SIMPLE AND COMPOUND INTEREST

7

INTRODUCTION

The chapter on Interest forms an 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, especially with the statistical concept of the Compounded Annual Growth Rate (referred to as CAGR), being numerically akin to the compound interest situation that you would study in this chapter.

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

Apart from *CAT*, questions on interest are also important for exams like *XAT*, *IIFT*, *SNAP*, *NMAT* and Bank P.O. exams. Hence, if you are planning to appear for the entire spectrum of management and aptitude exams—this chapter retains its importance for all these 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 bases 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

Simple interest		Compound interest
₹100	First year	₹100
₹100	Second year	₹110
₹100	Third year	₹121
₹100	Fourth year	₹133.1

Note: 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 from the second year onwards.

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 (SI)

The interest of one 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 one 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 =

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

Amount = Principal + Total interest, we can write

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 six-monthly rate, we take time in terms of six 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%.

Logical Understanding of Simple Interest: The students must have got through the understanding of the mathematical formulae pertaining to Simple Interests above. Before we move onto a discussion of compound interest however, let's revisit Simple Interest logically. We can do this through a few examples.

Suppose a man invests ₹100 @ 8% simple interest. He would be paid an interest of ₹8 per year (simply because 8% of ₹100 is ₹8). Further, going forward, if it is mentioned to us that 'the man kept earning 8% simple interest for five years on an investment of ₹100', the straight forward logical reaction is: He earns ₹8 interest per year for five years. Hence, his interest is ₹40. It is a straight logical thought and you would never fail to see it in any *QA* problem. Hence, there is absolutely no reason for you to remember the mathematical formulae of simple interests. Just treat every simple interest question like a percentage calculation situation and you would be logically able to work out all the reactions that you need to have for every kind of problem situation on percentages. In order to strengthen these logical structures, let us take a look at various standard statements and situations that you would regularly face in the percentages chapter.

1	Statement: *A* man invests ₹200 at 8% SI for 3 years.	**Reaction:** Each year's interest is ₹16 (@8% of 200). In 3 years, the interest would be 16 × 3 = 48.
2	A man invests a certain amount at 5% per annum simple interest for 8 years	**Reaction:** Since SI every year would be 5% of the principal, the SI for 8 years would be 5 × 8 = 40% of the principal.
3	A man invests a certain amount at 5% per annum simple interest for 8 years and earns an interest of ₹4000.	**Reaction:** Since the total SI would be 40% of the principal, it means that 40% of the principal = 4000 → the principal would be 10000.
4	On an investment of a certain amount at a certain rate of interest, a man earns an interest of ₹200 every year. After a certain period of time, he has earned ₹1000 as interest. What is the time period?	**Reaction:** ₹200 per year being the SI, the time period would be: 1000/200 = 5 years.

5	₹1000 is invested @10% per annum simple interest, where the interest is paid half-yearly. Find the interest after 30 months. Also, find the amount after 30 months.	Since, the interest is paid half-yearly, the effective half-yearly rate of interest would be 10/2 = 5%. Interest would be earned @5% per 6 months. In 30 months, a total interest of 5 × 5 = 25% would be earned. Hence, the total interest earned would be 25% of 10000 = 2500. The amount would be 10000 + 2500 = 12500.

Another crucial structural point about Simple Interest- The relationship between an SI situation and Arithmetic Progressions: In chapter 2 of this book, we have worked on the thought structures around Arithmetic Progressions (APs). You might remember the basic structures of an AP. Now let us see the relationship between an AP and SI. Consider a situation where a person invests ₹1000 @ 8% per annum SI. As the years go by, the principal of ₹1000 would grow by ₹100 every year. The following series would represent the amount after various years under this SI problem situation:

Original Amount	Amount after 1 year	Amount after 2 years	Amount after 3 years	Amount after 4 years	Amount after 5 years	Amount after 6 years	Amount after 7 years	Amount after 8 years	Amount after 9 years
1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
1st term of the AP	2nd term of the AP	3rd term of the AP	4th term of the AP	5th term of the AP	6th term of the AP	7th term of the AP	8th term of the AP	9th term of the AP	10th term of AP

As you can see from the table above, the numerical structure for the amounts after any period of time in a *SI*-based question, would be obeying an arithmetic progression with the principal as the first term and the annual interest amount as the common difference. Thus, if we want the amount after seven years, in this case, we can simply think about finding the 8th term of the *AP* whose first term is 1000 (principal) and common difference is 100 (interest per time period).

So for example, for a principal of 200, @8% *SI* per annum paid half-yearly, the *AP* would go as:

200, 208, 216, 224, 232

Here the amount is 208 (after 6 months), 216 (after 12 months), and 224 (after 18 months) and so on.

If you want to find the amount after 42 months, simply find the 8th term of the AP using: $200 + 7 \times 8 = 256$.

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.

Formulae

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 above formulae provide us with the mathematical structures in CI. Let us now proceed to have a logical discussion around compound interests:

While discussing SI, we had seen that the structure of an AP fits the SI situation perfectly. Similarly, in the numerical structure of CI, the other progression (geometric) fits perfectly. If you remember, a geometric progression was one where a starting number was consistently multiplied repetitively by a number referred to as the common ratio (r). Exactly the same thing occurs in a CI series. Consider the case, where ₹100 is invested @10% per annum CI for five years. What would be the growth pattern for this amount?

Well, after one year, 100 becomes 110. The next year, 110 increases to 121. In the third year, 121 increases to 133.1, followed by a fourth year, the end value of 146.41 and after five years, it would become: 161.051. If you notice, this series is nothing but the series defined by:

100, 100 × 1.1 = 110; 100 × 1.1 × 1.1 = 121 and so on. Thus, a GP with first term as 100 (the principal) and a common ratio of 1.1 (in the case of 10%) would

give you the series of numbers that would fit the CI situation. To illustrate a few more instances, if the interest rate is 12%, use a common ratio of 1.12, if CI rate is 8%; use a common ratio of 1.08. Use the common ratio as many times as the number of time-periods.

Notice, also that the depreciation and the population concepts discussed also fit the same structures. Thus, if a machine depreciates by 8% every year, its value would get multiplied by 0.92. If it depreciates by 10%, by 0.9 and by 12%, then multiply the amount by 0.88 and so on.

Note: The advantage of thinking this way is that you bypass the need for thinking through the formulae in these situations. You can think of all these problems as GP situations where the principal is taken as the first term of the ratio and the value of 'r' is created based on the thought structure explained above.

However, the biggest advantage of moving out of the formulae thinking for CI is to be able to use the successive percentage change use of the PCG (Percentage Change Graphic) for all CI, Population and Depreciation questions.

