1 Simple Interest and Compound Interest

Introduction

Interest is the amount of money a lender or a financial organisation charges for lending out money. Simple interest (SI) and compound interest (CI) are the continuations of the application of percentages. A full understanding and rigorous practice will make you able to tackle the SI and CI questions easily. Hardly, any tricky questions are asked from this chapter. To score more, we must rely on common sense and logic than formulae. In this chapter, we are going to study the following types of interest: SI, CI, and instalments.

Basic Terminologies

Principal

The amount of money that you lend to somebody or invest to earn interest is known as the principal. It is denoted by *P*.

Time Period

The time for which money is borrowed or lent to somebody is known as the time period. It is denoted by *t*.

Interest

The amount of money a lender or a financial organisation charges for lending out money is known as interest.

Rate of Interest

The rate at which interest is calculated on the principal is known as the rate of interest. It is denoted by *r*.

Amount

The sum of the original principal and the total interest earned is known as the amount. It is denoted by *A*.

Simple Interest

When the interest is calculated every year on the original principal, i.e., the sum at the beginning of the first year, such interest is called simple interest.

- If the principal (*P*), rate of interest (*r*), and the time period (*t*) are given, we will have

$$\text{Simple interest (SI)} = \frac{P \times r \times t}{100}$$

$$\text{Amount } (A) = P + \text{SI} = P + \frac{P \times r \times t}{100} = P\left(1 + \frac{rt}{100}\right)$$

- Out of the five variables, *A*, SI, *P*, *r*, and *t*, we can find any one if we have proper information about the remaining four variables.

Example 1:

Find the simple interest on ₹1,000 at 10% per annum for 3 years.

Solution: ₹300

Here, P = ₹1,000, r = 10% per annum, and t = 3 years.

$$\text{SI} = \frac{P \times r \times t}{100} = \frac{1{,}000 \times 10 \times 3}{100} = ₹300$$

Example 2:

Ashwani lends ₹8,000 to Neeti at 5% per annum, ₹7,000 to Raghav at 8% per annum, and ₹10,000 to Dheeraj at 10% per annum. Find the total simple interest Ashwani earns in 2 years.

Solution: ₹3,920

Here, $P_1 = ₹8{,}000$ $P_2 = ₹7{,}000$ $P_3 = ₹10{,}000$

$r_1 = 5\%$ $r_2 = 8\%$ $r_3 = 10\%$

$t_1 = 2$ years $t_2 = 2$ years $t_3 = 2$ years.

$$\text{SI} = \frac{P_1 \times r_1 \times t_1}{100} + \frac{P_2 \times r_2 \times t_2}{100} + \frac{P_3 \times r_3 \times t_3}{100}$$

$$\text{SI} = \frac{8{,}000 \times 5 \times 2}{100} + \frac{7{,}000 \times 8 \times 2}{100} + \frac{10{,}000 \times 10 \times 2}{100}$$

SI = 800 + 1,120 + 2,000

SI = ₹3,920

Keynote

- The principal remains the same every year.
- The interest for any year is the same as that for the first year.
- Amounts follow an arithmetic progression. This is because simple interest remains the same every year, so it acts as a common difference between the amounts of two consecutive years.

Example 3:

A sum of money doubles in 5 years. In how many years will it become three times itself at the same rate of simple interest?

Solution: 10 years

Let the principal be x.

Amount = $2x$.

SI = Amount – principal = $2x - x$

SI = x

$$SI = \frac{P \times r \times t}{100}$$

$$x = \frac{x \times r \times 5}{100}$$

r = 20% per annum

Now, the new amount = $3x$.

So, the new SI = $3x - x = 2x$

$$SI = 2x = \frac{P \times r \times t}{100}$$

$$2x = \frac{x \times 20 \times t}{100}$$

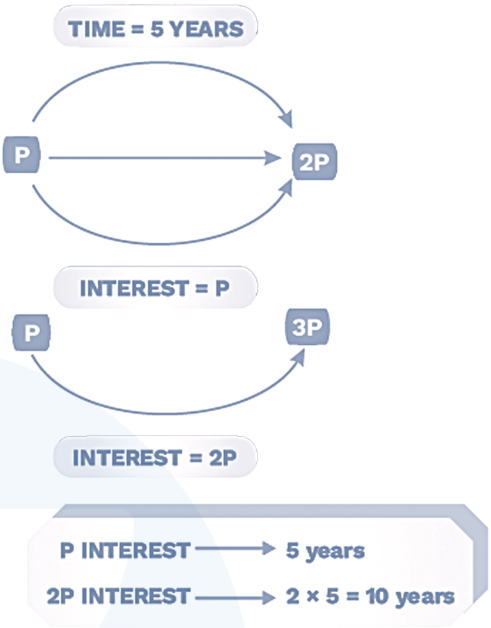
t = 10 years.

Alternate solution

Let the principal be ₹P. In 5 years, the principal becomes ₹$2P$. So the interest earned on ₹P in 5 years is ₹P.

Now, ₹P becomes ₹$3P$ in x years. So the interest earned on ₹P in x years is ₹$2P$. If ₹P interest has been earned in 5 years, then ₹$2P$ interest will be earned within 10 years (5 × 2).

Pictorially

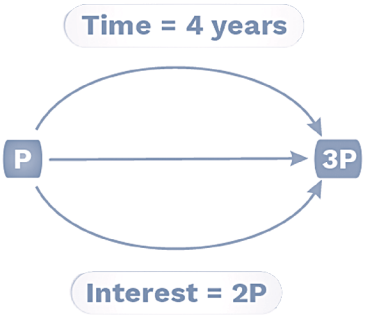


Example 4:

If a certain sum triples in 4 years under simple interest, in how many years would it become 7 times itself at the same rate of interest?

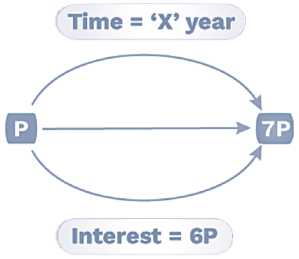
Solution: 12 years

Let the principal be P, which triples in 4 years.



∴ 2 interest in 4 years.

P becomes 7 times of itself in X years.



$2P \Rightarrow 4$ years.

$6P = 3 \times 2P \Rightarrow 3 \times 4$ years.

$X = 12$ years

Hence, in 12 years it becomes 7 times itself.

Compound Interest (Yearly)

- Compound interest is the theory of earning interest on your investment for the first year, then earning interest on your investment and the interest as well from the second year.
- The idea of compound interest is the concept of successive increases.
- If principal (P), rate (r), and time (t) are given, then the amount (A) = $P\left(1+\frac{r}{100}\right)^t$.

  Compound interest (CI) = Amount (A) – Principal (P).
- To understand the concept of compound interest, let us understand this table.
  Let the principal (P) = ₹1,000, rate (r) = 10% per annum, and time (t) = 4 years.

Years	Principal in Each Period (P)	Compound Interest at (r = 10%)	Amount at the End of the Year ($A = P +$ CI)
1st year	₹1,000	₹100	₹1,100
2nd year	₹1,100	₹110	₹1,210
3rd year	₹1,210	₹121	₹1,331
4th year	₹1,331	₹133.1	₹1,464.1

Here, we can observe an increase in the amount under compound interest each year. There is also an increment of r%, i.e., (10%) in the interest amount per year compared with the previous year's interest.

Compounding More than Once

Now we know how to calculate the amount and interest when compounding is done once a year. But compounding can also be done more than once a year. If the interest is added to the principal every 6 months, 4 months, and every 3 months, we say that compounding is done 2 times a year, 3 times a year, and 4 times a year, respectively.

Case 1: Compounding half-yearly

- It means that interest is given after every 6 months. Let us understand this with an example.

Keynote

In case of half year, rates become half and time doubles, i.e., (1 year = 2 half years).

Example 5:

A sum of ₹10,000 is lent for 2 years at the rate of 10% per annum and compounding is done every 6 months (half yearly). Find the amount.

Solution: ₹12,155.0625

Here, P = ₹10,000, $r = \frac{10}{2}$ = 5% per half year and, t = 2 years = 4 half years

$$\text{Amount} = P\left(1+\frac{r}{100}\right)^t = 10,000\left(1+\frac{5}{100}\right)^4$$

Amount = ₹12,155.0625

Case 2: Compounding quarterly

- It means that the interest is given after every 3 months. Let us understand this with an example.

Example 6:

A sum of ₹10,000 is lent for 1 year at the rate of 12% per annum, compounded quarterly. Find the amount.

Solution: ₹11,255.08

Here, P = ₹10,000, $r = \frac{12}{4}$ = 3%, and t = 1 year = 4 quarter years.

So, amount $= P\left(1+\frac{r}{100}\right)^{t}$

Amount $= 10{,}000 \times \left(1+\frac{3}{100}\right)^{4}$

Amount = ₹11,255.08

Case 3: Compounding every moment

- It means that the interest is given after every second or every minute; in other words, if you are given interest for every possible time increment, then we can say that the compounding is done 'every moment'.

  Amount $= P \times e^{\frac{rt}{100}}$

  where r = rate %

  t = number of years

  e = Euler's number = 2.71828

Example 7:

What would ₹10,000 amount to be in 20 years at 5% per annum, if the interest is compounded every moment? (Given e = 2.718).

Solution: ₹27,180

Here, principal (P) = ₹10,000

Time (t) = 20 years

Rate (r) = 5% p.a.

Amount $= P \times e^{\frac{r\times t}{100}}$

$= 10{,}000 \times (2.718)^{\frac{5\times 20}{100}} = 10{,}000 \times (2.718)^{1}$

Amount = ₹27,180

Useful Results

1. If an amount is given at a certain rate of interest, then some results are as follows:

P = principal

R = rate%

	1st Year	2nd Year	3rd Year
SI	PR	PR	PR
CI	PR	$PR + PR^2$	$PR + 2PR^2 + PR^3$

- Difference between CI and SI for 2 years: CI for 2 years – SI for 2 years.

  $(PR + PR + PR^2) - (PR + PR) = PR^2$

- Difference between CI and SI for 3 years: CI for 3 years – SI for 3 years.

  $(PR + PR + PR^2 + PR + 2PR^2 + PR^3) - (PR + PR + PR) = 3PR^2 + PR^3$

- Difference between the compound interest and simple interest for the second year only.

  $\left(CI_{\underset{only}{2}} - SI_{\underset{only}{2}}\right) = (PR + PR^2) - (PR) = PR^2$

- Difference between the compound interest and simple interest for the third year only.

