Engineering Economy

Time Value of Money

Time Value Of Money

- How much your allowances 10 years ago?
- If you want to buy something right now, how much candies you have?
- There are the difference between value of money and sum of money

Time Value Of Money

- Time is such important element in the decision
- A rupiah in hand today is worth more than a rupiah in hand tomorrow, why?
  - I could invest and gain profit tomorrow,
  - I could avoid loss due to inflation
  - …..

Time Value Of Money

- The value of money is changing as the time goes by
  - Why it happens?

    → Time value of money is measured in terms of interest rate

- Value of money DOESN'T equal with math expression
  - Value of money→ bank interest rate
  - Sum of money → math concept

Time Value Of Money

- Cost and benefit evolves at different times.
  - It cause the different value of money

- Equivalence : a method to estimate the equity value of money for different times

Equivalence

- We need rate of interest information to calculate it
- Assuming, mother wants to save 5 million in 2014 at the commercial bank, after one year later the saving has rised up to

5juta (t=2015) = 5 juta + (5 juta (t=2014) *interest)

Interest

- Amount of money paid as the use of loan
- A compensation as the decrease of value of money during the loan period
- to ensure the value of money stay the same

Interest = Present amount owned- original Investement
Bunga= Jumlah utang sekarang- jumlah pinjaman semula

Time Value Of Money

- Why is there interest on a loan?
  - There needs to be a return, given the value today vs. tomorrow.
  - The loss of value from the other potential uses must be recognized.
  - There are risks that the loan may not be repaid.

Time Value Of Money

- Four relevant variables in dealing with the time value of money:
  - The initial amount lent, called the **principal amount**
  - **The time** period of the loan
  - **The interest rate**
  - The time period to which the interest rate applies

Rate of Interest

$$\frac{\textit{Bunga yang dibayarkan per satuan waktu}}{\textit{jumlah pinjaman awal}}$$

Rate of Interest **= (interest at interval time/principal amount) x 100%**

Ex: A student borrows some money 15 million rupiah in 2011. At the end of 2014, his debt recorded 18 Million rupiahs. How much the accumulated interest he must pay ? Then calculate rate of interest

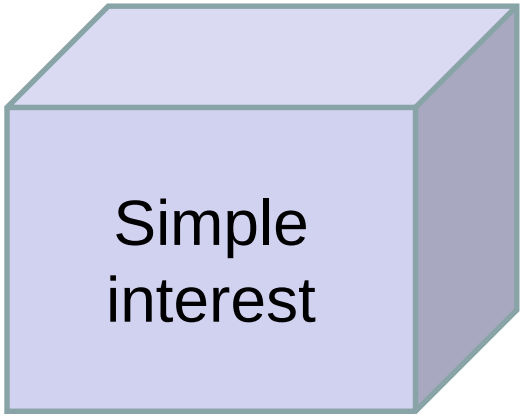
Interest = Rp.18.000.000-15.000.000

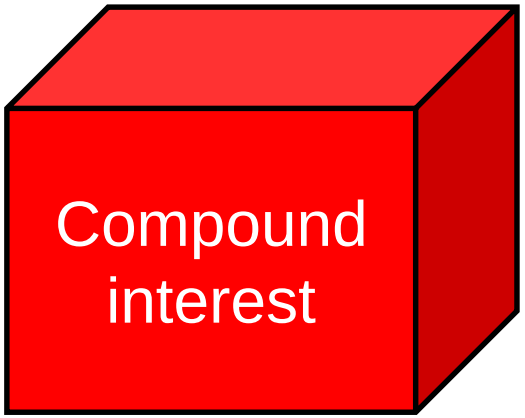
= Rp. 3.000.000

Rate of Interest = (Rp.1000.000 (annual) / 15.000.000) x 100 %

= 6,67%

Type of Interest





Applied to the initial amount, called the principal, for a given time period for interest.

Applied to the initial sum, plus any previous accumulated interest that has not been paid, for each successive time period for interest.

Simple Interest

year	Beginning balance	i=5%	Ending balance
1	200.000	5%x 200.000= 10.000	200.000+10.000=210.000
2	200.000	5%x 200.000= 10.000	210.000+10.000=220.000
3	200.000	5%x 200.000= 10.000	220.000+10.000=230.000
4	200.000	5%x 200.000= 10.000	230.000+10.000=240.000
Total interest		=40.000	

Simple Interest

- *P* = Principal amount
- *i* = Interest rate
- *N* = Number of interest periods

Formula for simple interest
Interest = P x I x n

- Interest= 5% x 200.000 x 4 = 40.000

Simple Interest

- *P* = Principal amount
- *i* = Interest rate
- *N* = Number of interest periods
- F= total amount of accumulated at the end of period

Formula for accumulated simple interest
F= P + (I.P) N

- F= 200.000 + (5% x 200.000) x 4 = 240.000

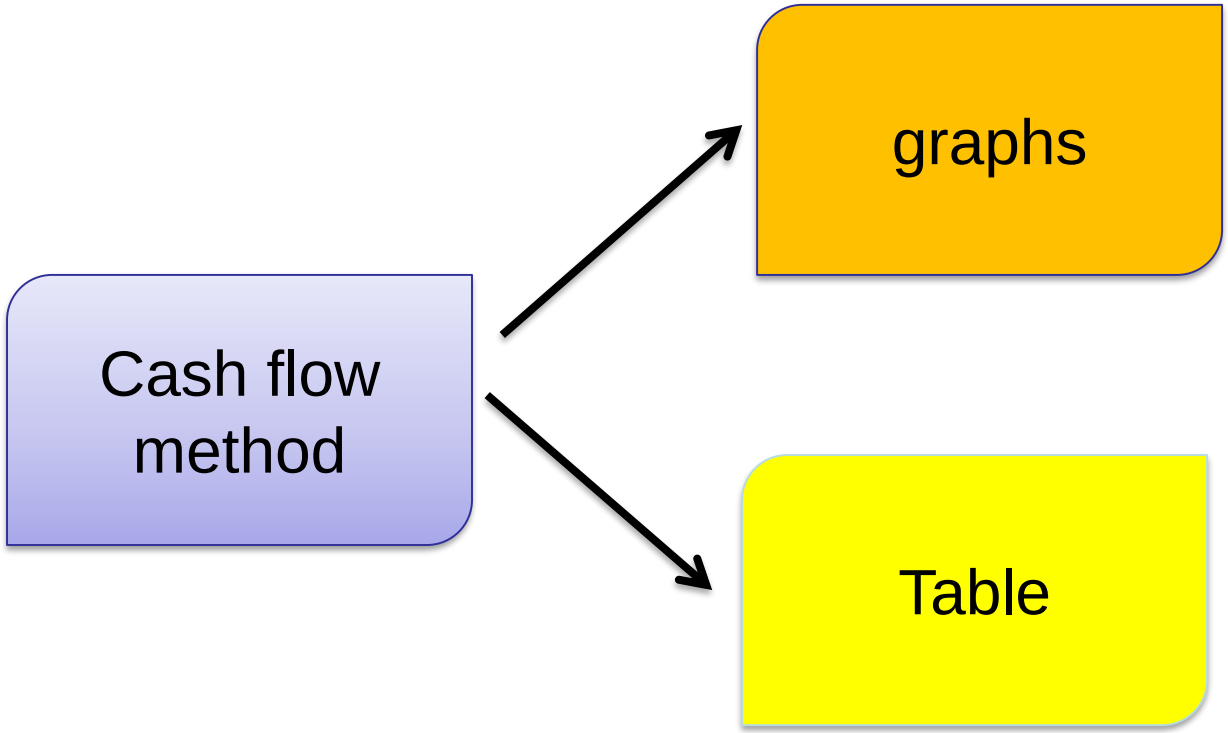
Compound Interest

year	Beginning balance	i=5%	Ending balance
1	200.000	5%x 200.000= 10.000	200.000+10.000=210.000
2	200.000	5%x 210.000= 10.500	210.000+10.500=220.500
3	200.000	5%x 220.500= 11.025	220.500+11.025=231.025
4	200.000	5%x 231.525= 11.576	231.525+11.576=243.101
Total interest		=43.101	