In fact, it is felt 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 × 1.064. 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.

The following illustrations would clear this for you:

₹1000 is invested @ 8% per annum for 5 years	**Reaction through GPs:** We need to find the sixth term of the GP with r = 1.08 and first term as 1000.	**Reaction through PCG:** 1000 → → → → → (increased by 10% for 5 times.)
₹8000 is invested @12% per annum CI compounded quarterly. What would it amount to after 21 months?	**Reaction through GPs:** Since there is quarterly compounding, 12% per annum translates to 12/4 = 3% per quarter. We need to find the eighth term of the GP with r = 1.03 and first term as 8000.	**Reaction through PCG:** 8000 → → → → → → → (increased by 3% for 7 times.)
A machine costing 100000, depreciates by 8% every year for 3 successive years.	**Reaction through GPs:** Find the fourth term of the GP with first term as 100000, and common ratio 0.92.	**Reaction through PCG:** Reduce 100000 successively 3 times by 8%.

APPLICATIONS OF INTEREST IN D.I. AND HANDLING MORE COMPLICATED CALCULATION SITUATIONS AROUND COMPOUNDING

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 familiarise you 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 move 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 three 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 obtained 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 three years.

(Up to 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 guess estimation 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:

$$100 \xrightarrow[+10]{10\%\uparrow} 110 \xrightarrow[+11]{10\%\uparrow} 121 \xrightarrow[+12.1]{10\%\uparrow} 133.1 \xrightarrow[+13.31]{10\%\uparrow} 146.4$$

$$\xrightarrow[14.64]{10\%\uparrow} 161.04 \xrightarrow[16.10]{10\%\uparrow} 177.14 \xrightarrow[17.71]{10\%\uparrow} 194.8 \xrightarrow[19.48]{10\%\uparrow} \ldots$$

$$214.3 \xrightarrow[21.43]{10\%\uparrow} 235.7 \xrightarrow[23.57]{10\%\uparrow} 259.2$$

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% of 125.44 = 12% of 112 + 12% of 13.44

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

Hence, our calculation changes to:

12% of 112 + 12% of 13.44 = 13.44 + 12% 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.

Hence, 12% of 13.44 = 1.44 + 12% of 1.44

= 1.44 + 0.17 = 1.61 (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% of 140.49 = 12% of 125.44 + 12% of 15.05

Already calculated

Compare this to the previous calculation:

12% of 125.44 = 12% of 112 + 12% 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 approximately 1.61). In this case, it will be approximately 1.8. Hence, you shall now add 16.85 and the PCG will look as:

$$100 \xrightarrow{+12} 112 \xrightarrow{+13.44} 125.44 \xrightarrow{+15.05} 140.49 \xrightarrow{+16.85} 166.34$$

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 realise 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:

$$100 \xrightarrow{+7} 107 \xrightarrow{+7.49} 114.49 \xrightarrow{+8.01} 122.5 \xrightarrow{+8.55} 131.05 \xrightarrow{+9.11} 140.16 \xrightarrow{+9.75} 149.91 \xrightarrow{+10.42} 160.33$$

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

This series is approximated giving all values in this table.

An approximate growth of 60.33%

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, +10.42 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.

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

Interest = (Principal × Rate × Time)/100

$$\Rightarrow \quad x/4 = (x \times t \times t)/100$$
$$\Rightarrow \quad t^2 = 25$$
$$\Rightarrow \quad t = 5\%$$

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 ≠ 4.5. Hence, option (a) is incorrect.

Also, 25/6 ≠ 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 three years is 6% per annum, for the next four years, 7 % per annum and for the period beyond seven years, 7.5 % per annum. If a man lent out ₹1200 for eleven 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 first three years @ 6% SI will be equal to 6 × 3 = 18%.

Again, interest for next four years will be equal to 7 × 4 = 28%.

And interest for next four years (till 11 years) –7.5 × 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 = (Interest × 100)/Principal × Time

= (x × 100)/(x × 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).

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

Then, difference in between the interest of five years and of two years equals to

₹800 – ₹704 = ₹96

So, interest for 3 years = ₹96

Hence, interest/year = ₹96/3 = ₹32

So, interest for 2 years → 2 × ₹32 = ₹64

So, the principal = ₹704 – ₹64 = ₹640

Thought-process here should be

₹96 interest in 3 years → ₹32 interest every year.

Hence, principal = 704 – 64 = 640.

Problem 7.5 A sum of money was invested at SI at a certain rate for threes 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 three 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.

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

Problem 7.6 A certain sum of money trebles itself in eight 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 eight years, which makes interest equal to 200% of principal.

So, 200% is added in eight 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 two years at 10% the amount becomes 605. Find the principal.

(a) ₹550

(b) ₹450

(c) ₹480

(d) ₹500

Solution: Using the formula, amount = 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's interest = ₹55, which gives the total amount ₹605 at the end of

first year. So it is not a valid option.

Option (b) ₹450

First year's interest = ₹45

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

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

So, it is also not valid.

Hence, the 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's interest = ₹48

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

So, amount at the end of two 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. his 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 → 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, it is 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; 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 three 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 first year will be → 10,000 + 10% of 10,000 = 11,000.

At the end of second year, it will be 11,000 + 20% 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 four 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 ten months by ten equal instalments 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 todayMoney 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.

→ Interest on ₹1 for 90 months – interest on ₹1 for 45 months = ₹10 – ₹9

→ 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.

LEVEL OF DIFFICULTY (I)

1. ₹1000 is lent out at 10% per annum simple interest for four years. Find the amount after four years.

   (a) ₹1200

(b) ₹1350

(c) ₹1400

(d) ₹1500

2. Interest obtained on a sum of ₹2000 for three years is ₹300. Find the rate per cent.

   (a) 7%

   (b) 6%

   (c) 5%

   (d) 10%

3. ₹1500 is lent at compound interest of 10% per annum for two years. Find the amount after two years.

   (a) ₹1800

   (b) ₹1815

   (c) ₹1850

   (d) ₹2920

4. ₹2205 is repaid after two years at compound interest. Which of the following is the value of the principal and the rate?

   (a) ₹1500, 10%

   (b) ₹1400, 12%

   (c) ₹2000, 5%

(d) ₹1800, 10%

5. Find the difference (in ₹) between the simple and the compound interest at 10% per annum for two years on a principal of ₹5000.

