Fundamentals of Engineering Economy

Course # 8012101

Fall Semester – 2020/2021

جامعة الطائف
TAIF UNIVERSITY

Lect. # 2

Cash Flows: Estimation and Diagramming

TERMINOLOGY AND SYMBOLS

P = value or amount of money at a time designated as the present or time 0. Also, P is referred to as present worth (PW), present value (PV), net present value (NPV), discounted cash flow (DCF), and capitalized cost (CC); dollars

F= value or amount of money at some future time. Also, F is called future worth (FW) and future value (FV); dollars.

A= series of consecutive, equal, end-of-period amounts of money. Also, A is called the annual worth (AW) and equivalent uniform annual worth (EUAW); dollars per year, dollars per month.

n = number of interest periods; years, months, days.

i= interest rate or rate of return per time period; percent per year, percent month, percent per day

t= time, stated in periods; years, months, days.

Example 1:

A new college graduate has a job with Boeing Aerospace. She plans to borrow $10,000 now to help in buying a car. She has arranged to repay the entire principal plus 8% per year interest after 5 years. Identify the engineering economy symbols involved and their values for the total owed after 5 years.

Solution

In this case, P and F are involved, since all amounts are single payments, as well as n and i.
Time is expressed in years.
The future amount F is unknown.

P = $10,000 i = 8% per year n = 5 years F = ?

Example 2:

Assume you borrow $2000 now at 7% per year for 10 years and must repay the loan in equal yearly payments. Determine the symbols involved and their values.

Solution

Time is in years.
P= $2000
A = ? per year for 10 years
n =10 years
i = 7% per year

Example: 3

You plan to make a lump-sum deposit of $5000 now into an investment account that pays 6% per year, and you plan to withdraw an equal end-of-year amount of $1000 for 5 years, starting next year. At the end of the sixth year, you plan to close your account by withdrawing the remaining money. Define the engineering economy symbols involved.

Solution

Time is expressed in years.

P = $5000

A = $1000 per year for 5 years

F = ? at end of year 6

i = 6% per year

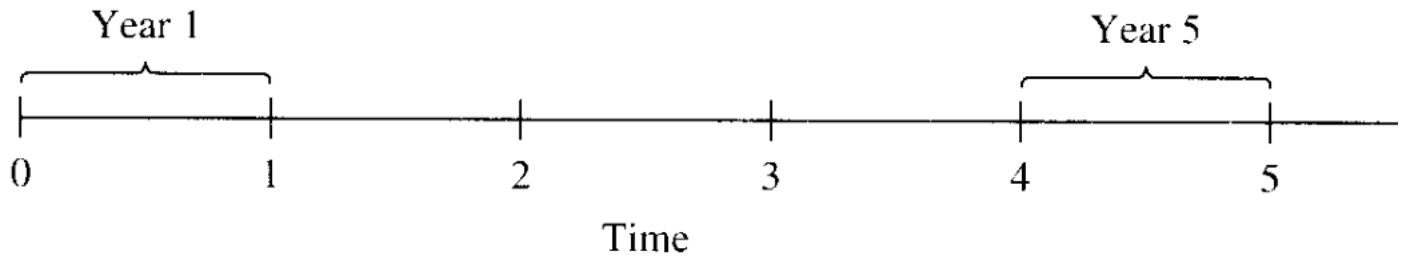
n = 5 years for the A series and 6 for the F value

Cash Flows

- To financially analyze engineering projects, we need to model the projects in terms of cash flows.
- Cash flows represent the flow or movement of money at some specific time over some period of time.
- Outflows represent cash that is leaving an account such as a withdrawal (expenses or disbursements or losses or costs).
- Inflows represent cash that is entering an account such as a deposit (revenues or receipts or benefits or incomes).

Cash Flows and Engineering Projects

- An engineering project can be viewed as an account with ***outflows*** and ***inflows.***
- Cash flow movements can be **visually displayed** through the use of a **cash flow diagram.**



CASH FLOW DIAGRAM

A cash flow diagram is a picture of a financial problem that shows all cash inflows and outflows plotted along a horizontal time line .

The cash flows over time are represented by arrows at relevant periods: upward arrows denote positive flows and downward arrows denote negative flows.

Arrows represent net cash flows since two or more values at the same time are summed and shown as a single arrow.