Compound interest is widely and mostly used, so this kind of interest will be more detailed in the next chapter

Cash Flow

- Data of cash in and cash-out at the interval period
- Cash- in means any kind of receipt e.g earnings and cash-out means any kind of disbursements e.g expenses



Graphical Methods

- Read carefully:

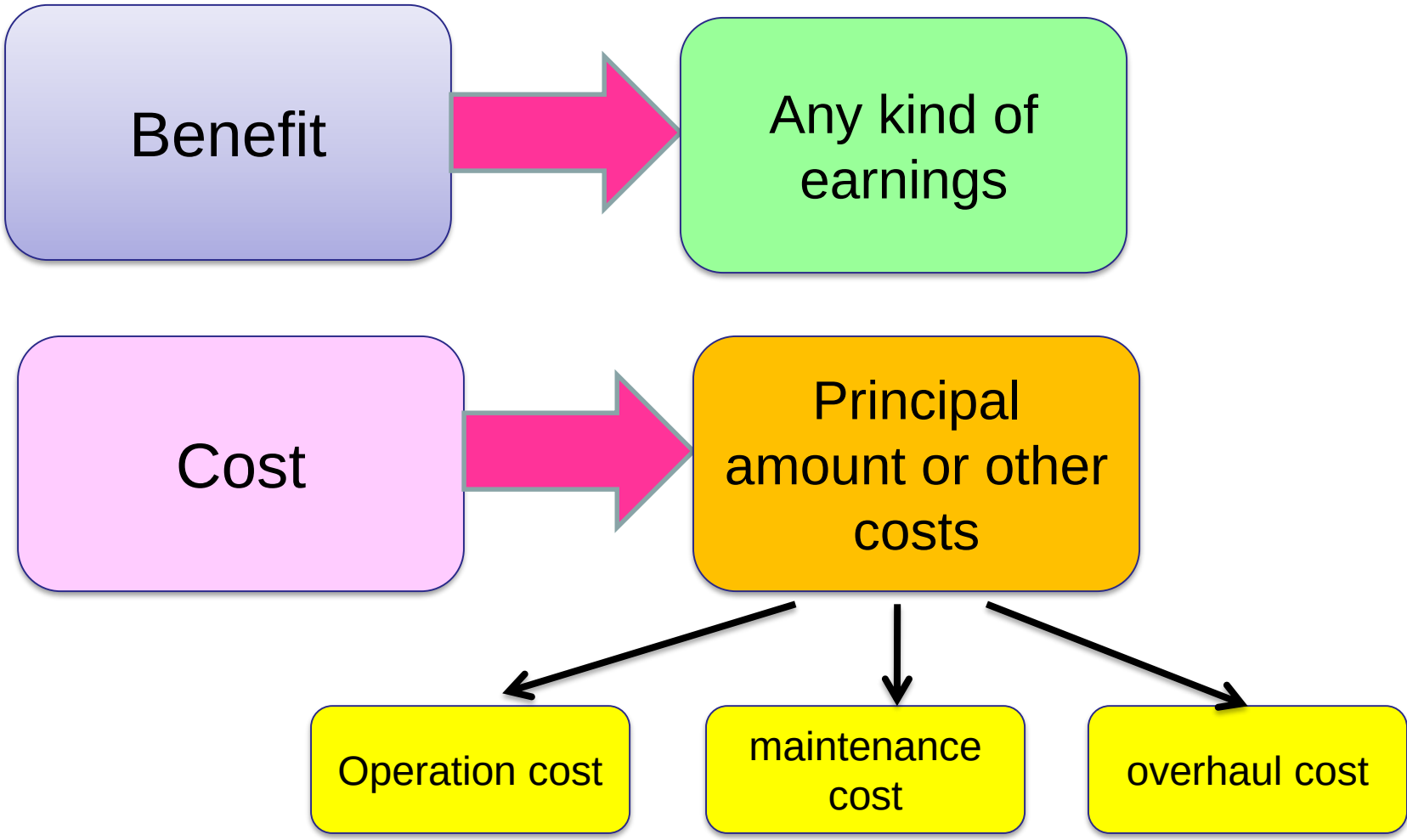
The horizontal axis presents time (time, notation is “n”)

The vertical axis presents cost and benefit

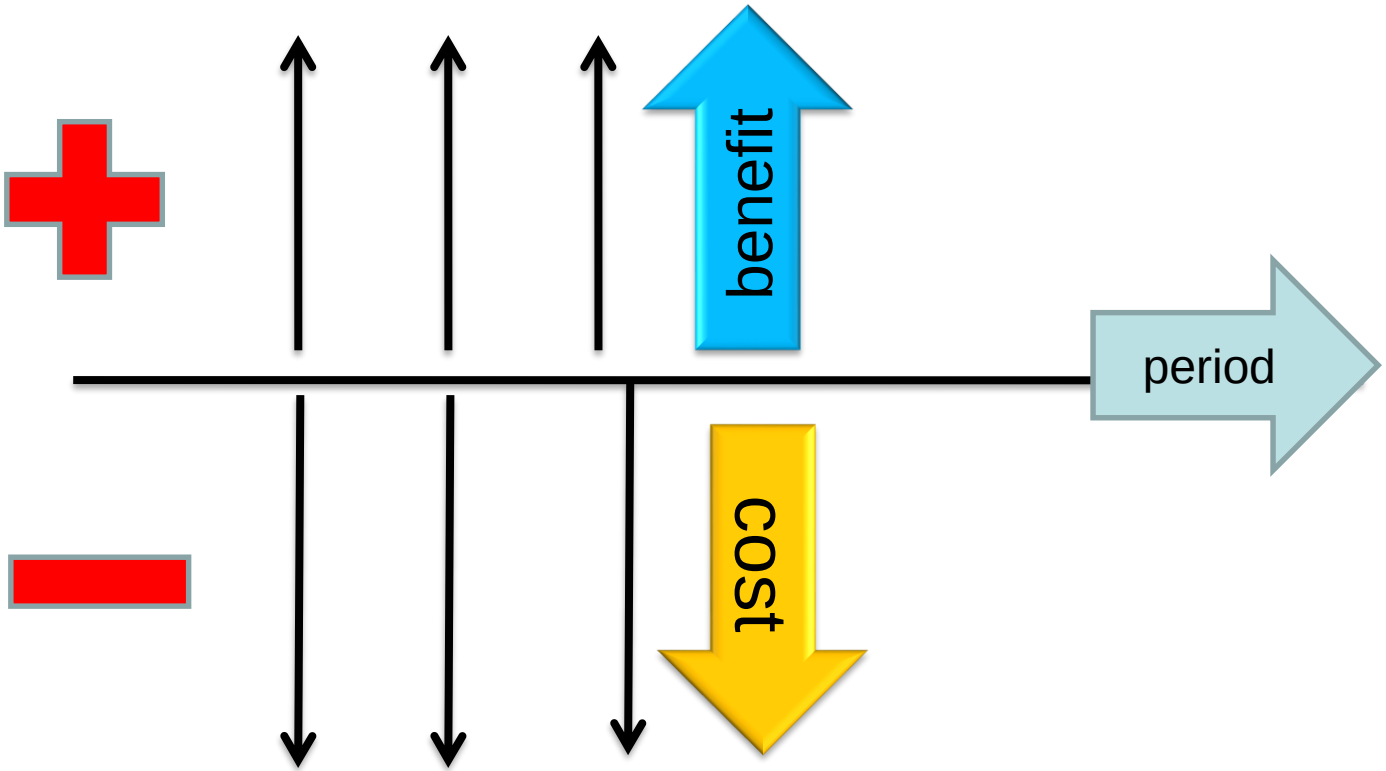
costs indicated by the down arrow (minus Y axis)

