

Interest

INTRODUCTION

The chapter on Interest forms another important topic from the CAT's point of view. Questions from this chapter are a regular feature of QA section of the Online CAT. Besides, this chapter also has the additional importance of being a core chapter for Data Interpretation.

Prior to studying this chapter however, you are required to ensure that a clear understanding of percentages and percentage calculation is a must. The faster you are at percentage calculation, the faster you will be in solving questions of interests.

However, questions on interest are still important for exams like MAT, SNAP, ATMA, CMAT, IRMA and Bank P.O. exams. Hence, if you are planning to go for the entire spectrum of management exams—this chapter retains its importance in terms of mathematics too.

Questions from LOD I and LOD II of the chapter regularly appear in exams like the Bank PO or others management exams.

CONCEPT OF TIME VALUE OF MONEY

The value of money is not constant. This is one of the principal facts on which the entire economic world is based. A rupee today will not be equal to a rupee tomorrow. Hence, a rupee borrowed today cannot be repaid by a rupee tomorrow. This is the basic need for the concept of interest. The rate of interest is used to determine the difference between what is borrowed and what is repaid.

There are two basis on which interests are calculated:

Simple Interest It is calculated on the basis of a basic amount borrowed for the entire period at a particular rate

of interest. The amount borrowed is the principal for the entire period of borrowing.

Compound Interest The interest of the previous year/s is/are added to the principal for the calculation of the compound interest.

This difference will be clear from the following illustration:

A sum of ₹ 1000 at 10% per annum will have

<i>Simple interest</i>		<i>Compound interest</i>
₹ 100	First year	₹ 100
₹ 100	Second year	₹ 110
₹ 100	Third year	₹ 121
₹ 100	Fourth year	₹ 133.1

Note that the previous years' interests are added to the original sum of ₹ 1000 to calculate the interest to be paid in the case of compound interest.

Terminology Pertaining to Interest

The man who lends money is the **Creditor** and the man who borrows money is the **Debtor**.

The amount of money that is initially borrowed is called the **Capital** or **Principal** money.

The period for which money is deposited or borrowed is called **Time**.

The extra money, that will be paid or received for the use of the principal after a certain period is called the **Total interest** on the capital.

The sum of the principal and the interest at the end of any time is called the **Amount**.

So, **Amount = Principal + Total Interest.**

Rate of Interest is the rate at which the interest is calculated and is always specified in percentage terms.

SIMPLE INTEREST

The interest of 1 year for every ₹ 100 is called the **Interest rate** per annum. If we say “the rate of interest per annum is $r\%$ ”, we mean that ₹ r is the interest on a principal of ₹ 100 for 1 year.

Relation Among Principal, Time, Rate Percent of Interest Per Annum and Total Interest

Suppose, Principal = ₹ P , Time = t years, Rate of interest per annum = $r\%$ and Total interest = ₹ I

Then
$$I = \frac{P \times t \times r}{100}$$

i.e. Total interest

$$= \frac{\text{Principal} \times \text{Time} \times \text{Rate of interest per annum}}{100}$$

Since the Amount = Principal + Total interest, we can write

$$\therefore \text{Amount (A)} = P + \frac{P \times t \times r}{100}$$

$$\text{Time} = \left(\frac{\text{Total interest}}{\text{Interest on the Principal for one year}} \right) \text{ years}$$

Thus, if we have the total interest as ₹ 300 and the interest per year is ₹ 50, then we can say that the number of years is $300/50 = 6$ years.

Note: The rate of interest is normally specified in terms of annual rate of interest. In such a case we take the time t in years.

However, if the rate of interest is specified in terms of 6-monthly rate, we take time in terms of 6 months.

Also, the half-yearly rate of interest is half the annual rate of interest. That is if the interest is 10% per annum to be charged six-monthly, we have to add interest every six months @ 5%.

COMPOUND INTEREST

In monetary transactions, often, the borrower and the lender, in order to settle an account, agree on a certain amount of interest to be paid to the lender on the basis of specified unit of time. This may be yearly or half-yearly or quarterly, with the condition that the interest accrued to the principal at a certain interval of time be added to the principal so that the total amount at the end of an interval becomes the principal for the next interval. Thus, it is different from simple interest.

In such cases, the interest for the first interval is added to the principal and this amount becomes the principal for the second interval, and so on.

The difference between the amount and the money borrowed is called the *compound interest* for the given interval.

Formula

Case 1: Let principal = P , time = n years and rate = $r\%$ per annum and let A be the total amount at the end of n years, then

$$A = P \left[1 + \frac{r}{100} \right]^n$$

Case 2: When compound interest is reckoned half-yearly.

If the annual rate is $r\%$ per annum and is to be calculated for n years.

Then in this case, rate = $(r/2)\%$ half-yearly and time = $(2n)$ half-years.

$\therefore$ From the above we get

$$A = P \left[1 + \frac{r/2}{100} \right]^{2n}$$

Case 3: When compound interest is reckoned quarterly.

In this case, rate = $(r/4)\%$ quarterly and time = $(4n)$ quarter years.

$\therefore$ As before,

$$A = P \left[1 + \frac{r/4}{100} \right]^{4n}$$

Note: The difference between the compound interest and the simple interest over two years is given by

$$Pr^2/100^2 \quad \text{or} \quad P \left(\frac{r}{100} \right)^2$$

DEPRECIATION OF VALUE

The value of a machine or any other article subject to wear and tear, decreases with time.

This decrease is called its *depreciation*.

Thus if V_0 is the value at a certain time and $r\%$ per annum is the rate of depreciation per year, then the value V_1 at the end of t years is

$$V_1 = V_0 \left[1 - \frac{r}{100} \right]^t$$

POPULATION

The problems on Population change are similar to the problems on Compound Interest. The formulae applicable to the problems on compound interest also apply to those on population. The only difference is that in the application of formulae, the annual rate of change of population replaces the rate of compound interest.

However, unlike in compound interest where the rate is always positive, the population can decrease. In such a case, we have to treat population change as we treated depreciation of value illustrated above.

The students should see the chapter on interests essentially as an extension of the concept of percentages. All the rules of percentage calculation, which were elucidated in the chapter of percentages, will apply to the chapter on interests. Specifically, in the case of compound interests, the percentage rule for calculation of percentage values will be highly beneficial for the student.

Besides, while solving the questions on interests the student should be aware of the possibility of using the given options to arrive at the solution. In fact, I feel that the formulae on Compound Interest (CI) unnecessarily make a very simple topic overly mathematical. Besides, the CI formulae are the most unusable formulae available in this level of mathematics since it is virtually impossible for the student to calculate a number like 1.08 raised to the power 3, 4, 5 or more.

Instead, in my opinion, you should view CI problems simply as an extension of the concept of successive percentage increases and tackle the calculations required through approximations and through the use of the percentage rule of calculations.

Thus, a calculation: 4 years increase at 6% pa CI on ₹ 120 would yield an expression: 120×1.06^4 . It would be impossible for an average student to attempt such a question and even if one uses advanced techniques of calculations, one will end up using more time than one has. Instead, if you have to solve this problem, you should look at it from the following percentage change graphic perspective:

$$120 \xrightarrow[=7.2]{+6\%} 127.2 \xrightarrow[6+1.62]{+6\%} 134.82 \xrightarrow[6+2.1]{+6\%} 142.92 \xrightarrow[6+2.58]{+6\%} 15.15 \text{ (approx.)}$$

If you try to check the answer on a calculator, you will discover that you have a very close approximation. Besides, given the fact that you would be working with options and given sufficiently comfortable options, you need not calculate so closely; instead, save time through the use of approximations.

APPLICATIONS OF INTEREST IN D.I.

The difference between Simple Annual Growth Rate and Compound Annual Growth Rate:

The Measurement of Growth Rates is a prime concern in business and Economics. While a manager might be interested in calculating the growth rates in the sales of his product, an economist might be interested in finding out the rate of growth of the GDP of an economy.

In mathematical terms, there are basically two ways in which growth rates are calculated. To familiarize yourself with this, consider the following example.

The sales of a brand of scooters increase from 100 to 120 units in a particular city. What does this mean to you? Simply that there is a percentage increase of 20% in the sales of the scooters. Now read further:

What if the sales moves from 120 to 140 in the next year and 140 to 160 in the third year? Obviously, there is a constant and uniform growth from 100 to 120 to 160 – i.e. a growth of exactly 20 units per year. In terms of the overall growth in the value of the sales over there years, it can be easily seen that the sale has grown by 60 on 100 i.e. 60% growth.

In this case, what does 20% represent? If you look at this situation as a plain problem of interests 20% represents the simple interest that will make 100 grow to 160.