   (a) 50

   (b) 1050

   (c) 45

   (d) 55

6. Find the rate of interest if the amount after two years of simple interest on a capital of ₹1500 is ₹1800.

   (a) 5%

   (b) 8%

   (c) 10%

   (d) 12%

7. After how many years will a sum of ₹10,000 become ₹14000 at the rate of 8% per annum?

   (a) 2 years

   (b) 3 years

   (c) 5 years

   (d) 4 years

8. What is the difference between the simple interest on a principal of ₹8000 being calculated at 5% per annum for five years and 6% per annum for six years?

(a) ₹880

(b) ₹1080

(c) ₹1200

(d) ₹4080

9. What is the simple interest on a sum of ₹6000 if the rate of interest for the first two years is 8% per annum and for the last three years is 5% per annum?

(a) ₹1269.5

(b) ₹1283

(c) ₹1860

(d) ₹1880

10. What is the simple interest for ten years on a sum of ₹5000 if the rate of interest for the first five years is 10% per annum and for the last four years is 7% per annum?

(a) 1300

(b) 1392

(c) 1352

(d) Cannot be determined

11. What is the difference between compound interest and simple interest for a sum of ₹15,000 over a two year period if the compound interest is calculated at 10% and simple interest is calculated at 15%?

(a) ₹1350

(b) ₹1060

(c) ₹1440

(d) ₹1450

12. Find the compound interest on ₹3000 at the rate of 12% per annum for 12 months when interest is compounded half-yearly.

(a) ₹370.8

(b) ₹331

(c) ₹310.80

(d) ₹308

13. Find the principal if the interest compounded at the rate of 10% per annum for two years is ₹630.

(a) ₹3000

(b) ₹3300

(c) ₹5000

(d) ₹4000

14. Find the principal if compound interest is charged on the principal at the rate of 15% per annum for two years and the sum becomes ₹529.

(a) ₹200

(b) ₹500

(c) ₹150

(d) ₹400

15. The SBI lent ₹1331 to the Tata group at a certain rate of compound interest charged annually 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 how many years will a sum of ₹18000 at 20% per annum compounded half-yearly become ₹23958?

    (a) 1

    (b) $1\frac{1}{2}$

    (c) 2

    (d) $2\frac{1}{2}$

17. If the simple interest on a sum of money for two years at 5% p.a. is ₹50, what is the compound interest on the same sum at the same rate and for the same time?

    (a) ₹51.25

    (b) ₹52.25

    (c) ₹54.25

    (d) ₹60.25

18. What will be the difference between simple and compound interest @ 10% p.a. on a sum of ₹1000 after four years?

    (a) ₹31

    (b) ₹32.10

    (c) ₹40.40

    (d) ₹64.10

19. The difference between the simple interest on a certain sum at the rate of 10% p.a. for two years and compound interest at the same rate, which is compounded every six months, is ₹124.05. What is the principal sum?

    (a) ₹6000

    (b) ₹8000

    (c) ₹10,000

    (d) ₹12,000

20. The compound interest on ₹10000 at $5\frac{1}{4}$% per annum for 122 days (assume that the given year is a leap year) is

    (a) ₹260

    (b) ₹600

    (c) ₹731

    (d) None of these

21. Bank of India offers10% compound interest calculated on half-yearly basis. A customer deposits ₹10000 each on 1st April and 1st October of a year. At the end 31 March of the next year, the interest given by bank to the customer will be

(a) ₹1025

(b) ₹1021

(c) ₹1220

(d) None of these

22. Find the difference between the compound interests on ₹20,000 for one year at 10% per annum compounded yearly and half-yearly?

(a) ₹50

(b) ₹30

(c) ₹25

(d) None of these

23. Find the compound interest on ₹15000 for six months at 12% p.a. compounded quarterly.

(a) ₹951.50

(b) ₹913.50

(c) ₹951

(d) None of these

24. The simple interest on a certain sum of money for three years at 8% per annum is half the compound interest on ₹4000 for two years at 10% per annum. The sum placed on simple interest is

(a) ₹1550

(b) ₹1650

(c) ₹1750

(d) ₹2000

25. There is 40% increase in an amount in eight years at simple interest. What will be the compound interest of ₹2,000 after two years at the same rate?

    (a) ₹205

    (b) ₹120

    (c) ₹300

    (d) None of these

26. The compound interest on a sum of money for two years is ₹3328 and the simple interest on the same sum for the same period is ₹3200. The difference of the compound interest and the simple interest for three years will be

    (a) ₹394.24

    (b) ₹392.24

    (c) ₹398.56

    (d) None of these

27. The difference between the simple interest on a certain amount at the rate of 20% per annum, for 1.5 years and compound interest which is compounded every six months is ₹155. What is the principal sum?

    (a) ₹4000

    (b) ₹5000

    (c) ₹6000

    (d) None of these

28. The effective annual rate of interest corresponding to a nominal rate of 10% per annum payable half-yearly is

(a) 10.25%

(b) 10.50%

(c) 10.08%

(d) None of these

29. A sum of money invested at compound interest amounts to ₹1050 in two years and to ₹1655 in three years. The rate of interest per annum is

(a) 5%

(b) 8%

(c) 10%

(d) None of these

30. A sum of ₹10,000 deposited at compound interest becomes double after five years. After fifteen years, it will become

(a) ₹80,000

(b) ₹40,000

(c) ₹1, 60,000

(d) None of these

31. If a sum on compound interest becomes two times in six years, then with the same interest rate, the sum will become eight times in

(a) 12 years

(b) 18 years

(c) 24 years

(d) None of these

32. The simple interest on ₹4,000 in three years at the rate of x% per annum equals the simple interest on 5,000 at the rate of 12% per annum in two years. The value of x is

(a) 10%

(b) 6%

(c) 8%

(d) 9%

33. If the difference between the simple interest and compound interest on some principal amount at 10% per annum for two years is ₹30, then the principal amount must be

(a) ₹2000

(b) ₹5000

(c) ₹3750

(d) ₹3000

34. Ramesh lent ₹4000 to Amit for two years and ₹1000 to Mani for eight years and received together from both ₹1600 as interest. Find the rate of interest, simple interest being calculated.

(a) 10%

(b) 6%

(c) 8%

(d) 9%

35. In what time will ₹5000 amount to ₹21,000 at 4% per annum? (simple interest being reckoned)

    (a) 80 years

    (b) 50 years

    (c) 110 years

    (d) 160 years

36. At some rate of simple interest, *A* lent ₹6000 to *B* for two years and ₹1500 to *C* for four years and received ₹900 as interest from both of them together. The rate of interest per annum was

    (a) 5%

    (b) 6%

    (c) 8%

    (d) 10%

37. A sum of money becomes seven times at simple interest in 15 years. What is the rate of interest?

    (a) 10%

    (b) 20%

    (c) 30%

    (d) 40%

38. A sum of money doubles itself in five years. In how many years will it become eight-fold (if interest is compounded)?

