CHAPTER – 4

SIMPLE INTEREST AND COMPOUND INTEREST

INTEREST

Interest is money paid to the lender by the borrower for using his money for a specified period of time. Various terms and their general representation are as follows:

(a) INTEREST
Money paid by borrower for using the lender's money. Denoted by I.

(b) PRINCIPAL
The original sum borrowed. Denoted by P.

(c) TIME
Time for which money is borrowed. Denoted by n. (n is expressed in number of periods, which is normally one year)

(d) RATE OF INTEREST
Rate at which interest is calculated on the original sum. Denoted by r and is expressed as a percentage or decimal fraction.

(e) AMOUNT
Sum of Principal and Interest. Denoted by A.

SIMPLE INTEREST

When interest is calculated every year (or every time period) on the original principal, i.e., the sum at the beginning of first year, such interest is called Simple Interest.

Here, year after year, even though the interest gets accumulated and is due to the lender, this accumulated interest is not taken into account for the purpose of calculating interest for latter years.

Simple Interest = $\frac{Pnr}{100}$

where P, n, r are as explained above.

Total Amount A = P + $\frac{Pnr}{100}$

= $P\left(1+\frac{nr}{100}\right)$

COMPOUND INTEREST

Under Compound Interest, the interest is added to the principal at the end of each period to arrive at the new principal for the next period.

In other words, the amount at the end of first year (or period) will become the principal for the second year (or period); the amount at the end of second year (or period) becomes the principal for the third year (or period) and so on.

If P denotes the principal at the beginning of Period 1, then, principal at the beginning of Period 2

= $P\left(1+\frac{r}{100}\right)$

= PR = Amount at the end of Period 1, where

R = $\left\{1+\left(\frac{r}{100}\right)\right\}$

P at the beginning of Period 3

= $P\left(1+\frac{r}{100}\right)^2$

= PR^2 = Amount at the end of Period 2

P at the beginning of Period (n + 1)

= $P\left(1+\frac{r}{100}\right)^n$ = PR^n

= Amount at the end of Period n

Hence the amount after n years (periods)

= PR^n = A

Interest = I = A – P = P [R^n – 1]

The following table gives an example of how simple interest and compound interest operate, i.e., how the Principal is for various years under simple interest and compound interest. A principal at the beginning of 1st year, of ₹100 and a rate of 10% p.a. are considered. The details are worked out for three years and shown below.

(All figures pertaining to Principal, interest and amount are in Rupees)

	Under **Simple Interest**				Under **Compound Interest**			
Year	Principal at the beginn. of the year	Interest for the year	Interest till the end of the year	Amount at the end of the year	Principal at the beginn. of the year	Interest for the year	Interest till the end of the year	Amount at the end of the year
1	100	10	10	110	100	10	10	110
2	100	10	20	120	110	11	21	121
3	100	10	30	130	121	12.1	33.1	133.1

As can be seen from the table,

In case of Simple Interest,
- The principal remains the same every year
- The interest for any year is the same as that for any other year.

In case of Compound Interest,
- The amount at the end of a year is the Principal for the next year
- The interest for different years is not the same

The compound interest for the first year (where compounding is done every year) is the same as the simple interest for one year.

COMPOUNDING MORE THAN ONCE A YEAR

We just looked at calculating the amount and interest when the compounding is done once a year. But, compounding can also be done more frequently than once a year. For example, the interest can be added to the principal every six months or every four months and so on.

If the interest is added to the principal every six months, we say that compounding is done twice a year. If the interest is added to the principal every four months, we say that compounding is done thrice a year. If the interest is added to the principal every three months, we say that compounding is done four times a year.

The formula that we discussed above for calculating the amount will essentially be the same,

i.e., Amount = $P\left(1+\frac{r}{100}\right)^{n}$

where r = rate % per annum and n = number of years, but the rate will not be for ONE YEAR but for the time period over which compounding is done and the power to which the term inside the bracket is raised (n in the above case) will not be the number of years but the number of years multiplied by the number of times compounding is done per year (this product is referred to as the total number of time periods).

For example, if a sum of ₹10000 is lent at the rate of 10% per annum and the compounding is done for every four months (thrice a year), then the amount will be equal to

$$10000\left(1+\frac{10}{3}\times\frac{1}{100}\right)^{2\times3}$$

Here, the dividing factor of 3 in the rate and the multiplying factor of 3 in the power (multiplying the number of years) - both shown by arrow marks - are nothing but the NUMBER OF TIMES compounding is done in a year.

When compounding is done more than once a year, the rate of interest given in the problem is called NOMINAL RATE OF INTEREST.

We can also calculate a rate of interest which will yield simple interest in one year equal to the interest obtained under the compound interest at the given nominal rate of interest. The rate of interest so calculated is called EFFECTIVE RATE OF INTEREST.

> If the number of times compounding is done in a year is increased to infinity, we say that the compounding is done EVERY MOMENT and then the amount is given by $P.e^{nr/100}$, where r is the rate% p.a. and n is the number of years

The following points should also be noted which are helpful in solving problems.

> The difference between the Compound Interest and Simple Interest on a certain sum for two years is equal to the interest calculated for one year on one year's Simple Interest.

