In Excel language, if the initial cash flow is an inflow (positive), then the future value must be an outflow (negative). Therefore you must add a negative sign before the FV (and PV) function. The inputs to the FV function are the interest rate, the number of periods, the payment (if calculating the FV of an annuity with the first payment made at time 1), and the present value (if calculating the FV of a one lump sum starting from time zero). To project a single cash flow into the future, set Payment = 0.

\[
\text{FV(rate, nper, pmt, pv, type)}
\]

- rate: interest rate per period
- nper: total number of annuity payment periods
- pmt: payment made each period (must remain fixed)
- pv: present value lump-sum value of the series; if omitted, pmt must be included
- type: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)

**Example:**

<table>
<thead>
<tr>
<th>rate</th>
<th>nper</th>
<th>pmt</th>
<th>pv</th>
<th>Future Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.00%</td>
<td>1</td>
<td>0</td>
<td>$100.00</td>
<td>$112.00</td>
</tr>
</tbody>
</table>
We can modify the FV function for more frequent compounding within each year. Divide the interest rate by the number of compounding periods, and define the number of periods as the number of years times the number of compounding periods. Remember to use a negative sign in front of the FV function. You can use more frequent compounding with either a single lump sum (present value) or an annuity (payment).

FV(rate,nper,pmt,pv,type)
- rate: interest rate per period
- nper: total number of annuity payment periods
- pmt: payment made each period (must remain fixed)
- pv: present value lump-sum value of the series; if omitted, pmt must be included
- type: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)

<table>
<thead>
<tr>
<th>Interest Rate</th>
<th>Number of Years</th>
<th>Compounding Periods</th>
<th>Payment Amount</th>
<th>Present Value</th>
<th>Future Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.00%</td>
<td>3</td>
<td>12</td>
<td>0</td>
<td>$100.00</td>
<td>$143.08</td>
</tr>
</tbody>
</table>

Interest is compounded into principal m times per year.
An annuity is defined as a fixed cash flow that recurs at regular intervals for a finite period of time. When applying Excel's FV function to an annuity, PV = 0 and payment = the regularly recurring cash flow. We can also project the FV of an annuity with more frequent compounding than once per year. In this case we would divide the interest rate by the number of compounding periods and multiply the number of periods times the number of compounding periods.

\[
\text{FV(rate, nper, pmt, pv, type)}
\]

- **rate**: interest rate per period
- **nper**: total number of annuity payment periods
- **pmt**: payment made each period (must remain fixed)
- **pv**: present value lump-sum value of the series; if omitted, pmt must be included
- **type**: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)
The inputs for the PV formula are the same as those for the FV formula. The discounting factor for the PV function is the inverse of the multiplier for the FV formula. Change the value of the interest rate and the number of discounting periods to see how sensitive the present value calculation is to changes in the discount factor. The PV function works the same way as the FV function. The payment value = zero, and a negative sign in front of the PV function is required.

```
PV(rate, nper, pmt, fv, type)
rate     interest rate per period
nper     total number of annuity payment periods
pmt      payment made each period (must remain fixed)
fv       future value lump-sum value of the series; if omitted, pmt must be included
 type    = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)
```
We can modify the FV function for more frequent compounding within each year. Divide the interest rate by the number of compounding periods, and define the number of periods as the number of years times the number of compounding periods. Remember to use a negative sign in front of the FV function. You can use more frequent compounding with either a single lump sum (present value) or an annuity (payment).

\[
\begin{array}{|c|c|c|c|}
\hline
\text{rate} & \text{interest rate per period} & \\
\text{nper} = \text{years} \times \text{comp. per.} & \text{total number of annuity payment periods} & \\
\text{pmt} & \text{payment made each period (must remain fixed)} & \\
\text{fv} & \text{future value lump-sum value of the series; if omitted, pmt must be included} & \\
\text{type} & = 0 \text{ if payments made at end of period, 1 if payments made at beginning of period (may be omitted)} & \\
\hline
\end{array}
\]

\text{PV(rate,nper,pmt,fv,type)}
An annuity is defined as a fixed cash flow that recurs at regular intervals for a finite period of time. When applying Excel's PV function to an annuity, FV = 0 and payment = the regularly recurring cash flow. We can also discount the PV of an annuity with more frequent compounding than once per year. In this case we would divide the interest rate by the number of compounding periods and multiply the number of periods times the number of compounding periods.