    (a) 15

    (b) 10

    (c) 12

    (d) 8

39. The difference between the interests received from two different banks on ₹5000 for two years is ₹250. What is the difference between their rates?

    (a) 2.5%

    (b) 2.2%

    (c) 2.3%

    (d) 1.5%

40. A sum of money placed at compound interest doubles itself in two years. In how many years will it amount to eight times itself?

    (a) 9 years

    (b) 8 years

    (c) 6 years

    (d) 7 years

41. If the compound interest on a certain sum of ₹100 for two years is ₹44. What could be the simple interest?

(a) ₹40

(b) ₹32

(c) ₹36

(d) ₹41

42. Divide ₹1000 into two parts so that simple interest on the first part for two years at 10% p.a. may be equal to the simple interest on the second part for five years at 1% p.a.

(a) ₹400, ₹600

(b) ₹800, ₹200

(c) ₹200, ₹800

(d) None of these

43. Divide ₹3903 between Amar and Akbar such that Amar's share at the end of seven years is equal to Akbar's share at the end of nine 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 two times of itself in five years at a certain rate of simple interest. Find the rate of interest.

(a) 20%

(b) 25%

(c) 8%

(d) 14%

45. Ajay borrowed ₹5000 at 5% p.a. and ₹1000 at 8% p.a. for the same duration. He had to pay ₹990 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 three 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 thrice at simple interest in ten years, what would be the rate of interest per annum?

(a) 20

(b) 10

(c) 12

(d) 15

48. Three friends A, B and C invested different amounts in a fixed deposit scheme for one year at the rate of 10% per annum and earned a total interest of ₹4600 at the end of the year. If the amount invested by B is ₹6000 more than the amount invested by A and the amount invested by C is ₹4000 more than the amount invested by B, what is the amount invested by B?

(a) ₹12,000

(b) ₹10,000

(c) ₹16,000

(d) ₹15000

49. A sum of ₹500 amounts to ₹620 in four years at simple interest. What will it amount to if the rate of interest is increased by 4%?

(a) ₹660

(b) ₹760

(c) ₹700

(d) ₹650

50. What is the amount of equal instalment, if a sum of ₹17800 due two years hence, has to be completely repaid in two equal annual instalments starting next year.

(a) 8900

(b) 9000

(c) 8500

(d) Cannot be determined

LEVEL OF DIFFICULTY (III)

1. A sum of money invested at simple interest doubles itself in five years at simple interest. Find in how many years will it become eight times itself at the same rate.

   (a) 34 years

   (b) 35 years

   (c) 30 years

   (d) 31 years

2. A sum of money invested at simple interest doubles itself in four years. How many times will it become in twenty years time?

   (a) 8 times

   (b) 7 times

   (c) 6 times

   (d) 9 times

3. If ₹2400 is obtained after lending out ₹x at 10% per annum for two years and ₹1320 is obtained after lending out ₹y at 5% per annum for two years, find $x + y$.

   (a) ₹3600

   (b) ₹3500

   (c) ₹3000

   (d) ₹3200

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:

   10% per annum for the initial two years

   10.5% per annum for the next six years

   17% per annum for the next one year

   10/3% per annum after the first nine years

   Find the amount which a sum of ₹10,000 taken for 12 years becomes at the end of 12 years.

   (a) 22,000

   (b) 19,000

   (c) 20,000

   (d) 21,000

5. If a person repaid ₹14,400 after ten years of borrowing a loan, at 8% per annum simple interest, find out what amount (in ₹) did he take as a loan?

   (a) 8, 000

   (b) 12, 000

   (c) 9,000

   (d) 10, 000

7. The population of a city is 300,000. If the annual birth rate and the annual death rate are 5% and 4% respectively, then calculate the population of the city after two years.

(a) 306,030

(b) 306,090

(c) 312,000

(d) 300,180

8. A part of ₹56000 is lent out at 4% per six months simple interest. The rest of the amount is lent out at 10% per annum simple interest after one year. The ratio of interest after four years from the time when first amount was lent out is 16: 125. Find the second part that was lent out at 10%.

   (a) ₹6,000

   (b) ₹50, 000

   (c) ₹47,500

   (d) ₹38,000

9. If the simple interest is 7.5% annual and compound interest is 8% annual, if the difference between the interests after two years is ₹164. Find the principal amount.

   (a) ₹10,000

   (b) ₹12,000

   (c) ₹16,000

   (d) ₹15,000

10. Ramesh borrows ₹15000 at 10% compound interest. At the end of every year he pays ₹3000 as a part of repayment. How much does he still owe after four years?

(a) ₹8038.50

(b) ₹7860.50

(c) ₹7789.50

(d) None of these

11. A lends a certain amount to *B* on simple interest for two years at 10% per annum. *B* gives this entire amount to *C* on compound interest for two years at the same rate annually. Find the percentage earning of *B* at the end of two years on the entire amount.

    (a) 1%

    (b) 3%

    (c) 4%

    (d) 8%

12. Find the compound interest on ₹24,000 for one year at the rate of 12% per annum compounded quarterly (to the nearest integer).

    (a) ₹3215

    (b) ₹3205

    (c) ₹3185

    (d) ₹3012

13. If a principal *A* becomes *B* in two years when interest *C* % is compounded half-yearly. And if the same principal *A* becomes *B* in two years when interest *D*% is compound annually, then which of the following is true?

    (a) $C > D$

(b) $C = D$

(c) $C < D$

(d) $C \leq D$

14. Find the compound interest at the rate of 10% for three years on that principal which in three years at the rate of 10% per annum gives ₹600 as simple interest.

(a) ₹662

(b) ₹620

(c) ₹660

(d) ₹666

15. The difference between CI and SI on a certain sum of money at 10% per annum for three years is ₹1240. Find the principal if it is known that the interest is compounded annually.

(a) ₹400,000

(b) ₹40,000

(c) ₹20,000

(d) ₹300,000

16. The population of Lucknow was ₹103950 on 1 January 2011 and the growth rate of population was 10% in the last year and 5% in the years prior to it, what was the population on 1 January 2009?