In mathematical terms, the difference between Compound Interest and Simple Interest for two years will be equal to $P(r/100)^2$, which can be written as P (r/100) (r/100). In this Pr/100 is the simple interest for one year and when this is multiplied by r/100 again, it gives interest for one year on Pr/100 i.e., interest for one year on one year's simple interest.

> The difference between the Compound Interest for k years and the Compound Interest for (k + 1) years is the interest for one year on the amount at the end of k^{th} year.
> This can also be expressed in terms of the amount as follows:
> The difference between the amount for k years and the amount for (k + 1) years under compound interest is the interest for one year on the amount at the end of the k^{th} year.

> The difference between the Compound Interest for the k^{th} year and the Compound Interest for the $(k + 1)^{th}$ year is equal to the interest for one year on the compound interest for the k^{th} year.

> If compounding is done k times a year (i.e., once every 12/k months), at the rate of r% p.a. then in n years, the principal of P will amount to
> $= P\left(1+\frac{r}{k\cdot100}\right)^{kn}$

PRESENT VALUE

Consider a given sum P and a rate of interest r.

We have seen that interest is cost of using the money over a period of time. That means a sum at the beginning of a period is always higher than the same amount after a period greater than or equal to 1.

Let the sum P that is being considered at a rate of interest r% p.a., becomes Y at the end of Year 1 and Z at the end of Year 2 (i.e., Y and Z are the amounts at the end of first and second years respectively on a principal of P).

Then we can say that what is P today is equal to Y at the end of one year and equal to Z at the end of the second year. In other words, if an amount of Y were to come at the end of one year from now, its value today is equal to P. Similarly, if an amount of Z were to come at the end of two years from now, its value today is equal to P.

So, P is the PRESENT VALUE of Y coming at the end of one year and P is the PRESENT VALUE of Z coming at the end of two years.

Similarly, if we consider n years (or n periods in general), and X is the amount that P will become in n periods, then we say that P is the PRESENT VALUE of X coming at the end of n periods.

If we consider a series of payments Y_1 at the end of first year, Y_2 at the end of second year and so on, the present value of the series of payments will then be equal to the sum of the present values of each of the payments calculated separately. If Z_1 is the present value of Y_1, Z_2 is the present value of Y_2 and so on, then the present value of the series of payments Y_1, Y_2, ... is equal to $Z_1 + Z_2 + ...$

Present Value can be looked at both under Simple Interest and Compound Interest.

If an amount of Y whose present value is P_1 comes at the end of Year 1, and an amount of Z whose present value is P_2 comes at the end of Year 2, then the present value of both the amounts together will be equal to $(P_1 + P_2)$, i.e., the present value of the stream of payments that come at different points of time is equal to the sum of the present values of the individual amounts coming in at various points of time.

Present Value Under Simple Interest

The principal P is amounting to X in n periods. From this we know that

$$X = P\left(1+\frac{nr}{100}\right) \Rightarrow P = \frac{X}{\left(1+\frac{nr}{100}\right)}$$

Hence, in general, the present value P of an amount X coming (or due) after n periods is given by

$$P = \frac{X}{\left(1+\frac{nr}{100}\right)}$$

where r is the rate percent per time period.

Present Value Under Compound Interest

The principal P is amounting to X in n periods. From this we know that

$$X = P\left(1+\frac{r}{100}\right)^n \Rightarrow P = \frac{X}{\left(1+\frac{r}{100}\right)^n}$$

Hence, in general, the present value P of an amount X coming (or due) after n periods is given by

$$P = \frac{X}{\left(1+\frac{r}{100}\right)^n}$$

where r is the rate percent per time period.

REPAYMENT IN EQUAL INSTALMENTS - COMPOUND INTEREST

If a sum P borrowed, is repaid in n equal instalments compound interest being calculated at r% per period of instalment, we can find out the value of each instalment. Let us consider the case of n equal ANNUAL instalments (Even if the instalments are not annual, but monthly, the approach will remain the same except that the rate of interest taken should then be the rate per month and not rate per annum).

Let each instalment (i.e., the amount paid at the end of each year) be X.
Instalment X paid after year 1 gives a present value of $\frac{X}{(1+{}^{r}/_{100})}$.

Instalment X, paid at the end of year 2 gives a present value of $\frac{X}{(1+{}^{r}/_{100})^2}$

Similarly, instalment X paid for nth period (at the end of year n) gives a present value of $\frac{X}{(1+{}^{r}/_{100})^n}$.

The sum of all these present values would be equal to the loan amount P (because only if the amount borrowed is equal to the amount repaid can we say that the loan is repaid).

$$\frac{X}{(1+{}^{r}/_{100})} + \frac{X}{(1+{}^{r}/_{100})^2} + \ldots\ldots + \frac{X}{(1+{}^{r}/_{100})^n} = P$$

Let $k = \frac{1}{(1+{}^{r}/_{100})} = \frac{100}{100+r}$

The above equation can then be rewritten as
$X\{k + k^2 + ... + k^n\} = P$

The terms within the brackets form a G.P with first term k and common ratio k.