Benefit indicated by the upside arrow (positive Y axis)

Graphical Methods



Graphical Methods



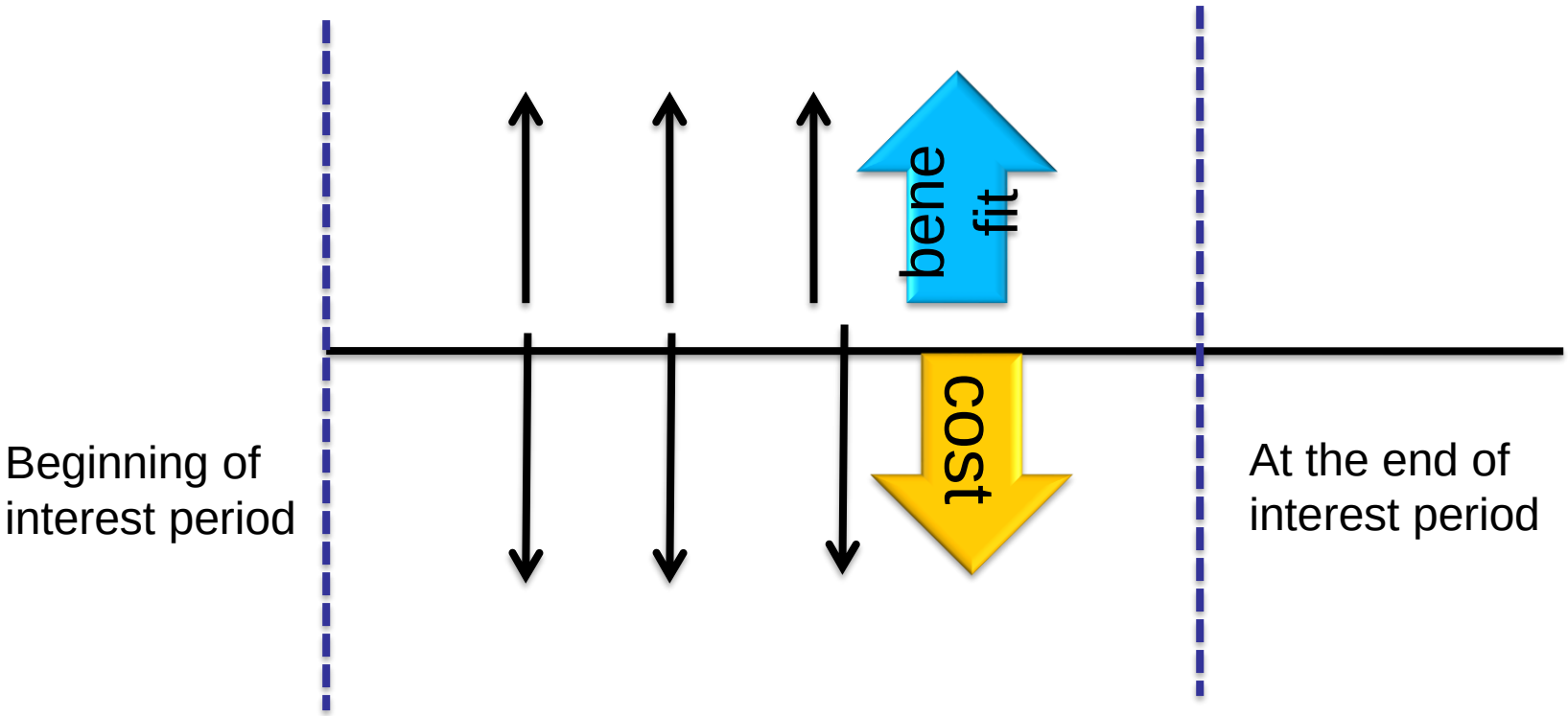
Graphical Methods

- Cash flows can occur at the beginning or in the middle of an interest period, or indeed, at practically any point in time.

- **End-of-period convention:**

  Unless otherwise mentioned, all cash flow transactions occur ***at the end of an interest period.***

