# Simple Interest and Compound Interest

Money is not free to borrow. People can always find a use for money, so it costs to borrow money. Different places charge different amounts at different times! It is called Interest. This lesson explains the concept of Simple Interest and Compound Interest. We will develop a basic understanding of these two different types of interests, their uses and properties.

**Simple Interest (SI)**

It is an easy and quick method of calculating an interest charge on a loan. Simple interest (S.I.) is determined by multiplying the principal (P) with rate of interest (R) and time period (T).

$$S.I. = \frac{P \times R \times T}{100}$$

**Example:** Henry borrowed Rs. 5000 for 4 years at an interest rate of 5% from a bank. How much of interest is that?

We know,

$$S.I. = \frac{P \times R \times T}{100}$$

Here P= Rs. 5000, R= 5%, T= 4 years

So, $I = \frac{5000 \times 5 \times 4}{100} = Rs.1000$

Ans: Henry has to pay Rs. 1000 as interest.

Clearly, in S.I. the principal remains constant throughout. But the above method is not generally used in day to day financial system like banks, insurance companies, post offices. They use a different method of computing interest. In this method the lender and the borrower agree to fix up a certain time interval, say a year or half a year or a quarter of a year for the computation of the interest and the amount. At the end of the first interval, the interest is computed and is added to the original principal. The amount obtained is added to the second interval of time. The amount of this principal at the end of the second interval of time is taken as the principal of the third interval of time and so on. At the end of the certain specified period, the difference between the amount and money borrowed, that is, the original principal is computed and it is called the compound interest. Let us simplify it.

**Compound Interest (CI)**

If the borrower and lender agree to fix up a certain interval of time, so that the amount (Principal + Interest) at the end of the interval becomes the principal of the next interval, then the total interest over all the interests, calculated in this way is called the Compound Interest or C.I..

Evidently, C.I. at the end of a certain specified period is equal to the difference between the amount at the end of the period and the original principal.

**C.I. = Amount – Principal**

**Conversion Period:** The fixed interval of time at the end of which the interest is calculated and added to the principal at the beginning of the interval is called the conversion period. In other words, the period at the end of which the interest is compounded is called the conversion period. For instance, when the interest is calculated and added to the principal every six months, the conversion period is six months. Likewise, the conversion period is three months when the interest is calculated and added quarterly.

*NOTE:* If no conversion period is specified, the conversion period is taken to be one year.

**Compound Interest Calculation from simple Interest where Interest is compounded annually.**

Q1. Find the Compound interest on Rs. 10000 for two years at 5% per annum.

Solution: Principal for the first year = Rs. 10000

Interest for the first year = $Rs \frac{10000 \times 5 \times 1}{100} = Rs.500$

[We are using the formula $S.I. = \frac{P \times R \times T}{100}$ ]

∴ Amount at the end of first year = Rs 10000 + Rs. 500 = Rs. 10500

Interest for the second year = $\frac{10500 \times 5 \times 1}{100} = Rs.525$

Principal of the second year was Rs. 10500 and so amount at the end of the second year = Rs. 10500 + Rs. 525 = Rs. 11025

So, Compound interest= Rs. (11025 – 10000) = Rs. 1025

*Note:* The C.I. can also be found by adding the interest for each year.

**Compound Interest Calculation from simple Interest where Interest is compounded half yearly.**
If the rate of interest is R% per annum and the interest is compounded half-yearly, then the rate of interest will be R/2% per half year.

**Q:** Find the compound interest on Rs. 10000 for 1½ years at 20% per annum, interest being payable half-yearly.

Solution: We know, R= 20% per annum
or, 10% per half year.

T= 1½ years = 3 half years

Original Principal (P) = Rs. 10000

I for the first half-year = $Rs.\frac{10000 \times 10 \times 1}{100} = Rs.1000$

P for the second half-year = Rs. 10000+1000= Rs. 11000

I for the second half-year = $Rs.\frac{11000 \times 10 \times 1}{100} = Rs.1100$

Amount at the end of the second half-year = Rs. 11000 + Rs. 1100 = Rs. 12100

P for the third half year= Rs. 12100

I for the third half-year = $Rs.\frac{12100 \times 10 \times 1}{100} = Rs.1210$

Amount at the end of third half-year = Rs. 12100 + Rs. 1210 = Rs. 13310

∴ C.I. = Rs. 13310 – Rs. 10000 = Rs. 3310.