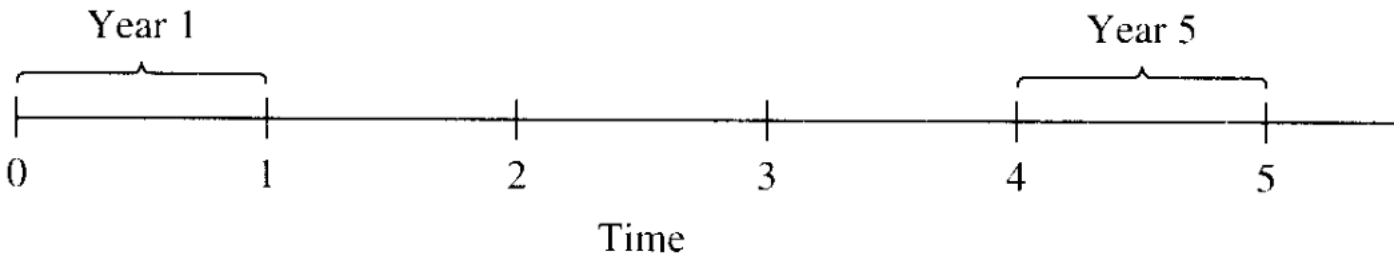
Net cash flows = receipts – disbursement

= cash inflows – cash outflows

CASH FLOW DIAGRAM

- **Generally, the start of the diagram represents the *beginning* of the interest period.**

- **When t = 0, this is the present**
- **When t = 1, this is the *end of the first year* or (*beginning of the second year*).**



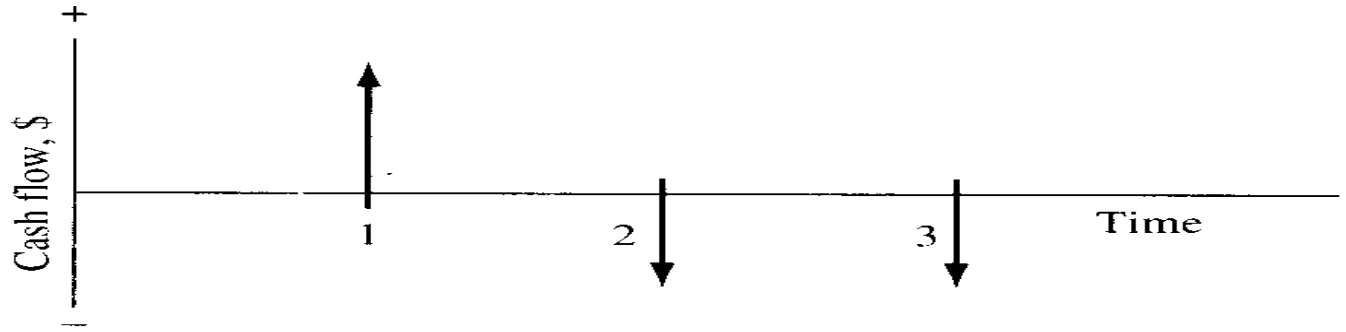
A typical cash flow time scale for 5 years

CASH FLOW DIAGRAM

Cash inflows are the receipts, revenues, incomes, and savings generated by project and business activity. A **plus sign** indicates a cash inflow.

Cash outflows are costs, disbursements, expenses, and taxes caused by projects and business activity. A **negative or minus sign** indicates a cash outflow. When a project involves only costs, the minus sign may be omitted for some techniques, such as benefit/cost analysis.

The figure illustrates a receipt (cash *inflow*) at the end of year 1 and equal disbursements (cash *outflows*) at the end of years 2 and 3.