  $CI_{\underset{(Only)}{3}} - SI_{\underset{(Only)}{3}} = (PR + 2PR^2 + PR^3) - (PR)$

  $= (2PR^2 + PR^3)$

2. If the compound interest for two consecutive years is given (CI_1 and CI_2), then we can directly find the rate of interest.

$R = \frac{(CI_2 - CI_1)}{CI_1} \times 100$

Examples based on the useful results.

Example 8:

The compound interest on a certain sum for the first year is ₹600 and the compound interest for the second year is ₹660. Calculate the rate of interest.

Solution: 10%

CI_1 = ₹600; CI_2 = ₹660

So, $R = \left(\frac{CI_2 - CI_1}{CI_1}\right) \times 100$

$\therefore \quad R = \left(\frac{660 - 600}{600}\right) \times 100$

Hence, $R = 10\%$

Example 9:

The difference between the compound interest and simple interest for 2 years is ₹120, and the difference between compound interest and simple interest for 3 years is ₹366. Calculate the principal and the rate of interest.

Solution: ₹48,000

Here, (CI – SI) for 2 years = ₹120

and (CI – SI) for 3 years = ₹366.

So, from the above results,

$PR^2 = ₹120$ ...(i)

$3PR^2 + PR^3 = ₹366$ ...(ii)

Put the value of PR^2 in equation (ii), we get

$PR^2 (3 + R) = 366$

$120 (3 + R) = 366$

$R = \frac{366}{120} - 3$

$R = \frac{6}{120} \times 100$

$R = 5\%$

Put the value of R in equation (i), we get

$P \times (5\%)^2 = ₹120$

$P \times \frac{5}{100} \times \frac{5}{100} = 120$

$P = ₹48,000.$

Example 10:

The difference between the simple interest and compound interest on a certain sum at 10% per annum for 3 years is ₹1,705. Find the sum.

Solution: ₹55,000

Here, the difference between the simple interest and the compound interest for 3 years is ₹1,705.

$\therefore \quad 3PR^2 + PR^3 = ₹1,705$ and rate $(R) = 10\%$

$PR^2 (3 + R) = ₹1,705$

$P \times \frac{10}{100} \times \frac{10}{100}\left(3 + \frac{10}{100}\right) = 1,705$

$P \times \frac{1}{10} \times \frac{1}{10} \times \left(3 + \frac{1}{10}\right) = 1,705$

$P = \frac{1,705 \times 1,000}{31}$

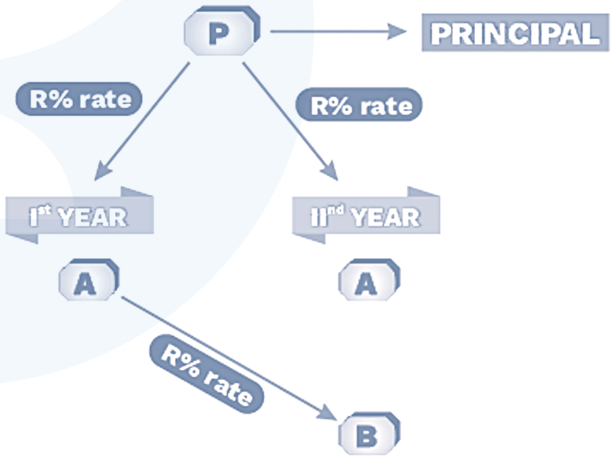
$\therefore \quad P = ₹55,000$

Tree Method

- Many questions are nearly impossible for a student to solve by the traditional method. But by using this method, we can easily solve the questions within seconds.

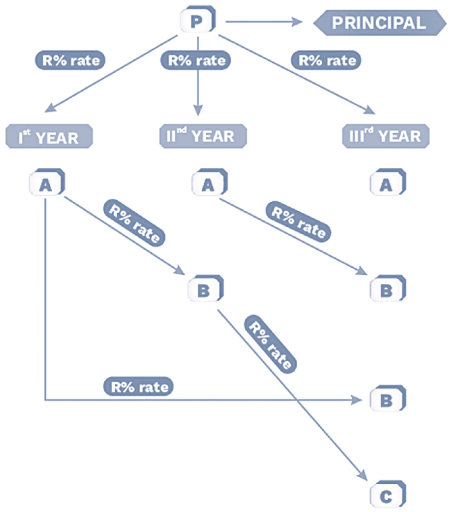
Concept of Tree Method for 2 Years

[Let the principal P lend at the rate of (R%) for 2 years].



- Here, A is the interest over principal at R% and B is the interest over A at R%.
  Total SI for 2 years = $A + A = 2A$
  Total CI for 2 years = $A + A + B = 2A + B$
  Total CI for the second year only = $(A + B)$
  Difference between CI and SI for 2 years = B

Concept of Tree Method for 3 Years



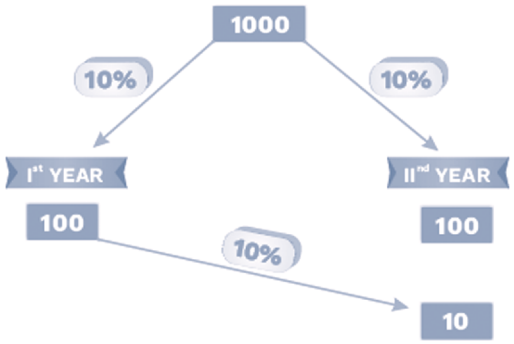
- Here A is the interest over principal at R%, B is the interest over A at R%, and C is the interest over B at R%.
  Total SI for 3 years = $A + A + A = 3A$
  Total CI for 3 years = $A + A + A + B + B + B + C = 3A + 3B + C$
  CI for third year only = $A + B + B + C = A + 2B + C$
  CI for second year only = $A + B$
  CI for first year = SI for the first year = A
  Difference between CI and SI for 2 years = B
  Difference between CI and SI for 3 years = $B + B + B + C \Rightarrow 3B + C$

Questions Based on Tree Method

Example 11:

Ankur borrowed ₹1,000 at 10% per annum for 2 years. Calculate the compound interest only for the second year.

Solution: ₹110

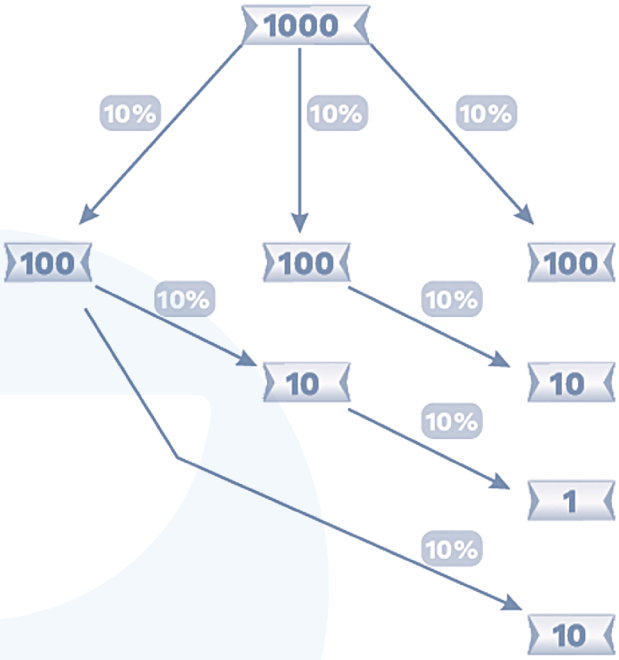


Compound interest for the second year only = 100 + 10 = ₹110.

Example 12:

Ankur borrowed ₹1,000 at 10% per annum for 3 years. Calculate the compound interest only for the third year.

Solution: ₹121



Compound interest for the third year only = 100 + 10 + 1 + 10 = ₹121.

Example 13:

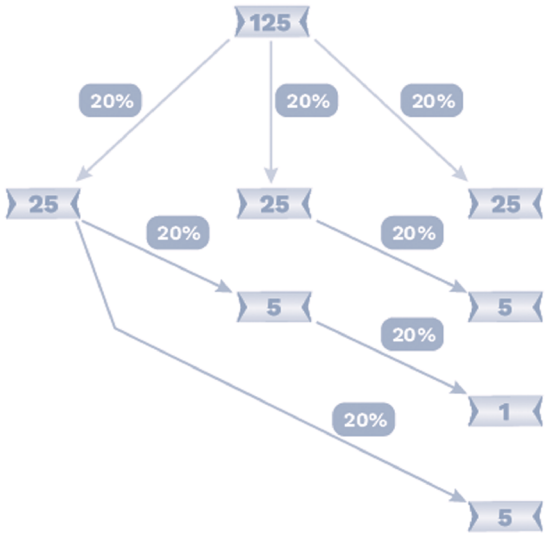
The difference between the simple interest and the compound interest on a certain sum at 20% per annum compounded annually for 3 years is ₹512. Find the sum.

Solution: ₹4,000

20% means $\left(\frac{1}{5}\right)$

Here, the principal is not given, so let the principal be a multiple of 5.

Let the principal = $(5)^3$ = 125 units



Difference between CI and SI for 3 years = (5 + 5 + 1 + 5) = 16 units.

16 units = ₹512

1 unit = ₹32

Principal = 125 units ⇒ 125 × 32 = ₹4,000

Application of Compound Interest

Depreciation

Depreciation is the continual, permanent, and gradual decline in the value of assets, population, number of items, etc. over a period of time.

$$V_f = V_i\left(1-\frac{r}{100}\right)^t$$

where V_i = initial value; V_f = final value; r = rate%; t = time period.

Appreciation

Appreciation is the continual, permanent, and gradual increase in the value of assets, population, number of items etc. over a period of time.

$$V_f = V_i\left(1+\frac{r}{100}\right)^t$$

where, V_i = initial value; V_f = final value; r = rate%; t = time period.

Example 14:

The population of India depreciates at the rate of 10% due to the Covid outbreak. Find the population of India after 3 years if initially there were 1,00,000 people.

Solution: 72,900 people

$V_i = 1,00,000$

$r = 10\%$

$t = 3$ years

So, $V_f = V_i\left(1-\frac{r}{100}\right)^t = 1,00,000\times\left(1-\frac{10}{100}\right)^3$

$V_f = 72,900$ people

Example 15:

The population of a village increased by 10% in the first year, 20% in the second year, and 30% in the third year. Calculate the population of the village after 3 years if initially there are 1,00,000 people.