**Computation of C.I. when Interest is compounded quarterly**

If the rate of interest is R% per annum and the interest is compounded quarterly, then the rate of interest will be R/4% per quarter.

Q: Find the compound interest on Rs. 10000 for 1 year at 20% per annum, compounded quarterly.

Solution: We have, R= 20% per annum = 20/4 % = 5% per quarter

T= 1 year= 4 quarters

P for the first quarter= Rs. 10000

Interest for the first quarter = $Rs.\frac{10000 \times 5 \times 1}{100} = Rs.500$

Amount at the end of first quarter= Rs. 10000 + Rs. 500 = Rs. 10500

P for the second quarter = Rs. 10500

Interest for the second quarter = $Rs.\frac{10500 \times 5 \times 1}{100} = Rs.525$

Amount at the end of second quarter= Rs. 10500 + Rs. 525 = Rs. 11025

P for the third quarter = Rs. 11025

Interest for the third quarter = $Rs.\frac{11025 \times 5 \times 1}{100} = Rs.551.25$

Amount at the end of third quarter = Rs. 11025 + Rs. 551.25 = Rs. 11576.25

P for the fourth quarter = Rs. 11576.25

Interest for the fourth quarter = $Rs.\frac{11576.25 \times 5 \times 1}{100} = Rs.578.8125$

Amount at the end of fourth quarter = Rs. 11576.25 + Rs. 578.8125= Rs. 12155.0625

∴ C.I. = Rs 12155.0625 – Rs. 10000 = Rs. 2155.0625 or Rs. 2155.06

**Compound Interest formula**

Let P be the principal and the rate of interest be R% per annum. If the interest is compounded annually, the amount A and the compound interest, C.I., at the end of n years is given by

$$A = P \times (1 + \frac{R}{100})^n$$

and, $C.I. = A - P = P \times [(1 + \frac{R}{100})^n - 1]$ respectively.

**Type 1: When the interest is compounded annually**

Q: Find the amount of Rs.8000 for 3 years, compounded annually at 10% per annum. Also find the C.I.

Here, P= Rs.8000, R= 10% per annum and n= 3 years.

Using the formula $A = P[1 + \frac{R}{100}]^n$, we get

Amount for 3 years $= Rs.[8000 \times (1 + \frac{10}{100})^3]$

$$= Rs.[8000 \times \frac{11}{10} \times \frac{11}{10} \times \frac{11}{10}]$$

$$= Rs.10648$$

Thus the amount after 3 years is Rs.10,648

And the C.I. = Rs. ( 10648 – 8000 ) = Rs. 2648.

**Type 2: When the interest is compounded annually but rates are different for different years.**

Let Principal = Rs. P, Time= 2 years, and let the rates of interest be p% per annum, during the first year and q% per annum during the second year.

Then the amount after 2 years $= Rs.[P \times (1 + \frac{p}{100}) \times (1 + \frac{q}{100})]$

This formula can be similarly extended for any number of years.

Q: Find the amount of R.s. 50000 after 2 years, compounded annually; the rate of interest being 8% p.a. during the first year and 9% p.a. during the second year. Also, find the compound interest.

Here, P = R.s. 50000, p= 8% p.a. and q= 9% p.a.

Using the formula $A = [P \times (1 + \frac{p}{100}) \times (1 + \frac{q}{100})]$, we have,

amount after 2 years $= Rs.[50000 \times (1 + \frac{8}{100}) \times (1 + \frac{9}{100})]$

$= Rs.[50000 \times \frac{27}{25} \times \frac{109}{100}] = Rs.58860.$

∴ amount after 2 years = Rs. 58860

And, the C.I. is Rs. [ 58860 – 50000 ] = Rs. 8860.

**Type 3: When interest is compounded annually but time is a fraction**

Suppose time is $\frac{3}{5}$ years.

Then, amount $= P \times [1 + \frac{R}{100}]^2 n \times [1 + \frac{3}{5} \times R]$

**Type 4: Interest Compounded Half-Yearly**

Let the Principal be Rs. P, The rate of interest be R% and time be n years.

Suppose the interest is compounded half-yearly. Then,

rate = (R/2) % per half year, time= 2n half-years and amount $= Rs.[1 + \frac{R}{2 \times 100}]^{2n}$

∴ Compound Interest = amount – principal

**Type 5: Interest Compounded Quarterly**

Let the Principal be Rs. P, The rate of interest be R% and time be n years.

