Chapter 08: Simple Interest

Chapter 09: Compound Interest works for you

The Power of Compound Interest working for you

Compound Interest works against you

Simple Interest

When you invest like putting it in a bank

When you borrow like taking out a loan

The Power of Compound Interest working against you

Fundamental truth of finance:
- A dollar received now is worth more than a dollar received later

Simple Interest!

Page 2 of 18

Math is Fun!
Chapter 8: Simple Interest

8.1) Basics of Simple Interest

Interest:
- Interest is rent paid on money
- Firms, businesses and individuals borrow money in order to invest the money and earn a higher rate of return than the interest rate
- Firms, businesses and individuals invest money to earn interest

Principal:
- Amount borrowed, lent out, or invested

Simple Interest:
- Interest paid on only the principal

Compound Interest:
- Interest paid on principal and past interest

Simple Interest Rate:
Annual % rate paid or received

Annual Rate !!

a. Solve for simple interest

\[ I = P \times R \times T \]

Interest = Principle x Simple Interest Rate x Time in years

\[ I = \text{Simple interest} \]
\[ P = \text{Principal} \]
\[ R = \text{Interest Rate} \]
\[ T = \text{Time in years} \]

\[ I = P \times R \times T = PRT \]

**Time given in years.** If time given in days or months, you must convert it to a fraction of a year.

**If rate given in %, you must convert to a decimal or fraction.**
Example:
Hank’s Auto shop takes out a loan from the bank for $10,000 in order to buy new equipment. Hank is considering whether he should take out the loan for 6 months at 7% or 1.5 years at 10%. Find the simple interest on both loans.

**Loan for 6 months at 7%**

**Step 1:** convert 6 months to a percentage of a year

\[
\text{Time} = \frac{6 \text{ months}}{1 \text{ year} (12 \text{ months})} = \frac{6}{12} = \frac{1}{2} = .5
\]

**Step 2:** Find interest

\[
I = P \times R \times T = 10,000 \times .5 \times .07 = 350.00
\]

**Loan for 1.5 years at 10%**

\[
I = P \times R \times T = 10,000 \times .1 \times 1.5
\]

\[
= 1500.00
\]

The interest on the first loan is $350.00 for ½ year & the interest on the second loan is $1500 for 1.5 years.

**b. Calculate maturity value**

**Maturity Value:**
- Amount that is paid when the loan is repaid

\[
M = P + I
\]

**Maturity Value = Principal + Interest**

\[
M = P + I
\]

Simple Interest!
Example:
Christina takes out a $6500.00 loan for 30 months at 10% interest in order to buy a used Jetta. Find the interest due on the loan and the maturity value.

**Step 1:** Find the interest

\[ I = P \times R \times T \]

\[ \text{Interest} = \frac{65000 \times 0.1 \times 30}{12} = \$1,625 \]

**Step 2:** Find the maturity value

\[ M = P + I \]

\[ \text{Maturity value} = 6,500 + 1,625 \]

\[ M = \$8,125 \]

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c. **Determine the number of days from one date to another, using the actual number of days in the month**

Use knuckle trick, memory, or card in your wallet

**Important:**
- Do not use the day of the loan
- However, you must use the day that the loan is repaid

Example:
Find the number of days from November 4 to February 21

<table>
<thead>
<tr>
<th>Nov 4</th>
<th>Nov 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 1</td>
<td>Dec 31</td>
</tr>
<tr>
<td>Jan 1</td>
<td>Jan 31</td>
</tr>
<tr>
<td>Feb 1</td>
<td>Feb 21</td>
</tr>
</tbody>
</table>

Days: 26 + 31 + 31 + 21 = 109 days
d. Find exact and ordinary interest

\[ I = PRT \]

**Exact Interest:**

\[ T = \frac{\text{# of days in the loan period}}{365} \]

*Most of the world uses 365!!!*

**Ordinary Interest or Banker’s Interest:**

\[ T = \frac{\text{# of days in the loan period}}{360} \]

This method is rarely used. It is too bad that the textbook uses it so much.