(a) 90,000

(b) 20,000

(c) 88,000

(d) 50,000

17. Gopal borrows ₹X from Ankit at 8% annual interest. He then adds ₹Y of his own money and lends ₹$X + Y$ to Ishan at 10% annual interest. At the end of the year, after returning Ankit's dues, the net interest retained by Gopal is the same as that accrued to Ankit. On the other hand, had Gopal lent ₹$X + 2Y$ to Ishan at 10%, and then the net interest retained by him would have increased by ₹150. If all interests are compounded annually, then find the value of $X + Y$ (IN ₹)

    (a) 3000

    (b) 2000

    (c) 4000

    (d) 5000

18. Anil borrows ₹1500 at 5% compound rate of interest. At the end of each year, he pays back ₹500. How much amount (in ₹) should he pay at the end of the third year to clear all his dues? (approximately)

    (a) ₹660

    (b) ₹650

    (c) ₹700

    (d) ₹620

19. A loan of 12,300 at 5% per annum compound interest is to be repaid in two equal annual instalments at the end of every year. Find the amount (in ₹) of each instalment.

(a) 6,651

(b) 6,615

(c) 6,516

(d) 6,156

20. A certain amount grows at an annual interest rate of 12%, compounded monthly. Which of the following equations can be solved to find the number of years, y, which it would take for the investment to increase by a factor of 64?

(a) $64 = (1.01)12y$

(b) $\frac{1}{64} = (1.04)12y$

(c) $64 = 1.04(12y)$

(d) $8 = 1.01(6y)$

21. Ashok lent out some money at 10% per annum simple interest and after 18 months, he again lent out some money at a simple interest of 20% per annum for six months. In both the cases, he got ₹200 as interest. Which of these could be the amount that was lent out at 5% per annum?

(a) ₹1000

(b) ₹1200

(c) ₹2200

(d) ₹2000

22. A person bought a car under the following scheme: Down payment of ₹150000 and the rest amount at 4% per annum for four years. In this way, he paid ₹289200 in total. Find the actual price of the car. (Assume simple interest)

    (a) ₹260000

    (b) ₹270000

    (c) ₹272000

    (d) ₹265000

23. Kumar borrows ₹14,000 at simple interest. At the end of three years, he again borrows ₹6000 and closes his account after paying ₹9230 as interest after eight years from the time he made the first borrowing. Find the rate of interest.

    (a) 2.5%

    (b) 1.5%

    (c) 5.5%

    (d) 6.5%

24. Some amount was lent at 8% per annum simple interest. After one year, ₹1000 is repaid and the rest of the amount is repaid at 9% per annum. If the second year's interest is ₹10 less than first year's interest, find what amount of money was lent out.

    (a) ₹8000

    (b) ₹8600

    (c) ₹7000

    (d) ₹5000

25. An amount of ₹25640 due three years hence is fully repaid in three annual instalments starting after one year. The first instalment is half the second instalment and the second instalment is 2/3 of the third instalment. If the rate of interest is 10% per annum, find the first instalment.

(a) ₹4800

(b) ₹3600

(c) ₹4000

(d) ₹5000

Directions for Questions 26 and 27: Read the following and answer the questions that follow.

After the recession of 2008, *XYZ* bank starts following loan schemes for start-ups.

	Loans up to	*Subsidized loan*	*Interest (Normal)*
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%

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

26. Start-up *A* took some loan under scheme 1, start-up *B* under scheme 2, start-up *C* under scheme 3 and start-up *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 loan with the lowest ratio of interest paid to the total loan over.)

(a) A

(b) B

(c) C

(d) D

27. Extending this plan, *XYZ* further announced that start-ups which are operating from last six months only 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. A start-up takes ₹40,000 under scheme 1 in one account for one year and ₹60,000 under scheme 2 for two years. Find the total interest paid by it over the two year period.

(a) ₹11600

(b) ₹10000

(c) ₹8800

(d) None of these

28. An amount is divided between *Anil* and *Biru* in the ratio of 1: 2. *Anil* purchased a bike from his part, which depreciates at $14\frac{2}{7}$ % per annum and Biru 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%

29. A 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 two 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%

30. According to the 2021 census, starting from that year itself 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 1st January 2021, was 30 lacs, then in which year would the first fall in population be witnessed?

(a) 2025

(b) 2026

(c) 2027

(d) Population would never fall.

ANSWER KEY

Level of Difficulty (l)

1. (c)
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. (b)
17. (a)
18. (d)
19. (b)
20. (d)
21. (d)
22. (a)

23. (b)
24. (c)
25. (a)
26. (a)
27. (b)
28. (a)
29. (c)
30. (a)
31. (b)
32. (a)
33. (d)
34. (a)
35. (a)
36. (a)
37. (d)
38. (a)
39. (a)
40. (c)
41. (a)
42. (c)
43. (a)
44. (a)
45. (b)
46. (a)
47. (a)

48. (c)

49. (c)

50. (d)

Level of Difficulty (II)

1. (b)
2. (c)
3. (d)
4. (d)
5. (a)
6. (a)
7. (a)
8. (b)
9. (a)
10. (a)
11. (a)
12. (d)
13. (c)
14. (a)
15. (b)
16. (a)
17. (c)
18. (a)
19. (b)
20. (a)
21. (a)
22. (b)

23. (d)

24. (a)

25. (c)

26. (a)

27. (b)

28. (a)

29. (c)

30. (b)

Solutions and Shortcuts

Level of Difficulty (I)

1. The annual interest would be ₹100. After four years, the total value would be 1000 + 100 × 4 = ₹1400.

2. The interest earned per year would be 300/3=100. This represents a 5% rate of interest on an amount of ₹2000.

3. 1500 + 10% of 1500 = ₹1650 (after 1 year). Next year, it would become:

   1650 + 10% of 1650 = 1650+ 165= ₹1815

4. By checking the options, we get that only option (c) gives us 2205 after two years. The thought-process would go as follows.

   ₹2000 after 1 year becomes ₹2100. After second year, 2210 becomes 2100 + 5% of 2100 = ₹2205.

5. Simple interest for two years = 500 + 500 = ₹1000.

   Compound interest for two years: Year 1 = 10% of 5000 = ₹500.

   Year 2: 10% of 5500 = ₹550 → Total compound interest = ₹1050.

Difference between the simple and compound interest = 1050 – 1000= ₹50.

6. Interest in two years = ₹300

   Interest per year = ₹1500

   Rate of interest = 10%

7. ₹10,000 @ 8% simple interest would give an interest of ₹800 per annum. For a total interest of ₹4000, it would take five years.

8. 5% for five years (SI) = 25% of the amount; at the same time 6% SI for six years means 36% of the amount. The difference between the two is 11% of the amount. 11% of 8000 = ₹880.

9. Total interest @ 8% for first two years = 16% of the principal amount

   Total interest @ 5% for next three years = 15% of the principal amount

   Hence, the required interest = 16 + 15 = 31% of the principal amount. 31% of 6000 = ₹1860.