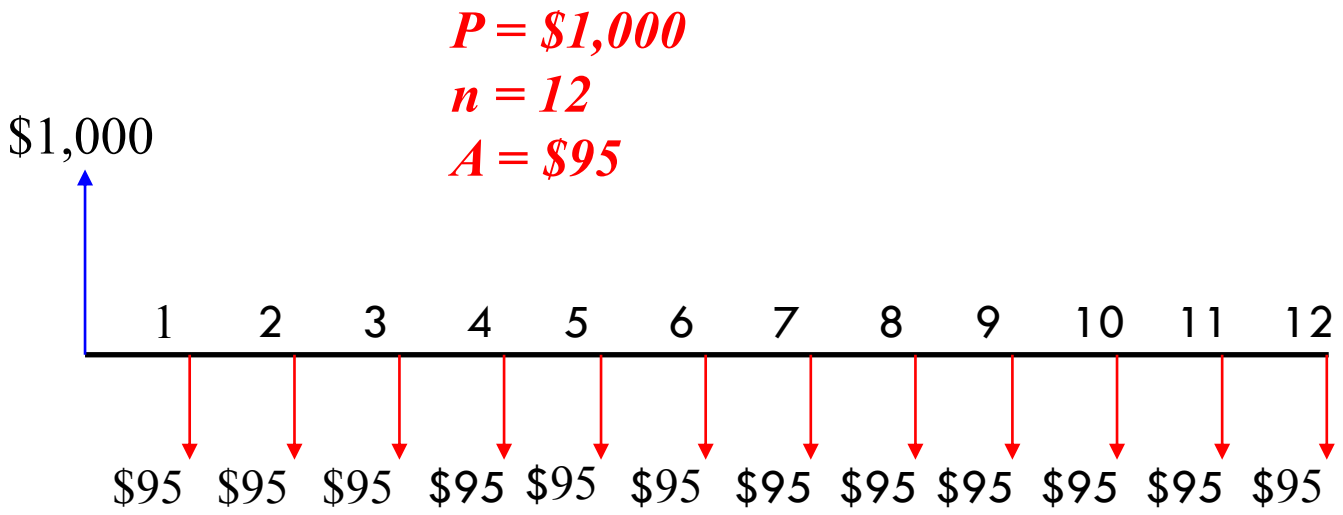


Example of positive and negative cash flows

CASH FLOW DIAGRAM – EXAMPLE [1]

- You borrowed $1,000 from a bank to purchase a laptop. The bank requires you to make 12 equal monthly payments of $95 to pay off the loan.

- **Draw the cash flow diagram for this scenario**



CASH FLOW DIAGRAM – EXAMPLE [2]

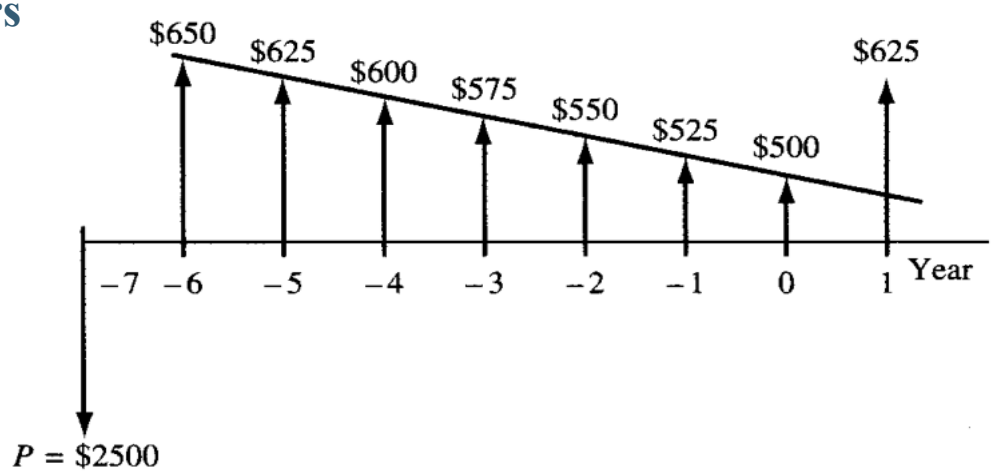
- A company spent $2,500 on a new compressor 7 years ago.
- The annual *income* from the compressor has been $750.
- Additionally, the $100 spent on *maintenance* during the first year has increased each year by $25.
- The company plans to sell the compressor at the end of next year for $150.
- Construct the cash flow diagram from the *company's perspective.*

CASH FLOW DIAGRAM – EXAMPLE [2]

- Use **now** as time **t = 0**

End of year	Income	Cost	Net Cash Flow
−7	$ 0	$2500	$−2500
−6	750	100	650
−5	750	125	625
−4	750	150	600
−3	750	175	575
−2	750	200	550
−1	750	225	525
0	750	250	500
1	750 + 150	275	625