In the context of D.I., this value of 20% interest is also called the Simple Annual Growth Rate. (SAGR)

The process for calculating SAGR is simply the same as that for calculating Simple Interest.

Suppose a value grows from 100 to 200 in 10 years – the SAGR is got by the simple calculation $100\%/10 = 10\%$

What is Compound Annual Growth Rate (CAGR)?

Let us consider a simple situation. Let us go back to the scooter company.

Suppose, the company increases its sales by 20% in the first year and then again increases its sales by 20% in the second year and also the third year. In such a situation, the sales (taking 100 as a starting value) trend can be easily tracked as below:

$$100 \xrightarrow[+20]{20\% \uparrow} 120 \xrightarrow[+24]{20\% \uparrow} 144 \xrightarrow[+28.8]{20\% \uparrow} 172.8$$

As you must have realised, this calculation is pretty similar to the calculation of Compound interests. In the above case, 20% is the rate of compound interest which will change 100 to 172.8 in three years.

This 20% is also called as the Compound Annual Growth Rate (CAGR) in the context of Data interpretation.

Obviously, the calculation of the CAGR is much more difficult than the calculation of the SAGR and the Compound Interest formula is essentially a waste of time for anything more than 3 years.

(upto three years, if you know your squares and the methods for the cubes you can still feasibly work things out

– but beyond three years it becomes pretty much infeasible to calculate the compound interest).

So is there an alternative? Yes there is and the alternative largely depends on your ability to add well. Hence, before trying out what I am about to tell you, I would recommend you should strengthen yourself at addition.

Suppose you have to calculate the C.I. on ₹ 100 at the rate of 10% per annum for a period of 10 years.

You can combine a mixture of PCG used for successive changes with guesstimation to get a pretty accurate value.

In this case, since the percentage increase is exactly 10% (Which is perhaps the easiest percentage to calculate), we can use PCG all the way as follows:

$$\begin{array}{l}
 100 \xrightarrow[+10]{10\% \uparrow} 110 \xrightarrow[+11]{10\% \uparrow} 121 \xrightarrow[+12.1]{10\% \uparrow} 133.1 \\
 \xrightarrow[+13.31]{10\% \uparrow} 146.4 \\
 \xrightarrow[14.64]{10\% \uparrow} 161.04 \xrightarrow[16.10]{10\% \uparrow} 177.14 \xrightarrow[17.71]{10\% \uparrow} 194.8 \\
 \xrightarrow[19.48]{10\% \uparrow} \dots \\
 214.3 \xrightarrow[21.43]{10\% \uparrow} 235.7 \xrightarrow[23.57]{10\% \uparrow} 259.2
 \end{array}$$

Thus, the percentage increase after 10 years @ 10% will be 159.2 (approx).

However, this was the easy part. What would you do if you had to calculate 12% CI for 10 years. The percentage calculations would obviously become much more difficult and infeasible. How can we tackle this situation?

$$100 \xrightarrow[+12]{12\% \uparrow} 112 \xrightarrow[?]{12\% \uparrow} ?$$

In order to understand how to tackle the second percentage increase in the above PCG, let's try to evaluate where we are in the question.

We have to calculate 12% of 112, which is the same as 12% of 100 + 12% of 12.

But we have already calculated 12% of 100 as 12 for the first arrow of the PCG. Hence, we now have to calculate 12% of 12 and add it to 12% of 100.

Hence the addition has to be:

$$12 + 1.44 = 13.44$$

Take note of the addition of 1.44 in this step. It will be significant later. The PCG will now look like:

$$100 \longrightarrow 112 \longrightarrow 125.44 \xrightarrow[?]{12\% \uparrow} ?$$

We are now faced with a situation of calculating 12% of 125.44. Obviously, if you try to do this directly, you will have great difficulty in calculations. We can sidestep this as follows:

$$12\% \text{ of } 125.44 = 12\% \text{ of } 112 + 12\% \text{ of } 13.44.$$

But we have already calculated 12% of 112 as 13.44 in the previous step.

Hence, our calculation changes to:

$$12\% \text{ of } 112 + 12\% \text{ of } 13.44 = 13.44 + 12\% \text{ of } 13.44$$

But 12% of 13.44 = 12% of 12 + 12% of 1.44. We have already calculated 12% of 12 as 1.44 in the previous step.

$$\text{Hence } 12\% \text{ of } 13.44 = 1.44 + 12\% \text{ of } 1.44$$

$$= 1.44 + 0.17 = 1.61 \text{ (approx)}$$

Hence, the overall addition is

$$13.44 + 1.61 = 15.05$$

Now, your PCG looks like:

$$100 \xrightarrow{+12} 112 \xrightarrow{+13.44} 125.44 \xrightarrow{+15.05} 140.49 \xrightarrow{+?} ?$$

You are again at the same point—faced with calculating the rather intimidating looking 12% of 140.49

$$12\% \text{ of } 140.49 = 12\% \text{ of } 125.44 + 12\% \text{ of } 15.05$$

already calculated

Compare this to the previous calculation:

$$12\% \text{ of } 125.44 = 12\% \text{ of } 112 + 12\% \text{ of } 13.44$$

already calculated

The only calculation that has changed is that you have to calculate 12% of 15.05 instead of 12% of 13.44. (which was approx 1.61). In this case it will be approximately 1.8. Hence you shall now add 16.85 and the PCG will look as:

$$100 \xrightarrow{+12} 112 \xrightarrow{+13.44} 125.44 \xrightarrow{+15.05} 140.49 \xrightarrow{+16.85} 157.34$$

If you evaluate the change in the value added at every arrow in the PCG above, you will see a trend—

The additions were:

+12, +13.44 (change in addition = 1.44), +15.05 (change in addition = 1.61), +16.85 (change in addition = 1.8)

If you now evaluate the change in the change in addition, you will realize that the values are 0.17, 0.19. This will be a slightly increasing series (And can be easily approximated).

Thus, the following table (on the next page) shows the approximate calculation of 12% CI for 10 years with an initial value of 100.

Thus, 100 becomes 309.78

(a percentage increase of 209.78%)

Similarly, in the case of every other compound interest calculation, you can simply find the trend that the first 2 – 3 years interest is going to follow and continue that trend to get a close approximate value of the overall percentage increase.

Thus for instance 7% growth for 7 years at C.I. would mean:

$$\begin{array}{l}
 100 \xrightarrow{+7} 107 \xrightarrow{+7.49} 114.49 \xrightarrow{+8.01} 122.5 \\
 \xrightarrow{+8.55} 131.05 \\
 \xrightarrow{+9.11} 140.16 \xrightarrow{+9.75} 149.91 \xrightarrow{+10.35} 160.24
 \end{array}$$

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At the end of	Principal (approx.)	Interest for the year	Change in Addition	Change in change in Addition
year 0	100	+12		
year 1	112	+13.44	1.44	0.17
year 2	125.44	+15.05	1.61	0.19
year 3	140.49	+16.85	1.8	0.21
year 4	157.36	+18.86	2.01	0.24
year 5	176.2	21.11	2.25	0.28
year 6	197.3	23.62	2.51	0.31
year 7	220.92	26.41	2.79	0.35
year 8	247.33	29.5	3.1	
year 9	276.83	32.95	3.45	
year 10	309.78			

This series is approximated giving all values in this table.

An approximate growth of 60.24%
The actual value (on a calculation) is around 60.57% –
Hence as you can see we have a pretty decent approximation for the answer.
Note: The increase in the addition will need to be increased at a greater rate than as an A.P. Thus, in this case if we had considered the increase to be an A.P. the respective addition would have been:

+7, +7.49, +8.01, +8.55, +9.11, +9.69, +10.29.
However +7, +7.49, +8.01, +8.55, +9.11, +9.75, +10.35 are the actual addition used. Notice that using 9.75 instead of 9.69 is a deliberate adjustment, since while using C.I. the impact on the addition due to the interest on the interest shows an ever increasing behaviour.

Space for Notes



WORKED-OUT PROBLEMS

Problem 7.1 The SI on a sum of money is 25% of the principal, and the rate per annum is equal to the number of years. Find the rate percent.

- (a) 4.5% (b) 6%
(c) 5% (d) 8%

Solution

Let principal = x , time = t years

Then interest = $x/4$, rate = $t\%$

Now, using the SI formula, we get

$$\text{Interest} = (\text{Principal} \times \text{Rate} \times \text{Time})/100$$

$$\Rightarrow x/4 = (x \times t \times t)/100$$

$$\Rightarrow t^2 = 25$$

$$\Rightarrow t = 5\%$$

Alternatively, you can also solve this by using the options, wherein you should check that when you divide 25 by the value of the option, you get the option's value as the answer.

