## Chapter - 18 Borrowing and Lending

18. Borrowing and Lending:

**Loan**: Often means the money borrowed – rate of interest agreed upon and total sum to be returned after the duration of the loan.

18.1 If you borrow a pen or pencil, your are supposed to return it.

If you borrow a book, you are supposed to read (or use it) and return. You should return the book after a reasonable time, whether you had read it or not.

There are many such borrowings in real-life. They include small amounts of money taken (or given to help) in an emergency situation. In these cases there is no extra money involved.

All these can come under the term, **Interest- Free Loans**.

18.2 For calculation purposes, there has to be some Interest. This calculation depends on many items:

Principal – Amount of money taken by the borrower (not head of a college).

Duration – Time for which the borrower keeps the money with him.

Rate of Interest – The extra money to be paid by the borrower for having used the principal amount.

**18.3 Exercises: (Activity)**

a. Students can write down (or discuss) loans taken by their relatives and friends.

They can write:

i. Amount of loan:
ii. When taken:
iii. From whom: Relative/Saukar/Bank/Sangha:
iv. Purpose (Real):
v. Rate of interest (clearly stated / no if clear; terms):
vi. Still paying interest:
vii. How much interest paid until now:

b. Students can be encouraged to discuss any moneylenders they know, then mode of paying, method and amount of collecting interest etc.

18.4 Rate of Interest in local small groups and social circles, is expressed in many different ways, sometimes per day, many occasions per week; mostly monthly. This is because in gambling and other places loan amount can range from Rs. 10 to Rs. 10000 and duration of loan can be as small as a day.

18.4.1 Activity: [Teachers, please do this activity. These may be less of arithmetic in this activity. But it will be enlightening socially]. Students could tell funny (or strange) stories of emergency loan taken and for what purposes.

18.5 10% rate of interest (R, hereafter) means, if the principal amount (P) is Rs. 100, duration of loan (T, time) is 1 year, interest is Rs.10.

Worked example:
What is the interest to be paid for a loan of Rs. 100 for 1 year at the rate of 10%?

Ans.: P=100 Rs., T= 1 year, R =10% (By definition of R, interest (I) = Rs. 10)

**Exercises:**

a. P = 100; what is I for 1 year? If R= 10%
b. P = 100; what is I for 1 year? If R= 20%

c. P = 100; what is I for R = 18%?

18.6 Interest to be paid increases if the loan amount increases. Simply stated Loan More, Interest More.

In mathematical language, they say, Interest is Directly Proportional to Loan.

Example1:
For a loan of Rs. 100 and 1 year duration, and rate of interest 10%? What is the amount of interest?

The same question can be written as, P = 100, T = 1 year, R = 10%, I =?
Ans: By definition of R, I = Rs. 10

Example2:
P = 200, T = 1year, R = 10%, I =?
Ans: IF $P_1$ =100, $I_1$ = 10
Now $P_2$ = 200, $I_2$ =?

$I_2 = 10 \times \frac{200}{100}$ = Rs. 20

**Exercises:**

a. R = 10%, T = 1 year, I =? For P = Rs.500
b. R = 10%, T = 1 year, I =? For P = Rs.1500
c. R = 10%, T = 1 year, I =? For P = Rs.3000
d. R = 10%, T = 1 year, I =? For P = Rs.10000
e. R = 10%, T = 1 year, I =? For P = Rs.50
f. R = 10%, T = 1 year, I =? For P = Rs.10

18.7 Interest to be paid increases if the loan amount is kept with you for a longer time.
i.e., Time More, Interest More.
i.e., Interest is directly proportional to the duration of loan.

Example1:
P=100, R = 10%, T=1 year, I=? (Ans.: By definition, I = Rs. 10)

Example2:
If T = 2 years, I =? (Ans.: I = 2 x 10 = Rs. 20)

**Exercises: All others are the same**

a. T = 5 years, I =?
b. T = 10 years, I =?
c. T = 2 ½ years, I =?
d. T = ½ year, I =?
e. T = 6 months I =?
f. T = 1 month, I =?
g. T = 73 days , I =?
(Loan was from 01.01.09 to 18.03.09) I=?