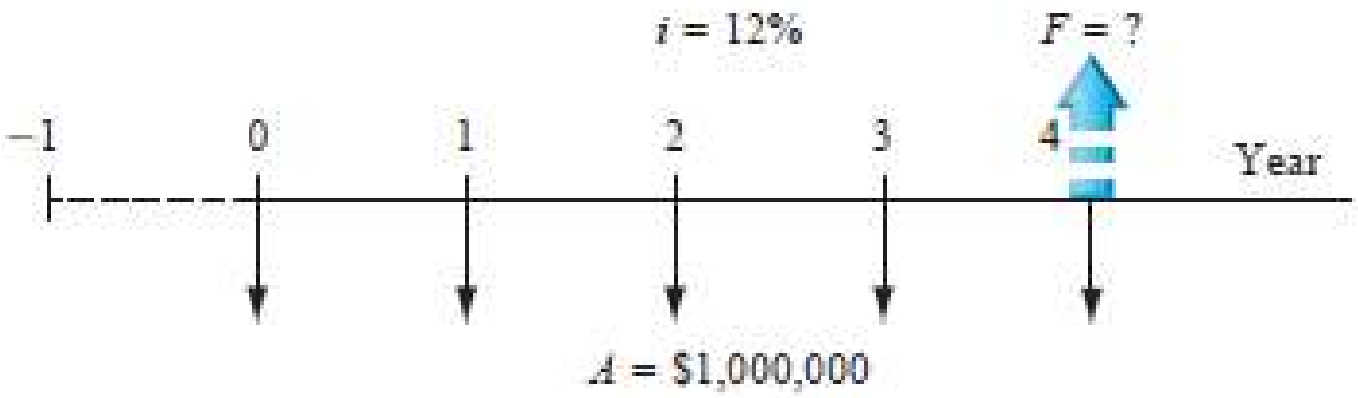
- The incomes and costs for years -7 through 1 (next year) are tabulated



CASH FLOW DIAGRAM – EXAMPLE [3]

Each year a company expends large amounts of funds for mechanical safety features throughout its worldwide operations. The company plans expenditures of $1 million *now* and each of the next 4 years just for the improvement of field-based pressure-release valves. **Construct the cash flow diagram** to find the equivalent value of these expenditures at the end of year 4, using a cost of capital estimate for safety-related funds of 12% per year.

Solution



Cash flow diagram, Example 3

CASH FLOW DIAGRAM – EXAMPLE [4]

- You ***deposited*** a $1,000 in your account in a bank that gives a ***daily*** interest of 0.003% where interest is paid monthly. Assume simple interest.

- [1] For this scenario, what is your balance after 30 days?

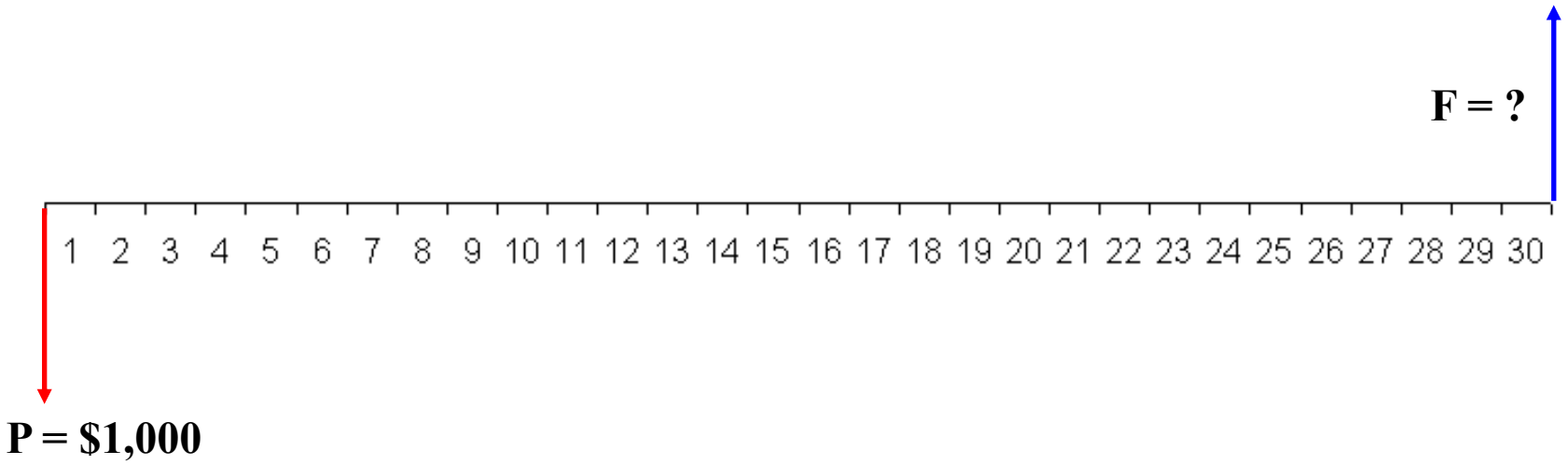
- [2] If you deposit another $2,000 on the 11^{th} day and withdraw $500 on the 26^{th} day, what is your balance at the end of the 30^{th} day?

