

CHAPTER
3

Simple Interest

INTRODUCTION

Every human being irrespective of their profession, deals with money either as a borrower or as a lender. Business organisations implement new ideas through new projects for expansion, diversification or modernisation. The entire operation is based on the concept that money belonging to one may be used by others and can be returned within a designated future date. The question which immediately arises in mind is whether the value of money borrowed today will remain same after one year. Answer is 'no'. Because money has time value (*i.e.* a rupee today is worth more than a rupee tomorrow). Money can be employed productively to generate returns. For example, suppose that you have deposited Rs. 1,000 in a saving bank account and the bank pays 6% per annum return. Then, the amount accumulated at the end of the year will be Rs. 1,060. The use of money bears the cost of interest. Interest plays so important role in business that many individuals and agencies are engaged directly or indirectly in the business of lending money. The goal of this chapter is to study about the types of interest and the computation of simple interest.

INTEREST

Interest is the consideration for the use of invested or borrowed money. For example, suppose that Mr. X borrows a particular sum of money from Mr. Y. Then Mr. X has to pay certain amount to Mr. Y for the use of this money. This amount is called Interest. The money borrowed is called the principal. When Mr. X return his indebtedness to Mr. Y, he has to pay back both the principal and the interest. Interest is of two kind :

- (i) Simple Interest
- (ii) Compound Interest

In case of simple interest, the interest earned is not added back to the principal amount whereas in compound interest, the interest earned is added back to principal, thus to form a new principal for the new term. Interest at the end of every term is calculated and added to the amount at the beginning of that term. This new amount will be treated as the principal for the new term. In simple interest, principal will remain same for every term.

In the succeeding sections of this chapter, we will elaborately study the formulas and application of simple interest. Now let us briefly discuss the difference between simple interest and compound interest by means of an illustration. Suppose that a person invests Rs. 10,000 for 3 years at 8% simple interest per annum. The year by year interest calculation is shown in the following table :

<i>Year</i>	<i>Principal at the beginning of every year</i>	<i>Interest for the year</i>	<i>Amount at the end of every year</i>
1	Rs. 10,000	8% of 10,000 = Rs. 800	Rs. 10,800
2	Rs. 10,000	8% of 10,000 = Rs. 800	Rs. 11,600
3	Rs. 10,000	8% of 10,000 = Rs. 800	Rs. 12,400

Amount accumulated at the end of 3 years is Rs. 12,400, so the total interest earned for the three year taken together is Rs. 2,400 (Rs. 12,400 – Rs. 10,000). Now suppose that the same amount Rs. 10,000 is invested at 8% per annum but compounded annually. Then the calculation of interest is as follows :

<i>Year</i>	<i>Principal at the beginning of every year</i>	<i>Interest for the year</i>	<i>Amount at the end of every year</i>
1	Rs. 10,000	8% of 10,000 = Rs. 800	Rs. 10,800
2	Rs. 10,800	8% of 10,800 = Rs. 864	Rs. 11,664
3	Rs. 11,664	8% of 11,664 = Rs. 933.12	Rs. 12,597.12

Total amount accumulated at the end of 3 years is Rs. 12,597.12. The total interest earned in this case is Rs. 2,597.12. It should be noted that compound interest is always more than simple interest.

SOME BASIC TERMS

(a) **Principal Amount.** This is the amount about to be invested or loaned. If a person apply for a bank loan of Rs. 20,000, this amount is referred to as the principal amount to be borrowed. Similarly, if XYZ Ltd. purchased a new machine for Rs. 3,00,000, this is the principal amount invested on the machinery. It is denoted by 'P'.

(b) **Number of Years (*t*).** This is the time period (in years) over which an amount of money is invested or borrowed.

(c) **Conversion period (*n*).** This is the number of times over which interest is compounded on a given principal. In many cases, interest is calculated more than once in a year. For example, in personal loans, interest is calculated on monthly basis but in case of

savings bank account interest is compounded on half-yearly basis. 'n' is determined using the following relation :

$$n = m \times t$$

where m is the number of conversions per year. Thus, if certain principal is invested for 10 years and interest is compounded quarterly, then the number of conversion periods will be 40. It should be noted that n equals t , only when interest is compounded annually.

(d) **Rate of Interest (r)**. This is the proportionate amount charged for the use of the principal. It is defined as the interest charged for keeping Rs. 100 for 1 year. So the rate of interest is always expressed as a percentage rate per annum. However, for the purpose of calculation, interest rate is written in equivalent decimal form : $r = 7\%$ as $r = 0.07$; $r = 12\%$ as 0.12 and so on.

(e) **Interest per Conversion Period (i)**. We have already discussed that the rate of interest (r) is the percentage rate per annum. What will be the interest rate, if the interest is compounded more than once in a year ? The interest rate ' i ' depends upon the number of conversion periods per year ' i ' is calculated as follows :

$$i = \frac{r}{m}$$

Thus, if the interest is calculated at 10% per annum but compounded quarterly then

$$i = \frac{0.1}{4} = 0.025 \text{ or } 2.5\%$$

If the number conversions per year is one, then $i = r$.