18.7.1 In the examples given above, if the duration is in days (not full months). What can be done? Banks face this problem always. They calculate fraction of the year: i.e., (no of days)/365.

18.8 Interest Rate to be paid increases if the rate of interest agreed upon is more.
i.e., Rate More, Interest More.
i.e., The amount of Interest is directly proportional to the rate of interest, all others being the same.

Example:
P=100, T = 1 year, R =15% I=? (Ans.: By definition I = Rs.15)

18.8.1 Rate of interest is clearly state as % in banks and other neat transactions. In daily life all kinds of agreements are made. We should convert them into % per year. This is called Annual Rate of Interest.

Example: It was agreed that one rupee loan, will earn 1 paisa per day as interest. Minimum loan is Rs. 100. What is the interest in a month?

Ans: 1 Re 1 day I= 1 paisa
1 Re 30 days I= 30 paisa
100 Rs. 30 days I= 30 x 100 Paise = Rs. 30

**Exercise:**

a. Interest of Re. 1 for loan of Rs. 10, every week.
b. Interest of Re. 2 for loan of Rs. 10, every month
c. Interest equal to loan amount, every 6 months

18.9 Put all things together (P, R, T, i.e. 18.6, 18.7, 18.8)

18.9.1 **Note for Teachers:**
Teachers allow the students to work out simple problems. Do not give out the formula at this time.

a. Loan Rs. 100 @ interest of 10%. Find the amount of interest to be paid after 1 year.

b. Let the interest rate remain at 10%. Increase the principal amount to 200, 300 ….1000. Ask the same question.

c. Let the loan amount be fixed at Rs. 100. Let the rate of interest go from 10% to 20, 30 …… 100%. Ask the same question**.** All Orally

18.9.2 From 18.9.1, try to find whether any student is able to make a formula. After some trials give out the formula.

18.9.3 **Total amount payable = Capital + Interest**
Try for various situations discussed earlier

$I = \frac{PTR}{100}$ Explain I = interest, P, T, R

If instead of T someone uses N it is also OK.

Here I = Amount of Interest
P = Principal (= Loan Amount)
T = Time (= duration of loan) in years
R = (annual) rate of interest (% per year)

Total amount = P + I = Loan + Interest

18.10.1 Worked Example:
What is the interest on a loan of Rs. 1000 for a period of 3 years at the rate of 20%?

Ans: $I = \frac{PTR}{100}$
P = Loan Amount
T = Period (=time) in years
R = Rate

Here: P = 1000 Rs.
T = 3 years
R = 20%

$$I = \frac{1000 \times 3 \times 20}{100} = \text{Rs. } 600$$

Example: In the above example, what is the total amount payable at the end of 3 years?

Ans: P=1000
I= 600
Total Amount = P + I
= 1000 + 600
= Rs. 1600

**18.10.2 Exercises**

a. Loan Rs. 1000, rate 20%, time 2 years, Interest=?

b. Loan Rs. 2000, rate 50%, time 1 year, Interest =?

c. A scooter on cash down payment costs Rs. 40000. They offer the same on monthly installment of Rs. 2000 for 3 years. Calculate the rate of interest charged [Approximate value is OK. Please do not go for complications].

d. If a bank gives loan for scooter at 12%. Which is better [compare with (c)].

18.11 More on Borrowing

18.11.1 **Note for Teachers:**

Teachers! Here's a chance to do some sociologically relevant mathematics

Ask the students to go and look for real life loan situations – their own kith & kin – some on daily, others on weekly or monthly rate of interest.

Calculate & show how much interest they are paying.
(As a manual writer, I cannot honestly say what all we discuss here is truly mathematics. But I will not mind if teachers digress far from maths to do some sociological education).

18.11.2 Now ask the same students to gather information on bank loans, mutual fund loans, money given by shree Shakti sanghas etc.

18.11.3 Calculate and show that these are less than the rates charged by friendly neighborhood moneylenders. Introduce the concept of banking. Let it first be customer point or view. What can you do with your money? Etc.

Let words like SB account, RD, FD be explained. If forms are brought and show also it is OK.