- In both cases, draw the cash flow diagram.

CASH FLOW DIAGRAM – EXAMPLE [4]

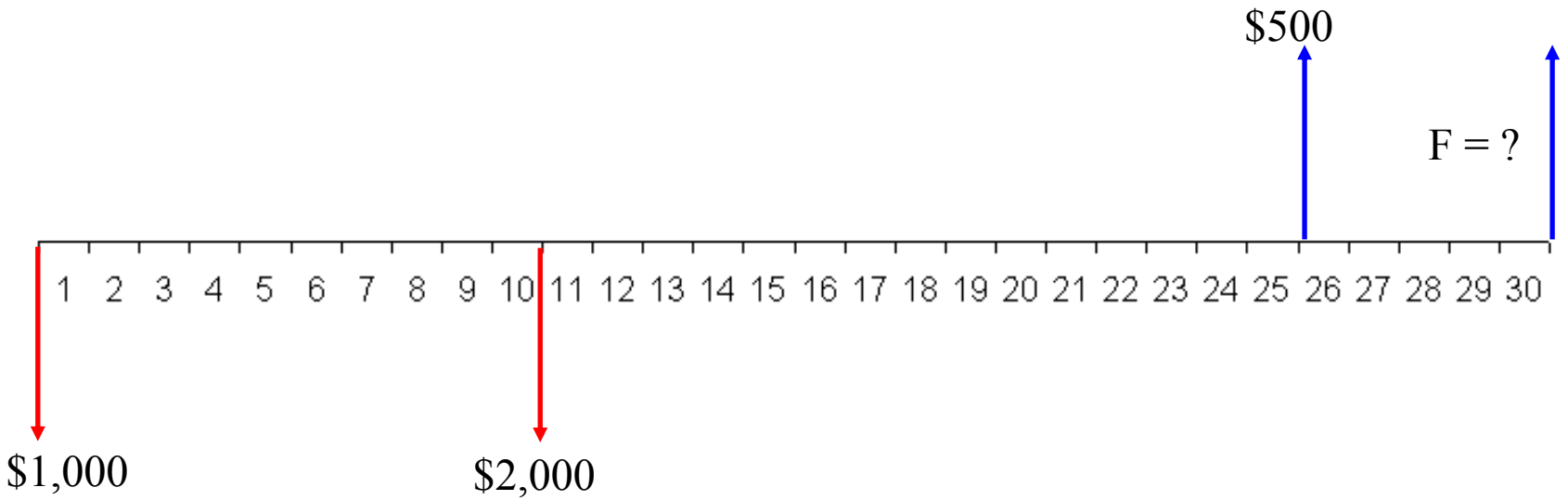
- [1] Since we have simple interest, then F = P(1+ni)

→ F = \$1,000×(1+30×0.003%) = \$1,000.9



CASH FLOW DIAGRAM – EXAMPLE [4]

- **[2] F = $1,000×(1+30×0.003%) + $2,000×(1+20×0.003%) – $500×(1+5×0.003%) = $2,502.03**



Just keep in mind that the day is represented by its beginning

CASH FLOW DIAGRAM – EXAMPLE [5]