Thus, $25/4.5 \neq 4.5$. Hence, option (a) is incorrect.

Also, $25/6 \neq 6$. Hence option (b) is incorrect.

Checking for option (c) we get, $25/5 = 5$. Hence, (c) is the answer.

Problem 7.2 The rate of interest for first 3 years is 6% per annum, for the next 4 years, 7 per cent per annum and for the period beyond 7 years, 7.5 percentages per annum. If a man lent out ₹ 1200 for 11 years, find the total interest earned by him?

- (a) ₹ 1002 (b) ₹ 912
(c) ₹ 864 (d) ₹ 948

Solution

Whenever it is not mentioned whether we have to assume SI or CI we should assume SI.

For any amount, interest for the 1st three years @ 6% SI will be equal to $6 \times 3 = 18\%$

Again, interest for next 4 years will be equal to $7 \times 4 = 28\%$.

And interest for next 4 years (till 11 years) $- 7.5 \times 4 = 30\%$

So, total interest = $18 + 28 + 30 = 76\%$

So, total interest earned by him = 76% of the amount

$$= \frac{(76 \times 1200)}{100} = ₹ 912$$

This calculation can be done very conveniently using the percentage rule as $75\% + 1\% = 900 + 12 = 912$.

Problem 7.3 A sum of money doubles itself in 12 years. Find the rate percentage per annum.

- (a) 12.5% (b) 8.33%
(c) 10% (d) 7.51%

Solution Let principal = x , then interest = x , time = 12 years.

Using the formula, Rate = $(\text{Interest} \times 100)/\text{Principal} \times \text{Time}$

$$= (x \times 100)/(x \times 12) = 8.33\%$$

Alternatively: It is obvious that in 12 years, 100% of the amount is added as interest.

So, in 1 year = $(100/12)\%$ of the amount is added.

Hence, every year there is an addition of 8.33% (which is the rate of simple interest required).

Alternatively, you can also use the formula.

If a sum of money gets doubled in x years, then rate of interest = $(100/x)\%$.

Problem 7.4 A certain sum of money amounts to ₹ 704 in 2 years and ₹ 800 in 5 years. Find the principal.

- (a) ₹ 580 (b) ₹ 600
(c) ₹ 660 (d) ₹ 640

Solution Let the principal be ₹ x and rate = $r\%$.

Then, difference in between the interest of 5 years and of 2 years equals to

$$₹ 800 - ₹ 704 = ₹ 96$$

So, interest for 3 years = ₹ 96

Hence, interest/year = ₹ $96/3 = ₹ 32$

So, interest for 2 years $\rightarrow 2 \times ₹ 32 = ₹ 64$

So, the principal = ₹ $704 - ₹ 64 = ₹ 640$

Thought process here should be

₹ 96 interest in 3 years $\rightarrow ₹ 32$ interest every year.

Hence, principal = $704 - 64 = 640$

Problems 7.5 A sum of money was invested at SI at a certain rate for 3 years. Had it been invested at a 4% higher rate, it would have fetched ₹ 480 more. Find the principal.

- (a) ₹ 4000 (b) ₹ 4400
(c) ₹ 5000 (d) ₹ 3500

Solution Let the rate be $y\%$ and principal be ₹ x and the time be 3 years.

Then according to the question = $(x(y + 4) \times 3)/100 - (xy \times 3)/100 = 480$

$$\Rightarrow xy + 4x - xy = 160 \times 100$$

$$\Rightarrow x = (160 \times 100)/4 = ₹ 4000$$

Alternatively: Excess money obtained = 3 years @ 4% per annum

= 12% of whole money

So, according to the question, 12% = ₹ 480

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So, $100\% = ₹ 4000$ (answer arrived at by using unitary method.)

Problem 7.6 A certain sum of money trebles itself in 8 years. In how many years it will be five times?

- (a) 22 years (b) 16 years
(c) 20 years (d) 24 years

Solution It trebles itself in 8 years, which makes interest equal to 200% of principal.

So, 200% is added in 8 years.

Hence, 400%, which makes the whole amount equal to five times of the principal, which will be added in 16 years.

Problem 7.7 If CI is charged on a certain sum for 2 years at 10% the amount becomes 605. Find the principal?

- (a) ₹ 550 (b) ₹ 450
(c) ₹ 480 (d) ₹ 500

Solution Using the formula, $\text{amount} = \text{Principal} (1 + \text{rate}/100)^{\text{time}}$

$$605 = p(1 + 10/100)^2 = p(11/10)^2$$
$$p = 605(100/121) = ₹ 500$$

Alternatively: Checking the options,

Option (a) ₹ 550

First year interest = ₹ 55, which gives the total amount ₹ 605 at the end of first year. So not a valid option.

Option (b) ₹ 450

First year interest = ₹ 45

Second year interest = ₹ 45 + 10% of ₹ 45 = 49.5

So, amount at the end of 2 years = 450 + 94.5 = 544.5

So, not valid.

Hence answer has to lie between 450 and 550 (since 450 yields a shortfall on ₹ 605 while 550 yields an excess.)

Option (c) ₹ 480

First year interest = ₹ 48

Second year interest = ₹ 48 + 10% of ₹ 48 = 52.8

So, amount at the end of 2 years = 580.8 ≠ 605

Option (d) ₹ 500

First year's interest = ₹ 50

Second year's interest = ₹ 50 + 10% of ₹ 50
= ₹ 55.

∴ Amount = 605.

Note: In general, while solving through options, the student should use the principal of starting with the middle (in terms of value), more convenient option. This will often reduce the number of options to be checked by the student, thus reducing the time required for problem solving drastically. In fact, this thumb rule should be used not only for the chapter of interests but for all other chapters in maths.

Furthermore, a look at the past question papers of exams like Lower level MBA exams and bank PO exams

will yield that by solving through options and starting with the middle more convenient option, there will be significant time savings for these exams where the questions are essentially asked from the LOD I level.

Problem 7.8 If the difference between the CI and SI on a certain sum of money is ₹ 72 at 12 per cent per annum for 2 years, then find the amount.

- (a) ₹ 6000 (b) ₹ 5000
(c) ₹ 5500 (d) ₹ 6500

Solution Let the principal = x

Simple interest = $(x \times 12 \times 2)/100$

Compound interest = $x[1 + 12/100]^2 - x$

So, $x[112/100]^2 - x - 24x/100 = 72$

$x[112^2/100^2 - 1 - 24/100] = 72 \Rightarrow x[12544/10000 - 1 - 24/100] = 72$

$\Rightarrow x = 72 \times 10000/144 = ₹ 5000$

Alternatively: Simple interest and compound interest for the first year on any amount is the same.

Difference in the second year's interest is due to the fact that compound interest is calculated over the first year's interest also.

Hence, we can say that ₹ 72 = Interest on first year's interest $\rightarrow$ 12% on first year's interest = ₹ 72.

Hence, first year's interest = ₹ 600 which should be 12% of the original capital. Hence, original capital = ₹ 5000 (this whole process can be done mentally).

You can also try to solve the question through the use of options as follows.

Option (a) ₹ 6000

First year's CI/SI = ₹ 720

Difference between second year's CI and SI = 12% of ₹ 720 ≠ ₹ 72

Hence, not correct.

Option (b) ₹ 5000

First year's CI/SI = 12% of ₹ 5000 = ₹ 600

Difference between second year's CI and SI = 12% of 600 = 72 year's CI and SI = 12% of 600 = ₹ 72

Hence option (b) is the correct answer.

Therefore we need not check any other options.

Problem 7.9 The population of Jhumri Tilaiya increases by 10% in the first year, it increases by 20% in the second year and due to mass exodus, it decreases by 5% in the third year. What will be its population after 3 years, if today it is 10,000?

- (a) 11,540 (b) 13,860
(c) 12,860 (d) 12,540

Solution Population at the end of 1 year will be $\rightarrow 10,000 + 10\% \text{ of } 10,000 = 11,000$

At the end of second year it will be $11,000 + 20\% \text{ of } 11,000 = 13,200$

At the end of third year it will be $13,200 - 5\%$ of $13,200 = 12,540$.

Problem 7.10 Seth Ankoosh Gawdekar borrows a sum of ₹ 1200 at the beginning of a year. After 4 months, ₹ 1800 more is borrowed at a rate of interest double the previous one. At the end of the year, the sum of interest on both the loans is ₹ 216. What is the first rate of interest per annum?