18.11.4 As per banking rules, calculations of interest follows some norms – teachers could try to find them and explain. (Alternatively, a visit to a friendly neighborhood branch of a banking institution could be arranged).

18.11.5 While on a visit to a bank, the student could learn about other available facilities.

18.11.6 Similarly a visit to a friendly electronics shop will reveal that they give (sell) goods on installment basis. One can collect information sheets on these items, their true prices on cash-down basis and compare.

18.11.7 If it is easy, teachers could even try to explain the term EMI. (If this involves compound interest or complicated calculations, one can wait or explain qualitatively. [EMI = Equal monthly installments].

18.12 Caution

18.12.1 Total amount to be paid,

A = P + I Where P = Principal Amount; I = Interest to be paid

And $I = \frac{P \times T \times R}{100}$ Where T = duration in years

R = rate of interest (% per year)

This is enough for us. This is called Simple Interest calculation.
Caution: Enough is enough. Learn no more.

18.12.2 Cautionary note for teachers:

Some persons make the pupils to memorize.

$A = P\ [1 + \frac{NR}{100}]$ NOT OK

Please DO NOT DO this. This kind of unwanted burden makes mathematics look like a monster.

Students! Remember that this kind of formula is neither necessary nor elegant. You do not have to remember this 2 formulas given in 18.12.1 given above together gives the above.

18.12.3 Example: If a person borrowed some money & returned a total sum of Rs. 120 after 1 year, what was the amount borrowed? Rate of Interest was 20%.

Ans: This can be easily (& elegantly as per some people's opinion) by the complicated formula $A = P\ [1+\frac{NR}{100}]$.

Let us do & see:

Method A: $= P\ [1+\frac{NR}{100}]$

Given: A = 120, P =? N = 1 year R = 20% / year

$\therefore\ 120 = P\ [1+\frac{20}{100}]$ Change sides frist

$P\ [1+\frac{20}{100}] = 120$

i.e., $P \times \frac{(100+20)}{100} = 120$

i.e., $P \times \frac{120}{100} = 120$

i.e., $P = 120 \times \frac{100}{120} = 100$

Method B: $I = \frac{P \times T \times R}{100}$ T = 1, R = 20

$= \frac{P \times 1 \times 20}{100} = P \times \frac{20}{100}$

$A = P + I$

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

$= P\ [1 + \frac{20}{100}]$ and so on.

Method B is OK; not longer; does not need any new formula to be memorized.

18.12.4 **Exercises: Do by both the methods seeing the book (open book)**

a. Total amount after 3 years at the rate of 15% was Rs. 690. What was the loan amount?

b. Total amount paid after 3 years on a loan of Rs. 200 was Rs. 750. What was the rate of interest?

18.13 Activity

Students write down (important points only).

a. How to calculate simple interest?
b. Sociological lessons you have learnt about borrowing and lending.

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## Chapter - 19 Compound Interest

19. Compound Interest:

Interest on a loan depends on the rate of interest agreed upon, duration of loan and the initial amount of loan. Such calculation shown earlier is called **SIMPLE INTEREST**.

19.1 What is the meaning of simple interest? If you have taken Rs. 1000 loan at 20% interest / year and keep it for 1 year, what is the amount of interest?

Rate of interest = 20% means,
Interest for Rs. 100 for 1 year = Rs. 20

$\therefore$ Interest for Rs. 1000 for 1 year = $\frac{1000}{100}$ X 20 = 200 Rupees

19.2 If a person A takes a loan of Rs. 1000 from B at 20% rate of interest and returns it after 4 years. What is the interest he should pay?

As per 19.1, interest for one year = 200
Interest for 4 years = 4 X 200 = 800
Now let us do it by formula

Interest = $\frac{PNR}{100}$ Here P = 1000, N = 4, R = 20

$\therefore$ I = $\frac{1000 \text{ X } 4 \text{ X } 20}{100}$ = 800 (OK)

19.3 Let us look at the problem once again. Annual rate of interest implies the debtor (person who took the loan) pays the interest at the end of the year (it is like a rent you pay for using something such as a house). If A had paid the interest of Rs. 200 at the end of the first year to B, B could have used the money. Isn't it so? He could have used it for 3 years. In fact B deserves to be paid more.