The sum of this G.P. $= \frac{k(k^n - 1)}{(k - 1)}$;

Thus $\frac{X \bullet k(k^n - 1)}{(k - 1)} = P \Rightarrow X = \frac{P(k-1)}{k(k^n - 1)}$

$$= \frac{\left[P\left\{{}^{100}/_{(100+r)}\right\} - 1\right]}{\left[\left\{{}^{100}/_{(100+r)}\right\}\right]\left[\left\{{}^{100}/_{(100+r)}\right\}^n - 1\right]}$$

$$= \frac{P \bullet r}{100\left[1 - \left\{{}^{100}/_{(100+r)}\right\}^n\right]}$$

$$\text{Each Instalment} = \frac{P \bullet r}{100\left[1 - \left\{{}^{100}/_{(100+r)}\right\}^n\right]}$$

Examples

4.01. Find the simple interest on a principal of ₹2400 at 5% per annum for a period of 4 years.

Sol: Simple interest on a sum of ₹P at r% p.a. for n years is given by $\frac{Pnr}{100}$

Here P = ₹2400; n = 4 years; r = 5%

$\therefore$ S.I. $= \frac{2400 \times 4 \times 5}{100}$ = ₹480

4.02. If ₹4000 becomes ₹4800 in 2 years, at what will ₹6000 become at the end of 6 years at the same rate of simple interest, under at?

Sol: Amount = Principal + Interest
Principal (P) = ₹4000 and amount (A) = ₹4800.
$\therefore$ interest (I) = 800

$\Rightarrow 800 = \frac{4000 \times 2 \times r}{100} \Rightarrow r = 10\%.$

For P = ₹6000, n = 6, and r = 10%,

$I = \frac{6000 \times 6 \times 10}{100} = ₹\ 3600$

Therefore, ₹6000 becomes ₹6000 + ₹3600 = ₹9600 at the end of 6 years.

4.03. What principal would amount to ₹9600 in 6 years at the rate of 10% p.a. simple interest?

Sol: Amount under simple interest = $P\left(1+\frac{nr}{100}\right)$

$9600 = P\left(1+\frac{(6)(10)}{100}\right)$

$9600 = P(1.6)$

$P = \frac{9600}{1.6} = Rs.\,6000$

4.04. If a certain sum doubles in five years at simple interest, in how many years would it become 6 times itself at the same rate of simple interest?

Sol: If P is the sum, the amount at the end of five years will be 2P (as the sum doubles).
Since Amount = Principal + Interest, the interest for five years is P.
If the sum has to become 6 times itself the amount should be 6P, out of which P is the principal and the balance 5P is the interest. Since the interest is P for five years, we get the interest of 5P in 25 years (as interest is same every year at simple interest).
$\therefore$ The sum becomes 6 times itself in 25 years.

4.05. What is the value that a sum of ₹12000 would amount to at 10% per annum compound interest?

Sol: If P is the principal, r is the rate of interest and n is number of years, then the amount under compound interest is given by

$P\left(1+\frac{r}{100}\right)^n = 12000\left(1+\frac{10}{100}\right)^3$

$= 12000\left(1+\frac{1}{10}\right)^3 = 12000\left(\frac{11}{10}\right)^3$

$= 12\,(1331) = ₹15972$

4.06. What sum would amount to ₹29282 in three years at the rate of 10% per annum compound interest?

Sol: Amount = $P\left(1+\frac{r}{100}\right)^n$

$29282 = P\left(1+\frac{10}{100}\right)^3 \Rightarrow 29282 = P(1.1)^3$

$\Rightarrow P = \frac{29282}{(1.1)^3} = ₹22000$

4.07. A certain sum triples in 4 years at a certain rate of compound interest. In how many years would the sum become 9 times itself at the same rate of compound interest?

Sol: Let P be the sum. Then amount at the end of 4 years is 3P. Therefore, we get,

$P\left(1+\frac{r}{100}\right)^4 = 3P$

If we say $\left(1+\frac{r}{100}\right) = R$, then we have $R^4 = 3$.

Now, since the sum has to become 9 times, the amount should be 9P i.e.

$P\left(1+\frac{r}{100}\right)^n = 9P \Rightarrow R^n = 3^2.$

Since $R^4 = 3$, the 3 on the right hand side can be replaced by R^4 giving us $R^n = (R^4)^2 = R^8$
$\Rightarrow n = 8.$
Thus the sum will become 9 times itself in 6 years.

4.08. If ₹8000 has been lent at 10% p.a. the interest being compounded annually, what is the interest for the fifth year?

Sol: The amount at the end of the 4th year will be the principal for the fifth year.
Amount at the end of the 4th year

$= 8000\left(1+\frac{10}{100}\right)^4 = 8000 \times 1.4641$

= ₹11712.8
Hence, interest for the 5th year
= 11712.8(0.1) = ₹1171.28.

4.09. How much will ₹20000 approximately amount to in 2 years at 15% p.a. the interest being compounded every half year?

Sol: If interest is compounded half yearly, then the amount is given by $P\left(1+\frac{r}{100}K\right)^{kn}$, where P is principal, r is the rate of interest, k is the number of compounding periods and n is the number of years. Since the interest is compounded every half year, the number of time periods is 4.
Amount at the end of 2 years

$= P\left[1+\frac{r}{2\times100}\right]^4 = 20{,}000\left[1+\frac{15}{200}\right]^4$

$\simeq$ ₹26709 (ignoring the decimal part)

4.10. If the rate of interest is 20% p.a, where interest is compounded every 4 months, what is the effective rate of interest per annum?