10. As we do not know the rate of interest for the sixth year, so we cannot determine the total simple interest for ten years. Hence, option (d) is correct.

11. Simple interest @ 15% for two years = 15,000 × 30/100 = ₹4500
    Compound interest @ 10%:

    After one year, total amount = ₹15,000 + ₹1500 = ₹16500

    After second year, total amount= ₹16500 + 10% of 1650 = ₹18150.

    → ₹3150 compound interest

Difference = 4500 – 3150 = ₹1350

12. 3000 -----(6% increase) ---- → 3000 + 180 = ₹3180

    3180 ------ (6% increase) --- → 3180 +190.80 = ₹3370.80

    Compound interest = ₹370.80

13. Solve using options. Thinking about option (a):

    3000 → 3300 (after 1 year) → ₹3630 (after 2 years) which gives us an interest of ₹630 as required in the problem. Hence, this is the correct answer.

14. $P \times 115/100 \times 115/100 = P \times 23/20 \times 23/20 = 529 \rightarrow P = ₹400$.

15. $1331 \times 1.090909 \times 1.090909 \times 1.090909 = 1331 \times 12/11 \times 12/11 \times 12/11 = 1728$. Hence, the rate of compound interest is 9.09%.

16. 20% per annum = 10% half-yearly

    Amount after 6 month = 18000 + 10% of 18000 = 19800
    Amount after 12 months = 19800 + 10% of 19800 = 19800 + 1980 =21780

    Amount after 18 months = 21780 + 2178 = 23958

    Hence, option (b) is correct.

17. 10% of the amount = 50

    Hence, the principal amount= ₹500
    Amount after 1 year = ₹500 + 5% of ₹500 = ₹525

    Amount after 2 years = ₹525 + 5% of 525 = ₹551.25

Compound interest = ₹51.25

18. $SI = ₹\left(\frac{1000\times10\times4}{100}\right) = ₹400$

$$CI = ₹\left[1000\times\left(1+\frac{10}{100}\right)^4 - 1000\right] = ₹464.10$$

∴ Required difference = ₹(464.10 – 400) = ₹64.10

19. Let the sum be ₹P. Then

$$p\left[\left(1+\frac{5}{100}\right)^4 - 1\right] - \frac{p\times10\times2}{100} = 124.05$$

$$\Rightarrow p\left[\left(\frac{21}{20}\right)^4 - 1 - \frac{1}{5}\right] = 124.05 \Rightarrow p\left[\frac{194481}{160000} - \frac{6}{5}\right] = \frac{12405}{100}$$

$$\Rightarrow p\left[\frac{194481-19200}{160000}\right] = \frac{12405}{100} \Rightarrow p = \left(\frac{12405}{100}\times\frac{160000}{2481}\right)$$

$$= 8000$$

An easier method to solve this question would be by using options. If we try with 8000, we would get: SI for 2 years @10% = 20% of 8000 = 1600. CI @10% annually compounded half-yearly means an effective CI rate of 5% per 6 months. This can be calculated by increasing 8000 by 5% successively four times. We would get: 8000 → 8400 → 8820 → 9261 → 9724.05. The required difference in CI and SI in this case can be seen to be the same (124.05) as given in the problem. Hence, Option (b) is correct.

20. Compound interest

$$= 10000\left[1+\frac{5.25}{100}\right]^{\frac{122}{366}} = 10000\left[\frac{105.25}{100}\right]^{\frac{1}{3}} = 10172.02.$$

Hence option (d) is correct.

Alternative method: Interest for 1 year = 5.25% of 10000 = ₹525. Options (b) and (c) are wrong because in these options interest for 122 days is greater than that of interest for 1 year.

In option (a), interest for 122 days is almost half of the interest for 1 year but if we are calculating the interest in compounded manner then interest for six months must be less than the half of 525 or 262.5, but here interest for 122 days is almost half of the interest for 1 year.

21. Required interest = Interest on the amount deposited on April 1 + Interest on amount deposited on October

$$1 = 10000\left[1+\frac{5}{100}\right]^{2}-10000+10000\left[1+\frac{5}{100}\right]^{1}.-10000 = 1025 + 500 = 1525.$$

22. Required difference =

$$20000\left[1+\frac{5}{100}\right]^{2}-20000\left[1+\frac{10}{100}\right]=22050-22000$$
$$=₹50$$

23. Required interest = $15000\left[1+\frac{3}{100}\right]^{2}-15000$
$=₹\ 913.50$

24. Let ₹x be the sum for simple interest then according to the question:

$$x\times3\times\frac{8}{100}=\frac{1}{2}(4000\left[1+\frac{10}{100}\right]^{2}-4000)$$
$$\frac{24x}{100}=\frac{840}{2}$$
$$x = ₹1750$$

25. $\left(sum \times 8 \times \frac{x}{100}\right) = 40\%\ of\ sum$

$x = 5\%$.

Compound interest = $2000\left[1+\frac{5}{100}\right]^2 - 2000 = ₹205$

26. Difference between CI and SI for 2 years = ₹(3328 – 3200) = ₹128

SI for 1 year = ₹1600

SI on ₹1600 for 1 year = ₹128

Interest rate = $\left(100 \times \frac{128}{1600}\right)$

Difference between CI and SI for 3rd year = 8% of (3200 + 128) = ₹266.24

Required difference = ₹(266.24 + 128)
= ₹394.24

27. We can solve this problem by checking the options:

Simple interest for ₹5000 = $5000 \times \frac{20}{100} \times \frac{3}{2}$

= ₹1500

Compound interest for ₹5000

= $5000\left(1+\frac{10}{100}\right)^3 - 5000$ = ₹1655

Required difference = ₹(1655 – 1500) = ₹155. Hence this option is correct.

28. Effective annual rate = $\left[\left(1+\frac{5}{100}\right)^3-1\right]100$ = 10.25%

29. Let the sum of money be ₹x and interest rate be r% per annum, then according to the question:

$$p\left(1+\frac{r}{100}\right)^2-p=1050 \quad (1)$$

$$p\left(1+\frac{r}{100}\right)^3-p=1655 \quad (2)$$

Equation 1 / equation 2 =

$$\left[p\left(1+\frac{r}{100}\right)^2-p\right]/\left[p\left(1+\frac{r}{100}\right)^3-p=1055/1655\right.$$

$$\frac{\frac{r}{100}\left(2+\frac{r}{100}\right)}{\left[\left(\frac{r}{100}\right)^3+3\left(\frac{r}{100}\right)^2+3\left(\frac{r}{100}\right)\right]}=\frac{1055}{1655}$$

$$\frac{2+\frac{r}{100}}{\left(\frac{r}{100}\right)^2+3\left(\frac{r}{100}\right)+3}=\frac{1055}{1655}$$

Now by putting different values of r from the given options, we get that option (c) satisfies the above equation. Hence, this one is the correct option.

