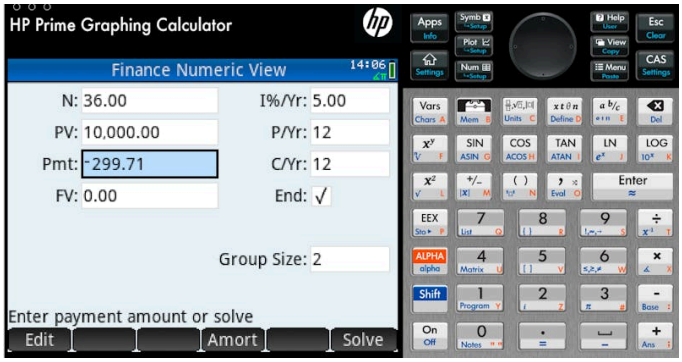
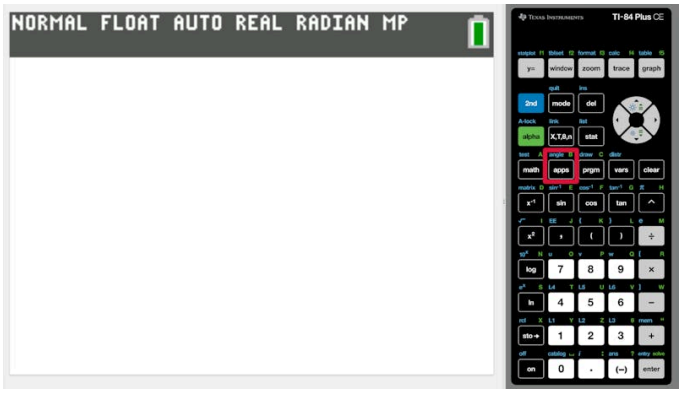
Steps	Explanation
The negative sign in front of the payment means, that we are giving the money, not receiving it. Note, that the sign of PV and Pmt is different. This indicates that the loan is coming **from** the bank, but the payment is going **to** the bank. Note, that there are five important parameters here: $$N, I, PV, FV, Pmt$$ This application can solve for any of these if the other four and P/Yr and C/Yr are given.	

Steps	Explanation
In these instructions you will see how to find the payment needed to pay off a $\$10000$ loan in three years using monthly payments if the bank charges 5% annual interest. This is the default setup in the applet above. To find this value, open the application (apps) menu, ...	

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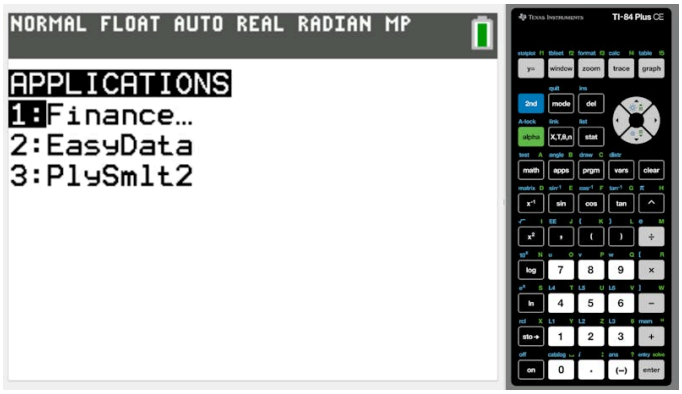
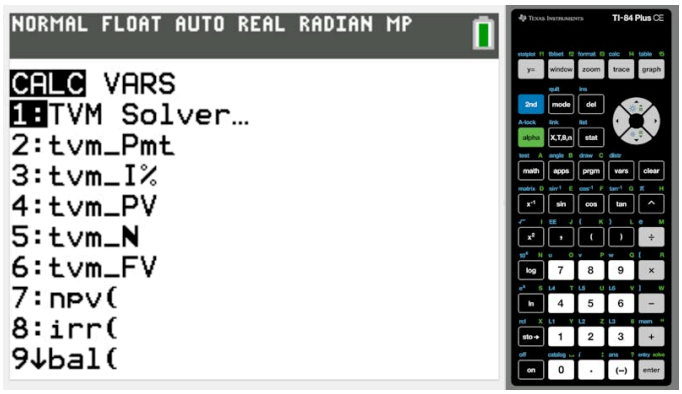
Steps	Explanation
... choose the finance application, ...	
... and choose the TVM (Time Value of Money) solver option.	