Suppose the interest is compounded quarterly. Then,

rate= (R/4) % per half year, time= 4n quarters and amount $= Rs.[1 + \frac{R}{4 \times 100}]^{4n}$

∴ Compound Interest = amount – principal

# Annuities

An annuity is a sequence of equal payments made at equal intervals of time. E.g. of annuities are weekly wages, monthly home mortgage payments, payments to a recurring deposit, quarterly stock dividend etc.

The time period between successive payments is called payment period or payment interval. It may be weekly, monthly, quarterly, annually etc. or any fixed period of time. The time from the beginning of first interval to the end of the last interval is called the term or duration of the annuity. The size of each payment of an annuity is called the periodic payment of the annuity. The person who receives the payment is called annuitant. The sum of all payments made in a year is called annual rent.

The amount or future value of an annuity is the total amount due at the end of the term of the annuity. It is principal plus interest. Thus, the amount is the sum total of each instalment kept on compound interest till the end of the term.

Present value of an annuity is the current value of a sequence of equal periodic payments made over a certain period of time.

Annuities are of three types:

1. In annuities certain, the no. of payments is fixed, i.e. the payments begin and end on fixed dates. An example is that you borrow some loan from a bank and repay it in 10 equal annual installments, the 1st installment being paid 1 year after date of borrowing.

2. A contingent annuity is one where the term depends upon some event whose occurrence is not fixed. An example is periodic payments of life insurance premiums which stop when the person dies.

3. A perpetual annuity is an annuity whose term does not end, i.e. it extends till infinity. Thus there is no last payment; they go on forever. An example is freehold property, where you can earn rent in perpetuity.

Annuities are further classified into three categories by payment dates:

1. An ordinary annuity or immediate annuity is where payments are made at the end of each payment period, i.e. 1st payment is made at the end of the 1st payment interval, and so on. Examples are repayment of car loans, house mortgage etc.

2. An annuity due is where payments are made at the beginning of each period. Examples are life insurance premium payments, recurring deposit payments etc.

3. If the payments start after specified no. of periods, we get a deferred annuity. Typical examples are pension plans floated by various insurance companies. When an annuity is left unpaid for a no. of years, it is said to be unpaid or fore-borne for that amount of period; the total amount for these intervals, alongwith interest, is called amount of deferred annuity.

**Amount and Present Value of Ordinary Annuities**

When we speak of annuities certain, we usually speak of ordinary (immediate) annuity, where payment is at the end of each payment interval. We will use the following notations in this article:

A= amount of each installment

V= present value of annuity

M= (future) amount of annuity

r= rate of interest (on one rupee per payment interval)

n= no. of installments (in case of annuity certain)

To Find Present Value (V):

$$V = \frac{A}{r} \times [1 - (1+r)^{(-n)}]$$

To Find Amount or Future Value (M):

$$M = \frac{A}{r} \times [(1+r)^n - 1]$$

Here r is the interest per payment period and n is the no. of interest periods. If payments are not annual, values of r and n should be stated correctly.

Observe that: $M = A(1+r)^n$

**Illustrative Examples:**

Example 1: Find the present value and amount of an ordinary annuity of 8 quarterly payments of Rs 500 each, the rate of interest being 8% p.a. compounded quarterly.

Solution:

Here, A=Rs 500

n= 8

$$r = \frac{8}{100} \times \frac{1}{4} = 0.02$$

$$\therefore V = \frac{A}{r} \times [1 - (1+r)^{(-n)}] = \frac{500}{0.02} \times [1 - (1.02)^{(-8)}]$$

Now, let $x = (1.02)^{(-8)} \Rightarrow \log x = -8 \log 1.02 = -8(0.0086)$

$$\Rightarrow \log x = -0.0688$$

$$\Rightarrow x = 0.8535$$

$$\therefore V = \frac{500}{0.02} \times [1 - 0.8535] = Rs\ 3662.50$$

Now, $M = \frac{A}{r} \times [(1+r)^{(n)} - 1] = \frac{500}{0.02} \times [(1.02)^{8} - 1]$

Let $x = (1.02)^(8) \Rightarrow \log x = 8 \log 1.02 = 0.0688$

$$\Rightarrow x = 1.171$$

$$\therefore M = \frac{500}{0.02} \times [1.171 - 1] = Rs\ 4275$$

Thus, the present value of annuity is Rs 3662.50 and amount is Rs 4275.

