Interest Formulas

PV, FV, n, r (No Payments)	
FV = PV(1+nr)	Future value FV of a present value PV at **simple interest** r for n years (periods).
$FV = PV(1+r)^n$	Future value F of a present value P at **compound interest** r for n years (periods).
$FV = PV(1+r/k)^{kn}$	Future value F of a present value P at **compound interest** r for n years (periods) when the compounding takes place k times per year. For example k=4, and k=12 are common.
$FV = PV\ e^{nr}$	Future value F of a present value P with **continuous compounding** at interest rate r for n years.
IAF	The interest rate adjustment factor (IAF) is the factor that converts between PV and FV, $(1+r)^n$.
EAR	Effective annual rate (EAR) = IAF – 1. In this case, IAF is usually equal to $(1+r/n)^{12}$, where n is the compounding periods per year.
$e = \lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$	The definition of the number e.
$r = \left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1$	The **interest rate** r that will grow an amount PV to an amount FV in n periods.
$n = \frac{\log\left(\frac{FV}{PV}\right)}{\log(1+r)}$	The **number of periods** n needed to grow an amount PV to an amount FV at an interest rate r.
$n = \frac{\log 2}{\log(1+r)}$	The number of periods needed to **double money** at an interest rate r.
PV, FV, s, n, r (Savings Formulas)	
$FV = s\frac{(1+r)^n - 1}{r}$	**Savings Future Value (Normal) .** Future value of an ordinary "savings" annuity with payment "s" at the end of the period with interest rate r for n periods. r is normally equal to "annual rate ÷12", and n is normally equal to "years × 12."
$s = \frac{rFV}{(1+r)^n - 1}$	**Savings Payment** based upon FV**.**
$FV = s(1+r)\frac{(1+r)^n - 1}{r}$	**Savings Future Value (Annuity Due)**. Future value of an **annuity due** with payment "s" at the beginning of the period with interest rate r for n periods. Notice that an annuity is just shifted by one period or by $(1+r)^n$. Not commonly used.
PV, FV, m, n, r (Loan Formulas)	
$m = \frac{PV(1+rn)}{n/12}$	**Loan Payment for add-on interest r**. Monthly payment m for a loan of an amount PV with add-on interest. Note that loans work with PV's and savings work with FV's. The future value of a loan is zero. n = number of months

$m = \frac{PVr(1+r)^n}{(1+r)^n - 1}$	**Loan Payment for amortized loan.** Monthly payment m for a loan of amount PV which **amortizes** at interest rate r. This is the rate associated with **APR** where interest is charged only on the **unpaid balance** of the loan. Note that there are no simple formulas for r and n. These values must be found with tables or iteratively on a calculator or computer. This also the formula for an **income annuity**.
$m = \frac{PVr}{1 - \frac{1}{(1+r)^n}}$	**Loan Payment – Calculator Format.** This formula is the same as the one above but expressed in a different format that facilitates the computations on a simple calculator without writing down intermediate values or using the store function. Notice that in this form, it is easy to see that the as the number of payment periods n becomes very large, the monthly payment converge to an interest only loan with a single balloon payment sometime in the future.
$m = s(1+r)^n$	**Savings to loan conversion factor**. The monthly payment for a loan of x dollars is equal to the monthly savings amount to reach x dollars multiplied by the IAF.
$PV(1+r)^i - \frac{m\left[(1+r)^i - 1\right]}{r}$	The **unpaid balance** of a loan at the end of period i.
$ABD = \frac{\sum_{i=1}^{n} B_i D_i}{\sum_{i=1}^{n} D_i}$	**Average Daily Balance** for credit card calculations, where B_i is the balance that exists for D_i days.
APR	**Annual Percentage Rate.** APR is the interest rate that would generate an equivalent monthly loan payment if interest were charged only on the unpaid balance during loan payback. To find APR, you must know the loan and the payment amounts. You must then iteratively test alternative rates until you find a rate which will give a monthly payment acceptably close to the stated payment.
PITI	**Monthly home mortgage payment** base upon the sum of **principal, interest, taxes, and insurance**. Principal and interest (PI) are typically computed as a single number equal to the monthly loan payment for a normal amortized loan at the specified rate and term. Taxes and insurance must be converted to monthly amounts and added to the loan payment to get the monthly amount sent to the mortgage company, commonly called the PITI amount.
PV, FV, a, n, r (Income Annuity)	
$a = \frac{PVr(1+r)^n}{(1+r)^n - 1}$	**Income Annuity.** This is the amount of money a that you could withdraw for n periods if you had PV invested at interest rate r. Note that this is the same formula used for loans.