19.4 The argument given in 19.3 tells us that interest not paid in time is not correct. A calculation, which includes the interest on interest, is called **COMPOUND INTEREST**.

In other words, if interest is not paid in time, it should be considered as additional loan amount from that date.

19.5 Let us workout 19.2 on the basis of COMPOUND INTEREST.

| | |
|---|---|
| Loan at zero time | = Rs. 1000 |
| Interest for 1 year | = Rs. 200 |
| | --- |

Amount due at the end of I year = Rs. 1200

Now treat this as loan amount for the second year.

Loan at start of II year = 1200

Interest for I year = $\frac{1200 \text{ X } 1 \text{ X } 20}{100}$ = 240

Total amount due at the end of II year = 1200 + 240 = 1440

This money earns interest for I year = $\frac{1440 \text{ X } 1 \text{ X } 20}{100}$ = 288

∴ Amount due at the end of III year = 1440 + 288 = 1728

This money earns interest for I year = $\frac{1728 \text{ X } 1 \text{ X } 20}{100}$ = 345.60

∴ Total amount due at the end of IV year = 1728 + 345.60 = 2073.60

19.6 Compare the result of 19.5 and the result of 19.2.

Total amount payable at the end of 4 years:

a. On SIMPLE INTEREST = 1800

b. On COMPOUND INTEREST = 2073.60

It certainly makes a difference. Most of the real life situations are calculated on the basis of compound interest.

19.7 We can make the calculation of 19.5 in another way also.

A should have paid B, interest at the end of each year.
He did not do so.
He kept Rs. 200 for 3 years.

Interest on this = $\frac{200 \text{X } 3 \text{ X } 20}{100}$ = 120 (I)

Another 200 remained with him for 2 years.

Interest on that = $\frac{200 \text{X } 2 \text{ X } 20}{100}$ = 80 (II)

Another 200 was with A for one year

Interest on this last year = $\frac{200 \text{X } 1 \text{ X } 20}{100}$ = 40 (III)

Thus A has to pay all these amounts:

| | | |
|---|---|---|
| Principal amount | = | 1000 |
| Interest on interest (I) | = | 120 |
| Interest on interest (II) | = | 80 |
| Interest on interest (III) | = | 40 |
| Plus the basic interest (See 19.2) | = | 800 |
| Total | = | 2040 |

On the basis of this calculation, total interest payable is 2040.

19.8 Let us tabulate.
Loan = 100, Rate = 20%, Duration = 4 years
Total amount due:
SIMPLE INTEREST CALCULATION = 1800
INTEREST ON INTEREST = 2040
COMPOUND INTEREST = 2073.60
Correct method is the last one. Others are approximations; they favor the debtor.

19.9 Teachers! There is a formula for compound interest. It involves EXPONENTS. Not necessary for us. We can use the longer method shown in 19.5. If some students want to know it is here.

19.10 Compound Interest Calculation:

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

Where A = Total amount to be paid
= (Principal + Interest)
P = Principal = Loan Obtained
r = Rate of interest (% per year)
n = number of years

[In the above example (section 19.2) P = Rs. 1000, r = 20%, n = 4

$$\therefore A = 1000\left[1 + \frac{20}{100}\right]^{4} = 1000 \times [1.2]^{4}$$

19.11 Loan amount was Rs. 200. Rate of interest was 15%. Duration of loan was 3 years.

1. What is the total amount to be paid after 3 years on the basis of Simple Interest?
2. On the basis of Compound Interest? [Note: For simple interest calculations go to chapter 18; use formula given there. For compound interest calculation, use any formula given here].
3. A loan (say Rs. 1000) was offered to you with 2 options: option X: you can pay simple interest of 25% or option Y: you can pay compound interest at a lower rate of 20% loan is only for 2 years. Which option will you take?
4. In (3) above if the loan is for a period of 5 years, will your option be the same?
5. [This is for advanced level students]. In 3 and 4 above, does the option depend on the amount of loan? [Answers should have calculations and numbers to justify your answer].