



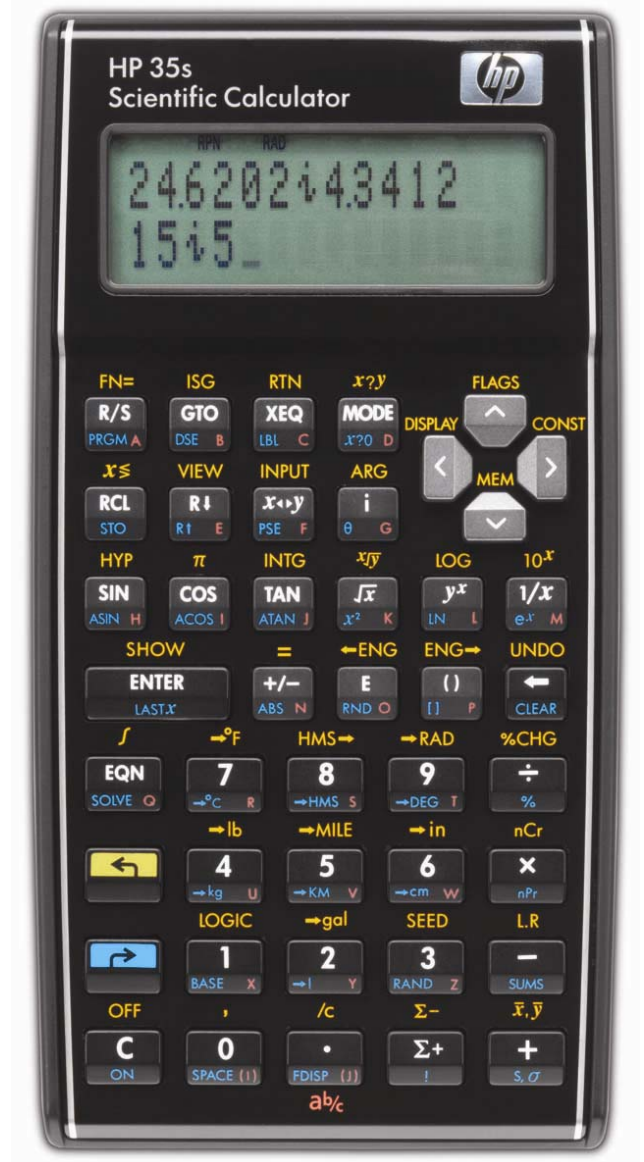
hp calculators

HP 35s Bond Prices

Bond Prices

The Time Value of Money on the HP 35s

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Bond Prices

A bond is a financial instrument where a company, government entity, or individual borrow money with the promise to pay interest periodically and to repay the initial amount borrowed at a specified future date. Bonds will usually have a specified interest rate (called the coupon rate) and are most often in denominations of \$1,000. Bonds also usually pay interest every six months. The interest rate the bond pays is fixed when the bond is first sold or issued, but changes in the market interest rate will change the price of the bond over its lifetime. If market interest rates have gone up since the bond was purchased, the price of the bond will have gone down. If, however, market interest rates have gone down since the bond was purchased, the price of the bond will have gone up. The HP 35s can directly solve for bond prices using the time value of money formula below in simple situations where a bond interest payment is exactly one period away. For other situations, the answers will be approximations.

The Time Value of Money on the HP 35s

To solve time value of money problems on the HP 35s, the formula below is entered into the flexible equation solver built into the calculator. This equation expresses the standard relationship between the variables in the time value of money formula. The formula uses these variables: N is the number of compounding periods; I is the *periodic* interest rate as a percentage (for example, if the *annual* interest rate is 15% and there are 12 payments per year, the *periodic* interest rate, i , is $15 \div 12 = 1.25\%$); B is the initial balance of loan or savings account; P is the periodic payment; F is the future value of a savings account or balance of a loan.

$$\text{Equation: } P \times 100 \times (1 - (1 + I \div 100)^{-N}) \div I + F \times (1 + I \div 100)^{-N} + B$$

To enter this equation into the calculator, press the following keys on the HP 35s:

$\boxed{\text{EQN}}$ $\boxed{\text{RCL}}$ \boxed{P} $\boxed{\times}$ $\boxed{1}$ $\boxed{0}$ $\boxed{0}$ $\boxed{\times}$ $\boxed{()}$ $\boxed{1}$ $\boxed{-}$ $\boxed{()}$ $\boxed{1}$ $\boxed{+}$ $\boxed{\text{RCL}}$ \boxed{I} $\boxed{\div}$ $\boxed{1}$ $\boxed{0}$ $\boxed{0}$ $\boxed{>}$ $\boxed{y^x}$
 $\boxed{+/-}$ $\boxed{\text{RCL}}$ \boxed{N} $\boxed{>}$ $\boxed{\div}$ $\boxed{\text{RCL}}$ \boxed{I} $\boxed{+}$ $\boxed{\text{RCL}}$ \boxed{F} $\boxed{\times}$ $\boxed{()}$ $\boxed{1}$ $\boxed{+}$ $\boxed{\text{RCL}}$ \boxed{I} $\boxed{\div}$ $\boxed{1}$ $\boxed{0}$ $\boxed{0}$ $\boxed{>}$ $\boxed{y^x}$ $\boxed{+/-}$
 $\boxed{\text{RCL}}$ \boxed{N} $\boxed{+}$ $\boxed{\text{RCL}}$ \boxed{B} $\boxed{\text{ENTER}}$

To verify proper entry of the equation, press

$\boxed{\leftarrow}$ $\boxed{\text{SHOW}}$

and hold down the $\boxed{\text{SHOW}}$ key. This will display the equation's checksum and length. The values displayed should be a checksum of CEFA and a length of 41.

To solve for the different variables within this equation, the $\boxed{\text{SOLVE}}$ button is used. This key is the right shift of the $\boxed{\text{EQN}}$ key.

Notes for using the SOLVE function with this equation:

- 1) If your first calculation using this formula is to solve for the interest rate I , press $\boxed{1}$ $\boxed{\text{SOLVE}}$ $\boxed{\text{STO}}$ \boxed{I} before beginning.
- 2) Press $\boxed{\text{EQN}}$. If the time value of money equation is not at the top of the list, press $\boxed{\uparrow}$ or $\boxed{\downarrow}$ to scroll through the list until the equation is displayed.
- 3) Determine the variable for which you wish to solve and press:
 - a) $\boxed{\text{SOLVE}}$ \boxed{N} to calculate the number of compounding periods.
 - b) $\boxed{\text{SOLVE}}$ \boxed{I} to calculate the periodic interest rate. Note: this will need to be multiplied by the number of compounding periods per year to get the annual rate. If the compounding is monthly, multiply by 12.
 - c) $\boxed{\text{SOLVE}}$ \boxed{B} to calculate the initial balance (or Present Value) of a loan or savings account.

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- d) \rightarrow **SOLVE** **P** to calculate the periodic payment.
- e) \rightarrow **SOLVE** **F** to calculate the future value of a loan or savings account.
- 4) When prompted, enter a value for each of the variables in the equation as you are prompted and press **R/S**. The solver will display the variables' existing value. If this is to be kept, do not enter any value but press **R/S** to continue. If the value is to be changed, enter the changed value and press **R/S**. If a variable had a value in a previous calculation but is not involved in this calculation (as might happen to the variable P (payment) when solving a compound interest problem right after solving an annuity problem), enter a zero for the value and press **R/S**.
- 5) After you press **R/S** for the last time, the value of the unknown variable will be calculated and displayed.
- 6) To do another calculation with the same or changed values, go back to step 2 above.

The SOLVE feature will work effectively without any initial guesses being supplied for the unknown variable with the exception noted above about the variable I in this equation. This equation follows the standard convention that money in is considered positive and money out is negative.

The practice problems below illustrate using this equation to solve a variety of problems involving bond prices.

Practice solving for the price of a bond

Example 1: A bond with 20 years left has a 5% coupon rate and pays interest semiannually. If the market interest rate is now 6%, compounded semiannually, for what price should this bond be selling?

Solution: First, enter the time value of money equation into the HP 35s solver as described earlier in this document.

Then press **EQN** and press \uparrow or \downarrow to scroll through the equation list until the time value of money equation is displayed. Then press:

\rightarrow **SOLVE** **B**

The HP 35s SOLVER displays the first variable encountered in the equation as it begins its solution. The value of 0.0000 is displayed below if this is the first time the time value of money equation has been solved on the HP 35s calculator. If any previous equations have used a variable used in the time value of money equation, they may already have been assigned a value that would be displayed on your HP 35s display. Follow the keystrokes shown below and the solution should be found as described.



Figure 1

The payment is found by multiplying the coupon interest rate, 5%, by the face value of the bond, \$1,000, then dividing the result by 2 for the semiannual interest payment amount, \$25.