Sol: Let the principal be ₹100. At 20% p.a. rate of interest compounded every 4 months, the amount at the end of one year will be

$= 100\left[1+\frac{20}{3\times100}\right]^3 = 100\,(1.066)^3 \simeq$ ₹121.36

An interest rate of 21.36% p.a. will also give an amount of ₹121.36 on a principal of ₹100 when compounding is done annually. Hence this 21.36% p.a. is called the effective rate of interest.

4.11. A certain sum amounts to ₹7200 after 2 years and to ₹8640 after 3 years, interest being compounded annually. Find the principal and the rate of interest

Sol: We know that the difference between the amounts at the end of the n^{th} year and $(n + 1)^{th}$ year is the interest for $(n + 1)^{th}$ year.
$\therefore$ The difference between ₹8640 and ₹7200 i.e. ₹1440 is the interest for 3rd year.
This is equal to the interest for one year on ₹7200. Therefore $7200 \times r/100$
$= 1440 \Rightarrow r = 20\%$ p.a.

If P is the principal, $P\left(1+\frac{20}{100}\right)^2 = 7200$

$\Rightarrow P = \frac{7200}{1.44} = 5000$

4.12. The compound interest on a certain sum at a certain rate of interest for the second year is ₹2400 and for the third year is ₹2880. Find the principal and the rate of interest.

Sol: Note that what is given is the compound interest for the second and third years but NOT for two and three years. We know that the difference between the compound interest for year and that for the Rth year is equal to the interest for one year on the compound interest for the Rth year. Hence the difference between the two figures ₹2400 and ₹2880 which is ₹480 will be equal to the interest for one year on ₹2400.
Therefore if the rate of interest is r, then

$2400 \times \frac{r}{100} = 480 \Rightarrow r = 20\%$ p.a.

The compound interest for the 2nd year will be equal to the difference between the amount at the end of the 2nd year and the amount at the end of the 1st year i.e.

$\Rightarrow P(1 + R)^2 - P(1 + R) = 2400$ where $R = \frac{r}{100}$

$\Rightarrow P(1 + R)(1 + R - 1) = 2400$

$\Rightarrow P(1{\cdot}2)(0{\cdot}2) = 2400 \Rightarrow P = \frac{2400}{0{\cdot}24} = ₹10000$

Therefore, principal and rate of interest are ₹10000 and 20% p.a. respectively.

4.13. The difference between the compound interest and the simple interest for two years on a certain sum at a certain rate of interest is ₹64. If the compound interest for two years is ₹704., find the principal

Sol: Simple interest for two years = compound interest for two years – Difference between C.I. and S.I. for two years = 704 – 64 = ₹640. We know that the difference between the compound interest and the simple interest for 2 years is equal to the interest for one year on first year simple interest. Since, simple interest for two years is ₹640, for one year it is ₹320. Hence interest for one year on first year's simple interest

$= \frac{r(320)}{100} = 64 \Rightarrow r = 20\%$ p.a.

Also $\frac{P \times 2 \times 20}{100} = 640 \Rightarrow P = ₹1600$

4.14. Sanjay borrowed ₹14000 at 10% p.a. compound interest, compound annually He repaid ₹8000 at the end of the 1st year. What amount should he pay at the end of the 2nd year to completely discharge the loan,?

Sol: At 10% p.a., amount at the end of the 1st year is ₹15400, out of which ₹8000 is repaid. The balance ₹7400 is the principal for the second year, which amounts to ₹8140 at the end of the 2nd year. Hence to discharge the loan completely at the end of the 2nd year, Sanjay has to repay ₹8140.

4.15. Hussain borrowed ₹15000 at the rate of 10% p.a. rate of compound interest, compound annually. He repaid a certain amount at the end of the first year. Then he paid ₹12100 at the end of the 2nd year to completely discharge the loan. What amount did he repay at the end of the 1st year?

Sol: ₹15000 borrowed at 10% p.a. will become ₹16500 at the end of the 1st year. Let k be the amount repaid at the end of the first year. Then the balance is ₹16500 – k will become the principal for the second year.
$\Rightarrow (16500 - k)\ 1.1 = 12100$
$\Rightarrow 16500 - k = 11000 \Rightarrow k = ₹5500$

4.16. Pavan borrowed ₹21000 at the rate of 10% p.a. compound interest. If this amount has to be repaid in two equal annual instalments, find the value of each instalment.

Sol: Let the value of each instalment be x. ₹21000 at 10% p.a. will become ₹23100 at the end of the 1st year. At this point an amount of x is repaid. Therefore balance at this point is ₹(23,100 – x). This sum at 10% p.a. will become 1·1 (23,100 –x) at the end of the 2nd year. Another amount of x is to be paid to discharge the loan completely.
$\therefore 1{\cdot}1\ (23{,}100 - x) = x \Rightarrow 1{\cdot}1 \times 23{,}100 = 2{\cdot}1x$
$x = \frac{(1.1).(23100)}{2.1} = ₹12100.$

4.17. Find the present value of the payments of ₹8400 to be received at the end of the first year and ₹8640 to be received at the end of the second year, if compound interest at 20% p.a. is reckoned.

