



## hp calculators

### HP 20b Time value of money basics

The time value of money

The time value of money application

Special settings

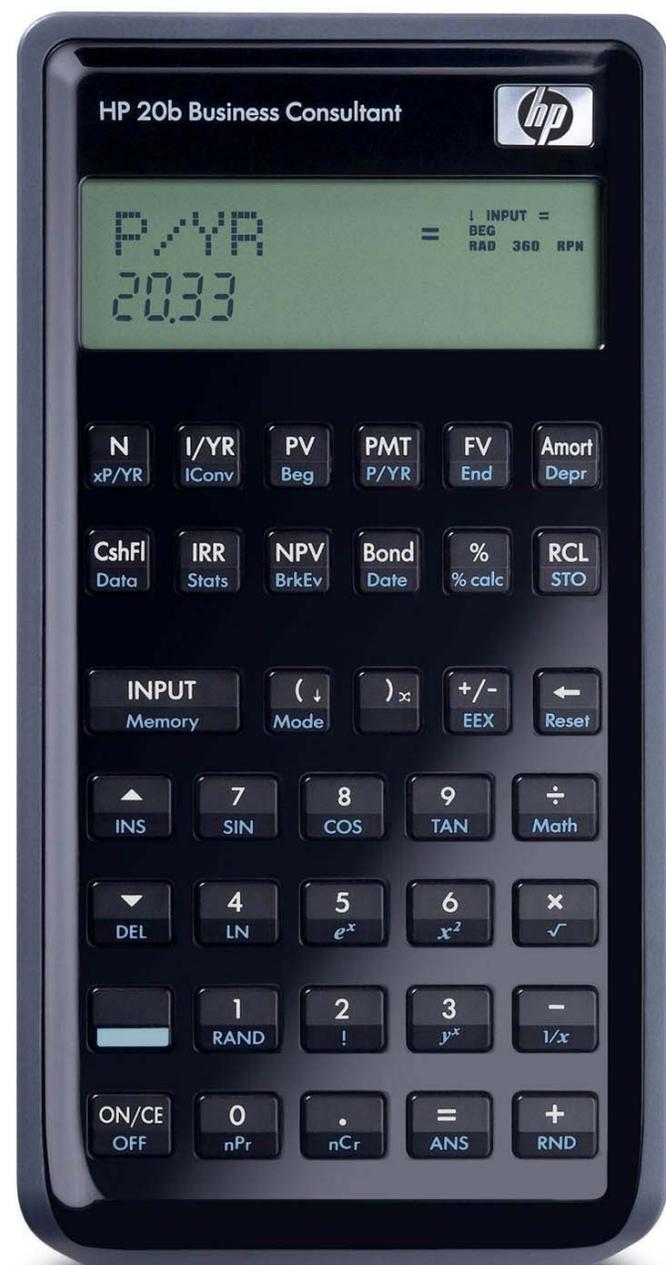
Clearing the time value of money registers

Begin / End mode

Periods per year

Cash flow diagrams and sign conventions

Practice solving time value of money problems



### The time value of money

Money has a time value. That simple statement is the basis for all of finance. The fact that money has a time value is easily understood by answering the question: "Would you rather have \$100 today or \$100 in 20 years?"

The answer should be "today." At the very least, the \$100 today could be deposited into a savings account and you would have more than \$100 in 20 years. It is also probably true that \$100 today would buy more pizzas than \$100 in 20 years. Therefore, money has a time value.

If you loan money to someone today and they will repay you in 5 years, you would expect to get more money back than you loaned. This incremental amount you would be repaid is called interest. Interest is effectively the cost of money.

Depending on the complexity of the financial arrangement, the appropriate solution may involve simple interest, compound interest, an annuity, or cash flow analysis.

This learning module will describe some basics of using the time value of money on the HP 20b calculator. Other learning modules will go into these topics in more detail.

### The time value of money application

The time value of money application built into the HP 20b is used to solve compound interest problems and annuities that involve regular, uniform payments. Compound interest problems require the input of 3 of these 4 values:

   . Annuity problems require the input of 4 of these 5 values:     . Once these values have been entered in any order, the unknown value can be computed by pressing the key for the unknown value. These keys and their shifted functions, are described in the table below.