In RPN mode, press: \rightarrow **0** **5** **ENTER** **1** **0** **0** **0** **x** **2** **÷** **R/S**
 In algebraic mode, press: \rightarrow **0** **5** **x** **1** **0** **0** **0** **÷** **2** **ENTER** **R/S**



Figure 2

In RPN mode, press: **6** **ENTER** **2** **÷** **R/S**
 In algebraic mode, press: **6** **÷** **2** **ENTER** **R/S**



Figure 3

In RPN mode, press: **2** **0** **ENTER** **2** **×** **R/S**
 In algebraic mode, press: **2** **0** **×** **2** **ENTER** **R/S**



Figure 4

In either RPN or algebraic mode, press: **1** **0** **0** **0** **R/S**



Figure 5

Answer: The price of the bond is \$884.43.

Example 2: A bond with 10 years left until it matures has a 6% coupon rate and pays interest semiannually. What is the price of this bond, if the market interest rate is 5%, compounded semiannually?

Solution: First, enter the time value of money equation into the HP 35s solver as described earlier in this document.

Then press **EQN** and press **↑** or **↓** to scroll through the equation list until the time value of money equation is displayed. Then press:

→ **SOLVE** **B**

The HP 35s SOLVER displays the first variable encountered in the equation as it begins its solution. The displays shown in the figures below assume the preceding example has just been worked. Follow the keystrokes shown below and the solution should be found as described.



Figure 6

The payment is found by multiplying the coupon interest rate, 6%, by the face value of the bond, \$1,000, then dividing the result by 2 for the semiannual interest payment amount.

In RPN mode, press: $\boxed{\cdot} \boxed{0} \boxed{6} \boxed{\text{ENTER}} \boxed{1} \boxed{0} \boxed{0} \boxed{0} \boxed{\times} \boxed{2} \boxed{\div} \boxed{\text{R/S}}$
 In algebraic mode, press: $\boxed{\cdot} \boxed{0} \boxed{6} \boxed{\times} \boxed{1} \boxed{0} \boxed{0} \boxed{0} \boxed{\div} \boxed{2} \boxed{\text{ENTER}} \boxed{\text{R/S}}$



Figure 7

In RPN mode, press: $\boxed{5} \boxed{\text{ENTER}} \boxed{2} \boxed{\div} \boxed{\text{R/S}}$
 In algebraic mode, press: $\boxed{5} \boxed{\div} \boxed{2} \boxed{\text{ENTER}} \boxed{\text{R/S}}$



Figure 8

In RPN mode, press: $\boxed{1} \boxed{0} \boxed{\text{ENTER}} \boxed{2} \boxed{\times} \boxed{\text{R/S}}$
 In algebraic mode, press: $\boxed{1} \boxed{0} \boxed{\times} \boxed{2} \boxed{\text{ENTER}} \boxed{\text{R/S}}$



Figure 9

In either RPN or algebraic mode, press: $\boxed{1} \boxed{0} \boxed{0} \boxed{0} \boxed{\text{R/S}}$



Figure 10

Answer: The price of the bond is \$1,077.95.

Example 3: A bond with 13 years left until it matures has a 5.5% coupon rate and pays interest semiannually. What is the price of this bond, if the market interest rate is 6.15%?

Solution: First, enter the time value of money equation into the HP 35s solver as described earlier in this document.

Then press $\boxed{\text{EQN}}$ and press $\boxed{\uparrow}$ or $\boxed{\downarrow}$ to scroll through the equation list until the time value of money equation is displayed. Then press:

$\boxed{\rightarrow} \boxed{\text{SOLVE}} \boxed{\text{B}}$

The HP 35s SOLVER displays the first variable encountered in the equation as it begins its solution. The displays for these prompts are not shown in this example. Follow the keystrokes shown below and the solution should be found as described.

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In RPN mode, press: **. 0 5 5 ENTER 1 0 0 0 × 2 ÷ R/S** (Enters P)
6 . 1 5 ENTER 2 ÷ R/S (Enters I)
1 3 ENTER 2 × R/S (Enters N)
1 0 0 0 R/S (Enters F)

In algebraic mode, press: **. 0 5 5 × 1 0 0 0 ÷ 2 ENTER R/S** (Enters P)
6 . 1 5 ÷ 2 ENTER R/S (Enters I)
1 3 × 2 ENTER R/S (Enters N)
1 0 0 0 R/S (Enters F)



Figure 11

Answer: The price of the bond is \$942.40.