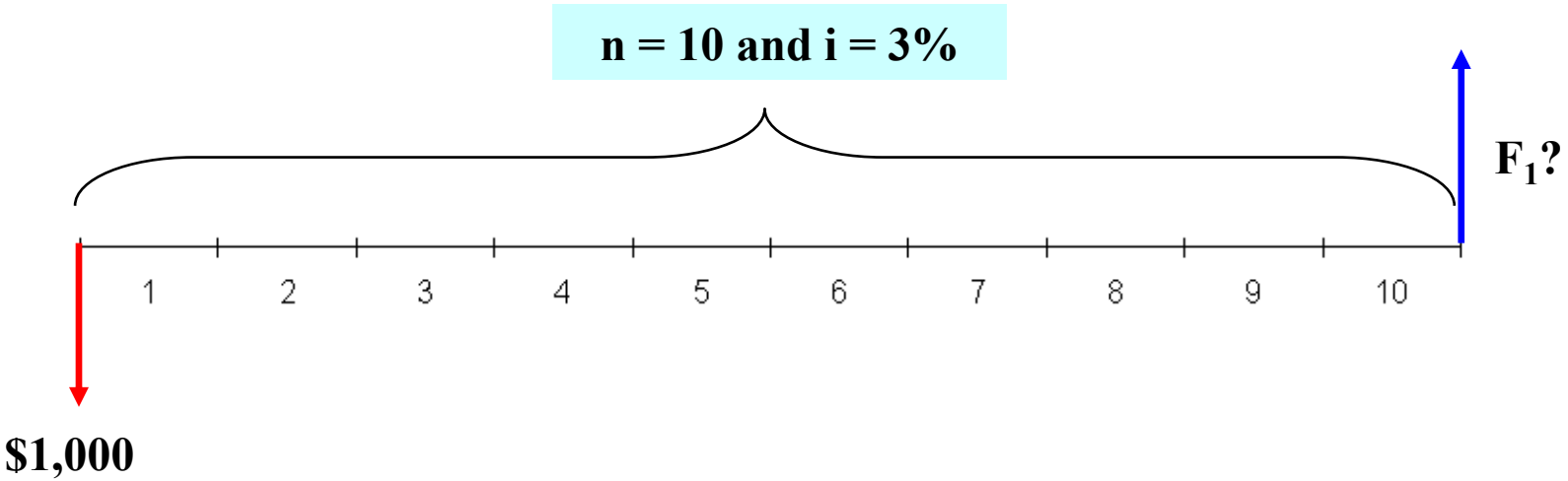
- **You have deposited $1,000 with an interest rate of 3% every 6 months where the interest is computed every 6 months.**

- **How much you will have after 5 years?**

- **Two years later after the initial deposit of the money, you deposited additional $1,000 with an interest rate of *2%* every 6 months (*applies only to this deposit*). How much will you have after 5 years?**

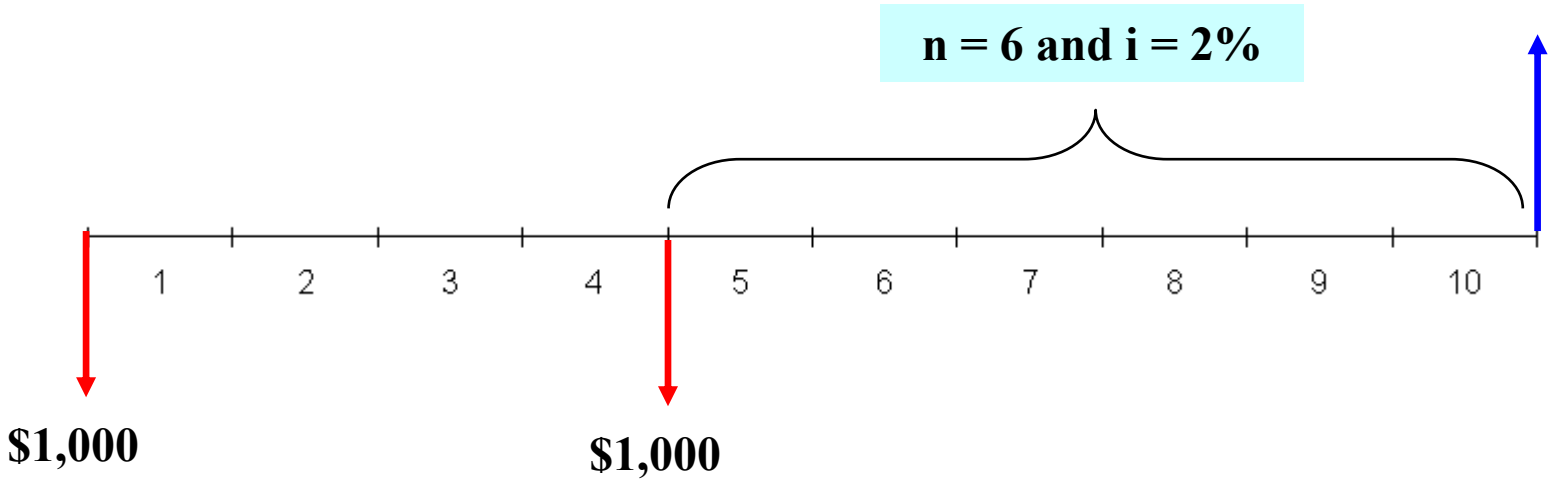
CASH FLOW DIAGRAM – EXAMPLE [5]