A much simpler way to think here is that since the CI for two years is 1050 and for three years is 1655, it means that the third year's CI is 1655

5000, we would get the required interest of 605. Thus, the required answer is 10%.

30. Let the interest rate be r% per annum.

As per the question: $10000\left(1+\frac{r}{100}\right)^4 = 20000$ or $\left(1+\frac{r}{100}\right)^5 = 2$

By cubing both sides of the above equation, we get:

Hence, the final amount after 15 years = 8 × 10000 = 80000.

(**Note:** The following thought is also usable in such situations: Since the series of numbers created in a CI situation is essentially a geometric progression, i.e if the amount is doubling after five years, it would become four times in ten years and again double to eight times in 15 years. Thus, 10,000 would become 80,000 in 15 years.)

31. Using the same logic as the one explained for the previous question, we can see that doubling in six years would mean becoming four times in 12 years and eight times in 18 years.

32. Simple interest on ₹4,000 in three years at the rate of x% per annum = $4000 \times 3 \times \frac{x}{100} = 120x$

Simple interest on ₹5,000 at the rate of 12% per annum in two years = $5000 \times \frac{12}{100} \times 2$ — $1200 = 120x = 1200$ or $x = 10\%$ per annum. Hence, option (a) is correct.

33. Solve using options. If we try 3000 (option d) for convenience, we can see that the difference between the two is ₹30 (as the SI would amount to 600 and CI would amount to 300 + 330 = 630).

Hence, ₹3000 is correct.

34. For $r = 10\%$

    Total effective amount lent for 1 year = ₹4000 × 2 + ₹1000 × 8 = ₹16,000

    Interest is ₹1600, and rate of interest 10%.

35. The value would increase by 4% per year or ₹200 per year. Hence, required time = $\frac{21000-5000}{200} = \frac{16000}{200}$ = 80 years.

36. Let the interest rate be r% per annum. According to the question:

$$\left(6000\times 2\times \frac{r}{100}\right)+\left(1500\times 4\times \frac{r}{100}\right) = 900$$

    $120r + 60r = 900$

    $r = 5\%$

    Hence, option (a) is correct.

37. The sum becomes seven times means that there is a 600% increase in the sum. This would be the interest earned (600% of the original amount in 15 years). It means that the yearly interest must be 40%.

38. It would take another five years to double again. Thus, a total of ten years to become four-fold. In another five years, it would double again to eight times its original value. Hence, option (a) is correct.

39. The difference in simple interest represents 5% of the amount invested. Since this difference has occurred in two years, annually the difference would be 2.5%.

40. If it doubles in two years, it would become four times in four years and eight times in six years.

41. If we take the principal as 100, the CI @ 20% rate of interest would be ₹44. In such a case, the SI would be ₹20 per year. For two years, it would be ₹40.

42. 20% of x = 5% of $(1000 - x)$ x = ₹200.

    Thus, the two parts should be ₹200 and ₹800.

43. Akbar's share should be such that at 4% p.a. compound interest, it should become equal to Amar's share in two years. Checking through the options, it is clear that option (a) fits perfectly as 1875 would become 2028 in two years @4% p.a. compound interest.

    Alternately, if you think about Akbar's share being ₹100 today, his share after 4% CI for two years would be 100 × 1.04 × 1.04 = 108.16. Thus, the ratio in which Akbar: Amar should divide the amount would be in the ratio of 100:108.16 = 625:676. Thus, the individual parts would be 1875 and 2028.

44. The total interest in 5 years = 100%

    Thus, per year SI = 20%

45. The interest he pays per year would be 250 + 80 = 330. Thus, in three years, the interest would amount to ₹990.

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. Money becoming thrice means that there is an increment of 200% in the amount. Since, this happens in ten years, the rate of interest per year = 200/10 =20%.

48. Ten per cent rate of interest on the amount invested gives an interest of ₹4600. This means that 0.1 A = 4600 or A = ₹46000. The sum of the investments should be ₹46,000. If B invests x, A invests x – 6000 and C invests x + 4000. Thus:

$x + x - 6000 + x + 4000 = 46000$ or x = ₹16000.

49. In four years, 500 becomes 620; SI per year = ₹30 and hence, the SI rate is 6%.

With an increment of 4% in the interest rate, at 10% rate of interest the value of 500 would become 700 in four years.

50. The rate of interest is not defined.

Hence, option (d) is correct.

Level of Difficulty (II)

1. In five years, the interest earned = 100%

Thus, per year interest rate = 100/5 = 20%

To become eight times, we need a 700% increase. This would require 700/20 = 35 years.

2. Doubling in four years means that the interest earned in four years is equal to 100% of the capital value. Thus, interest per year (simple interest) is 25% of the capital. In twenty years, total interest earned = 500% of the capital and hence, the capital would become six times its original value.

3. x = ₹2000 (as 2000 @ 10% for 2 years becomes equal to 2400).

Similarly y = ₹1200

$x + y = 3200$

4. 10% per annum for first two years = 20%

   10.5% per annum for next six years = 63%

   17% per annum for the next one year = 17%

   10/3% per annum for next three years = 10%

   Sum at the end of 12 years = 10000 + (20 + 63 + 17 + 10) % of 10000 = 10000 + 11000 = ₹21,000.

5. At 8% simple interest per year, the amount would be 180% of the initial amount in ten years. Thus, the original borrowing would be 14400/1.80 = ₹8,000.

6. Let each instalment is equal to ₹x.

$$1,00,000 = \left(\frac{x}{1+\frac{10}{100}} + \frac{x}{\left(1+\frac{10}{100}\right)^2} + \frac{x}{\left(1+\frac{10}{100}\right)^3}\right)$$

$$1,00,000 = x\left[\frac{10}{11} + \left(\frac{10}{11}\right)^2 + \left(\frac{10}{11}\right)^3\right]$$

   By solving, we get x = ₹40211.48.