**Example:**

Find the exact interest and the banker’s interest given the following data:

- Principal = $10,000
- Simple interest = 10%
- Loan taken out on January 1
- Loan paid back on July 31

**Step 1:** Find the number of days the loan is out

\[ \text{Count days from Jan 1 to July 31} \]

(Non-leap year) \[ \frac{211}{365} = 211 \]

**Step 2:** Find Exact Interest

\[ \text{Exact Interest} = 10000 \times 0.1 \times \frac{211}{365} = \$578.082192 \]

\[ = \$578.08 \]

**Step 3:** Find Banker’s Interest

\[ \text{Ordinary Interest} = 10000 \times 0.1 \times \frac{211}{360} = \$586.1111 \]

\[ = \$586.11 \]

**Assume for this textbook Ordinary/Banker’s interest will be used.**

Simple Interest!  Hold over from past

Ordinary Interest is always bigger

Math is Fun!
e. Define the basic terms used with notes

Promissory Notes:
- A legal document in which on person or firm agrees to pay:
  - A stated amount of money
  - Plus interest computed at a stated rate
  - At a stated time in the future
  - To another person or firm

- A promissory note is the written record of a loan

Maker or Payer or Debtor of the note:
The person borrowing the money

Payee or Creditor of the note:
The person lending the money

Term:
Length of time until the note is due

Face Value or Principal:
The principal amount due – the amount written of the face of the promissory note.

Simple Interest Note:
A promissory note for a loan in which the interest is calculated using the simple interest formula:

\[ I = PRT = \text{Face Value} \times \text{Simple Interest Rate} \times \text{Time} \]

Collateral:
Assets pledged to back the loan. If the loan is not paid off, the maker of the loan has the right to sell the pledged assets and use the proceeds to pay off the loan.

f. Find the due date of a note

- When the term for a loan is given in days, count the number of days from the day after the promissory note issue date.
- When the term for a loan is given in months, the loan is due on the same day the loan is made, after the number of months has passed
  - If the date should be at the end of the month, but that day does not exist, use the last day of the month, as it exists, as the due date
  - **When the loan term is given in months, do not convert the time to days in order to find the due date.**

Example:
When is a 6-month loan made on January 15 due?
It is due on the 15th, 6 months later:
July 15 is the due date.

Example:
When is a 3-month note made on January 31 due?
It is due on April 31, but April 31 does not exist.
The due date becomes April 30.
Finding Principal, Rate, and Time

The key to all these problems is to remember the formulas:

1st formula: \[ I = P \times R \times T = \text{Interest} \]
2nd formula: \[ P = \frac{I}{(R \times T)} = \text{Principal} \]
3rd formula: \[ R = \frac{I}{P \times T} = \text{Rate (simple)} \]
4th formula: \[ T = \frac{I}{P \times R} = \text{Time in years} \]

a. Find the principal

I = PRT

P = \frac{I}{RT}

**Cover with your finger to find formula**

Visual Trick to Remember Formula

Example:

Gardenia borrows a principal amount that earns $50 interest for the lender, the simple interest rate on the loan is 10\%, and the loan is out for 180 days. Find the principal amount.

\[ P = \frac{I}{RT} \]

\[ I = 50 \]
\[ R = .1 \]
\[ T = \frac{180}{360} = .5 \text{ years} \]

\[ P = \frac{50}{(.1 \times \frac{180}{360})} = \frac{50}{(.05 \times .5)} = \frac{50}{.05} = 1000 \]

From the data presented, we calculated the principal to be $1000.