Graphical Methods



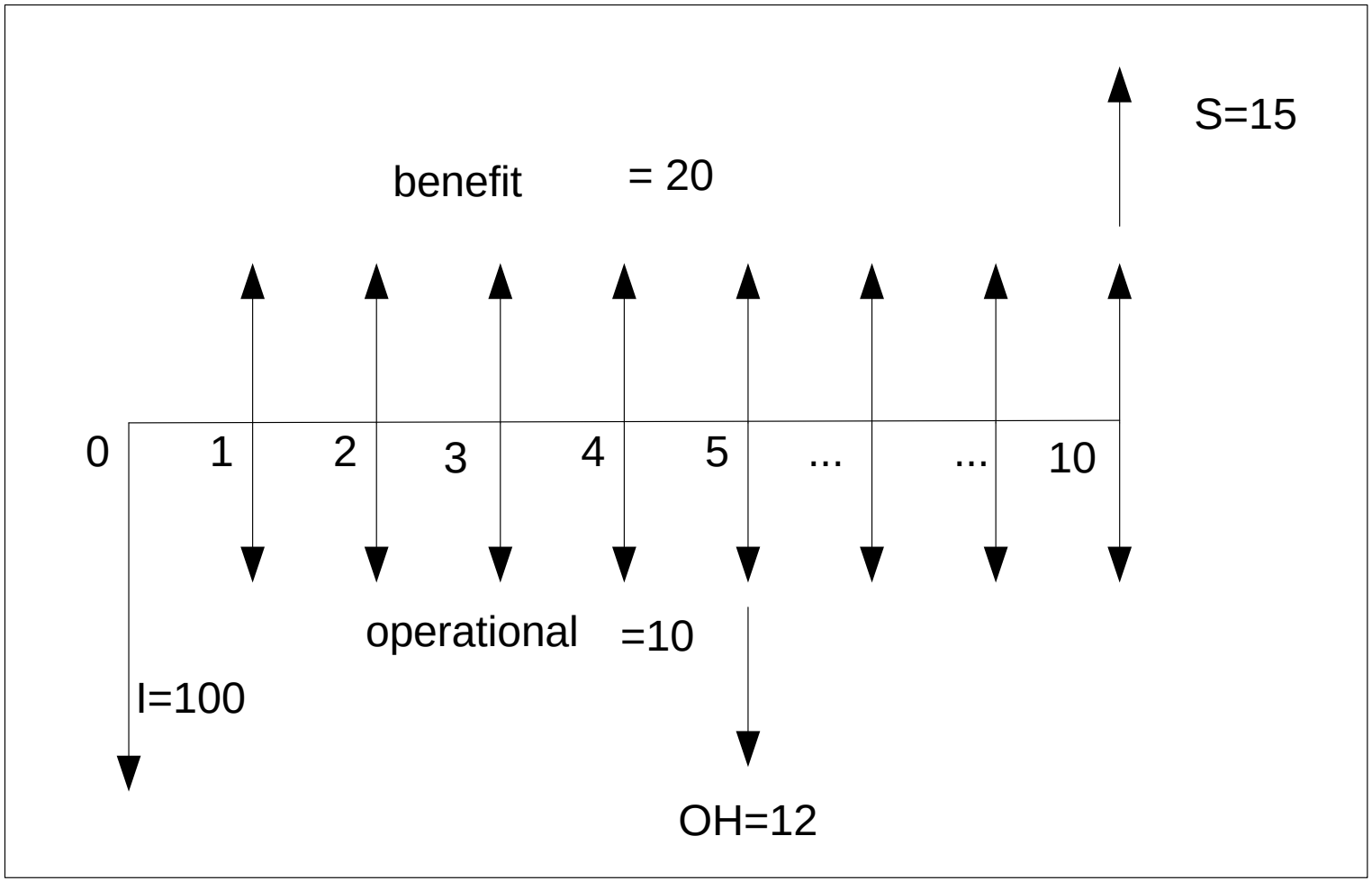
Practice problem

- Bakers Co. would purchase a production machine worth 50 million rupiah, followed by an operational cost which the average of 10 million / period. The benefit of the machine is gaining an average profit up to of 20 million rupiah / period
- At the end of year 5, the company will be performed overhaul worth 12 million and after 10 years usage, the machine can be sold 15 Million, Draw the cash flow using graphical and table method