Sol: If a sum of ₹z is going to be received at the end of the n years, then the present value of that amount is $\frac{z}{\left(1+\frac{r}{100}\right)^n}$

Hence, present value of the payments to be received is $\frac{8400}{1.2} + \frac{8640}{(1.2)^2} = \frac{8400}{1.2} + \frac{8640}{1.44}$
$= 7000 + 6000 = ₹13000$

Concept Review Questions

Directions for questions 1 to 15: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

1. Find the simple interest earned (in ₹) on ₹20000 for 2 years at 10% p.a.

2. If ₹2000 amounts to ₹2500 in 2 years at simple interest, what is the rate of interest per annum?
(A) 8% (B) 37.5% (C) 25% (D) 12.5%

3. The interest for the 3rd year on a certain sum that at simple interest is ₹3000. Find the sum of the interests accrued on it (in ₹) for the 6th, 7th and 8th years.

4. A sum of money, when rent, doubles in 8 years at simple interest. In how many years will the sum become 4 times the original sum?

5. Find the present value (in ₹) of ₹3000 due after 5 years at 10% p.a. simple interest.
(A) 1500 (B) 1800 (C) 2000 (D) 2500

6. Find the compound interest earned (in ₹) on ₹20000 for 2 years at 10% p.a, interest being compounded annually.

7. If ₹2000 amounts to ₹2880 in 2 years at compound interest, what is the rate of interest per annum if the interest is compounded annually?
(A) 10% (B) 20% (C) 15% (D) 25%

8. Find the interest earned (in ₹) in the first year on ₹400 at 20% p.a, interest being compounded half-yearly.

9. The difference between the interests earned on a principal under a certain rate of compound interest in the p^{th} year and the $(p + 1)^{th}$ year is more than that in the q^{th} year and the $(q + 1)^{th}$ year if _____.
(A) $p > q$ (B) $p < q$
(C) $p = q$ (D) can't say

10. Find the effective rate of interest (per annum) if the normal rate of interest is 10% p.a. and the interest is compounded every six months.

11. The interest on a certain sum lent at compound interest, the interest being compounded annually, in the 2nd year is ₹1200. The interest on it in the 3rd year is ₹1440. Find the rate of interest per annum.
(A) 10% (B) 15% (C) 20% (D) 25%

12. A certain sum when lent at compound interest, the interest being compounded annually, amounts to ₹1331 in 3 years and ₹1464.10 in 4 years. Find the rate of interest per annum.
(A) 10% (B) 15% (C) 20% (D) 5%

13. A sum doubles in 8 years at compound interest. In how many years will the sum become 4 times the original sum if the interest is compounded annually?

14. Which of the following rates of interest yield the maximum interest in 2 years on a certain sum?
(A) Interest compounded monthly at 1% p.m.
(B) Interest compounded quarterly at 3% per quarter.
(C) Interest compounded half-yearly at 6% per half year.
(D) Interest compounded annually at 12% p.a.

15. A sum was lent at 20% p.a. compound interest, the interest being compounded annually. ₹1200 was paid back after 1 year. After another year, ₹1440 was repaid to clear the loan. Find the sum lent.
(A) ₹8000 (B) ₹6000 (C) ₹2000 (D) ₹4000

Exercise – 4(a)

Directions for questions 1 to 25: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

1. A sum of money invested at simple interest amounts to ₹2480 at the end of four years and ₹4080 at the end of eight years. Find the principal.
(A) ₹2040 (B) ₹1480 (C) ₹1240 (D) ₹880

2. Raju took a loan at 8% per annum simple interest for a period of 5 years. At the end of five years he paid ₹10640 to clear his loan. How much loan did he take?
(A) ₹8500 (B) ₹8000 (C) ₹7700 (D) ₹7600

3. Under simple interest, due to the fall in the interest rate by 0.5 percentage point my yearly income from savings came down by ₹884. Find the savings (in ₹).

4. A person invested ₹p at a certain rate of simple interest. After 1, 2 and 3 years it amounted to ₹3/2p, ₹2p, ₹5/2p respectively. What will it amount to at the end of 20 years?
(A) ₹6p (B) ₹10p (C) ₹11p (D) ₹7p

5. A man borrowed ₹50000 at simple interest with the rate of interest not remaining constant for the entire period. He repaid the entire amount after 8 years. The rate of interest for the first two years is 8% p.a., for the next three years it is 10% p.a., for the next two years it is 5% p.a. and 7% for the last year. How much amount did he repay to clear his loan at the end of the period (in ₹)?

6. What annual installment will discharge a debt of ₹1815 due in 3 years at 10% simple interest (in ₹)?

7. A sum of money was invested at a certain rate of interest, compounded annually. It amounted to ₹1375 in 5 years and ₹1980 in 7 years. Find the annual rate of interest.