Student view

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Steps	Explanation
You will need to give the necessary information to the calculator. • number of payments: $N = 12 \times 3 = 36$ (twelve monthly payments for three years) • annual interest rate: $I\% = 5$ • present value: $PV = 10000$ (this is the amount to be borrowed, positive, because we get the money) • payment (PMT): leave this for now, this is what we are interested in. • future value: $FV = 0$ (zero, because the loan is paid back in full) • number of payments per year: $P/Y = 12$ (monthly payment means twelve payments in a year) • number of compounding periods: $C/Y = 12$ (unless the question specifically tells otherwise, C/Y is the same as P/Y) • Unless the question tells otherwise, use the option to indicate payment (PMT) at the end of the period. Once you are done setting all values, move to the line of the payment and press alpha/solve to ask the calculator to find the amount of monthly payments (PMT) needed.	

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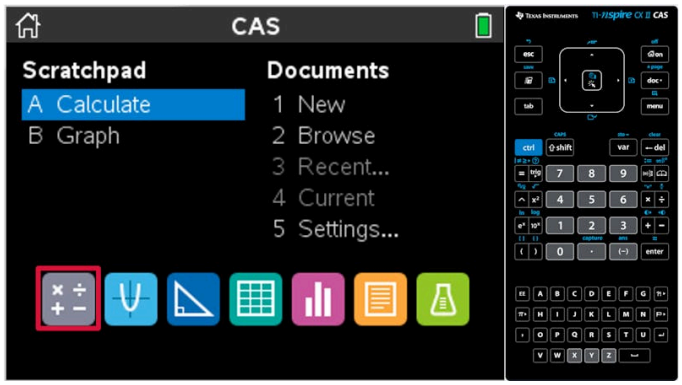
Steps	Explanation
The mark in front of the payment line indicates the value that changed. The negative sign in front of the payment means, that we are giving the money, not receiving it. Note, that the sign of PV and PMT is different. This indicates that the loan is coming **from** the bank, but the payment is going **to** the bank. Note, that there are five important parameters here: $$N, I, PV, FV, PMT$$ This application can solve for any of these if the other four and P/Y and C/Y are given.	

Steps	Explanation
In these instructions you will see how to find the payment needed to pay off a $\$10000$ loan in three years using monthly payments if the bank charges 5% annual interest. This is the default setup in the applet above. To find this value, open a calculator page, ...	

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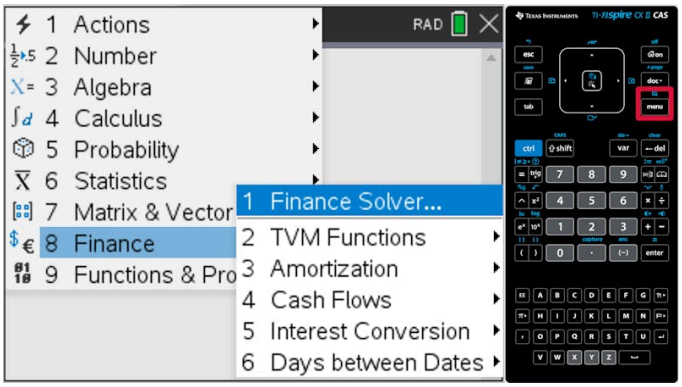
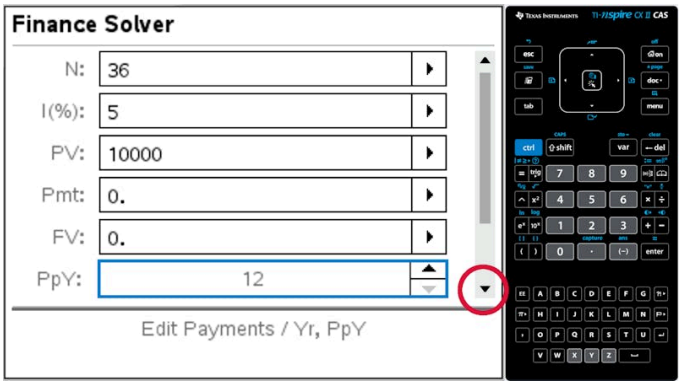
Steps	Explanation
... open the menu and find the finance solver.	
You will need to give the necessary information to the calculator. • number of payments: $N : 12 \times 3 = 36$ (twelve monthly payments for three years) • annual interest rate: $I(\%) : 5$ • present value: $PV : 10000$ (this is the amount to be borrowed, positive, because we get the money) • payment (Pmt): leave this for now, this is what we are interested in. • future value: $FV = 0$ (zero, because the loan is paid back in full) Scroll down to see the other options.	