- (a) 9% (b) 6%
(c) 8% (d) 12%

Solution Let the rate of interest be $= r\%$

Then, interest earned from ₹ 1200 at the end of year $= (1200r)/100 = ₹ 12r$

Again, interest earned from ₹ 1800 at the end of year $= (1800/100) \times (8/12) \times 2r = ₹ 24r$

So, total interest earned $= 36r$, which equals 216

$$\Rightarrow r = 216/36 = 6\%$$

Alternatively: Checking the options.

Option (a) 9%

Interest from ₹ 1200 $= 9\%$ of 1200 $= 108$

Interest from ₹ 1800 $=$ two-thirds of 18% on ₹ 1800 $= 12\%$ on ₹ 1800 $= ₹ 216$

Total interest $= ₹ 324$

Option (b) 6%

Interest earned from ₹ 1200 $= 6\%$ on 1200 $= ₹ 72$

Interest earned from ₹ 1800 $=$ two-thirds of 12% on ₹ 1800 $= ₹ 144$

(We were able to calculate the interest over second part very easily after observing in option (a) that interest earned over second part is double the interest earned over first part).

Total interest $= ₹ 216$

We need not check any other option now.

Problem 7.11 Rajiv lend out ₹ 9 to Anni on condition that the amount is payable in 10 months by 10 equal instal-

ments of ₹ 1 each payable at the start of every month. What is the rate of interest per annum if the first instalment has to be paid one month from the date the loan is availed.

Solution Money coming in : ₹ 9 today

Money going out:

₹ 1 one month later + ₹ 1, 2 months later ... + ₹ 1, 10 months later.

The value of the money coming in should equal the value of the money going out for the loan to be completely paid off.

In the present case, for this to happen, the following equation has to hold:

₹ 9 + Interest on ₹ 9 for 10 months $=$ (₹ 1 + Interest on ₹ 1 for 9 months) + (₹ 1 + interest on ₹ 1 for 8 months)

+ (₹ 1 + interest on ₹ 1 for 7 months) + (₹ 1 + interest on ₹ 1 for 6 months)

+ (₹ 1 + interest on ₹ 1 for 5 months) + (₹ 1 + interest on ₹ 1 for 4 months)

+ (₹ 1 + interest on ₹ 1 for 3 months) + (₹ 1 + interest on ₹ 1 for 2 months)

+ (₹ 1 + interest on ₹ 1 for 1 months) + (₹ 1)

₹ 9 + Interest on ₹ 1 for 90 months $=$ ₹ 10 + Interest on ₹ 10 for 45 months.

$\rightarrow$ Interest on ₹ 1 for 90 months $-$ Interest on ₹ 1 for 45 months $=$ ₹ 10 $-$ ₹ 9

$\rightarrow$ Interest on ₹ 1 for 45 months $=$ ₹ 1 (i.e. money would double in 45 months.)

Hence the rate of interest $= \frac{100\%}{45} = 2.222\%$ per month.

So, the annual rate of interest $= 26.66\%$ per annum.

Note: The starting equation used to solve this problem comes from crediting the borrower with the interest due to early payment for each of his first nine instalments.

Space for Rough Work

LEVEL OF DIFFICULTY (I)

1. ₹ 1200 is lent out at 5% per annum simple interest for 3 years. Find the amount after 3 years.
(a) ₹ 1380 (b) ₹ 1290
(c) ₹ 1470 (d) ₹ 1200
2. Interest obtained on a sum of ₹ 5000 for 3 years is ₹ 1500. Find the rate percent.
(a) 8% (b) 9%
(c) 10% (d) 11%
3. ₹ 2100 is lent at compound interest of 5% per annum for 2 years. Find the amount after two years.
(a) ₹ 2300 (b) ₹ 2315.25
(c) ₹ 2310 (d) ₹ 2320
4. ₹ 1694 is repaid after two years at compound interest. Which of the following is the value of the principal and the rate?
(a) ₹ 1200, 20% (b) ₹ 1300, 15%
(c) ₹ 1400, 10% (d) ₹ 1500, 12%
5. Find the difference between the simple and the compound interest at 5% per annum for 2 years on a principal of ₹ 2000.
(a) 5 (b) 105
(c) 4.5 (d) 5.5
6. Find the rate of interest if the amount after 2 years of simple interest on a capital of ₹ 1200 is ₹ 1440.
(a) 8% (b) 9%
(c) 10% (d) 11%
7. After how many years will a sum of ₹ 12,500 become ₹ 17,500 at the rate of 10% per annum?
(a) 2 years (b) 3 years
(c) 4 years (d) 5 years
8. What is the difference between the simple interest on a principal of ₹ 500 being calculated at 5% per annum for 3 years and 4% per annum for 4 years?
(a) ₹ 5 (b) ₹ 10
(c) ₹ 20 (d) ₹ 40
9. What is the simple interest on a sum of ₹ 700 if the rate of interest for the first 3 years is 8% per annum and for the last 2 years is 7.5% per annum?
(a) ₹ 269.5 (b) ₹ 283
(c) ₹ 273 (d) ₹ 280
10. What is the simple interest for 9 years on a sum of ₹ 800 if the rate of interest for the first 4 years is 8% per annum and for the last 4 years is 6% per annum?
(a) 400 (b) 392
(c) 352 (d) Cannot be determined
11. What is the difference between compound interest and simple interest for the sum of ₹ 20,000 over a 2 year period if the compound interest is calculated at 20% and simple interest is calculated at 23%?
(a) ₹ 400 (b) ₹ 460
(c) ₹ 440 (d) ₹ 450
12. Find the compound interest on ₹ 1000 at the rate of 20% per annum for 18 months when interest is compounded half-yearly.
(a) ₹ 331 (b) ₹ 1331
(c) ₹ 320 (d) ₹ 325
13. Find the principal if the interest compounded at the rate of 10% per annum for two years is ₹ 420.
(a) ₹ 2000 (b) ₹ 2200
(c) ₹ 1000 (d) ₹ 1100
14. Find the principal if compound interest is charged on the principal at the rate of $16\frac{2}{3}\%$ per annum for two years and the sum becomes ₹ 196.
(a) ₹ 140 (b) ₹ 154
(c) ₹ 150 (d) ₹ 144
15. The SBI lent ₹ 1331 to the Tata group at a compound interest and got ₹ 1728 after three years. What is the rate of interest charged if the interest is compounded annually?
(a) 11% (b) 9.09%
(c) 12% (d) 8.33%
16. In what time will ₹ 3300 become ₹ 3399 at 6% per annum interest compounded half-yearly?
(a) 6 months (b) 1 year
(c) $1\frac{1}{2}$ year (d) 3 months
17. Ranjan purchased a Maruti van for ₹ 1,96,000 and the rate of depreciation is $14\frac{2}{7}\%$ per annum. Find the value of the van after two years.
(a) ₹ 1,40,000 (b) ₹ 1,44,000
(c) ₹ 1,50,000 (d) ₹ 1,60,000
18. At what percentage per annum, will ₹ 10,000 amount to 17,280 in three years? (Compound Interest being reckoned)
(a) 20% (b) 14%
(c) 24% (d) 11%
19. Vinay deposited ₹ 8000 in ICICI Bank, which pays him 12% interest per annum compounded