8. A sum of money under compound interest doubles in 4 years. In how many years will it become 16 times itself?

9. A man borrowed ₹80000 at the rate of 10% p.a. compound interest, interest being compounded annually. How much amount should he have repaid at the end of the first year, if by repaying ₹55000 at the end of the second year he can clear the loan?
(A) ₹38000 (B) ₹40000
(C) ₹45000 (D) ₹50000

10. The compound interest for the 4^{th} year on a certain sum is ₹2000 and the compound interest for the 7^{th} year on the same sum is ₹2662. If interest is compounded annually, what is the annual rate of interest?
(A) 9% (B) 10% (C) 15% (D) 20%

11. The compound interests earned in the third and the fourth years on a certain sum of money are ₹576 and ₹691.2 respectively. Find the sum (in ₹).

12. A certain loan amount, under compound interest, compounded annually earns an interest of ₹1980 in the second year and ₹2178 in the third year. How much interest did it earn in the first year?

13. The difference in compound interests earned on a certain sum, for which the interest is compounded annually, in the first and the second year is ₹140. If the rate of interest becomes thrice the original rate, then the difference in the amounts (in ₹) would be .

14. A person deposited a sum of ₹x at a rate of r% p.a. simple interest. In one year the sum doubles. At the end of $1^1/_2$ years the sum amounts to _____.
(A) ₹3x (B) ₹$\frac{5}{2}$x (C) ₹2x (D) ₹$\frac{3}{2}$x

15. A sum was lent for an year, another sum was lent for 2 years and a third sum was lent for 3 years. Each sum was lent at 8% p.a compound interest. Each sum amounted to the same value. The ratio of the first, second and third sums is _____.
(A) 729 : 675 : 625
(B) 25 : 27 : 29
(C) 29 : 27 : 25
(D) 625 : 675 : 729

16. If the interest on a sum is compounded quarterly, which of the following is necessarily true?
(A) The effective rate of interest is the same for every year.
(B) The ratio of the interests for the $(m + 1)^{th}$ year to m^{th} year will be same as the ratio of interest for the $(n + 1)^{th}$ year to n^{th} year.
(C) Both (A) and (B)
(D) Neither (A) nor (B)

17. The difference between the interest earned under compound interest, interest being compounded annually and simple interest for two years on the same sum and at the same rate of interest is ₹25.60. Find the sum (in ₹) if the rate of interest is 8% p.a.

18. If the difference between compound interest at 8% p.a. and simple interest at 6½% p.a. on a certain sum of money for 2 years is ₹1820, then find the sum (in ₹).

19. A sum of money is lent at a certain rate of interest at compound interest. If, instead the same amount was lent at simple interest the interest for the first two years reduces by ₹160 and that for the first three years reduces by ₹488. Find the sum.
(A) ₹22000 (B) ₹46000
(C) ₹52000 (D) ₹64000

20. A certain sum of money increased by 72.8% at a certain rate in three years with interest being compounded annually. If the same sum is lent at simple interest at the same rate of interest, in how many years would it become four times itself?
(A) 5 years (B) 8 years
(C) 11 years (D) 15 years

21. ₹2000 was lent at compound interest, interest being compounded annually for 3 years. The respective rates of interest for the first, the second and the third years are 10% pa, 20% pa and 30% pa. Had the sum of ₹2000 been lent at 20% pa simple interest for 3 years, how much more/less interest would have been realized?
(A) ₹116 more (B) ₹116 less
(C) ₹232 less (D) ₹232 more

22. Ramu borrowed a certain sum at 26% p.a. compound interest for one year. Somu borrowed a certain sum at a certain rate of simple interest for five years. Each of the two repaid the same amount which is ₹50400. The total of the sums borrowed by the two is ₹71500. Find the rate of interest (per annum) at which Somu borrowed.

23. Find the present worth of ₹1749.6 due in 2 years at 8% per annum compound interest.
(A) ₹1200 (B) ₹1400 (C) ₹1500 (D) ₹1650

24. Ravi bought a car worth ₹755000. He paid ₹105000 as down payment and paid the remaining amount including interest, in 3 equal installments. Interest was charged at 14% p.a. compounded annually. If he paid the first, the second and the third installments at the ends of the first, second and third years respectively, the value of each installment he paid (in ₹) is. (Assume $\frac{1}{(1.14)^3} = 0.675$).

25. A sum was borrowed at 20% p.a. compound interest. It was repaid in three annual installments at the end of one year, two years and three years respectively. The first, second and third installments were ₹2400, ₹2304 and ₹5184 respectively. Find the sum borrowed (in ₹).

Exercise – 4(b)

Directions for questions 1 to 35: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

1. A person invested a sum of ₹750 in a bank at a certain rate of simple interest. After 5 years he received ₹1200. Find the rate of interest offered by the bank.
(A) 10% p.a. (B) 11% p.a.
(C) 20% p.a. (D) 12% p.a.

2. A person borrowed ₹1000 at the rate of 10% per annum simple interest. What is the amount he has to pay after 5 years to clear the debt?
(A) ₹1564 (B) ₹1532 (C) ₹1500 (D) ₹1550

3. Ram invested two equal sums in a bank. He invested one at 14% p.a. and the other at 16% p.a. He received a total interest of ₹2250 at the end of a year. Find each sum (in ₹)
(A) 7200 (B) 7500
(C) 9000 (D) 8500

4. A sum of money when invested at a certain rate of interest, compounded annually amounts to ₹1140 in 2 years and to ₹1710 in 3 years. Find the rate of interest per annum.

