

QMS 130: Mathematics of Finance

What Exactly Is Interest?

In simple words, it is the cost of borrowing money. When you borrow money, you are required to pay a certain extra amount to the lender. This amount is calculated as a percentage rate which could be fixed or variable.

Key Terms To Know

Principal	The amount borrowed
Interest Rate	The percentage of the amount that needs to be returned to the lender.
Term of loan	How long the loan is outstanding for
Effective Rate	The real return when the effects of compounding over time are taken into account.
Annuity	A fixed amount of money paid out in a series of payments over a period of time. (E.g. mortgage payments)
Annuity Due	Annuity whose payment is due at the beginning of the period.
Ordinary Annuity	Annuity whose payment is due at the end of the period.

There are two ways to calculate interest: Simple Interest and Compound Interest.

Simple Interest

This refers to the standard definition of interest where interest is found on the initial amount borrowed, the principal.

The formula is as follows:

$$\text{Simple Interest} = P \times r \times n$$

where:

P = Principal amount

r = Annual interest rate

n = Term of loan, in years

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Example:

A student gets a loan to pay one year of college tuition. The original amount is \$18,000. The loan's annual interest rate is 6%. The student gets a great job after graduation, cuts spending, and repays the loan over 3 years. How much interest will the student pay in total?

Using the formula, $P \times r \times n$

$$P = \$18,000$$

$$r = 6\%$$

$$n = 3 \text{ years}$$

$$\text{Total interest} = 18,000 \times 6\% \times 3 = \$1,080$$

Compound Interest

Compound interest is basically interest on interest. Unlike simple interest, compound interest builds over time. You earn interest on the principal plus any interest that has accumulated so far.

Interest may be compounded daily, monthly, quarterly, or annually—or based on some other period, like semiannually.

The formula is as follows:

$$\text{Compound Interest: } S = P \times (1+r)^n$$

where:

S = Compounded amount (the total amount at the end of the entire loan term)

P = Principal amount

r = The interest rate per compounding period

n = The number of compounding periods during the term of the loan

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Example:

You borrow \$6,500 from a bank to buy a car. The bank loans you the money at 7.25% compounded annually and would like you to pay off the car in 5 years. How much is your total payoff at the end of the 5 years?

Using the formula, $S = P \times (1+r)^n$

S = what we need to find

P = \$6,500

r = 7.25%

n = 5 years

$$S = 6,500 \times (1 + 7.25\%)^5 = \$9,223.59$$