Solution: 1,71,600 people

$V_i = 1,00,000$

$r_1 = 10\%$, $r_2 = 20\%$, and $r_3 = 30\%$

$t = 3$ years

$$V_f = V_i\left(1+\frac{r_1}{100}\right)^1\left(1+\frac{r_2}{100}\right)^1\left(1+\frac{r_3}{100}\right)^1$$

$$V_f = 1,00,000\times\left(1+\frac{10}{100}\right)\times\left(1+\frac{20}{100}\right)\times\left(1+\frac{30}{100}\right)$$

$$V_f = 1,00,000\times\frac{11}{10}\times\frac{6}{5}\times\frac{13}{10}$$

$V_f = 1,71,600$ people

Example 16:

The annual sales of a foreign company in 1940 was ₹1,500 and in 1945 it was ₹3,017. In the given period of time, find the compounded annual growth rate (CAGR) of sales of the company.

(A) 14.28% (B) 15%

(C) 25% (D) 20%

Solution: (B)

Principal = ₹1,500, amount = ₹3,017, and time = 5 years

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

$$3,017 = 1,500\left(1+\frac{r}{100}\right)^5$$

Here, we can see that our principal doubles in 5 years. So we can clearly understand that if the money is lent at simple interest, then the rate of interest must be 20%. But in this question, we have to find CAGR, so the rate of interest must be less than 20%. We can eliminate options (C) and (D).

Now, we just put options (A) and (B) to check which satisfies

$$3,017 = 1,500\left(1+\frac{15}{100}\right)^5$$

3,017 = 3,017.063 (approximately equal)

Hence, CAGR will be 15%.

Example 17:

Motu and Patlu were best friends. One day, Patlu was in trouble; so to get him out of the problem, Motu lent ₹50,000 to Patlu at 4% per annum of simple interest for 8 years. Meanwhile, Motu offered a discount on the rate of interest for friendship. Therefore, the rate of interest decreased to 2%. In this way, Patlu had to pay a total amount of ₹60,000. After how many years does Patlu get the discount in rate of interest?

(A) 2 years (B) 3 years

(C) 4 years (D) 6 years

Solution: (A)

Here, principal = ₹50,000, amount = ₹60,000, and time = 8 years.

Suppose Motu has not offered him a discount in the rate of interest, then

$$SI = \frac{50,000\times 4\times 8}{100} = ₹16,000$$

But according to the question, Motu receives ₹10,000 interest. We can conclude that a reduction in interest is due to a reduction in the rate of interest.

$$6,000 = \frac{50,000\times 2\times n}{100} \Rightarrow n = 6 \text{ years}$$

Hence, we can say that Motu offered him a discount on the rate of interest after 2 years.

Difference Between Compound Interest and Simple Interest

S. No.	Simple Interest	Compound Interest
1.	The principal remains the same.	The principal keeps on increasing.
2.	Interest remains fixed and is not added to the principal.	Interest keeps on increasing and is added to the principal after every compounding period.
3.	The amounts follow an arithmetic progression.	The amounts follow a geometric progression.

- For example, assume that two different sums are getting doubled at their respective rate of SI and CI in 4 years.

	After 4 Years	After 8 Years	After 12 Years	After 16 Years
At SI	2 times	3 times	4 times	5 times
At CI	2 times	4 times	8 times	16 times

In the case of SI, the amounts follow an arithmetic progression, and in the case of CI, the amounts follow a geometric progression.

Present Value

- We have seen that interest is the amount of money a lender or the financial organization charges for lending out money, which means a sum at the starting of a period is always less than the sum after a period more than or equal to 1.
  Let the sum *P* that is lent or borrowed at the rate of *r*% per annum become *A* at the end of the first year and *B* at the end of the second year. So, we can say that what is *P* today is equal to *A* at the end of the first year and equal to *B* at the end of the second year. We can find the present value under both simple interest and compound interest.

Present Value under Simple Interest

- The principal P is amounting to A in t years. From this, we can say that

$$A = P\left(1+\frac{rt}{100}\right) \Rightarrow P = \frac{A}{\left(1+\frac{rt}{100}\right)}$$

Present Value under Compound Interest

- The principal P is amounting to A in t years. From this, we can say that

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

Concept of Instalment

- Suppose you have to buy a bike for ₹1,00,000. You can pay the seller in two ways: first, you can pay the entire amount in one go; second, you pay some down payment in the beginning and pay the remaining amount in the form of equal instalments at regular intervals.

Down Payment

- The initial payment made to the seller when purchasing an item; the remaining balance must be paid at a later date.

Instalment under Simple Interest

- Suppose Ankur bought a TV worth ₹30,000 on EMI. Every month a fixed instalment has to be paid for the next t months where interest is charged at r% per annum on simple interest.
  Now, if the loan is for t months, then at the end of the first month he will pay interest for $(t-1)$ months, at the end of the second month, he will pay interest for $(t-2)$ months, at the end of the third month he will pay interest for $(t-3)$ months and similarly at the end of t^{th} month, he will pay no interest.
  The total amount paid by Ankur =

$$\left(x+\frac{x\left(t-1\right)\times r}{100\times 12}\right)+\left[x+\frac{x\left(t-2\right)\times r}{12\times 100}\right]+\ldots+x$$

  This amount will be equal to the principal borrowed, and the interest given on that for t months, $= P + \frac{P\times r\times t}{100\times 12}$
  We can write this process in the form of an equation.

$$P+\frac{P\times r\times t}{100\times 12}=x+\frac{x\times\left(t-1\right)\times r}{100\times 12}+x+\frac{x\times\left(t-2\right)\times r}{100\times 12}+\ldots+x.$$

- x denotes instalment variable.
- r denotes rate per annum.
- t denotes time.

Example 18:

A mobile phone is available for ₹5,000 cash or ₹500 down payment followed by four equal instalments. If the rate of interest charged is 25% per annum simple interest, calculate the monthly instalment.

Solution: ₹1,181.81

After paying the down payment of ₹500, the amount to be paid will be

$$5{,}000 - 500 = ₹4{,}500.$$

The total amount of instalment for 4 months will be:

$$p+\frac{p\times t\times r}{100\times 12}=\left[x+\frac{x\left(t-1\right)\times r}{100\times 12}\right]+\left[x+\frac{x\times\left(t-2\right)\times r}{100\times 12}\right]+\left[x+\frac{x\times\left(t-3\right)\times r}{100\times 12}\right]+x$$

$$4{,}500+375=4x+\frac{x}{16}+\frac{x}{24}+\frac{x}{48}$$

$$4{,}875=\frac{33x}{8}=\frac{4{,}875\times 8}{33}$$

$$\Rightarrow \quad x = ₹1{,}181.81$$

Example 19:

A phone is available for ₹6,000 or for ₹3,000 cash down payment together with ₹3,600 to be paid after 2 months. Find the rate of interest charged under this scheme.

Solution: 120%

Amount to be paid after down payment,

₹6,000 – ₹3,000 = ₹3,000

$$3,000 + \frac{3,000 \times 2 \times r}{100 \times 12} = 3,600$$

$$\frac{3,000 \times 2 \times r}{100 \times 12} = 3,600 - 3,000$$

r = 120%

Instalment under Compound Interest

- Let a sum P be borrowed and repaid in t equal instalments. Compound interest is calculated at r% per period of instalment. (Here we can assume that the amount is paid at the end of each year.)

  Let each instalment be I.

  Instalment I, paid at the end of the first year, has a present value of

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

  Instalment I, paid at the end of the second year, has a present value of

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

  Instalment I, paid at the end of the third year, has a present value of

  $$\frac{I}{\left(1+\frac{r}{100}\right)^3}$$

  Instalment I, paid at the end of t year, has a present value of

  $$\frac{I}{\left(1+\frac{r}{100}\right)^t}$$

  The sum of all these present values should be equal to the money borrowed.

  $$P = \frac{I}{\left(1+\frac{r}{100}\right)} + \frac{I}{\left(1+\frac{r}{100}\right)^2} + \frac{I}{\left(1+\frac{r}{100}\right)^3} + \ldots + \frac{I}{\left(1+\frac{r}{100}\right)^t}.$$

  Let us understand this formula with the help of examples.

Example 20:

Barsha borrowed ₹4,800 from Ashwani. She promised Ashwani to pay it back in two equal instalments. Find the amount of each instalment if the rate of interest is 5%.

Solution: ₹2,581.46

Here, P = ₹4,800; R = 5%

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

$$4,800 = \frac{I}{\left(1+\frac{5}{100}\right)} + \frac{I}{\left(1+\frac{5}{100}\right)^2}$$

$$4,800 = \frac{I}{1.05} + \frac{I}{(1.05)^2}$$

$$4,800 = \frac{2.05I}{(1.05)^2}$$

$$I = \frac{4,800 \times (1.05)^2}{2.05}$$

I = ₹2,581.46

Practice Exercise – 1

Level of Difficulty – 1

1. What is the present value of ₹15,000 due after 5 years at 10% p.a. simple interest?
(A) 12,000
(B) 14,000
(C) 10,000
(D) 15,000

2. A certain sum under compound interest compounded annually amounts to ₹6,442.04 in 5 years and ₹7,086.244 in 6 years. What is the annual rate of interest?
(A) 7%
(B) 8%
(C) 9%
(D) 10%

3. A certain sum doubles in 7 years under compound interest, compounded annually. In how many years will the sum become eight times itself?
(A) 14 years
(B) 15 years
(C) 21 years
(D) 18 years

4. A sum of money, compounded annually, amounts to ₹5,120 in 3 years and ₹7,290 in 6 years. Find the annual rate of interest.
(A) 12%
(B) 12.5%
(C) 14%
(D) 14.5%

5. A sum of money under CI, interest being compounded half-yearly, doubles in 3 years. In how many years will it become 32 times itself?
(A) 5 years
(B) 10 years
(C) 15 years
(D) 20 years

Level of Difficulty – 2

6. Raghav borrowed ₹8,000 at a 10% rate of interest. He repaid ₹4,000 at the end of the first year. What is the amount required to pay at the end of the second year to discharge his loan under compound interest?
(A) ₹5,200
(B) ₹5,250
(C) ₹5,280
(D) ₹6,300

7. Hoshiyar Singh left an amount of ₹3,40,000 to be divided between his two sons aged 10 years and 12 years such that both of them would get an equal amount when each attains 18 years of age. What is the share of the elder brother if the whole amount was invested at 10% simple interest?
(A) ₹1,60,000
(B) ₹1,80,000
(C) ₹2,00,000
(D) ₹1,40,000

8. A certain sum of money increased to 219.7% of its value at a certain rate of compound interest, compounded annually, in 3 years. If the same sum is lent at simple interest at the same rate of interest, in how many years would it become seven times itself?
(A) 10 years
(B) 15 years
(C) 20 years
(D) 5 years

9. Barsha borrowed some money on compound interest and returned it in three years in equal annual instalments. The rate of interest is 15% per annum, and the annual instalment is ₹4,86,680. Find the sum she borrowed.