**Table 1** The HP 20b Time Value of Money Keys

Keys	Description
	Stores or calculates the number of payments or compounding periods N.
	Multiplies a value by the number of payments per year and stores as N.
	Stores or calculates the nominal, annual interest rate.
	Stores or calculates the present value (PV). To a lender or borrower, PV is the amount of a loan; to an investor, PV is the initial investment. PV always occurs at the beginning of the first period.
	Stores or calculates the amount of each periodic payment (PMT).
	Stores the number of payments or compounding periods per year.
	Stores or calculates the future value (FV), a final cash flow. FV always occurs at the end of the last compounding period.
	Sets Begin mode (Beg). Payments occur at the beginning of each compounding period.
	Sets End mode (End). Payments occur at the end of each compounding period.

The time value of money application operates on the convention that money invested is considered positive and money withdrawn is considered negative. In a compound interest problem, for example, if a positive value is input for the **PV**, then a computed **FV** will be displayed as a negative number. In an annuity problem, of the three monetary variables, at least one must be of a different sign than the other two. For example, if the **PV** and **PMT** are positive, then the **FV** will be negative. If the **PMT** and **FV** are both negative, then the **PV** must be positive, etc. An analysis of the monetary situation should indicate which values are being invested and which values are being withdrawn. This will determine which are entered as positive values and which are entered as negative values.

Interest rates are always entered as the number is written in front of the percent sign, i.e., 5% is entered as a 5 rather than as 0.05. The stated annual nominal interest rate is always entered into **I/YR**, as shown in the examples.

### Special settings

There are several settings that affect the operation of the time value of money application.

**Clearing the time value of money registers.** The 5 storage registers that hold the time value of money values, **N**, **I/YR**, **PV**, **PMT**, **FV**, are cleared when **Reset** is pressed and then if TVM is shown in the display, by pressing **INPUT**. Note: If TVM is not displayed, use the **▼** or **▲** keys to scroll through the options until it is displayed. Another way to clear these TVM registers is to store a 0 in the unused register. Both methods are illustrated in problems below.

NOTE: Resetting the TVM registers resets the begin/end mode and also resets the P/YR value to 12.

**Begin/End Mode.** A special mode setting relates to the solution of problems known as annuities. This mode tells the HP 20b to solve these problems assuming that payments are made either at the beginning of a period or at the end of a period, which is why this mode is called Begin / End mode. When the HP 20b is in Begin mode, the display will show the word BEG in the top right corner of the screen. There is no indication in the HP 20b display when the calculator is in End mode, other than by the absence of the word BEG.

This mode is changed using the shifted BEG and END functions. The begin mode is on the front of the **PV** key and you press **Shift** **Beg** to activate begin mode. The end mode is on the front of the **FV** key and you press **Shift** **End** to activate end mode. When in begin mode, the HP 20b display will show a small BEG annunciator in the top right corner of the screen.

If you receive an unexpected result when solving an annuity problem, make sure that the calculator is in the proper mode and try resolving the problem.

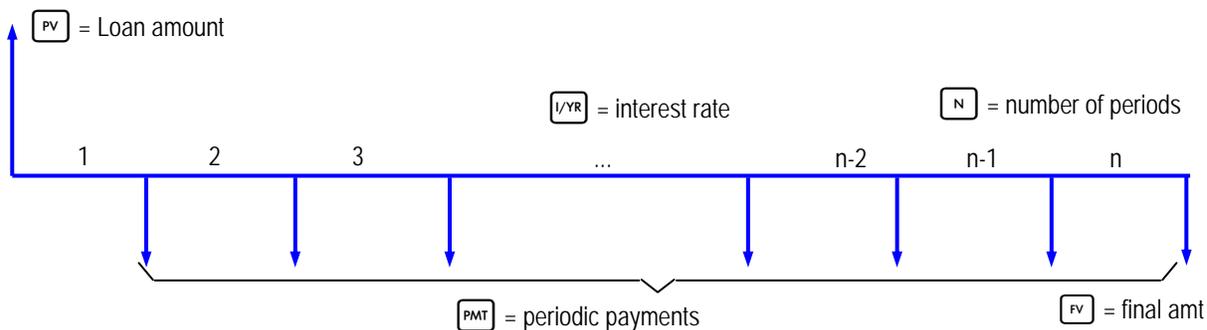
Begin / End mode does not affect compound interest problems or any other type of calculation other than annuities.