<table>
<thead>
<tr>
<th>interest Rate</th>
<th>Number of Periods</th>
<th>Payment Amount</th>
<th>Future Value</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.00%</td>
<td>20</td>
<td>$25,000.00</td>
<td>$0.00</td>
<td>$311,555.26</td>
</tr>
</tbody>
</table>

**PV(rate,nper,pmt,fv,type)**
- **rate**: interest rate per period
- **nper**: total number of annuity payment periods
- **pmt**: payment made each period (must remain fixed)
- **fv**: future value lump-sum value of the series; if omitted, pmt must be included
- **type**: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)
Here the present value, number of periods, interest rate and future value (0) are known, but the regularly recurring cash flow is unknown. Excel's PMT formula uses the same inputs as the PV formula to solve for the payment amount. Start the formula with a negative sign. For installment credit calculations, divide the interest rate by 12 inside the PMT function (payments are usually monthly).

\[
PMT(rate, nper, pv, fv, type)
\]

- **rate**: interest rate for the loan
- **nper**: total number of payment periods for the loan
- **pv**: pv of the loan (the principal amount borrowed)
- **fv**: fv of the loan, or cash balance after last payment (if omitted, assumed to be zero)
- **type**: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)

<table>
<thead>
<tr>
<th>rate</th>
<th>nper</th>
<th>pv</th>
<th>fv</th>
<th>Payment Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.99%</td>
<td>60</td>
<td>$20,000.00</td>
<td>$0.00</td>
<td>$359.28</td>
</tr>
</tbody>
</table>
Here the present value, number of periods, regularly recurring payment and present value are known, but the interest rate is unknown. Excel's RATE formula uses the same inputs as the PV formula to solve for the interest rate. In this case the negative sign goes in front of PV inside the RATE function. Usually we enter the payment and number of periods in terms of months, so the RATE function will output the rate in terms of months as well. Multiply times 12 to convert to an annual RATE.

<table>
<thead>
<tr>
<th>nper</th>
<th>PMT</th>
<th>PV</th>
<th>FV</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>$300.00</td>
<td>$13,027.00</td>
<td>$0.00</td>
<td>5.00%</td>
</tr>
</tbody>
</table>

$\text{RATE(nper,pmt,pv,fv,type)}$

- **nper**: total number of annuity payment periods
- **pmt**: payment made each period (must remain fixed)
- **pv**: total amount that a series of future payments is worth now
- **fv**: cash balance you want to attain after last payment; fv of a loan is 0
- **type**: = 0 if payments made at end of period, 1 if payments made at beginning of period (may be omitted)
Excel's NPV function allows you to discount a series of cash flows. Inputs to the NPV function are the discount rate and range of cells containing the cash flow values. The NPV function therefore works on annuities or cash flow streams where the cash flows may take different values. Notice that the function is mis-named, however: it is actually a present value function, as it assumes the first cash flow is paid at time period one. If there is a time zero cash outflow, that cash flow must be subtracted from the NPV function to complete a net present value calculation.

Discount Rate = 12.0%

<table>
<thead>
<tr>
<th>Period</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Flow</td>
<td>($3,000,000)</td>
<td>$1,000,000</td>
<td>$1,000,000</td>
<td>$2,000,000</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Present Value</td>
<td>$5,020,166</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net PV</td>
<td>$2,020,166</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NPV(rate,value1,value2,...)

- **rate**: discount rate used to calculate the present value of the cash flow stream
- **value**: the cash flows or cell references containing the cash flows to be discounted
- **note**: the NPV function assumes the first cash flow is paid one period after the time period in which the NPV calculation takes place.