(f) **Accumulated Amount (A)**. Amount is the sum of the principal and the interest. Some authors use the term 'sum' and denote it by 'S'.

$$A = P + I$$

SIMPLE INTEREST

Simple interest is generally used only for short-term investments or borrowings which are often of less than one year. It is payable on principal only. For example, simple interest on Rs. 1,000 at a rate of 6% per annum will be Rs. 60 every year through out the entire period.

Let P be the principal at a simple rate of interest $r\%$ per annum for a period of ' t ' years.

The interest charged at the end of t years is

$$I = P \times r \times t$$

The amount at the end of t years is given by :

$$A = P + I$$

$$\Rightarrow A = P + Prt$$

$$\Rightarrow A = P(1 + rt)$$

Given any three of the four variable A, P, r and t , we can solve for the fourth

$$i.e. \quad \boxed{P = \frac{A}{1 + rt}; r = \frac{A - P}{Pt}; t = \frac{A - P}{Pr}}$$

Remark. For any transaction, if the transaction is to be made for less than one year, the time may be given in months, weeks or days. Since in simple interest formula, ' t ' represents the number of years, the given time, if it is not in years, should be converted into year.

$$K \text{ days} = \frac{K}{365} \text{ years} \quad 30 \text{ days} = \frac{30}{365} \text{ years}$$

$$K \text{ weeks} = \frac{K}{52} \text{ years} \quad 12 \text{ weeks} = \frac{12}{52} \text{ years}$$

$$\text{and} \quad K \text{ months} = \frac{K}{12} \text{ years} \quad 4 \text{ months} = \frac{4}{12} = 1/3 \text{ years.}$$

Example 1 : Find the amount at 6% Simple Interest of Rs. 1,200

(a) in 2 years.

(b) in nine months.

Solution : Given principle $P = \text{Rs. } 1,200$

Rate of Interest $r = 6\% = 0.06$

(a) In 2 years :

$$\begin{aligned} \text{Amount } A &= P(1 + rt) \\ &= 1,200(1 + 0.06 \times 2) = 1,200(1 + 0.12) \\ &= 1,200(1.12) = \text{Rs. } 1,344 \end{aligned}$$

\therefore The amount is Rs. 1,344.

(b) In 9 months :

$$\begin{aligned} t = 9 \text{ months} &= \frac{9}{12} \text{ year} = \frac{3}{4} \text{ years} \\ A &= 1,200(1 + 0.06 \times 3/4) \\ &= 1,200(1 + 0.045) = 1,200(1.045) = \text{Rs. } 1,254 \end{aligned}$$

\therefore Amount is Rs. 1,254

Example 2 : Mr. X borrowed Rs. 7,500 on 26th March 1966 from a corporate bank at a rate of 8% p.a. If he wanted to clear the account on 7th June 1966 then what amount would he have to pay to bank ?

Solution : $P = \text{Rs. } 7,500$

$r = 8\%$ i.e. 0.08

$t = 73 \text{ days}$ or $\frac{73}{365} \text{ yr.} = \frac{1}{5} \text{ yr.}$

Amount $A = P(1 + rt)$

$$= 7,500 \left(1 + 0.08 \times \frac{1}{5} \right) = 7,500 (1 + 0.016)$$

$$= 7,500 (1.016) = \text{Rs. } 7,620$$

∴ The amount is Rs. 7,620.

Example 3 : *What time will be required for a sum of money to double itself at 5% simple interest ?*

Solution : Let P be the principal. Given that the sum is double of its principal

$$\therefore S = 2P \quad \dots(1)$$

Let t be the time, $r = 5\%$ or 0.05

$$S = P(1 + rt) \quad \dots(2)$$

$$(1) = (2) \Rightarrow 2P = P(1 + rt)$$

$$\Rightarrow 2 = 1 + rt$$

$$\Rightarrow rt = 1$$

Substituting $r = 0.05$, we get

$$0.05t = 1$$

$$\Rightarrow t = 20 \text{ years}$$

∴ 20 years are required to get the sum doubled.