Check the answer with I = PRT

50 = 1000 \times .1 \times \frac{180}{360} = 50
b. Find the rate

\[ I = PRT \]

\[ R = \frac{I}{PT} \]

**Cover with your finger to find formula**

Visual Trick to remember Formula

Example:
Gardenia borrows $750 and pays $75 interest. If the loan is out for 270 days, find the interest rate.

\[ P = 750 \]
\[ I = 75 \]
\[ T = \frac{270}{360} = 0.75 \text{ years} \]

\[ R = \frac{I}{P \times T} = \frac{75}{(750 \times \frac{270}{360})} = \frac{75}{(750 \times 0.75)} = \frac{75}{562.5} = 0.1333 \]

\[ = 13 \frac{1}{3} \% \]

From the data presented, we calculated

The simple interest rate is \(13 \frac{1}{3}\%\)

Check the answer with \( I = PRT \)

\[ 75 = 750 \times 0.133333 \times \frac{270}{360} \]

\[ = 75 \]
c. **Find the time**

\[ I = PRT \]
\[ T = \frac{I}{PR} \text{ (in years)} \]

**Important:**
"T" will be given as a fraction of a year. Multiply that fraction by 360 to get the number of days:

\[ T = \frac{I}{PR} \text{ (in years)} \rightarrow T = \frac{I}{PR} \times 360 \text{ (in days)} \]

**Really unrealistic**

But this is what the book uses

**Cover with your finger to find formula**

**Visual trick to remember formula**

**Example:**
Gardenia deposits $10,000 in a savings account at an interest rate of 10%. If she earns $750 interest, how many days did she leave the money in the account?

\[ P = 10,000 \]
\[ R = 10\% = 0.1 \]
\[ I = 750 \]

\[ T = \frac{I}{P \times R} = \frac{750}{10,000 \times 0.1} = \frac{750}{1000} = 0.75 \text{ years} \]

\[ \{ \text{Time} \} \text{ in Days} = 0.75 \times 360 = 270 \text{ days} \]

From the data presented, we calculated the time in days to be 270 days.

Check the answer with \( I = PRT \)
\[ 750 = 10,000 \times 0.1 \times \frac{270}{360} = 750 \]

Simple Interest!

Page 10 of 18

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8.3) Simple Discount Notes

a. Define the basic terms used with simple discount notes

Simple Discount Notes or “Interest in Advance Notes”:

- The bank collects the interest in advance
- The borrower pays the full face value back on the due date
- The borrower receives the face value minus the interest on the day that the funds are disbursed.
- The amount the borrower receives is called “Proceeds”
- The interest in advance is called “bank discount” or “discount”
- Proceeds = face value – bank discount

Amount borrower receives

Interest paid in advance to bank

Amount Borrower must pay back on due date

---

Compare Simple Interest Note and Simple Discount Note:

<table>
<thead>
<tr>
<th>Type of Note</th>
<th>Amount Received</th>
<th>Interest</th>
<th>Repayment amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple interest</td>
<td>Face value or Principal</td>
<td>Interest = Maturity value</td>
<td></td>
</tr>
<tr>
<td>Simple Discount</td>
<td>Proceeds + Bank Discount = Face Value or Maturity Value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** The face value and the maturity value are the same for a S. discount note

---

The idea of a Simple Discount Note is:

1. You go to bank and ask to borrow $1,000.
2. The bank says: “we will give you $900 today and then you must pay back $1,000 in 1 year.
3. You say: “why only 900, if I have to pay back $1,000”?
4. Bank says: “we collect interest up front ($100)!”

Simple Interest!
**Simple Discount:**

Bank Discount = Maturity Value \times Discount Rate \times Time

B = MDT

B = Bank Discount
M = Maturity Value = Face Value
D = Discount Rate
T = Time in years

**Variables in formula Defined**

---

Proceeds = Maturity Value – Bank Discount (Proceeds = Face value – Bank Discount)

P = M – B

P = Proceeds
M = Maturity Value
B = Bank Discount

**Variables in formula Defined**

---

**Example:**
If you take out a loan with a maturity value (face value) of $2000 and the bank discount is $150, what are the proceeds?