Example 2: A man borrowed some money and returned it in 3 equal quarterly installments of Rs 4630.50 each. What sum did he borrow if the rate of interest was 20% p.a. compounded quarterly? Find also the interest charged.

Solution:

Here, we have to find present value (V) of an ordinary annuity certain.

A= Rs 4630.50

n= 3

$$r = \frac{20}{100} \times \frac{1}{4} = 0.05$$

$$\therefore V = \frac{A}{r} \times [1 - (1+r)^{(-n)}] = \frac{4630.50}{0.05} \times [1 - (1.05)^{(-3)}] = Rs\ 12610$$

Thus, the sum borrowed was Rs 12160

Now, total money repaid $= 3 \times 4630.50 = Rs\ 13891.50$

Therefore, interest paid $= Rs\ 13891.50 - Rs\ 12160 = Rs\ 1281.50$

Example 3: A man borrows Rs 37500 and agrees to repay in semi-annual installments of Rs 2250 each, the first due in 6 months. How many payments must he make if rate of interest is 6% compounded semi-annually?

Solution:

Here, we have to find the number of payments, n

V= Rs 37500

A= Rs 2250

$$r = \frac{6}{100} \times \frac{1}{2} = 0.03$$

We know,

$$V = \frac{A}{r} \times [1 - (1+r)^{(-n)}] \Rightarrow 37500 = \frac{2250}{0.03} \times [1 - (1.03)^{(-n)}]$$

$$\Rightarrow 1 - (1.03)^{(-n)} = \frac{37500 \times 0.03}{2250} = 0.5$$

$$\Rightarrow (1.03)^{(-n)} = 0.5$$

$$\Rightarrow -n \log 1.03 = log 0.5$$

$$\Rightarrow -n(0.0128) = -0.3010$$

$$\Rightarrow n = \frac{-0.3010}{-0.0128}$$

$$\therefore n = 23.51$$

Thus, the money may be repaid in 23 installments with 23rd installment slightly more than Rs 2250, or the money may be repaid in 24 installments, the 24th installment slightly less than Rs 2250.

Now present value of first 23 installments of Rs 2250 each $= \frac{2250}{0.03} \times [1 - (1.03)^{(-23)}] = Rs\ 36998.12$

$\therefore$ present value of 24th installment $= Rs\ (37500 - 36998.12) = Rs\ 501.88$

Hence, amount of 24th installment $= Rs\ 501.88 \times (1.03)^(24) = Rs\ 1020.22$

Thus, there will be 23 installments of Rs 2250 and 24th installment of Rs 1020.22.

Amount and Present Value of Annuity Due

In annuity due, payment is done at the beginning of each payment period. For example, paying monthly house rent in advance each month.

Here, Present value (V):

$$V = \frac{A}{r} \times (1+r) \times [1-(1+r)^{-n}]$$

Amount (M):

$$M = \frac{A}{r} \times (1+r) \times [(1+r)^{n}-1]$$

This is easily obtained from formulae of ordinary annuity by multiplying by factor (1+r). This is so because all installments are shifted from end of period to beginning of period, so they amount to (1+r) times more.

Illustrative examples:

Example 1: Find the amount and present value of an annuity due of Rs 500 per quarter for 8 years and 9 months at 6% compounded quarterly.

Solution:

Here, rate of interest, r =1.5% per interest period =0.015

Number of interest periods, $n = 4 \times 8 + 3 = 35$

Each installment, A=Rs 500

Present value of annuity due,

$$V = \frac{A}{r} \times (1+r) \times [1-(1+r)^{-n}]$$

$$= \frac{500}{0.015} \times 1.015 \times [1-(1.015)^{-35}]$$

$$= Rs\, 13740.86$$

Amount of annuity due,

$$= \frac{A}{r} \times (1+r) \times [(1+r)^{n}-1]$$

$$= \frac{500}{0.015} \times 1.015 \times [(1.015)^{35}-1]$$

$$= Rs\, 23137.98$$

Example 2: Mr. Gupta has been accumulating a fund at 8% effective, which will provide him with an annual income of Rs 30000 for 15 years, the first payment being paid on his 60thbirthday. If he wishes to reduce the number of payments to 10, find how much annual income will he receive?

Solution:

In first case, we have annuity due of 15 terms.