10. Divide ₹14,311 between Muskan and Shivam such that Muskan's share at the end of 7 years is equal to Shivam's share at the end of 9 years, at 4% per annum compounded annually. Find the share of Muskan.

Level of Difficulty – 3

11. Ravi borrowed ₹63,000 from Baniya ji at 20% per annum compound interest, compounded annually. At the end of the first year, he cleared a certain part of what he borrowed and at the end of the second year, he repaid thrice the amount he repaid at the end of the first year and cleared the entire loan. What is the amount he paid at the end of the first year?

12. A person started a business with a capital of ₹60,000. In the first year, he made a profit of 20% and added it to the capital. In the second year, he made a profit of 10% and again added it to the capital. In the third year, he incurred a loss of 10% and he set off the loss from the capital. Had he invested the money in a bank that pays 10% per annum compound interest, instead of in the business, how much more he would have received (in ₹)?

(A) ₹8,000
(B) ₹8,750
(C) ₹8,580
(D) ₹8,550

13. In how many years will a sum of money invested at 20% per annum compounded annually double? [Given log (1.2) = 0.079])

(A) 3.2 years
(B) 3.4 years
(C) 3.6 years
(D) 3.8 years

14. Munna Bhai gave ₹1,00,000 to Circuit and ₹1,50,000 to Bulbul for 2 years compounded annually. The rate of interest for Circuit for the first year was 4% and then 10% on the total amount due for the second year. The rate of interest for Bulbul for the first year was 2% and then 8% on the total amount due for the second year. Circuit had paid ₹70,000, and Bulbul had paid ₹90,000 at the end of the first year. How much more interest did Bulbul pay than Circuit?

(A) ₹620
(B) ₹636
(C) ₹640
(D) ₹660

15. Aman borrowed a sum from Bimal at 6% p.a. simple interest and thrice of that sum from Kamal at 10% p.a. simple interest. He added some more money of his own and lent the whole sum to Vimal at 15% p.a. simple interest. At the end of a year, Aman gained ₹6,600. If Aman lent ₹80,000 to Vimal, then how much money did he borrow from Kamal?

(A) ₹15,000
(B) ₹45,000
(C) ₹20,000
(D) ₹40,000

Solutions

1. (C)

For SI Present value $= \dfrac{\text{Future value}}{\left(1+\dfrac{Rt}{100}\right)}$

Present value $= \dfrac{15,000}{1+\dfrac{10\times 5}{100}} = \dfrac{15,000\times 2}{3}$

Present value = ₹10,000

2. (D)

The difference in the amounts after 5 years and 6 years is the interest of ₹6,442.04.

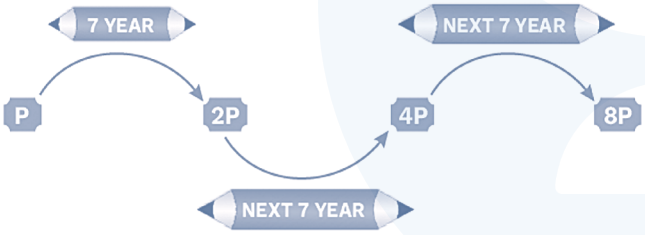
$\therefore$ 7,086.244 − 6,442.04 = ₹644.204

$\therefore$ Rate of interest $= \dfrac{644.204}{6442.04}\times 100 = 10\%$

Rate of interest = 10%

3. (C)

We know that in compound interest, amounts follow a geometric progression.



Hence, in 21 years the sum becomes eight times itself.

4. (B)

Let the sum be P and the rate of interest be r%:

$$P\left(1+\frac{r}{100}\right)^3 = 5,120\ldots(\text{i})$$

$$P\left(1+\frac{r}{100}\right)^6 = 7,290\ldots(\text{ii})$$

On dividing equation (ii) by (i), we get

$$\frac{P\left(1+\dfrac{r}{100}\right)^6}{P\left(1+\dfrac{r}{100}\right)^3} = \frac{7,290}{5,120}$$

$$\Rightarrow \left(1+\frac{r}{100}\right)^3 = \left(\frac{9}{8}\right)^3$$

$$\Rightarrow 1+\frac{r}{100} = \frac{9}{8}$$

$$\Rightarrow \frac{r}{100} = \frac{1}{8}$$

$\Rightarrow r = 12.5\%$

5. (C)

Method 1: (Traditional method)

Let the principal be P and the rate of interest be r% per half year

1 year = 2 half years

3 years = 6 half years

It becomes double in 6 half years

$$P\left(1+\frac{r}{100}\right)^6 = 2P$$

$$\Rightarrow \left(1+\frac{r}{100}\right)^6 = 2\ldots(i)$$

It becomes $32P$ in n half years.

$$P\left(1+\frac{r}{100}\right)^n = 32P$$

$$\Rightarrow \left(1+\frac{r}{100}\right)^n = (2)^5$$

$$\Rightarrow \left(1+\frac{r}{100}\right)^n = \left(\left(1+\frac{r}{100}\right)^6\right)^5$$

n = 30 half years

n = 15 years.

Alternate solution

In CI, amounts follow a geometric progression

$\Rightarrow$ 15 years.

6. (C)

Interest for the first year = $\frac{P \times R \times T}{100} = \frac{8,000 \times 10 \times 1}{100} = ₹800$

Amount = ₹8,800

Amount left = 8,800 – 4,000 = ₹4,800

Compound interest on ₹4,800 for 1 year at 10%,

Interest = $\frac{4,800 \times 10 \times 1}{100} = ₹480$

Amount to be paid = 4,800 + 480 = ₹5,280.

7. (B)

Let the amount given to the younger son be x and the amount given to the elder son be ₹3,40,000 – x.

The younger son will get interest for 8 years at 10% per annum, then the amount becomes

$$A_1 = x\left(1+\frac{8\times 10}{100}\right) = \frac{18x}{10}$$

The elder son will get interest for 6 years at 10% per annum, then the amount becomes

$$A_2 = (3,40,000 - x)\left(1+\frac{6\times 10}{100}\right)$$

$$A_2 = 5,44,000 - \frac{16}{10}x$$

Since, $A_1 = A_2$ is given in the question.

Hence,

$$\frac{18x}{10} = 5,44,000 - \frac{16}{10}x$$

$$\Rightarrow \frac{34x}{10} = 5,44,000$$

$$\Rightarrow x = ₹1,60,000$$

Amount given to the elder son
= (3,40,000 – x) = 3,40,000 – 1,60,000
= ₹1,80,000.

8. (C)

Let the sum be P and rate r%.

According to the question,

$$P\left(1+\frac{r}{100}\right)^3 = 2.197P$$

$$\Rightarrow \left(1+\frac{r}{100}\right)^3 = (1.3)^3$$

$$\Rightarrow \left(1+\frac{r}{100}\right) = 1.3$$

$$\Rightarrow r = 30\%$$

$$SI = \frac{P\times R\times t}{100}$$

$$6P = \frac{P\times 30\times t}{100}$$

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

9. ₹11,11,200

We know that

$$P = \frac{I}{\left(1+\frac{r}{100}\right)} + \frac{I}{\left(1+\frac{r}{100}\right)^2} + \frac{I}{\left(1+\frac{r}{100}\right)^3} \ldots + \frac{I}{\left(1+\frac{r}{100}\right)^n}$$

$$\Rightarrow P = I \times \left[\left[\frac{100}{(100+r)}\right] + \left[\frac{100}{100+r}\right]^2 + \left[\frac{100}{100+r}\right]^3 \ldots + \left(\frac{100}{100+r}\right)^n\right]$$

$$\Rightarrow P = 4,86,680\left[\frac{20}{23} + \left(\frac{20}{23}\right)^2 + \left(\frac{20}{23}\right)^3\right]$$

$$\Rightarrow P = ₹11,11,200$$

10. ₹7,436

Let the share of Muskan and share of Shivam be P_1 and P_2, respectively.

According to the question

$$P_1\left(1+\frac{4}{100}\right)^7 = P_2\left(1+\frac{4}{100}\right)^9$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{(1.04)^9}{(1.04)^7}$$

$$\Rightarrow \frac{P_1}{P_2} = (1.04)^2$$

$$\Rightarrow \frac{P_1}{P_2} = 1.0816 = \frac{10,816}{10,000} = \frac{676}{625}$$

Muskan's share = $\frac{676}{1,301} \times 14,311 = ₹7,436$

11. ₹21,600

Amount accrued at the end of the first year

$$= 63,000\left[1+\frac{20}{100}\right] = 75,600$$

Let the amount repaid by Ravi at the end of the first year be ₹x.

Amount left = (₹75,600 – x)

Amount accrued at the end of the second year,

$$(75,600 - x)\times\left[1+\frac{20}{100}\right] = 3x$$

$\Rightarrow$ 75,600 – x = 2.5x

$\Rightarrow$ 75,600 = 3.5x

$\Rightarrow$ x = ₹21,600

12. (C)

Capital at the end of 3 years when invested in business:

$$60,000 \times \frac{120}{100}\times\frac{110}{100}\times\frac{90}{100} = ₹71,280$$

Capital at the end of 3 years when invested in bank:

$$60,000 \times \left(1+\frac{10}{100}\right)^3$$

$= 60,000 \times (1.1)^3$ = ₹79,860

Required difference = (79,860) – (71,280) = (₹8,580)

13. (D)

Let the principal be P.

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

$$2P = P\left(1+\frac{20}{100}\right)^n$$

$\Rightarrow$ $2 = (1.2)^n$

Taking log on both sides

$\log 2 = n \log (1.2)$

$$\Rightarrow n = \frac{\log 2}{\log (1.2)} = \frac{0.3010}{0.0792} = 3.8 \text{ years.}$$

14. (C)

For Circuit :

$$\text{Interest for the first year} = \frac{100,000 \times 4 \times 1}{100}$$

= ₹4,000.

Remaining amount = 100,000 + 4,000 – 70,000 $\Rightarrow$ ₹34,000.

Interest for the second year

$$= \frac{34,000 \times 10 \times 1}{100} = ₹3,400.$$

Total interest paid by Circuit

= ₹4,000 + ₹3,400 = ₹7,400.

For Bulbul :

$$\text{Interest for the first year} = \frac{150,000 \times 2 \times 1}{100}$$

= ₹3,000.

Remaining amount

= 1,50,000 + 3,000 – 90,000 = ₹63,000.