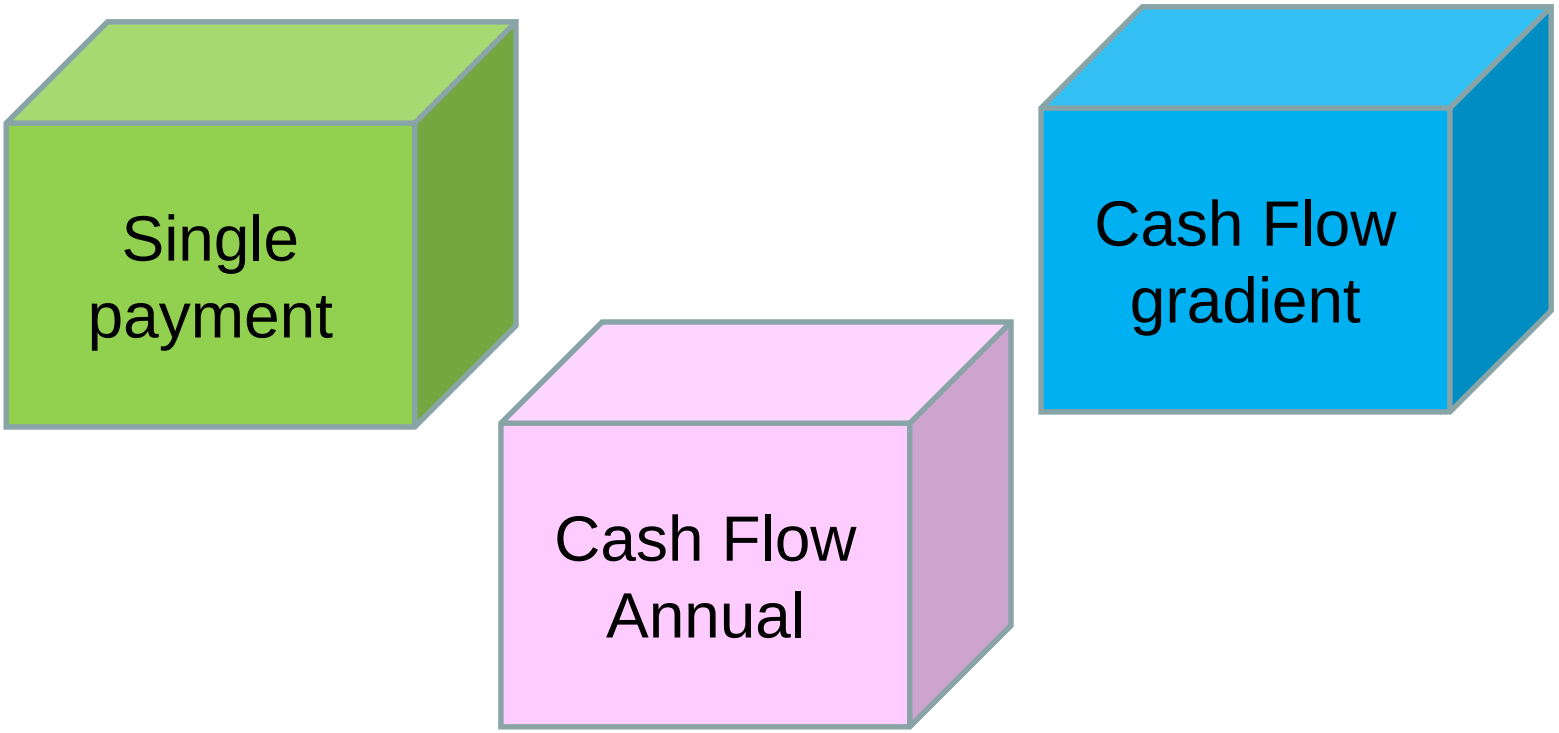
Table Methods

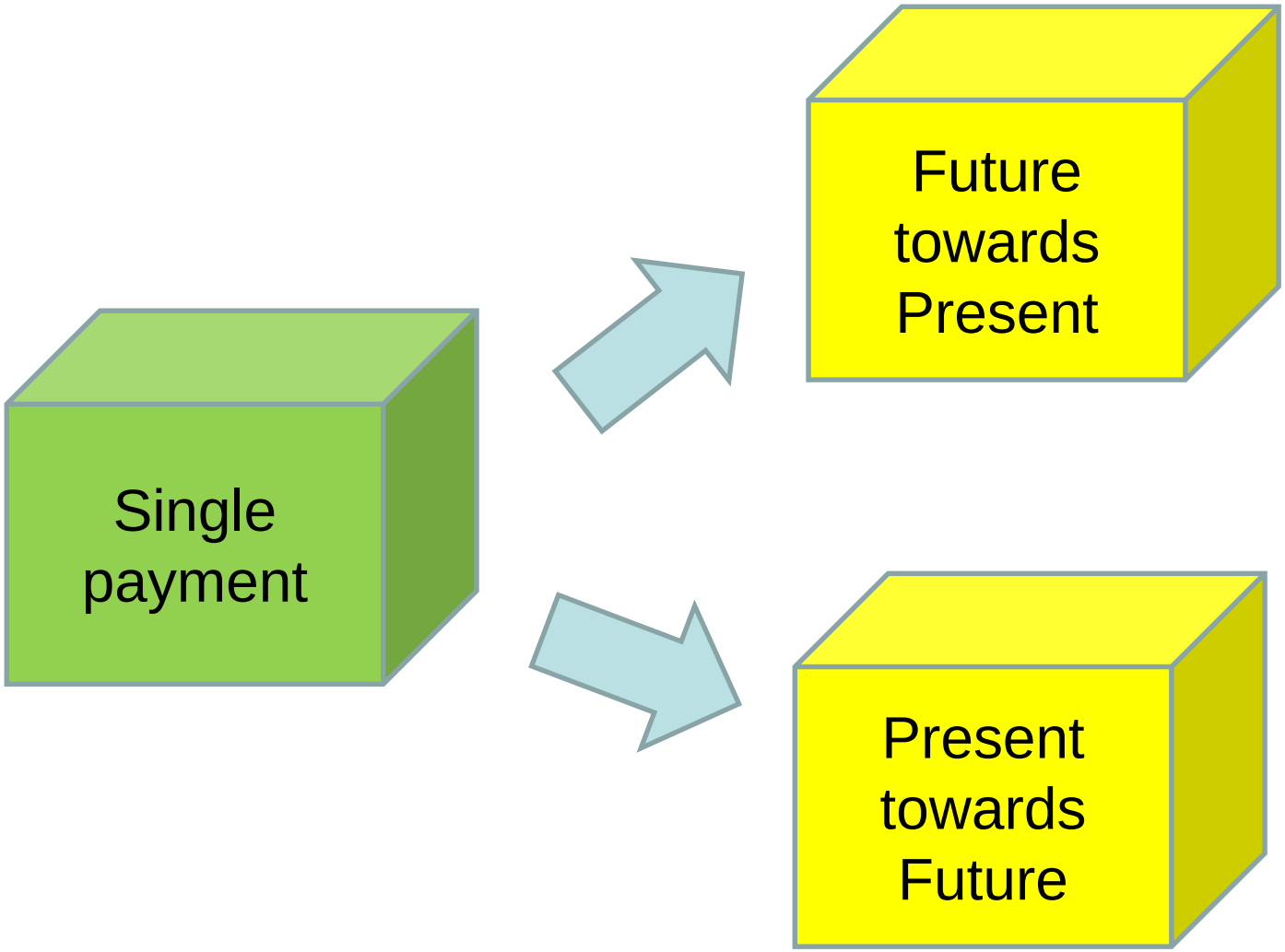
T-period	cash flow	
	cash-out (-) (Rp)	cash- in (+) (Rp)
0	50 juta	
1	10 juta	20 juta
2	10 juta	20 juta
3	10 juta	20 juta
4	10 juta	20 juta
5	10 + 12 = 22 juta	20 juta
...		
10	10 juta	15 juta + 20 juta

Graphical Methods



Equivalence and compound interest




Single payment
Future towards Present
Present towards Future

Single Payment

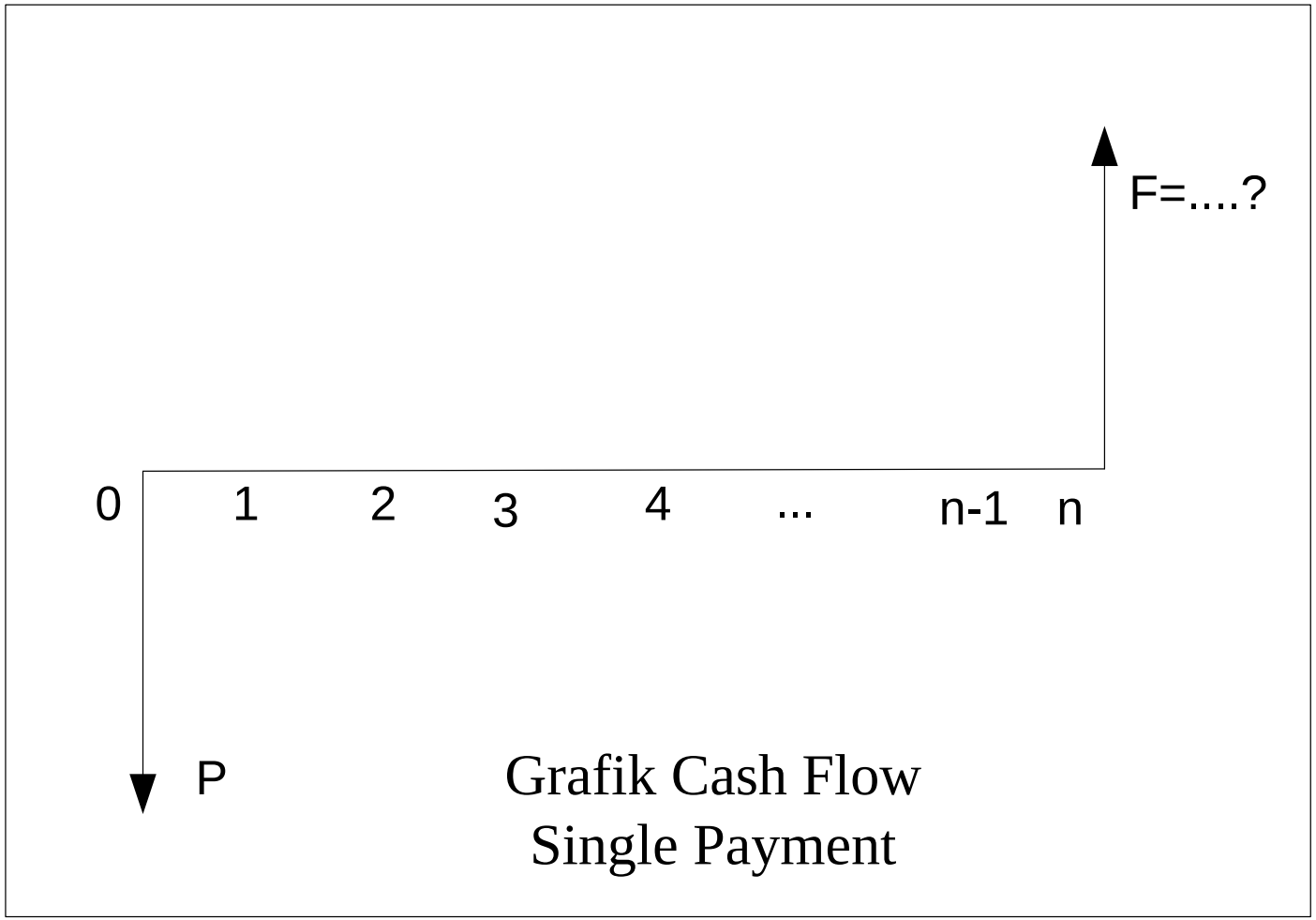
- $F = P\,(1+i)^n \rightarrow F = P\,(F/P,i,n)$

  $(1+i)^n$: *single payment compound amount factor*

- $P = F\,(1+i)^{-n} \rightarrow P = F(P/F,i,n)$

  $(1+i)^{-n}$: *single payment present worth factor*

Single Payment



Grafik Cash Flow
Single Payment

Practice Problem

A retired-man deposit Rp 150 Million now (*n* = 0) in a savings account that pays 20% interest, how much would he has at the end of year 5?