- quarterly. What is the amount that he receives after 15 months?
- (a) ₹ 9274.2 (b) ₹ 9228.8
(c) ₹ 9314.3 (d) ₹ 9338.8
20. What is the rate of simple interest for the first 4 years if the sum of ₹ 360 becomes ₹ 540 in 9 years and the rate of interest for the last 5 years is 6%?
- (a) 4% (b) 5%
(c) 3% (d) 6%
21. Harsh makes a fixed deposit of ₹ 20,000 with the Bank of India for a period of 3 years. If the rate of interest be 13% SI per annum charged half-yearly, what amount will he get after 42 months?
- (a) 27,800 (b) 28,100
(c) 29,100 (d) 28,500
22. Ranjeet makes a deposit of ₹ 50,000 in the Punjab National Bank for a period of $2\frac{1}{2}$ years. If the rate of interest is 12% per annum compounded half-yearly, find the maturity value of the money deposited by him.
- (a) 66,911.27 (b) 66,123.34
(c) 67,925.95 (d) 65,550.8
23. Vinod makes a deposit of ₹ 100,000 in Syndicate Bank for a period of 2 years. If the rate of interest be 12% per annum compounded half-yearly, what amount will he get after 2 years?
- (a) 122,247.89 (b) 125,436.79
(c) 126,247.69 (d) 122436.89
24. What will be the simple interest on ₹ 700 at 9% per annum for the period from February 5, 1994 to April 18, 1994?
- (a) ₹ 12.60 (b) ₹ 11.30
(c) ₹ 15 (d) ₹ 13
25. Ajay borrows ₹ 1500 from two moneylenders. He pays interest at the rate of 12% per annum for one loan and at the rate of 14% per annum for the other. The total interest he pays for the entire year is ₹ 186. How much does he borrow at the rate of 12%?
- (a) ₹ 1200 (b) ₹ 1300
(c) ₹ 1400 (d) ₹ 300
26. A sum was invested at simple interest at a certain interest for 2 years. It would have fetched ₹ 60 more had it been invested at 2% higher rate. What was the sum?
- (a) ₹ 1500 (b) ₹ 1300
(c) ₹ 2500 (d) ₹ 1000
27. The difference between simple and compound interest on a sum of money at 5% per annum is ₹ 25. What is the sum?
- (a) ₹ 5000 (b) ₹ 10,000
(c) ₹ 4000 (d) Data insufficient
28. A sum of money is borrowed and paid back in two equal annual instalments of ₹ 882, allowing 5% compound interest. The sum borrowed was
- (a) ₹ 1640 (b) ₹ 1680
(c) ₹ 1620 (d) ₹ 1700
29. Two equal sums were borrowed at 8% simple interest per annum for 2 years and 3 years respectively. The difference in the interest was ₹ 56. The sum borrowed were
- (a) ₹ 690 (b) ₹ 700
(c) ₹ 740 (d) ₹ 780
30. In what time will the simple interest on ₹ 1750 at 9% per annum be the same as that on ₹ 2500 at 10.5% per annum in 4 years?
- (a) 6 years and 8 months
(b) 7 years and 3 months
(c) 6 years
(d) 7 years and 6 months
31. In what time will ₹ 500 give ₹ 50 as interest at the rate of 5% per annum simple interest?
- (a) 2 years (b) 5 years
(c) 3 years (d) 4 years
32. Shashikant derives an annual income of ₹ 688.25 from ₹ 10,000 invested partly at 8% p.a. and partly at 5% p.a. simple interest. How much of his money is invested at 5% ?
- (a) ₹ 5000 (b) ₹ 4225
(c) ₹ 4800 (d) ₹ 3725
33. If the difference between the simple interest and compound interest on some principal amount at 20% per annum for 3 years is ₹ 48, then the principle amount must be
- (a) ₹ 550 (b) ₹ 500
(c) ₹ 375 (d) ₹ 400
34. Raju lent ₹ 400 to Ajay for 2 years, and ₹ 100 to Manoj for 4 years and received together from both ₹ 60 as interest. Find the rate of interest, simple interest being calculated.
- (a) 5% (b) 6%
(c) 8% (d) 9%
35. In what time will ₹ 8000 amount to 40,000 at 4% per annum? (simple interest being reckoned)
- (a) 100 years (b) 50 years
(c) 110 years (d) 160 years
36. What annual payment will discharge a debt of ₹ 808 due in 2 years at 2% per annum?
- (a) ₹ 200 (b) ₹ 300
(c) ₹ 400 (d) ₹ 350
37. A sum of money becomes 4 times at simple interest in 10 years. What is the rate of interest?

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- (a) 10% (b) 20%
(c) 30% (d) 40%
38. A sum of money doubles itself in 5 years. In how many years will it become four fold (if interest is compounded)?
(a) 15 (b) 10
(c) 20 (d) 12
39. A difference between the interest received from two different banks on ₹ 400 for 2 years is ₹ 4. What is the difference between their rates?
(a) 0.5% (b) 0.2%
(c) 0.23% (d) 0.52%
40. A sum of money placed at compound interest doubles itself in 3 years. In how many years will it amount to 8 times itself?
(a) 9 years (b) 8 years
(c) 27 years (d) 7 years
41. If the compound interest on a certain sum for 2 years is ₹ 21. What could be the simple interest?
(a) ₹ 20 (b) ₹ 16
(c) ₹ 18 (d) ₹ 20.5
42. Divide ₹ 6000 into two parts so that simple interest on the first part for 2 years at 6% p.a. may be equal to the simple interest on the second part for 3 years at 8% p.a.
(a) ₹ 4000, ₹ 2000 (b) ₹ 5000, ₹ 1000
(c) ₹ 3000, ₹ 3000 (d) None of these
43. Divide ₹ 3903 between Amar and Akbar such that Amar's share at the end of 7 years is equal to Akbar's share at the end of 9 years at 4% p.a. rate of compound interest.
(a) Amar = ₹ 2028, Akbar = ₹ 1875
(b) Amar = ₹ 2008, Akbar = ₹ 1000
(c) Amar = ₹ 2902, Akbar = ₹ 1001
(d) Amar = ₹ 2600, Akbar = ₹ 1303
44. A sum of money becomes $\frac{7}{4}$ of itself in 6 years at a certain rate of simple interest. Find the rate of interest.
(a) 12% (b) 12.5%
(c) 8% (d) 14%
45. Sanjay borrowed ₹ 900 at 4% p.a. and ₹ 1100 at 5% p.a. for the same duration. He had to pay ₹ 364 in all as interest. What is the time period in years?
(a) 5 years (b) 3 years
(c) 2 years (d) 4 years
46. If the difference between compound and simple interest on a certain sum of money for 3 years at 2% p.a. is ₹ 604, what is the sum?
(a) 5,00,000 (b) 4,50,000
(c) 5,10,000 (d) None of these
47. If a certain sum of money becomes double at simple interest in 12 years, what would be the rate of interest per annum?
(a) 8.33 (b) 10
(c) 12 (d) 14
48. Three persons Amar, Akbar and Anthony invested different amounts in a fixed deposit scheme for one year at the rate of 12% per annum and earned a total interest of ₹ 3,240 at the end of the year. If the amount invested by Akbar is ₹ 5000 more than the amount invested by Amar and the amount invested by Anthony is ₹ 2000 more than the amount invested by Akbar, what is the amount invested by Akbar?
(a) ₹ 12,000 (b) ₹ 10,000
(c) ₹ 7000 (d) ₹ 5000
49. A sum of ₹ 600 amounts to ₹ 720 in 4 years at Simple Interest. What will it amount to if the rate of interest is increased by 2%?
(a) ₹ 648 (b) ₹ 768
(c) ₹ 726 (d) ₹ 792
50. What is the amount of equal instalment, if a sum of ₹ 1428 due 2 years hence has to be completely repaid in 2 equal annual instalments starting next year.
(a) 700 (b) 800
(c) 650 (d) Cannot be determined

Space for Rough Work

LEVEL OF DIFFICULTY (II)

1. A sum of money invested at simple interest triples itself in 8 years at simple interest. Find in how many years will it become 8 times itself at the same rate?
(a) 24 years (b) 28 years
(c) 30 years (d) 21 years
 2. A sum of money invested at simple interest triples itself in 8 years. How many times will it become in 20 years time?
(a) 8 times (b) 7 times
(c) 6 times (d) 9 times
 3. If ₹ 1100 is obtained after lending out ₹ x at 5% per annum for 2 years and ₹ 1800 is obtained after lending out ₹ y at 10% per annum for 2 years, find $x + y$.
(a) ₹ 2500 (b) ₹ 3000
(c) ₹ 2000 (d) ₹ 2200
- Directions for Questions 4 to 6:** Read the following and answer the questions that follow.
4. A certain sum of money was lent under the following repayment scheme based on Simple Interest:
8% per annum for the initial 2 years
9.5% per annum for the next 4 years
11% per annum for the next 2 years
12% per annum after the first 8 years
Find the amount which a sum of ₹ 9000 taken for 12 years becomes at the end of 12 years.
(a) 20,200 (b) 19,800
(c) 20,000 (d) 20,160
 5. If a person repaid ₹ 22,500 after 10 years of borrowing a loan, at 10% per annum simple interest find out what amount did he take as a loan?
(a) 11,225 (b) 11,250
(c) 10,000 (d) 7500
 6. Mr. X, a very industrious person, wants to establish his own unit. For this he needs an instant loan of ₹ 5,00,000 and, every five years he requires an additional loan of ₹ 100,000. If he had to clear all his outstandings in 20 years, and he repays the principal of the first loan equally over the 20 years, find what amount he would have to pay as interest on his initial borrowing if the rate of interest is 10% p.a. Simple Interest.
(a) ₹ 560,000 (b) ₹ 540,000
(c) ₹ 525,000 (d) ₹ 500,000
7. The population of a city is 200,000. If the annual birth rate and the annual death rate are 6% and 3% respectively, then calculate the population of the city after 2 years.
(a) 212,090 (b) 206,090
(c) 212,000 (d) 212,180
 8. A part of ₹ 38,800 is lent out at 6% per six months. The rest of the amount is lent out at 5% per annum after one year. The ratio of interest after 3 years from the time when first amount was lent out is 5 : 4. Find the second part that was lent out at 5%.
(a) ₹ 26,600 (b) ₹ 28,800
(c) ₹ 27,500 (d) ₹ 28,000
 9. If the simple interest is 10.5% annual and compound interest is 10% annual, find the difference between the interests after 3 years on a sum of ₹ 1000.
(a) ₹ 15 (b) ₹ 12
(c) ₹ 16 (d) ₹ 11
 10. A sum of ₹ 1000 after 3 years at compound interest becomes a certain amount that is equal to the amount that is the result of a 3 year depreciation from ₹ 1728. Find the difference between the rates of CI and depreciation. (Given CI is 10% p.a.). (Approximately)
(a) 3.33% (b) 0.66%
(c) 3% (d) 2%
 11. The RBI lends a certain amount to the SBI on simple interest for two years at 20%. The SBI gives this entire amount to Bharti Telecom on compound interest for two years at the same rate annually. Find the percentage earning of the SBI at the end of two years on the entire amount.
(a) 4% (b) $3(1/7)\%$
(c) $3(2/7)\%$ (d) $3(6/7)\%$
 12. Find the compound interest on ₹ 64,000 for 1 year at the rate of 10% per annum compounded quarterly (to the nearest integer).
(a) ₹ 8215 (b) ₹ 8205
(c) ₹ 8185 (d) None of these
 13. If a principal P becomes Q in 2 years when interest $R\%$ is compounded half-yearly. And if the same principal P becomes Q in 2 years when interest $S\%$ is compound annually, then which of the following is true?
(a) $R > S$ (b) $R = S$
(c) $R < S$ (d) $R \leq S$
 14. Find the compound interest at the rate of 10% for 3 years on that principal which in 3 years at the rate of 10% per annum gives ₹ 300 as simple interest.