Interest for the second year

$$= \frac{63,000 \times 8 \times 1}{100} = ₹5,040.$$

Total interest paid by Bulbul

= ₹3,000 + ₹5,040 = ₹8,040.

Required difference = 8,040 – 7,400

= ₹640.

Hence, Bulbul paid ₹640 more than Circuit.

15. (B)

Let Aman borrow ₹x from Bimal, ₹3x from Kamal, and ₹y money of his own.

According to the question

$$\frac{(4x+y)\times 15\times 1}{100} - \left[\frac{x\times 6\times 1}{100} + \frac{3x\times 10\times 1}{100}\right] = 6,600$$

$$\Rightarrow \frac{60x + 15y - 36x}{100} = 6,600$$

$\Rightarrow$ 24x + 15y = 660,000 ...(i)

Now, 4x + y = 80,000 ...(ii)

On solving equations (i) and (ii), we get

y = ₹20,000 and x = ₹15,000.

Aman borrowed ₹3x from Kamal = 3 × 15,000 = ₹45,000.

Practice Exercise – 2

Level of Difficulty – 1

1. An amount becomes three times itself in 5 years when invested at a certain rate of interest under simple interest. Find the minimum number of integral years in which the same amount, when invested at the same rate of interest under the compound interest, becomes more than 2.5 times itself.

2. A person invested a certain sum of ₹*P* in a bank at *R*% p.a. with interest being compounded annually, such that the amount at the end of 15 and 20 years will be ₹6,174 and ₹43,218, respectively. Find the amount (in ₹) when the sum *P* has been invested at 20% p.a. simple interest for 20 years.

3. Rohan borrowed ₹20,000 from Saurav at simple interest at 12% per annum. At the end of the second year, Rohan paid back a certain amount and at the end of the fourth year, he paid back ₹17,680 and cleared the debt. What amount (in ₹) did he pay back after the second year?

4. A sum doubles in 3 years at a certain rate of compound interest and doubles in 4 years at a certain rate of simple interest. How many years before the sum amounts to 16 times itself in simple interest and would it have amounted to 16 times itself in compound interest?
(A) 12
(B) 36
(C) 48
(D) 60

5. A sum of money when kept at simple interest doubled in 9 years 5 months. If the rate of interest is doubled, in which year does the same sum become thrice of itself under compound interest?
(A) Fourth year
(B) Sixth year
(C) Seventh year
(D) Fifth year

6. The compound interest on a certain sum at a certain rate of interest for 2 years is equal to the simple interest on the same sum at 40% of the compound interest rate and four times the number of years. Find the rate of interest per annum.
(A) 120%
(B) 100%
(C) 80%
(D) 60%

7. Rita invests ₹250,000 at 10% p.a. compound interest. If the income tax on returns earned deducted is 20% every year, what are her returns at end of 3 years?
(A) ₹64,928
(B) ₹31,492
(C) ₹62,948
(D) No gain

8. A businessman deposited ₹50,000 in a financial institution at the beginning of each quarter for four successive quarters. If the institution pays 8% p.a. interest, compounded every quarter, the balance in his account at the end of the year is nearest to:
(A) ₹2,00,000
(B) ₹1,80,000
(C) ₹2,40,000
(D) ₹2,10,000

9. Ram lent ₹56,000 to Rahim at a certain rate of interest compounded annually, with the assurance that Rahim would return ₹35,000 every year for 2 years. What is the approximate value of compound interest per annum that Ram is charging to Rahim?
(A) 19%
(B) 12%
(C) 22%
(D) 16%

10. On a certain sum of money, the total compound interest earned (with interest being compounded annually) at the end of 3 years is ₹2,170. Total compound interest at the end of 2 years is ₹1,360. Find the sum of money initially invested.
(A) ₹4,800
(B) ₹5,000
(C) ₹5,120
(D) ₹5,400

Level of Difficulty – 2

11. Assuming Rita saves $20,000 at the very start of each year and puts the money in a bank that pays 10% interest per year, interest compounded annually what would her total savings be at the end of 6 years?
(A) 1,69,744
(B) 1,77,650
(C) 1,23,435
(D) 5,34,500

12. Akshay invested a certain amount for 3 years at compound interest with interest being compounded annually. The total compound interest earned at the end of 2 years was ₹440 and at the end of 3 years was ₹728. What was the amount he invested (in ₹)?

13. Kamal invested a certain amount of money at 20% per annum interest, compounded half-yearly. After 2 years, Kamal received ₹1,02,487 (interest + principal). Find the amount of money (in ₹) that Kamal had invested.

14. Kamal invests ₹24,000 at 16% p.a. interest, compounded annually, and ₹20,000 at 12% p.a. interest, compounded semi-annually, both investments being for one year. Vimal invests his money at 15% simple interest for 1 year. If Kamal and Vimal get the same amount of interest, then the amount (in ₹) invested by Vimal is:

15. A sum when invested becomes $\frac{216}{125}$ times of itself in 3 years with the rate of interest being r% p.a., interest compounded annually. Find out in how many years the same sum with the rate of interest as $\frac{r}{2}$% p.a. will become thrice of itself if invested at simple interest.
(A) 5 years
(B) 10 years
(C) 20 years
(D) 30 years

16. The difference between the simple interest for 3 years at (8 + 1/3) % p.a. on a certain sum and the compound interest for 3 years at 12.5% p.a. on the same sum compounded annually is ₹5,340. Find the sum (in ₹).

17. The difference between the compound interest for 2 years at 12.5% per annum and the simple interest for 4 years at 6% per annum is ₹3,649. If the principal is the same in both the conditions, then find the principal amount in (₹)

18. Mr. Krishna invests equal amounts of money in a simple interest scheme and a compound interest scheme. Initially, both the schemes were paying an equal interest rate of 10%. But after 2 years, the interest rate of the CI scheme changes such that the total interest received by both the schemes in 3 years is equal. Find the new interest rate in the CI scheme.
(A) 6.24%
(B) 7.44%
(C) 8.56%
(D) 9.66%

19. Sanju deposited ₹15,000 in a bank at the rate of 20% p.a. with interest being compounded annually. At the end of the first year, he added ₹K along with the matured amount (principal + interest) and kept in the bank for 1 more year. At the time of maturity of the same, he deposited ₹2K along with the matured sum

and kept for one more year. If doing this, at the end of 3 years, he ended up getting the matured amount, which is $\frac{13}{5}$ times his initial deposit, then what is the approximate value of K (in ₹)?

(A) 3,100
(B) 3,200
(C) 3,300
(D) 3,400

20. If the difference between compound interest and simple interest for the third year is ₹775, where the rate of interest is 6.6% compounded annually, then find the compound interest for 3 years.

(A) ₹18,000
(B) ₹18,025
(C) ₹18,725
(D) ₹19,320

Level of Difficulty – 3

21. Sanjay bought a bus for ₹56,00,000. He decided to pay the whole amount in eight equal instalments divided uniformly into 2 years and the first instalment is paid at the end of 3 months from the day on which the bus was bought. The rate of interest was 12% per annum compounded quarterly. Find the approximate amount that Sanjay has to pay in each instalment. Assume $(1.03)^8 = 1.2667$

(A) ₹90,000
(B) ₹85,000
(C) ₹80,000
(D) ₹75,000

22. The simple interest on a certain sum of money (x) will be \$500 after 10 years. Let y be the total interest at the end of the tenth year if the principal is made four times. If the same sum of money (x) is invested in the following manner one-third of it is invested at 3% for 2 years, one-sixth at 6% for 2 years, and the rest at 8% at simple interest, for 2 years, then the total interest earned in this manner is \$600. What is the relation between x and y?

(A) $x > 5y$
(B) $x > 6y$
(C) $x > 4y$
(D) $x > 3y$

23. Rahul borrows ₹10,000 from a bank at 1% interest per month. Each month, he pays back ₹400 towards the principal plus the monthly interest on the outstanding balance. By the time the loan is repaid, how much money has he paid the bank?

(A) 11,300
(B) 13,310
(C) 12,100
(D) 13,100

24. A bank lent Raju ₹2 lakh at an interest rate of 10% per annum, compounded annually. He repaid the loan in two equal instalments. He repaid the first instalment after the completion of the first year and another instalment after the second year. His first instalment included first-year interest and some part of the principal amount. The second instalment included the remaining principal amount and due interest. Find each instalment.

(A) ₹1,16,850.5
(B) ₹1,15,750.5
(C) ₹1,15,238.09
(D) ₹1,17,850.5

25. Jagan invested 50% of his income in a Plan X that offers simple interest for 2 years and received ₹550 as interest. He invested the remaining income in a Plan Y, which offers compound interest that is compounded annually, for the same 2 years at the same rate of interest, and received ₹605 as interest. Find his total income before investing in Plans X and Y.

(A) ₹2,880
(B) ₹2,770
(C) ₹2,850
(D) ₹2,750

26. Sumegha borrowed ₹30,000 from Alisha at 10% compound interest compounded annually. She had to repay the loan in three annual instalments that were in arithmetic progression. She paid ₹36,000 in total. Find the amount she paid in the first year.
(A) ₹13,000
(B) ₹11,000
(C) ₹14,000
(D) ₹12,000

27. A customer buys a bike from a dealer for ₹60,000 or on the condition that he should pay ₹5,000 as a down payment and the remaining in three equal instalments. The dealer charges interest at the rate of 15% p.a. compounded half-yearly. If the customer buys the bike under an instalment plan, then the value of each instalment is:
(A) ₹20,145
(B) ₹21,154
(C) ₹22,674
(D) ₹21,145

28. Anil deposited ₹15,000 in a bank at the rate of 12% compounded annually. At the end of the first year, he added ₹x along with the matured amount and kept it in the bank for one more year. At the time of maturity of the same, he deposited ₹2x along with the matured sum and kept it for one more year. If by doing this, he ended up getting $\frac{17}{5}$ times of his initial deposit after 3 years, what is the value of x (in ₹) closest to?
(A) 7,368
(B) 8,386
(C) 8,564
(D) 8,743

29. Ramesh borrowed a certain sum of money at a certain rate of simple interest. If instead the sum was borrowed at compound interest with interest being compounded annually, the total interest for the first 2 years would have increased by ₹120, while the total interest for the first 3 years would have increased by ₹375, find the sum.

30. On a certain sum of money, total compound interest earned (with interest being compounded annually) at the end of 3 years is ₹10,140. Total compound interest at the end of 2 years is ₹16,510. Find the sum of money initially invested.
(A) ₹24,000
(B) ₹25,800
(C) ₹28,080
(D) ₹29,400

Solutions

1. 3 years

Let the amount be P and the rate of interest be r%.
For SI: principal = P, rate = r, time = 5 years.