Its present value (as on Mr. Gupta's 60th birthday),

$$V = \frac{30000}{0.08} \times 1.08 \times [1 - (1.08)^{-15}]$$

Now if only 10 payments are to be received, we have annuity due of10 terms. If A is the amount of each annual installment,

$$V = \frac{A}{0.08} \times 1.08 \times [1 - (1.08)^{-10}]$$

Thus,

$$\frac{A}{0.08} \times 1.08 \times [1 - (1.08)^{-10}] = \frac{30000}{0.08} \times 1.08 \times [1 - (1.08)^{-15}]$$

$$A = 30000 \times \frac{[1 - (1.08)^{-15}]}{[1 - (1.08)^{-10}]}$$

$$A = Rs\, 38268.44$$

Hence, Mr. Gupta will receive approx. Rs 38268 per year for 10 years.

Amount and Present Value of Deferred Annuity

If the payments start after a specified number of periods, we get a deferred annuity.

Here, Present value (V):

$$V = \frac{A}{(1+r)^{m+n}} \times [1 + (1+r) + \ldots + (1+r)^{n-1}]$$

$$= \frac{A}{(1+r)^{m+n}} \times \frac{(1+r)^n - 1}{(1+r) - 1}$$

$$= \frac{A}{r(1+r)^m} \times [1 - (1+r)^{-n}]$$

Sometimes we use $V = \frac{A}{r} \times [\frac{1}{(1+r)^m} - \frac{1}{(1+r)^{m+n}}]$

Similarly, future amount,

$$M = \frac{A}{r} \times [(1+r)^n - 1]$$

Note that formula for M is same as that for ordinary annuity whereas formula for V is obtained by dividing formula for annuity by $(1+r)^m$.

Illustrative Examples:

Example 1: Find the present value of a sequence of annual payments of Rs 10000 each, the first being made at the end of 5th year and the last being made at the end of 12th year, if money is worth 6%.

Solution: Here, we have a deferred annuity of 8 terms(n), deferred for 4 terms.

Each installment, A=Rs 10000

Rate of interest, r=6%=0.06

m= 4, m + n=12

Using the formula, present value

$= Rs\, 49187.38$

Example 2: Veena is allotted an LIG flat for which she has to make an immediate payment of Rs 1 lac and 10 semi-annual payments of Rs 50000 each, the first being made at the end of 3 years. If money is worth 10% per annum compounded half-yearly, find the cash price of the flat.

Solution: Cash price=Down payment + Present value of annuity

Here, down payment is Rs 1 lac, while we have an annuity of 10 terms i.e. n, deferred for $2\frac{1}{2}$ years i.e. 5 terms.

Each installment, A=Rs 50000

Rate of interest, r=10% p.a. compounded half-yearly=0.05

m= 5, m + n= 15

∴ Present value of annuity,

$$V = \frac{A}{r} \times [\frac{1}{(1+r)^m} - \frac{1}{(1+r)^{m+n}}]$$

$$= \frac{50000}{0.05} \times [(1.05)^{-5} - (1.05)^{-15}]$$

$$= Rs\, 302509.07$$

Hence, cash price of the flat=Rs 100000+Rs 302509 =Rs 402509.

## <u>Sinking Fund</u>

A company may accumulate money over the years to discharge a future obligation (liability) like repayment of debentures, replacing a machine, for modernization/expansion of business etc.

Thus, in sinking fund method, the debtor or the company makes equal periodic deposits into this fund so that just after the last deposit, the fund amounts to the original debt/money required. If a sum A is deposited after every period and there are n such installments, and rate of interest is r (per rupee per interest period), then the amount of obligation which can be discharged is

$$M = \frac{A}{r} \times [(1+r)^n - 1]$$

Illustrative Example:

Example 1: A machine costing Rs 2 lacs has effective life of 7 years and its scrap value is Rs 30000. What amount should the company put into a sinking fund earning 5% per annum so that it can replace the machine after its useful life? Assume that a neqw machine will cost Rs 3 lacs after 7 years.

Solution:

Cost of new machine=Rs 3 lacs

Scrap value of old machine=Rs 30000

Hence, money required for new machine after 7 years= Rs 300000-Rs 30000= Rs 270000

If A is the annual deposit into sinking fund, then we have

Amount of annuity, M=Rs270000

Number of periods=7

Rate of interest per period=0.05.

$$\therefore M = \frac{A}{r} \times [(1+r)^n - 1]$$

$$\Rightarrow 270000 = \frac{A}{0.05} \times [(1.05)^7 - 1]$$

$$\Rightarrow A = \frac{270000 \times 0.05}{(1.05)^7 - 1}$$

$$\therefore A = Rs\, 33161.35$$

Thus, the company has to deposit Rs 33161.35 at the end of each year for 7 years.