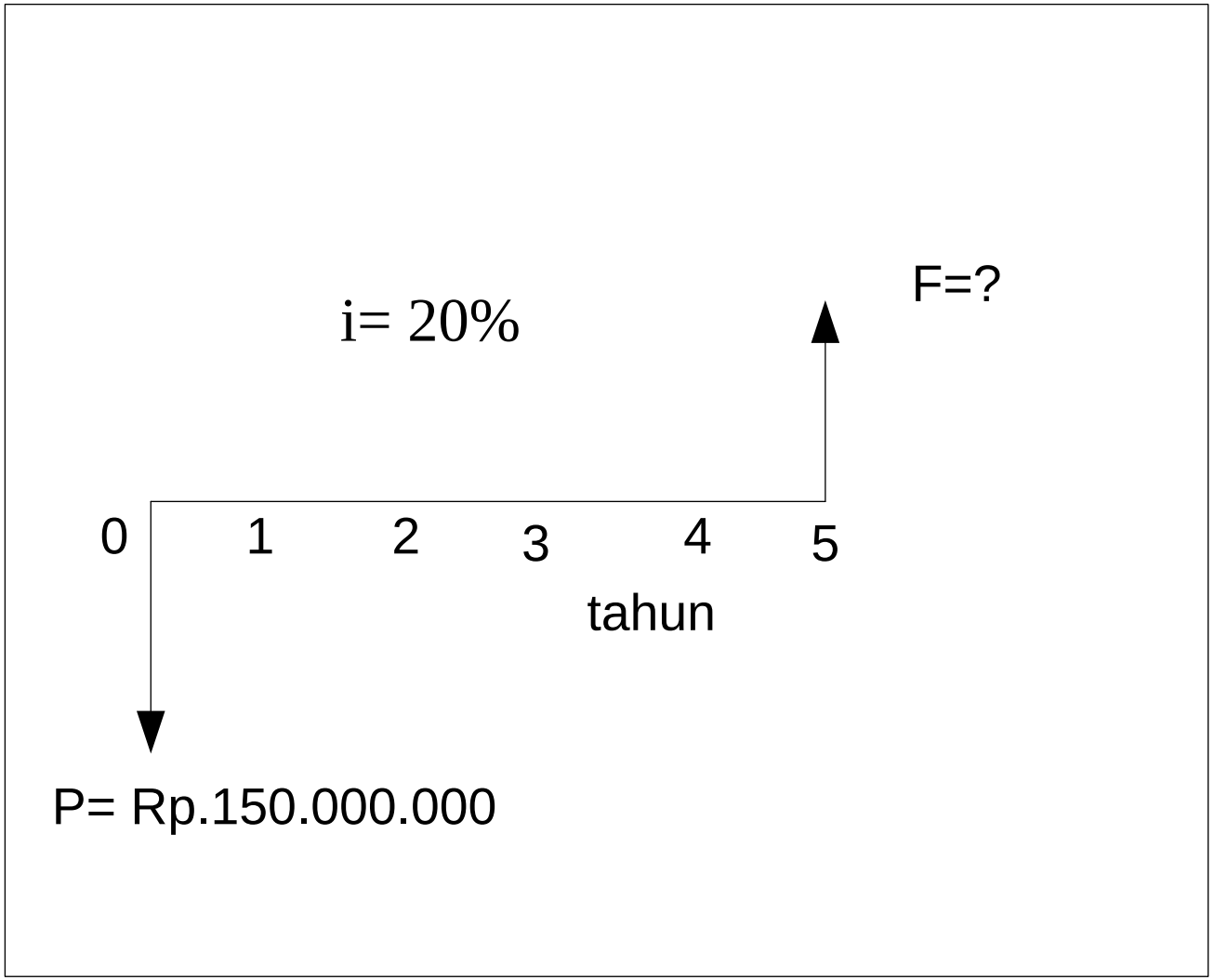
Problem:

P=Rp 150.000.000

I= 20% (annual percentage rate “APR”)

N= 5 years

question : 5 years later deposit→ F?


F=?
i= 20%
0
1
2
3
4
5
tahun
P= Rp.150.000.000

20% Compound Interest Factors 20%

n	Single Payment: Compound Amount Factor Find F Given P F/P	Single Payment: Present Worth Factor Find P Given F P/F	Uniform Payment Series: Sinking Fund Factor Find A Given F A/F	Uniform Payment Series: Capital Recovery Factor Find A Given P A/P	Uniform Payment Series: Compound Amount Factor Find F Given A F/A	Uniform Payment Series: Present Worth Factor Find P Given A P/A	Arithmetic Gradient: Gradient Uniform Series Find A Given G A/G	Arithmetic Gradient: Gradient Present Worth Find P Given G P/G	n
1	1.200	.8333	1.0000	1.2000	1.000	0.833	0	0	1
2	1.440	.6944	.4545	.6545	2.200	1.528	0.455	0.694	2
3	1.728	.5787	.2747	.4747	3.640	2.106	0.879	1.852	3
4	[illegible]	.4823	.1863	.3863	5.368	2.589	1.274	3.299	4
5	2.488	.4019	.1344	.3344	7.442	2.991	1.641	4.906	5

F

F = P (F/P,i,n)

F= 150.000.000 (2,488)

F=Rp373.200.000

How to use FV in Excel?

- Syntax : =FV (rate, nper, pmt, [pv], [type])
  - **rate** - The interest rate per period.
  - **nper** - The total number of payment periods.
  - **pmt** - The payment made each period. Must be entered as a negative number. (not relevant in this case)
  - **pv** - [optional] The present value of future payments. If omitted, assumed to be zero. **Must be entered as a negative number.**
  - **type** - [optional] When payments are due. **0 = end of period,** 1 = beginning of period. Default is 0.

Excel Formula:
F = FV(20%,5,0,-150000000,0)
F= 373.248.000

Practice Problem

- Student want to gain earnings 4 years later, up to Rp.30.000.000 to enroll Post Graduated Programmed. How much cash she should be deposit if the APR (annual percentage rate) 15 % ?