5. Kumar borrowed a certain sum at 12% p.a. simple interest for 8 years. At the end of 8 years he paid ₹14112 to clear the debt. What is the sum he borrowed (in ₹)?

6. P borrowed a sum of money from Q at simple interest. The rate of interest is 10% p.a. for the first 2 years and 12% p.a. for the next 3 years and 15% p.a. thereafter. If P paid ₹5332 as interest after 7 years, then find the sum (in ₹).

7. A sum of money becomes eight times itself in 12 years at simple interest. In how many years does it become 15 times itself?
(A) 16 (B) 44 (C) 32 (D) 24

8. A sum of money amounts to ₹1694 in 5 years and ₹2016 in 7 years at a certain rate of compound interest, compounded annually. Find the rate of interest.
(A) $9\frac{1}{11}$ % p.a. (B) 10% p.a.
(C) $11\frac{1}{9}$% p.a. (D) 8% p.a.

9. What sum of money gives ₹2655 interest for second year at 18% p.a. compound interest, compounded annually?
(A) ₹12000 (B) ₹13500
(C) ₹12500 (D) ₹13000

10. The difference between the compound interest and simple interest on a certain sum at 12% per annum for 2 years is ₹126.72. Find the sum (in ₹).

11. A person invested ₹20000 in a bank which is offering 10% per annum simple interest. After two years he withdrew the money from the bank and deposited the total amount in another bank which gives an interest rate of r% p.a. compounded annually. After 2 years he received an amount of ₹2460 more than what he had invested in that bank. Find the value of r.

12. A person invested a certain sum for five years at the rate of r% per annum simple interest. If he had invested the same sum at the same rate compounded half yearly for one year, he would have received the same amount. Find the value of r.

13. A person invested certain amount (P_1) at a rate of 40% p.a. compounded quarterly. Another person invested certain amount (P_2) at a rate of 20% p.a. compounded half yearly. Both received the same amount after n years. Find the value of $\left(\frac{P_2}{P_1}\right)^{1/n}$.

14. A certain sum at a certain rate of compound interest, yields interests of ₹1260 and ₹1512 for the third and the fourth years respectively. Find the sum.
(A) ₹4500 (B) ₹4375
(C) ₹4650 (D) ₹4425

15. A person deposited ₹100 in a bank which pays at r% p.a. with interest being compounded annually. The same person invested another ₹100 in another bank which pays at 2r% p.a. simple interest. In how many years will the two deposits amount the same?
(A) 2 years
(B) 3 years
(C) 4 years
(D) depends on the value of r.

16. The difference between the compound interest and the simple interest for 2 years on a sum of ₹12000 at certain rate of interest is ₹120. Find the rate of interest in percent (per annum).

17. A person deposits an amount of ₹10000 at 10% p.a. compound interest. For the 1st year the interest is compounded annually. For the 2nd year the interest is compounded half yearly. At the end of two years find the value of the amount deposited (in ₹).

18. A person invested a sum of ₹P for 2 years, which is compounded annually at a rate of r% p.a. Another person invested the same sum for same period at same rate at simple interest. The difference in their amounts after 2 years is found to be ₹4P. Find the rate of interest at which they have invested their sums.
(A) 100% (B) 150%
(C) 200% (D) None of these

19. A person invested half of the money he has at a rate of 10% p.a. compounded annually and the remaining half at a rate of 20% p.a. simple interest. After 2 years he received a total of ₹2610 from both the investments. How much will he receive after 3 years?
(A) ₹2300 (B) ₹2931 (C) ₹2642 (D) ₹2800

20. The simple and compound interests on a certain sum at a certain rate of interest for 2 years are ₹160 and ₹170 respectively. Find the annual rate of interest (in percent).

21. A person invested a sum of ₹91.3. In how many years will the sum become ₹5000, if it is compounded every moment at the rate of 100% p.a.? (given e = 2.72)
(A) 2 (B) 4 (C) 6 (D) 1

22. A person invested two equal sums, one at simple interest and another at compound interest at the same rate for two years. After 2 years the ratio of amounts at compound and simple interest is 25 : 16. Find the annual rate of interest (in percent).

23. Varun invested a certain sum at simple interest and Vikram invested the same sum at compound interest. The ratio of rates (in percent per annum) of simple and compound interest is 2 : 1. After 2 years if the two of them receive equal amounts, then at what annual rate (in percent) did Vikram invest?

24. Kavitha borrowed ₹72000 from Karuna and Kalyani. Karuna charges 12% p.a. compound interest and Kalyani charges 7% p.a. compound interest. At the end of a year Kavita paid ₹6120 as interest. Find the sum borrowed from Kalyani.
(A) ₹48600 (B) ₹50400
(C) ₹49200 (D) ₹51300

25. A person deposited a sum of ₹10000 in a bank for a period of n_1 years at a rate of 20% p.a. compounded annually. The same person deposited a sum of ₹11520 in other bank for a period of n_2 years at a rate of 25% p.a. simple interest. The amounts received from the two banks are equal and the total amount is ₹34560. Find n_1 and n_2.
(A) $n_1 = 3, n_2 = 2$ (B) $n_1 = 2, n_2 = 2$
(C) $n_1 = 1, n_2 = 3$ (D) Cannot be determined

