Annuity (Payment → Future Value)
Sinking Fund (Future Value → Payment)

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An **Ordinary Annuity** is a sequence of *equal* payments made at the end of *equal* intervals.

Previously, given an interest rate **r**, a period of time **t**, and maybe a number of compounding periods per year **m**, we have been considering two major problems and a couple of minor ones:

1. Given the Present Value (PV), find the Future Value (FV)
2. Given the Future Value (FV), find the Present Value (PV)

Now we add equal payments and consider

1. Given the payment amount, what will the Future Value be worth in the future:

$$\mathbf{FV} = \mathbf{PMT}\left[\frac{(1+\mathbf{i})^{\mathbf{n}}-1}{\mathbf{i}}\right]$$

where

FV = Future Value = Future Amount
PMT = equal periodic payment at the end of each fixed period
i = interest rate per period in decimal form
(usually not **r**, the annual rate)
n = number of equal payments (number of periods)

2. Given what we want the Future Value to be worth in the future, what does the equal periodic payment need to be? The is referred to as the Sinking Fund Problem:

$$\mathbf{PMT} = \mathbf{FV}\left[\frac{\mathbf{i}}{(1+\mathbf{i})^{\mathbf{n}}-1}\right]$$

where

FV = Future Value = Future Amount

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PMT = equal periodic payment at the end of each fixed period
i = interest rate per period in decimal form
(usually not **r**, the annual rate)
n = number of equal payments (number of periods)

These formulas are complicated (they could be worse) and assume that these equal payments are made at the end of each period.

Example 01: Find the Future Value of an ordinary annuity if \$500 is deposited each month for 10 years with a fixed annual rate of 5.5 %. Also, how much interest is earned?

Solution:

We have

$$\mathbf{FV} = \mathbf{PMT}\left[\frac{(1+\mathbf{i})^{\mathbf{n}}-1}{\mathbf{i}}\right] = \mathbf{PMT}\left[\frac{\left(1+\frac{\mathbf{r}}{100\,\mathbf{m}}\right)^{\mathbf{m*t}}-1}{\frac{\mathbf{r}}{100\,\mathbf{m}}}\right]$$

$$= \$500\left[\frac{\left(1+\frac{5.5}{100*12}\right)^{12*10}-1}{\frac{5.5}{100*12}}\right] = \$79,753.80$$

The interest is given by $\mathbf{Interest} = \mathbf{FV} - \mathbf{PMT} * \mathbf{m} * \mathbf{t} = \$19,753.80$

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Example 02: If Bob M wants to retire in 25 years worth $1,000,000, how much should he contribute to his tax-deferred account each month if this account pays a guaranteed 4.8% annually?

Solution:

We have

$$\mathbf{PMT} = \mathbf{FV}\left[\frac{\mathbf{i}}{(1+\mathbf{i})^{\mathbf{n}}-1}\right] = \mathbf{FV}\left[\frac{\frac{\mathbf{r}}{100\,\mathbf{m}}}{\left(1+\frac{\mathbf{r}}{100\,\mathbf{m}}\right)^{\mathbf{m*t}}-1}\right]$$

$$= \$1000000\left[\frac{\frac{4.8}{100*12}}{\left(1+\frac{4.8}{100*12}\right)^{12*25}-1}\right] = \$1729.97$$

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