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- (a) ₹ 331 (b) ₹ 310
(c) ₹ 330 (d) ₹ 333
15. The difference between CI and SI on a certain sum of money at 10% per annum for 3 years is ₹ 620. Find the principal if it is known that the interest is compounded annually.
(a) ₹ 200,000 (b) ₹ 20,000
(c) ₹ 10,000 (d) ₹ 100,000
16. The population of Mangalore was 1283575 on 1 January 2011 and the growth rate of population was 10% in the last year and 5% in the years prior to it, the only exception being 2009 when because of a huge exodus there was a decline of 20% in population. What was the population on January 1, 2005?
(a) 1,000,000 (b) 1,200,000
(c) 1,250,000 (d) 1,500,000
17. According to the 2011 census, the population growth rate of Lucknow is going to be an increasing AP with first year's rate as 5% and common difference as 5%, but simultaneously the migration, rate is an increasing GP with first term as 1% and common ratio of 2. If the population on 31 December 2010 is 1 million, then find in which year will Lucknow witness its first fall in population?
(a) 2015 (b) 2016
(c) 2017 (d) 2018
18. Mohit Anand borrows a certain sum of money from the Mindworkzz Bank at 10% per annum at compound interest. The entire debt is discharged in full by Mohit Anand on payment of two equal amounts of ₹ 1000 each, one at the end of the first year and the other at the end of the second year. What is the approximate value of the amount borrowed by him?
(a) ₹ 1852 (b) ₹ 1736
(c) ₹ 1694 (d) ₹ 1792
19. In order to buy a car, a man borrowed ₹ 180,000 on the condition that he had to pay 7.5% interest every year. He also agreed to repay the principal in equal annual instalments over 21 years. After a certain number of years, however, the rate of interest has been reduced to 7%. It is also known that at the end of the agreed period, he will have paid in all ₹ 270,900 in interest. For how many years does he pay at the reduced interest rate?
(a) 7 years (b) 12 years
(c) 14 years (d) 16 years
20. A sum of ₹ 8000 is borrowed at 5% p.a. compound interest and paid back in 3 equal annual instalments. What is the amount of each instalment?
(a) ₹ 2937.67 (b) ₹ 3000
(c) ₹ 2037.67 (d) ₹ 2739.76
21. Three amounts x , y and z are such that y is the simple interest on x and z is the simple interest on y . If in all the three cases, rate of interest per annum and the time for which interest is calculated is the same, then find the relation between x , y and z .
(a) $xyz = 1$ (b) $x^2 = yz$
(c) $z = x^2y$ (d) $y^2 = xz$
22. A person lent out some money for 1 year at 6% per annum simple interest and after 18 months, he again lent out the same money at a simple interest of 24% per annum. In both the cases, he got ₹ 4704. Which of these could be the amount that was lent out in each case if interest is paid half-yearly?
(a) ₹ 4000 (b) ₹ 4400
(c) ₹ 4200 (d) ₹ 3600
23. A person bought a motorbike under the following scheme: Down payment of ₹ 15,000 and the rest amount at 8% per annum for 2 years. In this way, he paid ₹ 28,920 in total. Find the actual price of the motorbike. (Assume simple interest).
(a) ₹ 26,000 (b) ₹ 27,000
(c) ₹ 27,200 (d) ₹ 26,500
24. Hans Kumar borrows ₹ 7000 at simple interest from the village moneylender. At the end of 3 years, he again borrows ₹ 3000 and closes his account after paying ₹ 4615 as interest after 8 years from the time he made the first borrowing. Find the rate of interest.
(a) 3.5% (b) 4.5%
(c) 5.5% (d) 6.5%
25. Some amount was lent at 6% per annum simple interest. After one year, ₹ 6800 is repaid and the rest of the amount is repaid at 5% per annum. If the second year's interest is half of the first year's interest, find what amount of money was lent out.
(a) ₹ 17,000 (b) ₹ 16,800
(c) ₹ 16,500 (d) ₹ 17,500
26. An amount of ₹ 12820 due 3 years hence, is fully repaid in three annual instalments starting after 1 year. The first instalment is $\frac{1}{2}$ the second instalment and the second instalment is $\frac{2}{3}$ of the third instalment. If the rate of interest is 10% per annum, find the first instalment.
(a) ₹ 2400 (b) ₹ 1800
(c) ₹ 2000 (d) ₹ 2500

Directions for Questions 27 and 28: Read the following and answer the questions that follow.

The leading Indian bank ISBI, in the aftermath of the Kargil episode, announced a loan scheme for the Indian Army. Under this scheme; the following options were available.

	<i>Loans upto</i>	<i>Soft loan</i>	<i>Interest (Normal)</i>
Scheme 1	₹ 50,000	50% of total	8%
Scheme 2	₹ 75,000	40% of total	10%
Scheme 3	₹ 100,000	30% of total	12%
Scheme 4	₹ 200,000	20% of total	14%

Soft loan is a part of the total loan and the interest on this loan is half the normal rate of interest charged.

27. Soldier *A* took some loan under scheme 1, soldier *B* under scheme 2, soldier *C* under scheme 3 and soldier *D* under scheme 4. If they get the maximum loan under their respective schemes for one year, find which loan is MUL (MUL—Maximum Utility Loan, is defined as the ratio of the total loan to interest paid over the time. Lower this ratio the better the MUL).
- (a) *A* (b) *B*
(c) *C* (d) *D*
28. Extending this plan, ISBI further announced that widows of all the martyrs can get the loans in which the proportion of soft loan will be double. This increase in the proportion of the soft loan component is only applicable for the first year. For all subsequent years, the soft loan component applicable on the loan,

follows the values provided in the table. The widow of a soldier takes ₹ 40,000 under scheme 1 in one account for 1 year and ₹ 60,000 under scheme 2 for 2 years. Find the total interest paid by her over the 2 year period.