Example 4 : *Mr. Ram deposited Rs. 10,000 in a saving bank account which pays 10% simple interest. He makes two more deposits of Rs. 15,000 each, the first at the end of 3 months and the second in 6 months. How much will be in the account at the end of the year, if he makes no other deposits and no withdrawals during this time ?*

Solution : In case of the deposit of Rs. 10,000

principle, $P = \text{Rs. } 10,000$

time, $t = 1 \text{ yr.}$

rate of interest, $r = 8\% = 0.08$

Amount is given by

$$A = P(1 + rt)$$

$$\text{Here } A_1 = 10,000 (1 + 0.08 \times 1)$$

$$= 10,000 (1.08) = \text{Rs. } 10,800$$

Two deposit of Rs. 15,000 are made at the end of 3 months and 6 months respectively. In case of 3 months, the amount will remain in the account for remaining 9 months.

$$\therefore t = \frac{9}{12} = \frac{3}{4} \text{ years}$$

$$P = \text{Rs. } 15,000$$

$$A_2 = 15,000 \left(1 + 0.08 \times \frac{3}{4} \right)$$

$$A_2 = 15,000 (1.06) = \text{Rs. } 15,900$$

In case of 6 months, the amount will remain for 6 months (1 year – 6 months)

$$\therefore t = \frac{6}{12} = \frac{1}{2} \text{ years}$$

$$P = \text{Rs. } 15,000.$$

$$A_3 = 15,000 (1 + 0.08 \times 1/2)$$

$$A_3 = 15,000 (1.04) = \text{Rs. } 15,600$$

$$\text{Total amount} = A_1 + A_2 + A_3$$

$$= 10,800 + 15,900 + 15,600 = \text{Rs. } 42,300$$

\therefore At the end of the year, Rs. 42,300 will remain in the account.

Example 5 : A shopkeeper borrowed Rs. 20,000 from two money lenders. For one loan he paid 12% simple interest and for the other 14% simple interest per annum. After one year, he paid Rs. 2,560 as total interest. How much did he borrow from each money lender ?

Solution : Let the shopkeeper borrows Rs. P from money lender 1 at 12%.

Then amount borrowed from money lender 2 will be Rs. $(20,000 - P)$ at 14%.

Interest is given by

$$I = Prt$$

Interest paid to money lender 1,

$$I_1 = P \times 0.12$$

Interest paid to money lender 2,

$$I_2 = (20,000 - P) \times 0.14$$

Given that total interest paid is Rs. 2,560.

$$\therefore I_1 + I_2 = 2,560$$

$$\Rightarrow 0.12 P + 0.14 (20,000 - P) = 2,560$$

$$\Rightarrow 0.12 P + 2,800 - 0.14 P = 2,560$$

$$\Rightarrow 0.02 P = 240$$

$$\Rightarrow P = 12,000$$

$$\therefore 20,000 - P = 8,000$$

$$\therefore \text{Money borrowed at 12\%} = \text{Rs. } 12,000$$

$$\text{Money borrowed at 14\%} = \text{Rs. } 8,000$$

Example 6 : What percentage of simple interest must a person get on his investment of Rs. 25,000, if he wants his investment to grow to Rs. 26,500 in 6 months ?

Solution : Here $P = \text{Rs. } 25,000$

$$A = \text{Rs. } 26,500$$

$$t = \frac{6}{12} = \frac{1}{2} \text{ years}$$

We know that $I = A - P$

$$\text{Here } I = 26,500 - 25,000 = \text{Rs. } 1,500$$

Simple interest I is given by

$$I = Prt$$

$$\therefore r = \frac{I}{Pt}$$

Here $r = \frac{1,500}{25,000 \times (1/2)} = 0.12 = 12\%$

\therefore Required simple interest rate = 12%.

EXERCISES

1. Find the simple interest and amount on an investment of Rs. 5,000 for 3 years, if the interest is calculated at 4% simple interest per annum. [Ans. Rs. 600, Rs. 5,600]
2. At what rate will Rs. 1,500 yield Rs. 25 simple interest in 8 months? [Ans. 2.5%]
3. What principal will amount to Rs. 645 in $1\frac{1}{2}$ years at 5% simple interest? [Ans. Rs. 600]
4. What time will be required for a certain sum of money to double itself at 10% simple interest? [Ans. 10 years]
5. How much should an investor deposit now in a Bank to get Rs. 20,000 in 3 months, if bank calculates 9% simple interest? [Ans. Rs. 19,560]
6. How long will Rs. 3,000 take to amount to Rs. 3,300 at 4% simple interest? [Ans. 2.5 years]
7. Ram borrowed Rs. 5,000 from Shyam at 8% simple interest. After 9 months again he borrowed Rs. 2,000, promising to return the entire indebtedness at the end of two years. What amount Shyam will get from Ram? [Ans. Rs. 8,000]
8. Suresh borrowed Rs. 830 from Vikas at 12% rate of interest for 3 years. He then added some more money to the borrowed sum and lend it to Deepak for the same time at 14% simple interest. If Suresh gains Rs. 93.90 in the whole transaction, find the sum lent by him to Deepak. [Ans. 935]
9. A certain amount of money was invested at 8% simple interest and after 9 months an equal amount was invested at 10% simple interest. Find the period in which the amount in each case becomes Rs. 52,000. How much money was invested in each case? [Ans. $3\frac{3}{4}$ yrs. , Rs. 40,000]