**Periods per year.** The number of periods per year is set using the shifted **Shift** **P/YR** function. Problems involving annual compounding or annual payments should be solved with this value set to 1. Problems involving monthly compounding or monthly payments should be solved with this value set to 12. To set this value to 4 for quarterly payments / quarterly compounding, for example, you would press **4** **Shift** **P/YR**, etc.

Although in the interest rate conversion environment the HP 20b can compute a real number for the number of periods per year that satisfy a relationship specified in that environment, for TVM problems, the number of periods per year should always be an integer or an error message will result.

### Cash flow diagrams and sign conventions

The sign conventions for cash flows in the HP 20b follow this simple rule: money received is positive (arrow pointing up), money paid out is negative (arrow pointing down). The key is keeping the same viewpoint through each complete calculation. The regular use of cash flow diagrams allows a faster approach to solve most TVM-related problems. The cash flow diagram below represents the most common borrower viewpoint (an ordinary annuity where payments occur at the end of each period) and their relationship to the TVM variables.



### Practice solving time value of money problems

**Example 1:** If you deposit \$100 today, how much is it worth in 20 years, if interest is compounded at a 4% annual rate?

**Solution:**

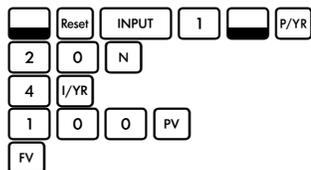


Figure 1

**Answer:** \$-219.11. Note that the solution is displayed as a negative value. The problem is set up with the \$100 as a deposit. The value at the end of the 20-year period would be a withdrawal and is therefore shown as a negative value.

**Example 2:** If you deposit \$50 a month starting one month from today, how much do you have in the account in 10 years, if the account begins with \$1000 in it and earns 5%, compounded monthly?

**Solution:**

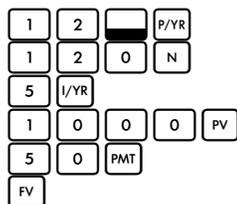


Figure 2

**Answer:** \$-9,411.12. Note that both the \$1000 and the \$50 are entered as positive values since they are deposits into the account. The result is negative, indicating a withdrawal from the account.

**Example 3:** If you need \$50,000 in 20 years, how much do you need to deposit each quarter into an account, if the account earns 6%, compounded quarterly?

**Solution:**

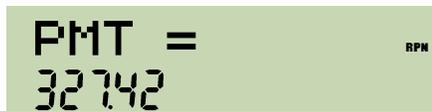
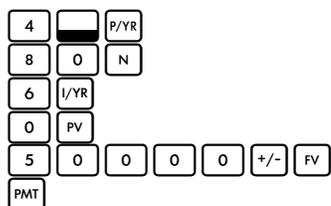


Figure 3

**Answer:** \$327.42. Note that the \$50,000 is entered as a negative number since it will be withdrawn from the account in 20 years.

**Example 4:** If you need \$50,000 in 20 years, what interest rate do you need to earn, compounded quarterly, if you can make deposits of \$310 per quarter?

**Solution:**

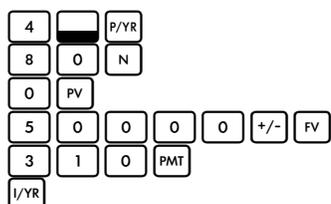


Figure 4

**Answer:** 6.47%, compounded quarterly.

**Example 5:** How many deposits of \$300 per quarter are needed to accumulate \$50,000, if the account earns 5%, compounded quarterly and the account begins with \$4,000 in it?

**Solution:**

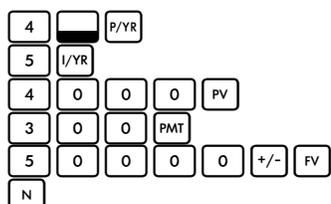


Figure 5

**Answer:** 78.23 quarterly deposits. In reality, this means 78 full deposits of \$300 and a smaller deposit at quarter 79, or 77 full deposits followed by a final 78<sup>th</sup> deposit that is larger than the \$300 normal deposit.