- (a) ₹ 11,600 (b) ₹ 10,000
(c) ₹ 8800 (d) None of these
29. A sum is divided between *A* and *B* in the ratio of 1 : 2. *A* purchased a car from his part, which depreciates $14\frac{2}{7}\%$ per annum and *B* deposited his amount in a bank, which pays him 20% interest per annum compounded annually. By what percentage will the total sum of money increase after two years due to this investment pattern (approximately)?
- (a) 20% (b) 26.66%
(c) 30% (d) 25%
30. Michael Bolton has \$90,000 with him. He purchases a car, a laptop and a flat for \$15,000, \$13,000 and \$35,000 respectively and puts the remaining money in a bank deposit that pays compound interest @15% per annum. After 2 years, he sells off the three items at 80% of their original price and also withdraws his entire money from the bank by closing the account. What is the total change in his asset?
- (a) -4.5% (b) +3.5%
(c) -4.32% (d) +5.5%

Space for Rough Work

ANSWER KEY

Level of Difficulty (I)

- | | | | |
|---------|---------|---------|---------|
| 1. (a) | 2. (c) | 3. (b) | 4. (c) |
| 5. (a) | 6. (c) | 7. (c) | 8. (a) |
| 9. (c) | 10. (d) | 11. (a) | 12. (a) |
| 13. (a) | 14. (d) | 15. (b) | 16. (a) |
| 17. (b) | 18. (a) | 19. (a) | 20. (b) |
| 21. (c) | 22. (a) | 23. (c) | 24. (a) |
| 25. (a) | 26. (a) | 27. (d) | 28. (a) |
| 29. (b) | 30. (a) | 31. (a) | 32. (d) |
| 33. (c) | 34. (a) | 35. (a) | 36. (c) |
| 37. (c) | 38. (b) | 39. (a) | 40. (a) |
| 41. (a) | 42. (a) | 43. (a) | 44. (b) |
| 45. (d) | 46. (a) | 47. (a) | 48. (b) |
| 49. (b) | 50. (d) | | |

Level of Difficulty (II)

- | | | | |
|---------|---------|---------|---------|
| 1. (b) | 2. (c) | 3. (a) | 4. (d) |
| 5. (b) | 6. (c) | 7. (d) | 8. (b) |
| 9. (c) | 10. (d) | 11. (a) | 12. (d) |
| 13. (c) | 14. (a) | 15. (b) | 16. (b) |
| 17. (b) | 18. (b) | 19. (c) | 20. (a) |
| 21. (d) | 22. (c) | 23. (b) | 24. (d) |
| 25. (a) | 26. (c) | 27. (a) | 28. (b) |
| 29. (a) | 30. (c) | | |

Solutions and Shortcuts

Level of Difficulty (I)

- The annual interest would be ₹ 60. After 3 years the total value would be $1200 + 60 \times 3 = 1380$
- The interest earned per year would be $1500/3 = 500$. This represents a 10% rate of interest.
- $2100 + 5\% \text{ of } 2100 = 2100 + 105 = 2205$ (after 1 year). Next year it would become:
 $2205 + 5\% \text{ of } 2205 = 2205 + 110.25 = 2315.25$
- $1400 \xrightarrow{10\% \uparrow} 1540 \xrightarrow{10\% \uparrow} 1694$.
- Simple Interest for 2 years = $100 + 100 = 200$.
Compound interest for 2 years: Year 1 = 5% of 2000 = 100.
Year 2: 5% of 2100 = 105 → Total compound interest = ₹ 205.
Difference between the Simple and Compound interest = $205 - 200 = ₹ 5$
- Interest in 2 years = ₹ 240.
Interest per year = ₹ 120
Rate of interest = 10%
- 12500 @ 10% simple interest would give an interest of ₹ 1250 per annum. For a total interest of ₹ 5000, it would take 4 years.

- 5% for 3 years (SI) = 15% of the amount; At the same time 4% SI for 4 years means 16% of the amount. The difference between the two is 1% of the amount. 1% of 500 = ₹ 5
- 8% @ 700 = ₹ 56 per year for 3 years
 $7.5\% \text{ @ } 700 = ₹ 52.5$ per year for 2 years
Total interest = $56 \times 3 + 52.5 \times 2 = 273$.
- 8% of 800 for 4 years + 6% of 800 for 4 years = $64 \times 4 + 48 \times 4 = 256 + 192 = 448$. However, we do not know the rate of interest applicable in the 5th year and hence cannot determine the exact simple interest for 9 years.
- Simple interest @ 23% = $4600 \times 2 = 9200$
Compound interest @ 20%
 $20000 \xrightarrow{20\% \uparrow} 24000 \xrightarrow{20\% \uparrow} 28800$
→ ₹ 8800 compound interest.
Difference = $9200 - 8800 = ₹ 400$.
- $1000 \xrightarrow{10\% \uparrow} 1100 \xrightarrow{10\% \uparrow} 1210 \xrightarrow{10\% \uparrow} 1331$.
Compound interest = $1331 - 1000 = ₹ 331$
- Solve using options. Thinking about option (a):
 $2000 \rightarrow 2200$ (after 1 year) → 2420 (after 2 years)
which gives us an interest of ₹ 420 as required in the problem. Hence, this is the correct answer.
- $P \times 7/6 \times 7/6 = 196 \rightarrow P = (196 \times 6 \times 6)/7 \times 7 = 144$.
- $1331 \times 1.090909 \times 1.090909 \times 1.090909 = 1331 \times 12/11 \times 12/11 \times 12/11 = 1728$. Hence, the rate of compound interest is 9.09%.
- Since compounding is half yearly, it is clear that the rate of interest charged for 6 months would be 3%
 $3300 \xrightarrow{3\% \uparrow} 3399$.
- The value of the van would be $196000 \times 6/7 \times 6/7 = 144000$
- Solve through options:
 $10000 \xrightarrow{20\% \uparrow} 12000 \xrightarrow{20\% \uparrow} 14400 \xrightarrow{20\% \uparrow} 17280$.
- 12% per annum compounded quarterly means that the amount would grow by 3% every 3 months.
Thus, $8000 \rightarrow 8000 + 3\% \text{ of } 8000 = 8240$ after 3 months → $8240 + 3\% \text{ of } 8240 = 8487.2$ after 6 months and so on till five 3 month time periods get over. It can be seen that the value would turn out to be 9274.2.
- For the last 5 years, the interest earned would be: 30% of 360 = 108. Thus, interest earned in the first 4 years would be ₹ 72 → ₹ 18 every year on an amount of ₹ 360- which means that the rate of interest is 5%
- He will get $20000 + 45.5\% \text{ of } 20000 = 29100$.
[Note: In this case we can take 13% simple interest

compounded half yearly to mean 6.5% interest getting added every 6 months. Thus, in 42 months it would amount to $6.5 \times 7 = 45.5\%$

22. $50000 \xrightarrow{6\% \uparrow} 53000 \xrightarrow{6\% \uparrow} 56180 \xrightarrow{6\% \uparrow} 59550.8 \xrightarrow{6\% \uparrow} 63123.84 \xrightarrow{6\% \uparrow} 66911.27$
23. $100000 + 6\% \text{ of } 100000 \text{ (after the first 6 months)} = 106000$.
 After 1 year: $106000 + 6\% \text{ of } 106000 = 112360$
 After $1\frac{1}{2}$ years: $112360 + 6\% \text{ of } 112360 = 119101.6$
 After 2 years: $119101.6 + 6\% \text{ of } 119101.6 = 126247.69$
24. $(73/365) \times 0.09 \times 700 = ₹ 12.6$.
 (Since the time period is 73 days)
25. The average rate of interest he pays is $186 \times 100/1500 = 12.4\%$.
 The average rate of interest being 12.4%, it means that the ratio in which the two amounts would be distributed would be 4:1 (using alligation). Thus, the borrowing at 12% would be ₹ 1200.
26. Based on the information we have, we can say that there would have been ₹ 30 extra interest per year. For 2% of the principal to be equal to ₹ 30, the principal amount should be ₹ 1500
27. The data is insufficient as we do not know the time period involved.
28. $882 \times (1.05) + 882 = P \times (1.05)^2$
 Solve for P to get $P = 1640$
29. The difference would amount to 8% of the value borrowed. Thus $56 = 0.08 \times \text{sum borrowed in each case} \rightarrow \text{Sum borrowed} = ₹ 700$.
30. 42% on 2500 = ₹ 1050. The required answer would be: $1050/157.5 = 6$ years and 8 months.
31. Interest per year = ₹ 25. Thus, an interest of ₹ 50 would be earned in 2 years.
32. The average Rate of interest is 6.8825%. The ratio of investments would be 1.1175: 1.8825 (@5% is to 8%). The required answer = $10000 \times 1.1175/3 = 3725$.
33. Solve using options. If we try 500 (option b) for convenience, we can see that the difference between the two is ₹ 64 (as the SI would amount to 300 and CI would amount to $100 + 120 + 144 = 364$).
 Since, we need a difference of only ₹ 48 we can realize that the value should be $3/4^{\text{th}}$ of 500. Hence, 375 is correct.
34. Total effective amount lent for 1 year
 $= ₹ 400 \times 2 + ₹ 100 \times 4 = ₹ 1200$
 Interest being ₹ 60, Rate of interest 5%
35. The value would increase by 4% per year. To go to 5 times it's original value, it would require an increment of 400%. At 4% SI it would take 100 years.
36. $A \times (1.02) + A = 808 \times (1.02)^2 \rightarrow A = ₹ 400$