- We have a total of 10 periods each period of 6 months for the $1,000
- $F1 = P(1+i)^n = \$1,000 \times (1+3\%)^{10} = \$1,343.92$



CASH FLOW DIAGRAM – EXAMPLE [5]

- We have a total of 10 periods each period of 6 months for the first $1,000 [F1].
- We have a total of 6 periods each period of 6 months for the second $1,000 [F2].
- $F = F1+F2 = \$1,000\times(1+3\%)^{10} + \$1,000\times(1+2\%)^{6} = \$2,470.08$



EXAMPLE [6]

- **What would be the future worth after two years of a deposit of $1,000 now if the interest rate for the first year is 10% and for the second year is 5%?**

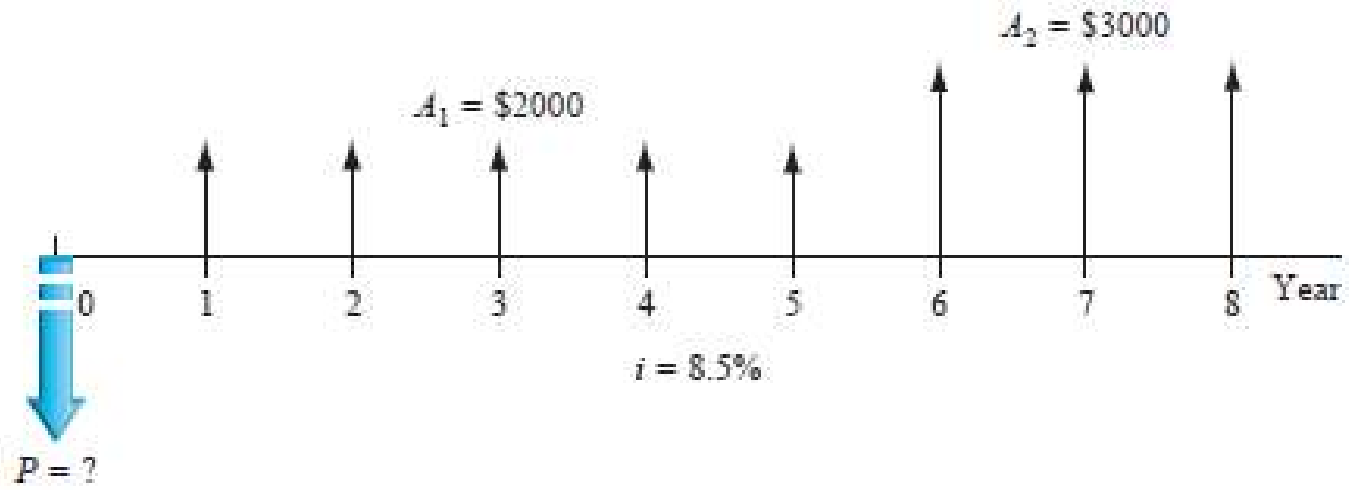
- **By the end of the *first* year, the total amount becomes:**
  $1{,}000(1+10\%)^1 = \$1{,}100$

- **By the end of the *second* year, the total amount becomes:**
  $1{,}100(1+5\%)^1 = \$1{,}155$

EXAMPLE [7]

An electrical engineer wants to deposit an amount *P* now such that he can withdraw an equal annual amount of A1 = $2000 per year for the first 5 years, starting 1 year after the deposit, and a different annual withdrawal of A2 = $3000 per year for the following 3 years. How would the cash flow diagram appear if i = 8.5% per year?

Solution



Cash flow diagram with two different *A* series, Example 7