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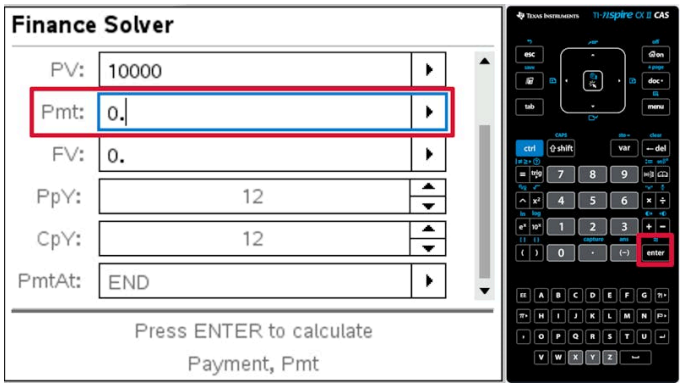
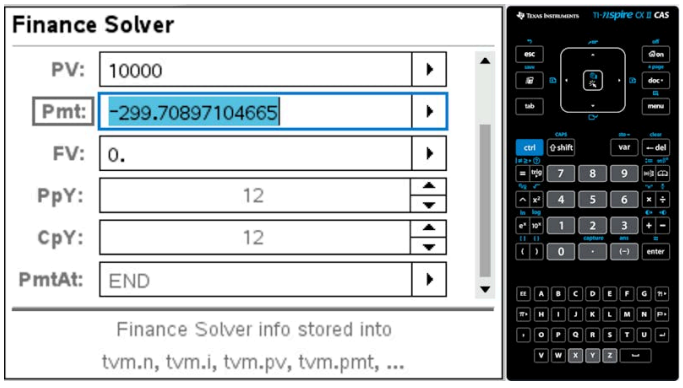
Steps	Explanation
• number of payments per year: PpY : 12 (monthly payment means twelve payments in a year) • number of compounding periods: CpY : 12 (unless the question specifically tells otherwise, CpY is the same as PpY) • Unless the question tells otherwise, use the option to indicate payment (PmtAt) at the end of the period. Once you are done setting all values, move to the line of the payment and press enter to ask the calculator to find the amount of monthly payments (Pmt) needed.	
The negative sign in front of the payment means, that we are giving the money, not receiving it. Note, that the sign of PV and Pmt is different. This indicates that the loan is coming **from** the bank, but the payment is going **to** the bank. Note, that there are five important parameters here: $$N, I, PV, FV, Pmt$$ This application can solve for any of these if the other four and PpY and CpY are given.	

Exam tip

In the exam, you will be expected to solve amortization questions using technology. You should know how to use the financial application on your calculator and how to interpret information from a spreadsheet (such as the one shown in the above

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applet).

Example 1

★★☆

Gorgas is taking out a $£175\,000$ mortgage to buy an apartment. He plans to repay it in 15 years.

a) Find the amount of his monthly amortization payments if the interest rate is 3.7% per annum.

b) Find the amount of interest that Gorgas will pay over the duration of the loan.

	Steps	Explanation
a)	Using the financial application: $N = 15 \times 12 = 180$ $I = 3.7\%$ $PV = 175\,000$ $FV = 0$ $PpY = 12$ $CpY = 12$ Press 'enter' for Pmt. The monthly payment is: $£1268.3027 \approx 1270$. (3 significant figures)	$FV = 0$ because you want the loan t be fully paid back. PV is the present value or the principal value of the loan.
b)	He will pay a total of: $1268.3027 \times 180 = 228\,294.49$ $\text{Interest} = 228\ 294.49 - 175\ 000 = 53\ 294.49 \approx £53\,300$. (3 significant figures)	Interest $=$ total amount paid $-$ initial loan amount.

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Important

Interest $=$ total amount paid $-$ initial loan amount.

Exam tip

Pay close attention to the accuracy instructions in the question.

If no instructions are given, round to 3 significant figures.

Always use more than the required number of significant figures for your calculations. Only round your final answers.

Be aware

Unless the question specifies otherwise, the interest is compounded monthly on a loan that is repaid monthly and is compounded yearly on a loan that is repaid yearly.

Example 2

★★☆

Given that a loan of €$5\,200$ is taken out at an interest rate of 4.5% per annum, find the minimum number of monthly payments necessary to repay this loan with a monthly payment of €200.

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Steps	Explanation
Using the financial application: $N =$ is what you need to find $I = 4.5\%$ $PV = 5\,200$ $Pmt = -200$ $FV = 0$ $PpY = 12$ $CpY = 12$ According to the calculator: $N = 27.4077$ It will take 28 monthly payments.	Since $N = 27.4077,$ the last month's payment will be less than € 200 .

Example 3

★★☆

Sandra is looking to buy a house. She has found two banks that will lend her the $\$300\,000$ that she needs. The conditions offered by the banks are as follows:

$$\text{Bank A : } 5.7\% \text{ per annum for } 30 \text{ years}$$

$$\text{Bank B : } 3.2\% \text{ per annum for } 15 \text{ years}$$

a) Determine which bank has a better offer if she is trying to minimise her monthly payment.

b) Determine which bank charges her more interest over the course of the loan.