37. The sum becomes 4 times $\rightarrow$ the interest earned is 300% of the original amount. In 10 years the interest is 300% means that the yearly interest must be 30%.
38. It would take another 5 years to double again. Thus, a total of 10 years to become four fold.
39. The difference in Simple interest represents 1% of the amount invested. Since this difference has occurred in 2 years, annually the difference would be 0.5%.
40. If it doubles in 3 years, it would become 4 times in 6 year and 8 times in 9 years.
41. If we take the principal as 100, the CI @ 10% Rate of interest would be ₹ 21. In such a case, the SI would be ₹ 20.
42. $12\% \text{ of } x = 24\% \text{ of } (600 - x) \rightarrow x = 4000$
 Thus, the two parts should be ₹ 4000 and ₹ 2000.
43. Akbars' share should be such that at 4% p.a. compound interest it should become equal to Amar's share in 2 years. Checking thorough the options it is clear that option (a) fits perfectly as 1875 would become 2028 in 2 years @4% p.a. compound interest.
44. The total interest in 6 years = 75%
 Thus per year = $SI = 12.5\%$
45. The interest he pays per year would be $36 + 55 = 91$.
 Thus, in 4 years the interest would amount to ₹ 364.
46. Solve through trial and error using the values of the options. Option (a) 500000 fits the situation perfectly as the $SI = ₹ 30000$ while the $CI = 30604$.
47. $100/12 = 8.33\%$
48. 12% Rate of interest on the amount invested gives an interest of ₹ 3240. This means that $0.12 A = 3240 \rightarrow A = ₹ 27000$. The sum of the investments should be ₹ 27000. If Akbar invests x , Amar invests $x - 5000$ and Anthony invests $x + 2000$. Thus:
 $x + x - 5000 + x + 2000 = 27000 \rightarrow x = 10000$.
49. 600 becomes 720 in 4 years SI $\rightarrow$ SI per year = ₹ 30 and hence the SI rate is 5%.
 At 7% rate of interest the value of 600 would become 768 in 4 years. $(600 + 28\% \text{ of } 600)$
50. The rate of interest is not defined.
 Hence, option (d) is correct.

Level of Difficulty (II)

1. In 8 years, the interest earned = 200%
 Thus, per year interest rate = $200/8 = 25\%$
 To become 8 times we need a 700% increase
 $700/25 = 28$ years.
2. Tripling in 8 years means that the interest earned in 8 years is equal to 200% of the capital value. Thus, interest per year (simple interest) is 25% of the capital. In 20 years, total interest earned = 500%

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- of the capital and hence the capital would become 6 times its original value.
3. $x = ₹ 1000$ (As $1000 @ 5\%$ for 2 years = 1100).
Similarly $y = ₹ 1500$.
 $x + y = 2500$.
 4. $9000 + 720 + 720 + 855 + 855 + 855 + 855 + 990 + 990 + 1080 + 1080 + 1080 + 1080$
 $= 9000 + 720 \times 2 + 855 \times 4 + 990 \times 2 + 1080 \times 4$
 $= 20160$
 5. At 10% simple interest per year, the amount would double in 10 years. Thus, the original borrowing would be $22500/2 = 11250$.
 6. The simple interest would be defined on the basis of the sum of the AP.
 $50000 + 47500 + 45000 + \dots + 2500 = 525000$.
 7. The yearly increase in the population is 3%. Thus, the population would increase by 3% each year. 200000 would become 206000 while 206000 would become 212180.
 8. $\frac{F \times (0.06) \times 6}{(38800 - F) \times 0.05 \times 2} = 5/4$
where F is the first part.
 $1.44F = 19400 - 0.5F$
 $F = 19400/1.94 = 10000$.
Thus, the second part = $38800 - 10000 = 28800$
 9. At 10% compound interest the interest in 3 years would be $33.1\% = ₹ 331$
At 10.5% simple interest the interest in 3 years would be $31.5\% = ₹ 315$
Difference = ₹ 16
 10. The amount @ 10% CI could become ₹ 1331. Also, ₹ 1728 depreciated at $R\%$ has to become ₹ 1331.
Thus,
 $1728 \times [(100-R)/100]^3 = 1331$ (approximately).
The closest value of $R = 8\%$
Thus, the difference is 2%.
 11. SBI would be paying 40% on the capital as interest over two years and it would be getting 44% of the capital as interest from Bharti Telecom. Hence, it earns 4%.
 12. $64000 \times (1.025)^4 = 70644.025$.
Interest 6644.025
Option (d). None of these is correct.
 13. Since the interest is compounded half yearly at $R\%$ per annum, the value of R would be lesser than the value of S . (Remember, half yearly compounding is always profitable for the depositor).
 14. At 10% per annum simple interest, the interest earned over 3 years would be 30% of the capital. Thus, 300 is 30% of the capital which means that the capital is 1000. In 3 years, the compound interest on the same amount would be 331.
 15. Go through trial and error of the options. You will get:
 $20000 \times (1.3) = 26000$ (@ simple interest)
 $20000 \times 1.1 \times 1.1 \times 1.1 = 26620$ @ compound interest.
Thus 20000 is the correct answer.
 16. Solve through options to see that the value of 1200000 fits the given situation.
 17. Population growth rate according to the problem:
Year 1 = 5%, year 2 = 10%, year 3 = 15%
Year 4 = 20%, year 5 = 25%, year 6 = 30%.
Population decrease due to migration:
Year 1 = 1%, year 2 = 2%, year 3 = 4%
Year 4 = 8%, year 5 = 16%, year 6 = 32%.
Thus, the first fall would happen in 2016.
 18. $P + 2$ years interest on $P = 1000 + 1$ years interest on $1000 + 1000$
 $\rightarrow 1.21P = 2100 \rightarrow P = 1736$ (approx).
 19. Solve this one through options. Option (c) reduced rate for 14 years fits the conditions.
 20. Let the repayment annually be X . Then:
 $8000 + 3$ years interest on 8000 (on compound interest of 5%) = $X + 2$ years interest on $X + X + 1$ years interest on $X + X \rightarrow X = 2937.67$
 21. You can think about this situation by taking some values. Let $x = 100$, $y = 10$ and $z = 1$ (at an interest rate of 10%). We can see that $10^2 = 100 \rightarrow y^2 = xz$
 22. $4200 + (4\% \text{ of } 4200) 3 \text{ times} = 4200 + 0.04 \times 3 \times 4200 = 4704$.
 23. Solve using options. If the price is 27000, the interest on 12000 (after subtracting the down payment) would be 16% of 12000 = 1920. Hence, the total amount paid would be 28920.
 24. The interest would be paid on
7000 for 3 years + 10000 for 5 years.
@ 6.5% the total interest for 8 years
 $= 1365 + 3250$
 $= ₹ 4615$
 25. It can be seen that for 17000, the first year interest would be 1020, while the second year interest after a repayment of 6800 would be on 10200 @ 5% per annum. The interest in the second year would thus be ₹ 510 which is exactly half the interest of the first year. Thus, option (a) is correct.
 26. Solve using options. Option (c) fits the situation as:
 $12820 = 2000 + 2$ years interest on 2000 + 4000 + 1 years interest on 4000 + 6000 (use 10% compound interest for calculation of interest) $\rightarrow$
 $12820 = 2000 + 420 + 4000 + 400 + 6000$.
Thus, option (c) fits the situation perfectly.
 27. Interest for $A = 6\%$ of 50000.
Interest for B , C and D the interest is more than 6%.
Thus A 's loan is MUL.

28. Interest she would pay under scheme 1:

Year 1 the entire loan would be @ 4% – hence interest on 40000 = ₹1600.

Total interest = 1600

Interest on loan 2:

In year 1: 80% of the loan (I.e 48000) would be on 5%, 12000 would be @10% – hence total interest = 3600

Year 2: 40% of the loan (24000) would be on 5%, while the remaining loan would be on 10% – hence total interest = 4800

Thus, total interest on the two loans would be 1600 + 3600 + 4800 = 10000.

29. Let the amounts be ₹100 and ₹200 respectively. The value of the 100 would become $100 \times 6/7 \times 6/7 = 3600/49 = 73.46$

The other person's investment of 200 would become $200 \times 1.2 \times 1.2 = 288$

The total value would become $288 + 73.46 = 361.46$

This represents approximately a 20% increase in the value of the amount after 2 year. Hence, option (a) is correct.

30. The final value would be:

$$0.8 \times 63000 + 27000 \times 1.15 \times 1.15 = 86107.5.$$

→ Drop in value = 4.32%