Simple Interest
&
Compound Interest

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Simple Interest & Compound Interest

Simple Interest: Simple interest is when the interest is charged on the principal sum only for daily/weekly/monthly/yearly basis but not on the interest accumulated on the principal sum of money.
Formula for calculating Simple Interest:
S.I. = $\frac{P \times R \times T}{100}$
Here, P = Principal Sum,
R% = Interest rate per year
T = Time period for the principal sum is invested
Amount accumulated = P + S.I.

Note:
1. When a Principal sum becomes "n" times of itself in t years at simple interest then
R% = $\frac{100(n-1)}{t}$
2. If a certain sum is invested in n types of investments in such a manner that equal amount is obtained on each investment where interest rates are R₁, R₂, R₃ ……, Rn, respectively and time periods are T₁, T₂, T₃, ……, Tn, respectively, then the ratio in which the amounts are invested is:

$$\frac{1}{100 + R_1 T_1} : \frac{1}{100 + R_2 T_2} : \frac{1}{100 + R_3 T_3} : \dots \dots \dots : \frac{1}{100 + R_n T_n}$$

3. If a certain sum of money becomes n times itself in T years at a simple interest, then the time T in which it will become m times itself is given by

$$T' = \frac{(m-1)}{(n-1)} \times T \; years$$

4. If a certain sum of money P lent out at SI amounts to A₁ in T₁ years and to A₂ in T₂ years, then $P = \frac{A_1 T_2 - A_2 T_1}{T_2 - T_1}$ and $R = \frac{A_1 - A_2}{A_1 T_2 - A_2 T_1} \times 100 \%$
5. If a certain sum of money P lent out for a certain time T amounts to A₁ at R₁ % per annum and to A₂ at R₂ % per annum, then
$P = \frac{A_2 R_1 - A_1 R_2}{R_1 - R_2}$ and $T = \frac{A_1 - A_2}{A_2 R_1 - A_1 R_2} \times 100 \; years$
6. If an amount P₁ lent at the simple interest rate of R₁ % per annum and another amount P₂ at the simple interest rate of R₂ % per annum, then the rate of interest for the whole sum is

$$P = \frac{P_1 R_1 + P_2 R_2}{P_1 + P_2}$$

Compound Interest: It is addition of interest to the principal sum and then again earning interest on the principal sum along with previously earned interest.
Formula for calculating Compound Interest:
C.I. = Amount accumulated – Principal Sum
Compound Interest (C.I.) = $\left[P \left(1 + \frac{R}{100}\right)^t - P \right]$

And, Amount A = $P \left(1 + \frac{R}{100}\right)^t$
Here, P = Principal Sum,
R% = Interest rate per year
t = Time period for the principal sum is invested
A = Amount generated after "t" time period
Note: It must be noted that the interest rate remains same for whole time period "t".

Different cases of Compound Interest:
Case 1: There are some cases when interest rate is different for different time periods. In that case,

$$A = P \left(1 + \frac{R1}{100}\right)^{t1} \left(1 + \frac{R2}{100}\right)^{t2} \dots \dots \dots$$

Here, R_1 = Interest rate per year for t_1 time period
R_2 = Interest rate per year for t_2 time period
And so on.

Also, Compound Interest (C.I.) = $\left[P \left(1 + \frac{R1}{100}\right)^{t1} \left(1 + \frac{R2}{100}\right)^{t2} \dots \dots \dots - P \right]$

Case 2: When compound interest is compounded half yearly (twice a year):
In this case the Interest rate is divided by 2 and time period is multiplied by 2. So,

A = $P \left(1 + \frac{\frac{R}{2}}{100}\right)^{t \times 2}$

Case 3: When compound interest is compounded quarter yearly (four times a year):
In this case the Interest rate is divided by 4 and time period is multiplied by 4. So,

A = $P \left(1 + \frac{\frac{R}{4}}{100}\right)^{t \times 4}$

Note: When a Principal sum becomes "n" times of itself in t years at compound interest then

$$R\% = 100(n^{\frac{1}{t}} - 1)$$

Relationship between S.I. and C.I.:
Case 1: When the difference between C.I. and S.I. on a Principal sum is given for 2 years of time period and interest rate R% is given:

Difference between S.I. and C.I. = $\text{Principal} \times \left(\frac{R}{100}\right)^2$

Case 2: When the difference between C.I. and S.I. on a Principal sum is given for 3 years of time period and interest rate R% is given:

$$\text{Principal} = \frac{\text{Difference} \times 100^3}{R^2(300 + R)}$$

Annual Installment/Payment/EMI: When an article is purchased or a loan is taken and amount/debt is paid back in the form of annual installment/payments in "t" time period at r% interest rate per annum. Then

Annual installment/Payment/EMI = $\frac{2 \times Debt\ Amount \times 100}{2 \times 100t + rt(t-1)}$

Example: A man takes a loan of Rs.1888 to pay it into 6 annual equal installments at the rate of 16% p.a. on S.I. What will be the annual payment to pay off the debt?
Solution:
Annual installment = $\frac{2 \times 1888 \times 100}{2 \times 100 \times 6 + 16 \times 6 \times 5}$ = Rs.224.76