- Argument:

  F= 30.000.000

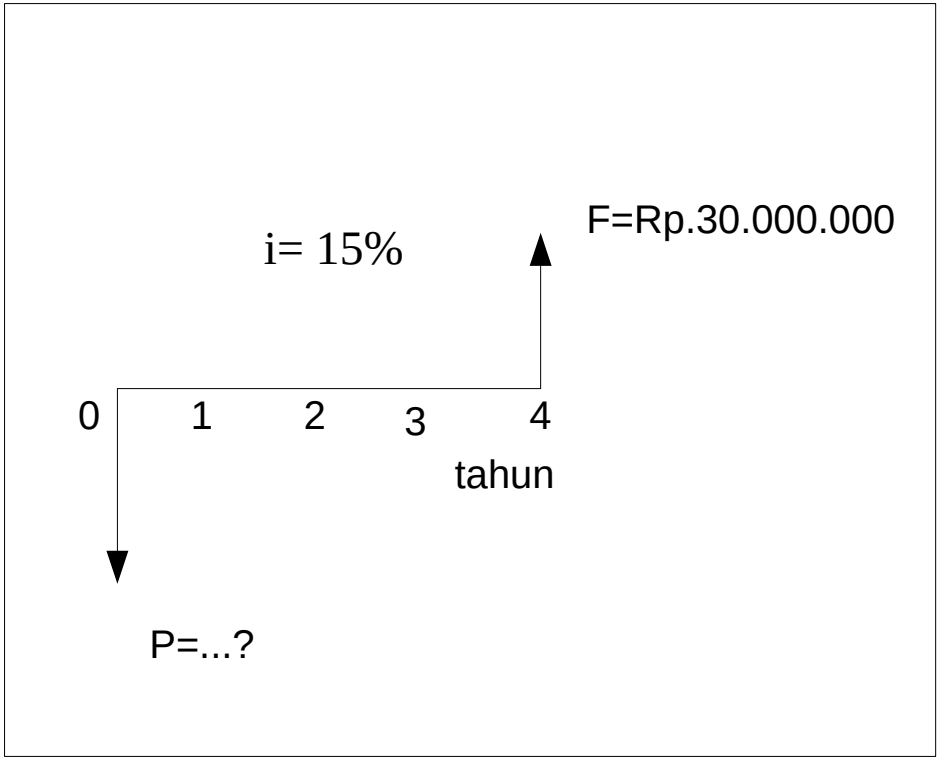
  I= 15% per year

  N= 4 years

  question : deposit cash→ P?

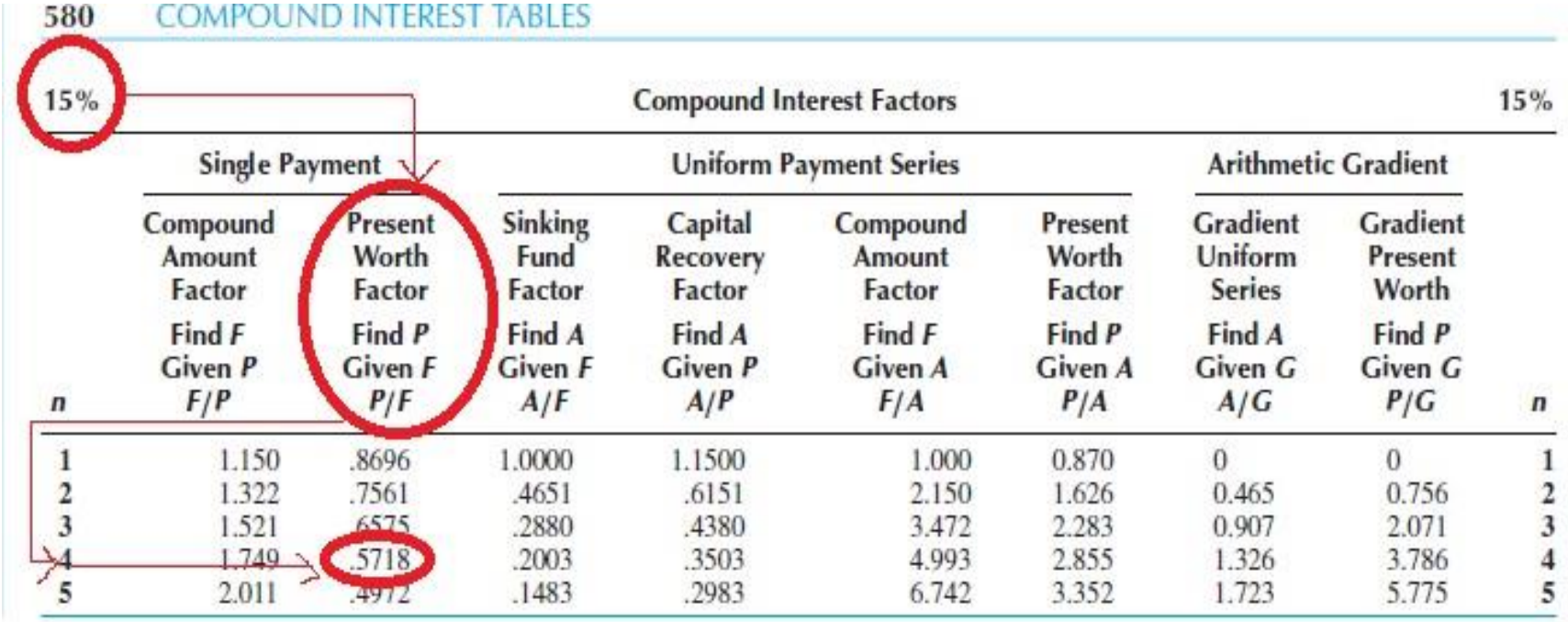
First Step

- Draw cash flow!



Second Step

- Find compound interest factor which suitable for a given case



580 COMPOUND INTEREST TABLES

15% Compound Interest Factors 15%

n	Single Payment: Compound Amount Factor Find *F* Given *P* *F/P*	Single Payment: Present Worth Factor Find *P* Given *F* *P/F*	Uniform Payment Series: Sinking Fund Factor Find *A* Given *F* *A/F*	Uniform Payment Series: Capital Recovery Factor Find *A* Given *P* *A/P*	Uniform Payment Series: Compound Amount Factor Find *F* Given *A* *F/A*	Uniform Payment Series: Present Worth Factor Find *P* Given *A* *P/A*	Arithmetic Gradient: Gradient Uniform Series Find *A* Given *G* *A/G*	Arithmetic Gradient: Gradient Present Worth Find *P* Given *G* *P/G*	n
1	1.150	.8696	1.0000	1.1500	1.000	0.870	0	0	1
2	1.322	.7561	.4651	.6151	2.150	1.626	0.465	0.756	2
3	1.521	.6575	.2880	.4380	3.472	2.283	0.907	2.071	3
4	1.749	.5718	.2003	.3503	4.993	2.855	1.326	3.786	4
5	2.011	.4972	.1483	.2983	6.742	3.352	1.723	5.775	5

- Compund interest factor= 0,5718

  The Cash that must be deposited is:

  P= F(P/F,i,n)

  P= 30.000.000 (0,5718)

  P=Rp Rp17.154.000

How to use PV in Excel?