**Step 1**

(face value) = $2000

Bank Discount = $150

**Step 2**

\[ P = M - B = 2000 - 150 = 1850 \]

**Step 3**

The proceeds are $1850 and we have to pay a Bank Discount of $150 and pay back $2000 on the due date.
b. Find the bank discount and proceeds

Example:
Cynthia Thomas signs an $8500, 9-month note. If the bank discounts the note at 9%, find the amount of the discount and proceeds.

\[
\begin{align*}
M &= 8500 \\
T &= 9 \text{ months} \Rightarrow years = \frac{9}{12} \\
\text{Discount Rate} &= 9\% \Rightarrow .09
\end{align*}
\]

**Step 1:** find the bank discount

\[
B = M \times D \times T = 8500 \times .09 \times \frac{9}{12} = 573.75
\]

Proceeds = \(M - B\) = \$8500 - 573.75 = \$7926.25

The interest in advance is called “bank discount” or “discount”

\[
B = MDT = 8500 \times .09 \times 9/12 = \$573.75
\]

**Step 2:** Find the proceeds

Even though we must pay back \$8,500, the bank only gave us \$7,926.25. This is because the took out the Bank Discount (Interest) of \$573.75, before they gave us the proceeds.

c. Find the face value

If you know the proceeds you want, how do you figure out the amount to borrow, the maturity value or face value?

\[
\begin{align*}
P &= M - B \\
B &= M - P \\
B &= MDT \\
B &= B \\
MDT &= M - P \\
P &= M - MDT \\
P &= M(1 - DT) \\
M &= P/(1 - DT)
\end{align*}
\]

**Formula for find the proceeds**

\[
M = \frac{P}{(1 - DT)}
\]
\[ p = M - B \]
\[ B = M - p \]
\[ B = M \text{DT} \]
\[ M \text{DT} = M - p \]
\[ M \text{DT} - M = -p \]
\[ M - M \text{DT} = p \]
\[ M (1 - \text{DT}) = p \]
\[ M = \frac{p}{(1 - \text{DT})} \]
Example:
Mike Modigliani needs $4000 to buy a machine. Find the amount he needs to borrow (maturity value) if he plans to repay the note in 180 days and the bank charges a 12% discount rate.

**Step 1**
- **Proceeds**: $4000
- **Maturity value**: $M$
- **Time in years**: $T = \frac{180}{360} = 0.5$
- **Discount Rate**: $D = 0.12$

**Step 2**

\[
Maturity\ value = \frac{\text{Proceeds}}{1 - (\text{Discount Rate} \times \text{Time})} = \frac{4000}{1 - (0.12 \times 0.5)}
\]

\[
= \frac{4000}{1 - 0.06} = \frac{4000}{0.94} = 4255.3191 = 4255.32
\]

**Step 3**

- If Mike needs proceeds of $4000, the face value would have to be $4255.32.
d. Find the effective interest rate on a simple discount note

<table>
<thead>
<tr>
<th></th>
<th>Simple Interest Note</th>
<th>Simple Discount Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Value</td>
<td>$7500</td>
<td>$7500</td>
</tr>
<tr>
<td>Interest</td>
<td>$225</td>
<td>$225</td>
</tr>
<tr>
<td>Amount available to borrower</td>
<td>$7500</td>
<td>$7275</td>
</tr>
<tr>
<td>Maturity value</td>
<td>$7725</td>
<td>$7500</td>
</tr>
</tbody>
</table>

The trick is to find out the effective interest rate for each 90 day loan.

Formula for finding the interest rate:

\[ I = PRT \]

\[ R = \frac{I}{P \times T} \]

\[ D = \frac{B}{P \times T} \]

**R** = Interest Rate or Bank Discount Rate

**I** = Interest or Bank Discount

**P** = Principal or Proceeds

**T** = Time in years

Simple Interest Note:

\[ R = \frac{I}{P \times T} = \frac{225}{7500 \times \frac{90}{360}} = 0.12 \implies 12.00\% \]

Simple Discount Note:

\[ D = \frac{B}{P \times T} = \frac{225}{7275 \times \frac{90}{360}} = 0.123711 \implies 12.37\% \]

**Because you paid the same amount of interest but received fewer initial funds.**