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Question Part	Explanation
a)	**Bank A** $N = 30 \times 12$ $I = 5.7\%$ $PV = 300\,000$ $FV = 0$ $PpY = 12$ $CpY = 12$ Monthly payment is: $1741.2013 \approx$ \$1740 (3 significant figures)
	Bank B $N = 15 \times 12$ $I = 3.2\%$ $PV = 300\,000$ $FV = 0$ $PpY = 12$ $CpY = 12$ Monthly payment is: $2100.7236 \approx$ \$2100 (3 significant figures)
	Bank A has a lower monthly payment and is a better offer if Sandra is trying to minimise her monthly payments.
b)	$\begin{aligned}\text{Interest for Bank A} &= 1741.2013 \times 360 - 300\,000 \\ &= 326\,832.478 \approx (327\,000\,(3 \text{ significant figures}) \\ \text{Interest for Bank B} &= 2100.7236 \times 180 - 300\,000 \\ &= 78\,130.248 \approx (78\,100\,(3 \text{ significant figures})\end{aligned}$
	Bank A charges significantly more interest over the life of the loan.

Student view

Annuity

You can think of an annuity as the reverse of a mortgage. Rather than borrowing a certain amount from a bank and being charged interest, in an annuity, you invest a certain amount of money and the bank pays it back to you with interest by means of regular payments.

Who do you think would benefit from an annuity?

Example 1

★☆☆

There is £240 000 in an annuity fund on the day of Mina's retirement.

If the fund pays 3.2% interest rate per annum, find the value of the monthly payments made to Mina if she plans to withdraw the money from this annuity over the next 20 years.

Give your answer correct to the nearest penny.

Steps	Explanation
$N = 12 \times 20$ $I = 3.2\%$ $PV = -240\,000$ $FV = 0$ $PpY = 12$ $CpY = 12$ Monthly payments are: £1355.19.	Annuity calculations are done in exactly same way as mortgage amortization calculations except that, instead of the payments going to the bank, the payments are made by the bank to the annuity holder. When entering the present value in the calculator, usually a negative sign is used to indicate that the bank has our money.

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Example 2

★★☆

Jahu retires when he is 70 years old and has $800 000 in his annuity plan which pays 4.7% interest rate annually. He plans to withdraw $4500 per month from this annuity account until it runs out.

a) Calculate Jahu's age, to the nearest year, when the annuity account runs out of money.

b) Find the maximum monthly withdrawals he can make if he wants the annuity to last until he is 100 years old. Give your answer correct to the nearest cent.

	Steps	Explanation
a)	$I = 4.7\%$ $PV = -800\,000$ $Pmt = 4500$ $FV = 0$ $PpY = 12$ $CpY = 12$ The number of payments is: 304.86. The number of years is: $\frac{304.86}{12} = 25.4$. His age will be $70 + 25.4 = 95.4 \approx 95$ years.	Note that you need to enter the present value and the payment using opposite signs to indicate the direction of the flow of the money between Jahu and the bank.

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	Steps	Explanation
b)	$N = 12 \times 30$ $I = 4.7\%$ $PV = -800\,000$ $FV = 0$ $PpY = 12$ $CpY = 12$ Maximum monthly withdrawal is: $\$4149.10$.	If he is exactly 70 years old when the withdrawals start, he will be 100 years old in 30 years.

International Mindedness

Annuity accounts are often used as both government-sanctioned and private sector pension schemes. Do some research to find out what kind of pension options are available in your country.

3 section questions

1. Number and algebra / 1.7 Amortization and annuity

Checklist

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What you should know

By the end of this subtopic you should be able to:

- recognise questions involving amortization models
- use your calculator to find the unknown value in amortization questions
- understand that annuity accounts function along the same lines as amortization models
- use your calculator to find the unknown value in annuity questions.

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Investigation

Section Student... (0/0) Feedback Print (/study/app/m/sid-122-cid-754029/book/investigation-id-27393/print/) Assign

Part 1

Payday loans are sometimes called predatory loans. Do some research to find loan conditions for a payday loan. Determine an amortization schedule for this type of loan. Discuss why this type of loan may be called predatory.

Now do some research into how credit cards work. Find one that might be available to you once you become a college student. Compare the monthly payments for a loan taken out using a credit cards with one obtained from a payday loan. Comment on your results.

Part 2

The difficulty that many people have in repaying their student loans is an important social and political topic in the United States. Do some research to find the average size, interest rate, and loan duration for a student loan in the United States. Calculate the monthly payment on this loan. Compare it with the average monthly wage of a college graduate in the United States. Comment on your findings

Student view