   (**Note:** The principal used above is of the time value of money – 1 rupee today is not equal to 1 rupee tomorrow and both these are not equal to 1 rupee yesterday. Thus, if you want to equate cash flows that have happened at different points of time, you need to get each of the cash flows to the same time. In the solution above, we have brought the value of the cash payments 1, 2 and 3 year hence, to the time point, when the loan was taken. As you saw, the calculations involved in this were quite tedious. I will now illustrate a simpler way for you to use the same principle of time value of money such that the calculations are easier. For

this, we rather than taking the instalments paid to an earlier time frame- equate all the amounts to the time point when the last payment was made. This would yield the following thought:

Basic principle for a loan to be repaid: money taken = money repaid. Let the instalment value be M. Then:

100000+ 3 years Interest on 100000 @10% per annum compounded = (M + 2 years interest on M @ 10% per annum compounded) + (M+1 year interest on M @ 10% per annum compounded) + M →

$100000 \times 1.1 \times 1.1 \times 1.1 = (1.1 \times 1.1M) + 1.1M + M \rightarrow$

$133100 = 3.31M \rightarrow M = 133100/3.31 = 40211.48.$)

7. The yearly increase in the population is 1%. Thus, the population would increase by 1% each year. 300000 would become 303000 while 303000 would become 306030.

8. Let the first and the second part of the amount be ₹x and ₹$(56,000 - x)$.

$$\frac{x \times 8 \times 4}{(56000 - x) \times 10 \times 3} = \frac{16}{125}$$

On solving the above equation, we get, x = ₹6000.

Thus, the second part = 56000 – 6000 = ₹50,000.

9. At 8% compound interest, the interest in two years would be 16.64%.

At 7.5% simple interest, the interest in two years would be 15%.

Difference = 1.64% of the amount = ₹164

Principal amount= ₹10,000

10. Remaining amount after four years =

$$\left[15000\left(1+\frac{10}{100}\right)^4-\left\{3000\left(1+\frac{10}{100}\right)^3+3000\left(1+\frac{10}{100}\right)^2+3000\left(1+\frac{10}{100}\right)+3000\right\}\right]$$

₹8038.50

11. *B* would be paying 20% on the capital as interest over two years and he would be getting 21% of the capital as interest from *C*. Hence, he earns 1% of the capital in two years.

12. $24{,}000 \times (1.03)^4 = 27{,}012.21$.

    Interest = ₹3012.21

    Hence, option (d) is correct.

13. Since the interest is compounded half-yearly at *C*% per annum, the value of *C* would be lesser than the value of *D*. (Remember, half-yearly compounding is always profitable for the depositor. For instance, 10% per annum compounded half-yearly is better than 10%).

14. At 10% per annum simple interest, the interest earned over three years would be 30% of the capital. Since, this amount is given to us as 600; it means that the principal would be 20,000.

    At 10% per annum compound interest, the interest earned over three years would be 33.1% of the capital. Thus, the CI would be equal to 33.1% of the capital = 662.

15. The difference in CI and SI in three years would be 3.1% of the principal amount (since SI @10% would be 30% and CI @ 10% would be 33.1%). This difference (3.1%) is 1240. Hence, the principal = 40000.

16. Check the options, only option (a) is correct because

$90000 \times 1.05 \times 1.1 = 103950$

17. Net interest earned by Ankit = $\frac{8x}{100}$

Net interest earned by Gopal after paying Ankit's dues = $\frac{(x+y)10}{100} - \frac{8x}{100} = \frac{2x+10}{100}$

According to the question:

$$\frac{8x}{100} = \frac{2x+10y}{100}$$

$$\frac{6x}{100} = \frac{10y}{100}$$

Or $x: y = 5: 3$.

Net interest earned by Gopal after paying Ankit's dues = $\frac{(x+y)10}{100} - \frac{8x}{100} = \frac{2x+20}{100}$

According to the question:

$$\frac{2x+2y}{100} - \frac{2x+10}{100} = 0.1y = 150 \; or \; y = Rs.1500$$

As $X: Y = 5: 3$

$X = ₹2500$.

Hence, $X + Y = 2500 + 1500 = ₹4000$.

Hence, option (c) is correct.

18. Total amount after 1 year = 1500 + 5% of 1500 = 1500 + 75.

After payment of ₹500, the remaining amount = 1500 + 75 – 500 = 1000 + 75.

After two years, the net amount = 1000 + 75 + 5% of (1000 + 75) – 500 = 500 + 75 + 50 + 5% of 75 = 625 + 5% of 75.

After three years, the net amount = 625 + 5% of 75 + 5% of (625 + 5% of 75) = 625 + 3.75 + 31.25 + 0.1875 ≈ ₹660.

19. Let the amount of each instalment be ₹x.

    According to the question:

$$12300 = \frac{x}{1+\frac{5}{100}} + \frac{x}{\left(1+\frac{5}{100}\right)^2}$$

    x = ₹6615.

20. Rate of interest =12% per annum or 1% per month.

    Time = 12 y month.

    $64 = 1\left(1+\frac{1}{100}\right)^{12y}$ = 1.0112y. Hence, option (a) is correct.

21. 1000 + (5 % of 1000) 4 times = 1000 + 0.05 × 4 × 1000 = 1200. Interest = ₹200.

    2000 + (10 % of 2000) = 2200. Interest = ₹200.

22. Solve using options. If the price is ₹27,0000, the interest (after subtracting the down payment) would be 16% of 120000 = 19200. Hence, the total amount paid would be ₹289200. This matches the requirement of the question. Hence, option (b) is correct.

23. The interest would be paid on 14000 for 3 years + 20000 for 5 years @ 6.5% the total interest for 8 years

    = 2730 + 6500

    = ₹9230

24. It can be seen that for ₹8,000 the first year interest would be ₹640, while the second year interest after a repayment 1000 would be ₹630 (10 less than 640, as stated in the question). On a balance loan of 7000, @9%, the interest would be exactly 630 and this figure matches the problem situation. Hence, option (a) is correct.

25. Solve using options. option (c) fits the situation as:

    25640 = 4000 + 2 years interest on 4000 + 8000 + 1 years interest on 8000 + 12000 (use 10% compound interest for calculation of interest) →

    25640 = 4000 + 840 + 8000 + 800 + 12000

    Thus, Option (c) fits the situation perfectly.

26. Interest for *A* = 6% of 50000.

    Interest for *B*, *C* and *D* would respectively be 7.5, 9 and 10.5.

    Thus, *A*'s loan is MUL.

27. Interest the start-up 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

28. Let the amounts be ₹100 and ₹200 respectively. The value of the 100 would become 100 × 6/7 × 6/7 = 3600/49 = 73.46.

    The other person's investment of 200 would become 200 × 1.2 × 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 two years. Hence, option (a) is correct.

29. The final value would be:

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

→ Drop in value = 4.32%

30. 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 the sixth year, i.e. 2026.