## Exercise

1. A sum of Rs 2522 is borrowed from a money lender at 5% p.a. compounded annually. If this amount is to be paid back in 3 equal installments, find the annual installment.
2. A dealer advertises that a tape recorder is sold at Rs 450 cash down followed by two yearly installments of Rs 680 and Rs 590 at the end of the 1st year and 2nd year respectively. If the interest charged is 18% p.a. compounded annually, find the cash price of the tape recorder.
3. A man borrowed some money and paid back in 3 equal installments of Rs 2160 each. What sum did he borrow if the rate of interest charged was 20% p.a. compounded annually? Find also the total interest charged.
4. A company borrows Rs 200000 on the condition to repay it with C.I. at 5% p.a. by annual installments of Rs 20000 each. In how many years will the debt be paid off?
5. Mr. X purchased an annuity of Rs 2500 per year for 15 years from an insurance company which reckons the interest at 3% compounded annually. If the first payment is due in one year, what did the annuity cost Mr. X?
6. Calculate the amount of ordinary annuity of Rs 7000 at the rate of 10% p.a. compounded annually for 10 years.
7. Find the present value of an annuity of Rs 1200 payable at the end of each 6 months for 3 years when the interest is earned at 8% per year compounded semi-annually.
8. Urvashi is making monthly deposits into an annuity that will be worth Rs 250000 in 30 years. The annuity earns an annual rate of 7.2% compounded monthly. What are her monthly payments?

9. The price of a tape recorder is Rs 1561. A person purchased it by paying a cash of Rs 300 and the balance with due interest, in 3 half-yearly equal installments. If the dealer charges interest at the rate of 10% p.a. compounded half yearly, find the value of each installment.

10. What amount should be set aside at the end of each year to amount to Rs 148970 at the end of 8 years at 5% p.a. compounded annually?

11. What equal payments made at the beginning of the year for 3 years will pay for a house priced at Rs 400000, if money is worth 15% per annum compounded monthly?

12. A person invests Rs 1000 every year with a company which pays interest at 10% per annum. He allows his deposits to accumulate with the company at compound interest. Find the amount standing to his credit one year after he has made his yearly installment for the tenth time.

13. A person buys a house for which he agrees to pay Rs 5000 at the beginning of each month for 5 years, the first installment being paid immediately. If the money is worth 6% per annum compounded monthly, what is the cash price of the house? Round off the answer to nearest thousand rupees.

14. If monthly house rent is Rs 600 payable in advance, i.e. at the beginning of each month, what is equivalent yearly rental paid in advance? Interest is reckoned at 6% per annum compounded monthly.

15. How much must be deposited on 1$^{st}$ April 2000 in a fund paying 4% compounded semi-annually in order to be able to make semi-annual withdrawals of Rs 500 each beginning 1$^{st}$ April 2015 and ending 1$^{st}$ October 2030?

16. Sheela purchased a washing machine paying Rs 5000 down and promising to pay Rs 200 every month for 3 years, the first being made at the end of first year. Find the cash price of the washing machine, assuming that money is worth 9% per annum compounded monthly.

17. Suman buys a machine for Rs 33000 and agrees to make 16 semi-annual payments, the first payment being made at the end of 4 years. Find the half-yearly payments, if the money is worth 7% per annum compounded semi-annually.

18. A machine costs a company Rs 525000 and its effective life is estimated to be 20 years. A sinking fund is created for replacing the machine at the end of its lifetime when its scrap realises a sum of Rs 25000 only. Calculate what amount should be provided every year out of profits, for the sinking fund if it accumulates an interest of 5% per annum compounded annually.

19. A person sets up a sinking fund in order to have Rs 100000 after 10 years for his children's college education. How much amount should be set aside after every 6 months into an account paying 5% per annum compounded half-yearly?

20. A company sets aside a sum of Rs 2000 at the end of each year for 15 years to pay off a debenture issue of Rs 40000. If the fund accumulates at 12% per annum, compounded annually, find the surplus amount after redemption of debenture issue.