Then SI = $\frac{(p \times r \times t)}{100} = \frac{(p \times r \times 5)}{100} = \frac{p \times r}{20}$

Hence, Amount = $P + SI = P + p \times r/20$
According to the question,

$$P + p \times \frac{r}{20} = 3P$$

$$\Rightarrow \quad p \times \frac{r}{20} = 2P$$

$$\Rightarrow \quad r = 40\% \qquad \text{....(i)}$$

For CI: principal = P, rate = 40, time = n years

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

$$\Rightarrow \quad P\left(1+\frac{40}{100}\right)^n = 2.5\ P \text{ (approximately)}$$

$$\Rightarrow \quad \left(\frac{7}{5}\right)^n = 2.5 \text{ (approximately)}$$

$$\Rightarrow \quad (1.4)^n = 2.5 \text{ (approximately)}$$

$$\Rightarrow \quad (1.4)^3 = 2.744 \text{ which is more than } 2.5$$

Therefore, a minimum of 3 years are required for the amount to become more than 2.5 times itself.

2. 72

Let us assume the principal = ₹P
According to the question

$$P\left(1+\frac{R}{100}\right)^{15} = 6174 \qquad \text{....(i)}$$

$$\Rightarrow P\left(1+\frac{R}{100}\right)^{20} = 43218 \qquad \text{....(ii)}$$

Divide equation (ii) by (i)

$$\left(1+\frac{R}{100}\right)^5 = 7$$

Taking cube of both sides

$$\left(1+\frac{R}{100}\right)^{15} = 7^3 = 343 \qquad \text{....(iii)}$$

From equations (i) and (iii)

$$P\left(1+\frac{R}{100}\right)^{15} = 6174$$

$$\Rightarrow P\ (343) = 6{,}174$$

$$\Rightarrow P = 18$$

Now, simple interest on ₹18 in 20 years at a 20% rate of interest

$$= \frac{18 \times 20 \times 20}{100} = 72$$

3. ₹11,800

SI for first 2 years = 2 × 12 % of 20,000 = 4,800.
Total amount due for Rohan at the end of 2 years = 20,000 + 4,800 = 24,800.
Let us assume that he paid ₹K at the end of 2 years.
So, net due at the end of 2 years
= 24,800 – K = principal for the next 3 years.
SI for next 3 years
= 3 × 12 % of (24,800 – K)
= 36% of (24,800 – K).
Total amount due for Rohan at the end of 5 years
= 136% of (24,800 – K) = 17,680, solving which we will get K = 11,800.
Hence, Rohan paid ₹11,800 at the end of 2 years.

4. (C)

The amount doubles in 4 years at a certain rate of simple interest.
Total interest in 4 years is 100%.
Hence, the rate of interest per year is 25%.

Time taken for the to be 1,500% (16 times)

$$= \frac{1500}{25} = 60 \text{ years.}$$

It doubles in 3 years in CI.

$$\text{Hence, } 2A = A\left(\frac{1+r}{100}\right)^3$$

For the amount to be 16 times, let the time taken be t years.

Hence, $16A = A\left(\frac{1+r}{100}\right)^t$

t = 12 years

So the number of years before the sum amounts to 16 times itself in simple interest than it would have amounted to 16 times itself in compound interest is 60 – 12 = 48 years.

Hence, option (C) is the correct answer.

5. (B)

Let the sum be ₹100.

Hence, the interest is ₹100.

$\therefore \quad 100 = \frac{100 \times 113 \times R}{12 \times 100}$

$\Rightarrow \quad R$ = 10.62% p.a.

$\therefore$ New rate of interest is 21.24% p.a.

Let after n years, the sum becomes thrice of itself.

$$300 = 100\left(1+\frac{21.24}{100}\right)^n$$

$\Rightarrow \quad 3 = (1.2124)^n$

For n = 2, RHS = 1.47

For n = 3, RHS = 1.78

For n = 4, RHS = 2.16

For n = 5, RHS = 2.62

In sixth year, the sum becomes thrice of itself.

Hence, option (B) is correct.

6. (A)

Let the sum of ₹P and rate of interest is r% per annum.

$\because$ Compound interest = Amount – Principal

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

Also, simple interest = $\frac{P \times 40\% \times r \times 4 \times 2}{100}$

Now, according to the question, both interests are equal.

$$\therefore \quad P\left(1+\frac{r}{100}\right)^2 - P = \frac{P \times r \times \frac{2}{5} \times 8}{100}$$

$$\Rightarrow 1+\frac{r^2}{100^2}+\frac{2r}{100}-1=\frac{16r}{500}$$

$$\Rightarrow r\left[\frac{r}{100^2}+\frac{2}{100}\right]=\frac{16}{500}$$

$$\Rightarrow r\,\frac{r}{100^2}=\frac{16}{500}-\frac{2}{100}$$

$$\Rightarrow \frac{r}{100^2}=\frac{16}{500}-\frac{10}{500}$$

$$\Rightarrow r=\frac{6}{500}\times 100\times 100$$

$\Rightarrow r$ = 120%

Hence the rate of interest is 120% per annum.

Hence, option (A) is the correct answer.

7. (A)

Since 20% of returns are deducted, 80% of returns are gained.

So resultant interest will be 80% of 10%

$= \frac{80}{100} \times 10\% = 8\%$

Amount gained

$= 2{,}50{,}000 \times \left(1+\frac{8}{100}\right)^3 - 2{,}50{,}000$

= ₹64,928

8. (D)

The financial institution compounds the interest at 8% or 2% per quarter.

Let the balance in the business man's credit (in ₹) = A.

Now, A = 50,000 [$(1.02)^4 + (1.02)^3 + (1.02)^2 + (1.02)$] = 50,000$k$.

where $k = (1.02)^4 + (1.02)^3 + (1.02)^2 + (1.02)$

= 1.08 + 1.06 + 1.04 + 1.02

= 4.2 (approximately)

Thus, A = 50,000 × 4.2 = ₹210,000.

Hence, option (D) is the correct answer.

9. (D)

Let the required rate of interest be r%.

Amount Rahim need to pay after 1 year = 56,000 (1 + r%).

Amount paid by Rahim at the end of 1 year = 35,000.

So, the net amount at which interest for the 2nd year will be calculated

= 56,000 (1 + r%) – 35,000

Now, the net amount with the interest he has to pay at the end of the second year [56,000 (1 + r%) – 35,000] (1 + r%).
Now, we know that in the second year, Rahim paid a total of 35,000 to clear all his dues towards Ram, so

[56,000 (1 + r%) – 35,000] (1 + r%) = 35,000

[56(1 + r%) – 35] (1 + r%) = 35

Let $m = 1 + r\%$

$\therefore$ $56m^2 - 35m - 35 = 0$

$\therefore$ $8m^2 - 5m - 5 = 0$

$$\therefore \quad m = \frac{-(-5) \pm \sqrt{(-5)^2 - 4 \times 8 \times -5}}{2 \times 8}$$

$$\therefore \quad m = \frac{5 \pm \sqrt{185}}{16}$$

$\therefore$ $m = 1.1625$

$\therefore$ $1 + r\% = 1.1625$

$\therefore$ $r\% = 0.1625$

$\therefore$ $r = 16.25\%$, which is approximately 16%.

10. (C)

Let us assume the sum = P and the rate of interest is R% p.a. compounded annually.

So, total compound interest at the end of 2 years $= P\left(\frac{1+R}{100}\right)^2 - P$

If we assume $\frac{R}{100} = K$, then the total CI at the end of 2 years

$= P(1 + K)^2 - P = 1,360$ ....(i)

Similarly, the total CI at the end of 3 years

$= P(1 + K)^3 - P = 2,170$ ....(ii)

Now, dividing equation (ii) by (i)

$$\frac{\left[P(1+K)^3 - P\right]}{\left[P(1+K)^2 - P\right]} = \frac{2170}{1360}$$

$$\Rightarrow \quad \frac{\left[(1+K)^3 - 1\right]}{\left[(1+K)^2 - 1\right]} = \frac{217}{136}$$

$$\Rightarrow \quad \frac{\left[K^2 + 3K + 3\right]}{\left[K + 2\right]} = \frac{217}{136}$$

Cross-multiplying and solving further, we will get $K = \frac{1}{8}$

$K = \frac{1}{8} = \frac{R}{100}$, which means $R = 12.5\%$

Put the value of K in equation (i)

$$P\left(1 + \frac{1}{8}\right)^2 - P = 1360$$

$$\Rightarrow \quad P \times \frac{17}{64} = 1,360$$

$P = 5,120$

Hence, option (C) is the correct answer.

11. (A)

The first \$20,000 would become 20,000 $(1.1)^6$ after 6 years; the second will become 20,000 $(1.1)^5$. The third will become 20,000 $(1.1)^4$, the fourth will become 20,000 $(1.1)^3$, the fifth will become 20000 $(1.1)^2$, and the sixth will become 20,000 (1.1).

Total amount= $20,000 [(1.1) + (1.1)^2 + (1.1)^3 + (1.1)^4 + (1.1)^5 + (1.1)^6]$

$= (20,000)(1.1)[1 + (1.1) + (1.1)^2 + (1.1)^3 + (1.1)^4 + (1.1)^5]$

$$= 22,000 \times \frac{(1.1)^6 - 1}{1.1 - 1} = \$169,744$$

12. 1,000

Let amount invested be a. Rate of interest is r.

$a(1 + r)^3 - a = 728$ ...(i)

$a(1 + 4)^2 - a = 440$ ...(ii)

Dividing the two equations, we get

$$\Rightarrow \frac{(1+r)^3 - 1}{(1+r)^2 - 1} = \frac{728}{440}$$

$$\Rightarrow \frac{(1+r)^3 - 1}{(1+r)^2 - 1} = \frac{0.728}{0.440}$$

$$\Rightarrow \frac{(1+r)^3 - 1}{(1+r)^2 - 1} = \frac{1.728 - 1}{1.440 - 1}$$

$$\Rightarrow \frac{(1+r)^3 - 1}{(1+r)^2 - 1} = \frac{(1.2)^3 - 1}{(1.2)^2 - 1} d$$

$\Rightarrow r = 20\%$

$\Rightarrow a(1 + r)^2 - a = 440$

$\Rightarrow a((1 + r)^2 - 1) = 440$

$\Rightarrow a \times 0.44 = 440$

$\Rightarrow a = 1,000$

13. 70,000

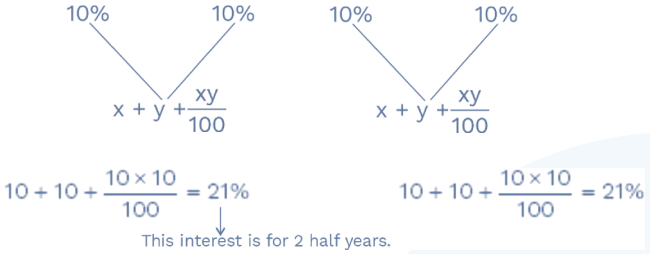
Since the interest is compounded half yearly.