26. A man borrowed ₹25000 from a bank at 20% compound interest. At the end of every year he paid ₹8000. At the end of the third year, he wanted to clear the loan. How much should he pay to clear the loan?
(A) ₹12400 (B) ₹16040
(C) ₹20800 (D) ₹22080

27. A person borrowed a sum of ₹20000 at a rate of 20% p.a. compounded annually for three years. But after two years he paid ₹12800 and after 3rd year he cleared the remaining balance. How much did he pay at the end of the 3rd year?
(A) ₹18200 (B) ₹18700
(C) ₹19200 (D) None of these

28. The value of a motorcycle is ₹80000 and its value depreciates by 20% every year, with respect to its value at the beginning of the year. What is the profit earned by selling the motorcycle at the end of the 2nd year at ₹53600?
(A) ₹2200
(B) ₹2400
(C) ₹2300
(D) ₹2100

29. What annual instalment (in ₹) will discharge a debt of ₹717.60 due in 4 years at 20% p.a. simple interest, if each instalment is paid at the end of a year?

30. A loan is taken today and repaid in two annual instalments (paid at the end of the year) of ₹2662 each. The rate of interest is 10% p.a. and it is compounded annually. Find the sum borrowed.
(A) ₹4540
(B) ₹4620
(C) ₹2848
(D) ₹2152

31. Dolly deposited ₹20000 at 10% p.a. simple interest for a period of n years. Lilly deposited ₹18000 at the same rate at compound interest for the same period. After n years amount received by Dolly is ₹2042 more than the amount received by Lilly. Find the value of n.

32. A person deposited a certain amount in a bank which is offering 10% p.a. compound interest for the first two years and for the next two years, each year the rate of interest is 10% points more than previous year. The value of his investment at the end of the 3rd year is ₹4840 more than that at the end of the second year. Find the total amount received by the person at the end of the 4th year.
(A) ₹37752
(B) ₹38572
(C) ₹38752
(D) Cannot be determined

33. A lender had received his amount in three annual equal instalments at ₹2662 per instalment at a rate of 10% p.a. being compounded annually. Find the initial sum (in ₹) that the lender had given.

34. A person invested a sum of ₹P at a certain rate of compound interest, interest being compounded annually. After three years the sum becomes ₹8P. If it had been compounded half yearly approximately how much more would he have received?
(A) ₹4.5P
(B) ₹3.6 P
(C) ₹3.4 P
(D) ₹4.4 P

35. A person borrowed a certain sum at the rate of 20% p.a. compound interest. He paid a total of ₹4000 in two annual equal instalments. What interest did he pay approximately?
(A) ₹955 (B) ₹944
(C) ₹933 (D) ₹922

Directions for questions 36 to 40: Each question is followed by two statements, I and II. Indicate your responses based on the following directions:

Mark (A) if the question can be answered using one of the statements alone, but cannot be answered using the other statement alone.
Mark (B) if the question can be answered using either statement alone.
Mark (C) if the question can be answered using statements I and II together but not using I or II alone.
Mark (D) if the question cannot be answered even using statements I and II together.

36. A scooter is purchased by making a down payment plus five equal instalments. What is the total amount paid by the customer for the scooter?
I. The down payment is 40% of the total amount paid by the customer.
II. Each instalment is ₹1272.

37. What is the principal deposited by Krishna, in a bank?
I. The interest earned on the fixed deposit for 2 years is ₹4830
II. The bank offers 10% interest compounded annually on fixed deposits.

38. Sohini invests in three schemes which offer her simple interests of 8% p.a., 10% p.a., 20% p.a. respectively. She invested in each scheme for one year. What is the sum that Sohini invested?
I. The interest she earned on each of the schemes is the same.
II. The total interest she earns is ₹1200.

39. What is the compound interest earned on ₹20000 for 2 years?
I. If the rate of interest had been 3 percentage points more, an additional interest of ₹1302 would have accrued for the two years.
II. ₹98 is the difference between the simple interest and the compound interest at the same rate for two years.

40. A person gets an interest of ₹30 more for two years by lending an amount at compound interest rather than at simple interest when the interest is compounded, it its compounded at a certain frequency. What is the rate of interest per annum?
I. The amount lent is ₹12000.
II. The interest is compounded annually

Key

Concept Review Questions

1. 4000	4. 24	7. B	10. 10.25	13. 16
2. D	5. C	8. 84	11. C	14. A
3. 9000	6. 4200	9. A	12. A	15. C

Exercise – 4(a)

1. D	6. 550	11. 2000	16. C	21. C
2. D	7. 20	12. 1800	17. 4000	22. 12
3. 176800	8. 16	13. 1260	18. 50000	23. C
4. C	9. A	14. B	19. D	24. 280000
5. 81500	10. B	15. A	20. D	25. 6600

Exercise – 4(b)

1. D	9. C	17. 12127.5	25. A	33. 6620
2. C	10. 8800	18. C	26. D	34. C
3. B	11. 5	19. B	27. C	35. B
4. 50	12. 1600	20. 12.5	28. B	36. C
5. 7200	13. 1.21	21. B	29. 138	37. C
6. 6200	14. B	22. 150	30. B	38. C
7. D	15. D	23. 200	31. 3	39. B
8. A	16. 10	24. B	32. A	40. C