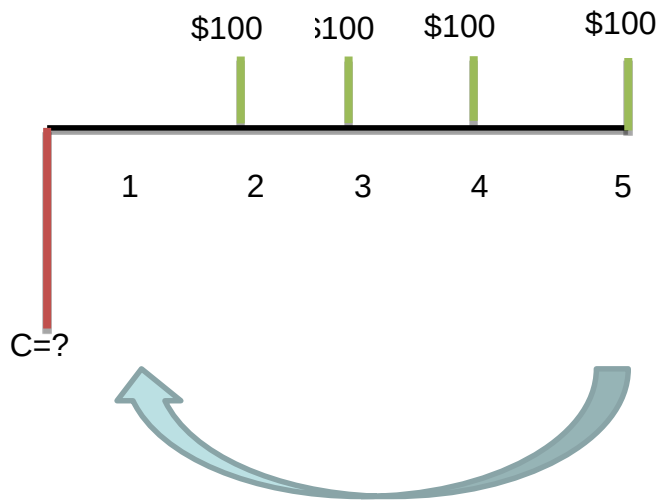
Syntax : =PV (rate, nper, pmt, [fv], [type])

- **rate** - The interest rate per period.
- **nper** - The total number of payment periods.
- **pmt** - The payment made each period.
- **fv** - [optional] A cash balance you want to attain after the last payment is made. If omitted, assumed to be zero.
- **type** - [optional] When payments are due. 0 = end of period, 1 = beginning of period. Default is 0.

Excel Formula:

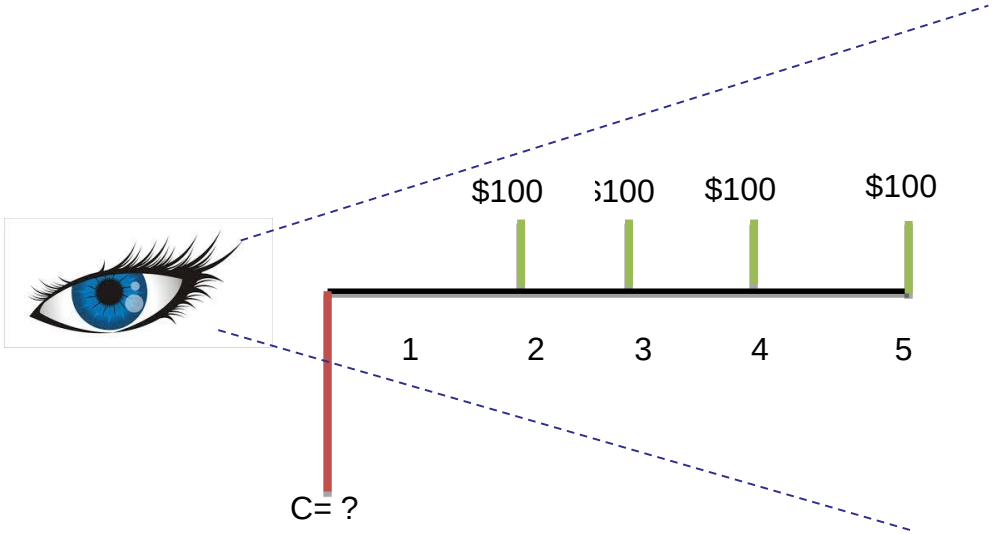
P = PV(15%,4,0,30000000,0)

P= 17.152.597, 37



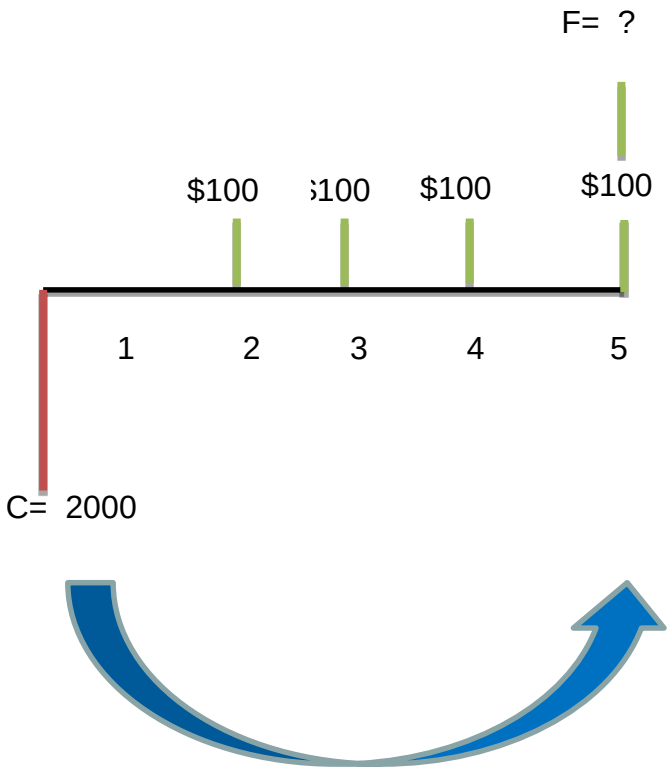
- i = 15%, calculate C!

Answer



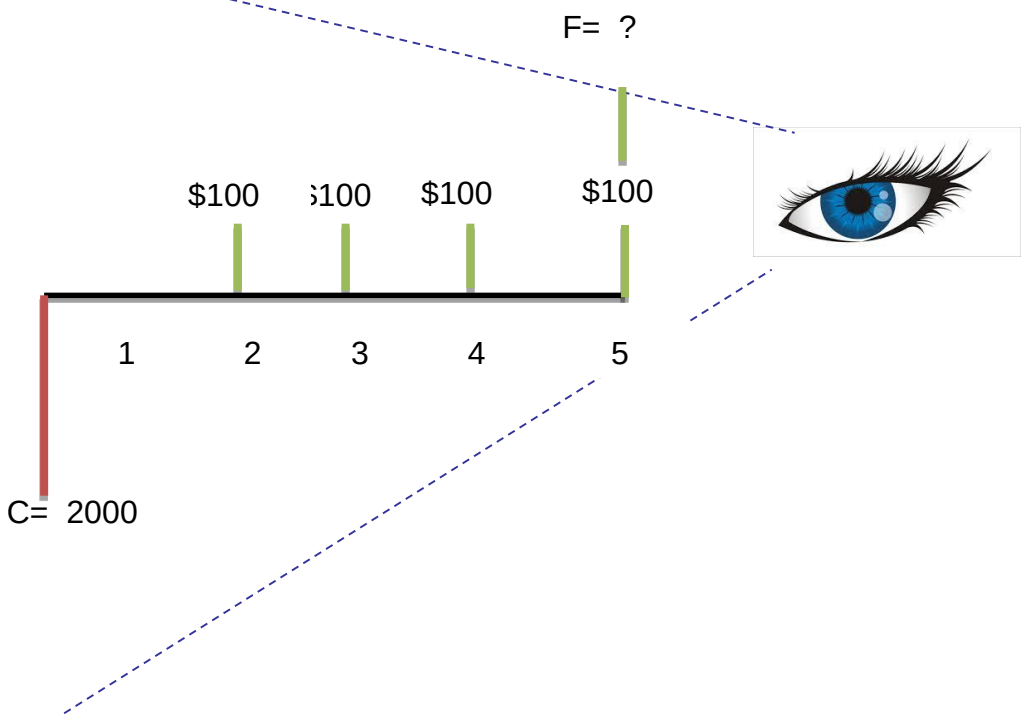
C= 100 (P/f, 15%, 2) + 100 (P/f, 15%, 3) +

100 (P/f, 15%, 4) + 100 (P/f, 15%, 5)=…



- i = 15%, calculate F!

Answer



F= 100 + 100 (F/p, 15%, 1) +

100 (F/p, 15%, 2) + 100 (F/P, 15%, 3) - 2000 (F/p. 15%, 5)=…