Half-yearly rate of interest = $\frac{20}{2}$ = 10%

Also, 2 years means 4 half years.

If we apply the successive change formula $\left(x + y + \frac{xy}{100}\right)$

Then,



Again, apply the successive change for getting interest for 4 half years.

Therefore, $21 + 21 + \frac{21 \times 21}{100} = 46.41\%$

Total compound interest after 2 years or 4 half years compounded half-yearly = 46.41%

Since we know that the principal is always 100%.

Amount = P + CI = 100% + 46. 41%

= 146.41%

146.41% ₹102,487

100% $\frac{102,487}{146.41} \times 100$ = ₹70,000

Hence, the amount of money that Kamal had invested is ₹70,000.

14. ₹42,080

The interest obtained by Kamal on ₹24,000 at 16% p.a.

In 1 year = 24,000 × 16% = ₹3,840

Again, the interest obtained by Kamal on ₹20,000 @ 12% p.a. compounded semi-annually.

Since interest compounds semi-annually

∴ Semi-annually = $\frac{12\%}{2}$ = 6%

Therefore, interest in 1 year (2 half years):

$6 + 6 + \frac{6 \times 6}{100} = 12.36\%$

∴ Interest obtained in ₹ on

The principal amount ₹20,000

= 20,000 × 12.36% = 1,236 × 2 = ₹2,472.

Total interest obtained by Kamal on both principals

= ₹3,840 + ₹2,472 = ₹6,312

Now according to the question, since Kamal and Vimal get the same amount of interest, let the amount invested by Vimal is ₹x.

x × 15% = ₹6,312

$x \times \frac{3}{20}$ = ₹6,312

or x = ₹42,080

∴ Amount invested by Vimal is ₹42,080.

15. (C)

Let the sum invested be P.

r = rate of interest

n = 3 (for CI)

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

Given that in 3 years, $A = \frac{216}{125}P$

$\Rightarrow \quad \frac{216}{125}P = P\left(1 + \frac{r}{100}\right)^3$

$\Rightarrow \quad \left(1 + \frac{r}{100}\right)^3 = \frac{216}{125}$

Taking cube root on both sides:

$\Rightarrow \quad 1 + \frac{r}{100} = \frac{6}{5}$

$\Rightarrow \quad \frac{r}{100} = \frac{6}{5} - 1 = \frac{1}{5}$

$\Rightarrow \quad r = \frac{1}{5} \times 100 = 20\%$

Now for SI:

P = Principal

$r = \frac{1}{2} \times 20 = 10$

T =?

Also, amount is tripled = (3P)
So, $A = P + SI$ or $3P = P + SI \Rightarrow SI = 2P$.
Substituting above values is

$SI = \frac{P \times r \times T}{100}$ or $2P = \frac{P \times 10 \times T}{100} \Rightarrow T = 20$ years.

So, in 20 years, the same amount will triple when invested in SI.
Hence, option (C) is the correct answer.

16. ₹30,720

As the rate of interest for CI = 12.5% = $\left(\frac{1}{8}\right)$ and we have to do compounding 3 times.
So, let us assume principal = P = (8 × 8 × 8) K = 512K.

$SI \text{ for 3 years} = 3 \times \left(8 + \frac{1}{3}\right)\% \text{ of } 512K =$

$3 \times \left(\frac{25}{3}\right)\% \text{ of } 512K$

$= 25\% \text{ of } 512K = \frac{1}{4} \times 512K = 128K$

CI first year = 12.5% of 512K = $\frac{1}{8} \times 512K$
= 64K

CI second year = $64K + \frac{1}{8} \times 64K = 72K$

CI third year = $72K + \frac{1}{8} \times 72K = 81K$

CI 3 year = 64K + 72K + 81K = 217K

Given $CI_{3year} - SI_{3year} = 5,340$

$217K - 128K = 5,340$

$89K = 5,340$ or $K = 60$

Required sum = 512K = 512 × 60 = ₹30,720.

17. ₹1,42,400

Let the principal amount be ₹P.
∴ Amount at the end of 2 years at 12.5% compound interest

$$P\left(1 + \frac{12.5}{100}\right)^2 = P\left(1 + \frac{1}{8}\right)^2 = P\left(\frac{9}{8}\right)^2$$

Thus, compound interest was obtained in 2 years.

= Amount − Principal

$$= P\left(\frac{9}{8}\right)^2 - P = \frac{81P - 64P}{64} = \frac{17P}{64}$$

Also, according to the second condition, we have to find the simple interest for 4 years at 6% per annum and the same principal.

$$SI = \frac{P \times 6 \times 4}{100} = \frac{6P}{25}$$

Therefore, $CI_{2 \text{ years}} - SI_{4 \text{ years}} = ₹3,649$

$$\frac{17P}{64} - \frac{6P}{25} = 3649$$

$$\frac{425P - 384P}{64 \times 25} = 3649$$

$$\frac{41P}{64 \times 25} = 3649$$

P = 89 × 64 × 25

P = ₹1,42,400

Hence, the principal amount is ₹1,42,400.

18. (B)

Let the money invested in schemes be ₹10,000 each.
Total interest in SI after 3 years: $\frac{Prt}{100} = \frac{10,000 \times 10 \times 3}{100} = 3,000$.
Amount in SI after 3 years: P + SI
= ₹10,000 + ₹3,000 = ₹13,000.
Amount in CI after 2 years: $P\left(1 + \frac{r}{100}\right)^2 = 10,000\left(\frac{11}{10}\right)^2 = 12,100$ which acts as the principal amount for the third year.
Let the interest rate in the third year be x%.
Amount at end of 3 years = 13,000

$$A = 12,100\left(1 + \frac{x}{100}\right)^1 = 13,000$$

$$\left(1 + \frac{x}{100}\right) = \frac{130}{121}$$

$$\frac{x}{100} = \frac{130}{121} - 1 = \frac{9}{121}$$

$$x = \frac{900}{121} \approx 7.438\% \approx 7.44\%$$

19. (D)

The initial deposit is ₹15,000, and the rate of interest every year is 10% per annum compounded annually.

Matured amount at the end of first year = 1.2 (15,000) = 18,000.

Amount invested at the beginning of the second year = 18,000 + K.

Matured amount at the end of the second year = 1.2 (18,000 + K) = 21,600 + 1.2K.

Amount invested at the beginning of the third year = 21,600 + 1.2K + 2K

= 21,600 + 3.2K.

Matured amount at the end of the third year = 1.2 (21,600 + 3.2K) = 25,920 + 3.84K

According to the question 25,920 + 3.84K

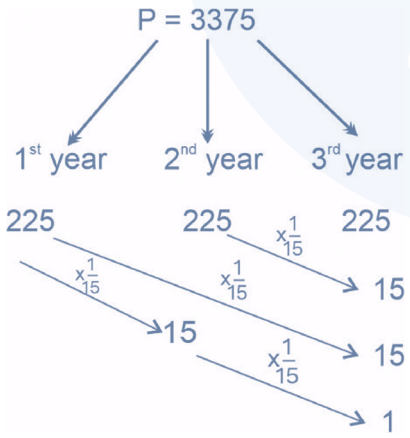
$= \frac{13}{5}(15{,}000) = 39{,}000$

which means K = approximately equal to 3,400.

20. (B)

Here r = 6.6% = $\frac{1}{15}$. Since time is 3 years.

For simplicity, Let $P = (15)^3$ = ₹3,375 units



Since compound interest for third year –

Simple interest for third year = ₹775

31 units = ₹775

1 unit = ₹25

Hence, compound interest for 3 years = (225 × 3) × (15 × 3) + 1

= 821 units = 721 × 25 = ₹18,025

Hence, option (B) is the correct answer.

21. (C)

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

Since interest is compounded quarterly, the rate of interest per quarter

$= \frac{12}{4} = 3\%$

Amount = $56{,}00{,}000\left(1+\frac{3}{100}\right)^8$

Therefore, $56{,}00{,}000\left(1+\frac{3}{100}\right)^8$

$= x\times\left(1+\frac{3}{100}\right)^7 + x\times\left(1+\frac{3}{100}\right)^6 + x\times\left(1+\frac{3}{100}\right)^1 + x\left(1+\frac{3}{100}\right)^0$

$56{,}00{,}000(1.2667) = x\times\frac{\left[(1.03)^8-1\right]}{1.03-1}$

$70{,}93{,}520 = x\times\frac{\left[1.2667-1\right]}{(1.03-1)}$

$70{,}93{,}520 = \frac{x\times 0.2667}{0.03}$

70,93,520 = x × 8.89

x = ₹7,97,921.2598, which is approximately equal to ₹80,000.

Hence, Sanjay has to pay each instalment of ₹80,000 approximately.

22. (B)

Simple interest for 10 years = $500

Therefore, SI for 1 year = $50

Therefore, SI for 5 years = $250

Now, if the principal is made four times, the interest will also become four times.

Therefore, SI for the next 5 years

= $ 500 × 4 = $2,000.

So, y = 2,000

Now, the rest part $= 1-\frac{1}{3}-\frac{1}{6}=\frac{1}{2}$

As the principal is x.

$600 = \frac{\frac{x}{3}\times 3\times 2}{100} + \frac{\frac{x}{6}\times 6\times 2}{100} + \frac{\frac{x}{2}\times 8\times 2}{100}$

So, x = 5,000.

So, (B) is the correct option.

23. (A)

Rahul will pay $400 + 100\frac{\{10,000 \times 1\}}{100}$

In the next month $400 + 96\frac{\{9,600 \times 1\}}{100}$

Last month he will pay $400 + 4\frac{\{400 \times 1\}}{100}$

So this will take 25 months $= \frac{10,000}{400}$

The total amount he will pay is 400 × 25 + (100 + 96 + 92 +...+ 4)

$$10,000 + \frac{(100+4)}{2} \times 25$$

10,000 + 1,300 = 11,300.

24. (C)

Given: Raju borrowed ₹2,00,000 at 10% per annum compound interest compounded annually.

Amount to be paid after 1 year = ₹2,00,000 × 1.1 = ₹2,20,000.

Suppose the first Instalment is x.

So, the remaining amount after first instalment is paid = ₹220,000 – x.

Remaining amount for second year = ₹(220,000 - x) × 1.1 = instalment for the second year.

We have, instalment for year 1 = instalment for year 2 = x

$\Rightarrow$(220,000 - x) × 1.1 = x

$\Rightarrow$ 242,000 - 1.1x = x

$\Rightarrow$ 2.1x = 2,42,000

$\Rightarrow x = \frac{2,45,300}{2.1}$

$\Rightarrow x$ = 1,15,238.095

Hence, each instalment is ₹1,15,238.095

25. (D)

Given: Jagan invested 50% of his income in Plan X and the remaining in Plan Y for the same 2 years in SI and CI, respectively.

Let P and R be the principal amount and rate of interest for both SI and CI.

Then, for Plan X,

SI, $\frac{P \times R \times 2}{100} = 550$

$\Rightarrow \frac{PR}{100} = 275$ .....(i)

For Plan Y,

CI, $P\left\{\left(1+\frac{R}{100}\right)^2 - 1\right\} = 605$

$\Rightarrow \frac{PR}{100}\left(\frac{R}{100} + 2\right) = 605$

$\Rightarrow 275\left(\frac{R}{100} + 2\right) = 605$ .....using equation (i)

$\Rightarrow \left(\frac{R}{100}\right) = +2 = \frac{605}{275}$

$\Rightarrow \frac{R}{100} = \left(\frac{121}{55}\right) - 2$

$\Rightarrow \frac{R}{100} = \frac{1}{5}$

$\Rightarrow R$ = 20%

Again, from equation (i)

$$P \times \frac{20}{100} = 275$$

$\Rightarrow P$ = 275 × 5

$\Rightarrow P$ = 1,375.

Total amount before investment = $P + P$ = ₹1,375 + ₹1,375 = ₹2,750.

Hence, the total income of Jagan before the investment is ₹2,750.

26. (A)

Sungha borrowed ₹30,000 from Alisha at 10% compound interest compounded annually. She paid total ₹36,000.

Repayment is made in three instalments.

Three annual instalments are in A.P.

Let $a - d$, a, $a + d$ are the instalment paid in the first, second, and third years, respectively.

Now, $a - d + a + a + d$ = 36,000

$\Rightarrow$ 3a = 36,000

$\Rightarrow$ a = 12,000

Instalments are 12,000 – d, 12,000, 12,000 – d.

Total amount to be paid after the first year = ₹ 30,000 × 1.1 = ₹ 33,000.

End of the first year,
Amount to be paid after the first instalment,
33,000 – (12,000 -d) = 21,000 + d
End of the second year,
Total amount to be paid (21,000 + d) × 1.1 = 23,100 + 1.1d
Remaining amount to be paid after second instalment,
23,100 + 1.1d – 12,000 = 11,100 + 1.1d
End of third year,
Total amount to be paid,
(11,100 + 1.1d) × 1.1 = 12,000 + d
$\Rightarrow$ 12,210 + 1.21d = 12,000 + d
$\Rightarrow$ -0.21d = 210
$\Rightarrow$ d = –1,000
Therefore, the first instalment is
12,000 – d = 12,000 –(–1,000) = ₹ 13,000
Hence, Sumegha paid ₹13,000 in the first year.

27. (B)

Given: Total cost of the bike = ₹60,000
Down payment by customer = ₹5,000
Remaining amount to be paid
= ₹60,000 – ₹5,000 = ₹55,000.
Rate of interest = 15% per year compounded half-yearly.
Let the value of each instalment be ₹x.
Present worth of ₹x due 6 months; hence + present worth of ₹x due 1 year; hence + present worth of ₹x due 3/2 years; hence = 55,000

$$55,000 = \frac{x}{\left(1+\frac{15}{2\times 100}\right)} + \frac{x}{\left(1+\frac{15}{2\times 100}\right)^2} + \frac{x}{\left(1+\frac{15}{2\times 100}\right)^3}$$

$\Rightarrow$ 55,000 = (40/43)x + $(40/43)^2x$ + $(40/43)^3x$
$\Rightarrow$ 55,000 = (40/43)x + (1,600/1,849) + (64,000/79,507)x
$\Rightarrow$ 55,000 = 0.930x + 0.865x + 0.805x
$\Rightarrow$ 55,000 = 2.6x
$\Rightarrow$ $x = \frac{55000}{2.6}$
$\Rightarrow$ x = 21,154
Hence, the value of each instalment is ₹21,154.

28. (C)

The initial deposit is ₹15,000, and the rate of interest every year is 12% per annum compounded annually.

Deposit	Matured Amount	Years Completed
15,000	1.12(15,000) = 16,800	1
(16,800) + x	1.12(16,800 + x) = 18,816 + 1.12x	2
(18,816 + (1.12x)	1.12(18,816 + 3.12x) = 21,073.92 + 3.4944x	3

We know that the amount becomes double of the initial deposit after 3 years
21,073.92 + 3.4944x = $\frac{17}{5}$ × 15,000
So, 3.4944x = 29,926.08
x = 8,564 (approx.).

29. ₹7,680

Let us assume the sum = P and rate of interest = R% p.a. compounded annually.
Now, in the first year SI = CI = R% of P = A
(Here we have assumed R% of P = A.)
In second year, SI = R% of P = A
CI = A + R% of A = A + B (Here we have assumed R% of A = B).
So, difference in the total CI and total SI in 2 years = (2A+ B) – 2A = B = 120
In the third year, SI = R% of P = A
CI = (A + B) + R% of (A + B)
= A + B + R% of A + R% of B
= A + B + B + C = A + 2B + C
(Here we have assumed R% of B = C.)
So, difference in the total CI and total SI in 3 years.
= (A + 2B + C + A + B + A) – 3A = 3B + C = 375
3B + C = 375
3 × 120 + C = 375
C = 15
R% of B = C

R% of 120 = 15, which means R = 12.5%.
Now, R% of A = B
12.5% of A = 120, which means A = 960.
Now, R% of P = A
12.5% of P = 960, which means P = 7,680.

30. (C)

Let us assume the sum = P and rate of interest = R% p.a. compounded annually. So, total compound interest at the end of 2 years $= P\left(\frac{1+R}{100}\right)^2 - P$

If we assume $\frac{R}{100} = K$, then total CI at the end of 2 years

$= P(1 + K)^2 - P = 10{,}140$ ....(i)

Similarly, the total CI at the end of 3 years

$= P(1 + K)^3 - P = 16{,}510$ ....(ii)

Now, divide equation (ii) by (i)

$$\frac{\left[P(1+K)^3 - P\right]}{\left[P(1+K)^2 - P\right]} = \frac{16,510}{10,140}$$

$$\Rightarrow \frac{\left[(1+K)^3 - 1\right]}{\left[(1+K)^2 - 1\right]} = \frac{127}{78}$$

$$\Rightarrow \frac{\left[K^2 + 3K + 3\right]}{\left[K + 2\right]} = \frac{127}{78}$$

Cross multiplying and solving further we will get $K = \frac{1}{6}$

$K = \frac{1}{6} = \frac{R}{100}$, which means R = 16.66%

Put the value of K in I

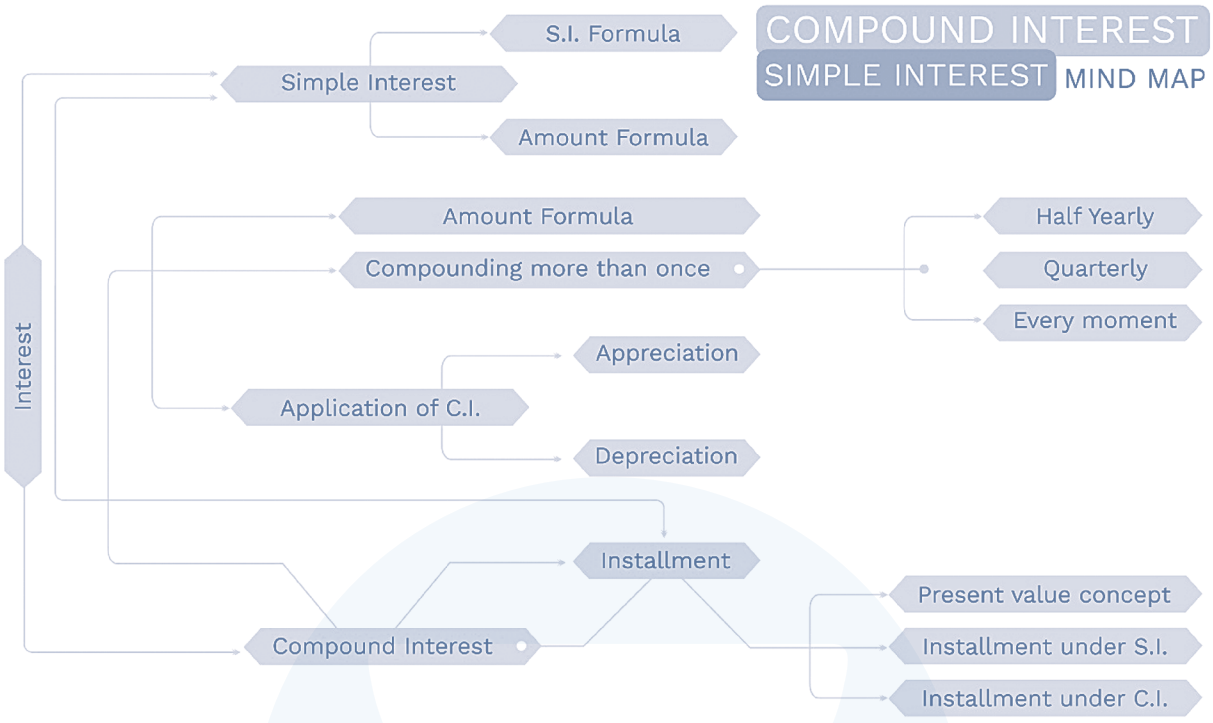
$$P\left(1+\frac{1}{6}\right)^2 - P = 10{,}140$$

$$\Rightarrow P \times \frac{13}{36} = 10{,}140$$

P = 28,080

Hence, option (C) is the correct answer.

Mind Map


COMPOUND INTEREST
SIMPLE INTEREST MIND MAP
Interest
Simple Interest
S.I. Formula
Amount Formula
Compound Interest
Amount Formula
Compounding more than once
Half Yearly
Quarterly
Every moment
Application of C.I.
Appreciation
Depreciation
Installment
Present value concept
Installment under S.I.
Installment under C.I.