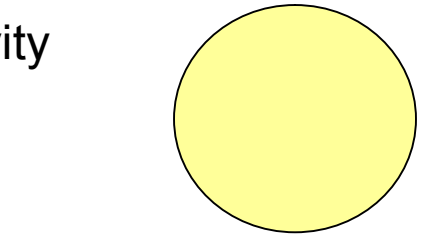
Critical Path Analysis

- Critical Path Analysis (CPA), is sometimes called Network Analysis
- It is a tool used to plan activities so that a job can be completed in the shortest time
- It breaks a job down into a number of tasks, and looks at the dependency of them
  - For example, list the activities that must be completed in order to make a cup of coffee
- It is used commonly in manufacturing and construction

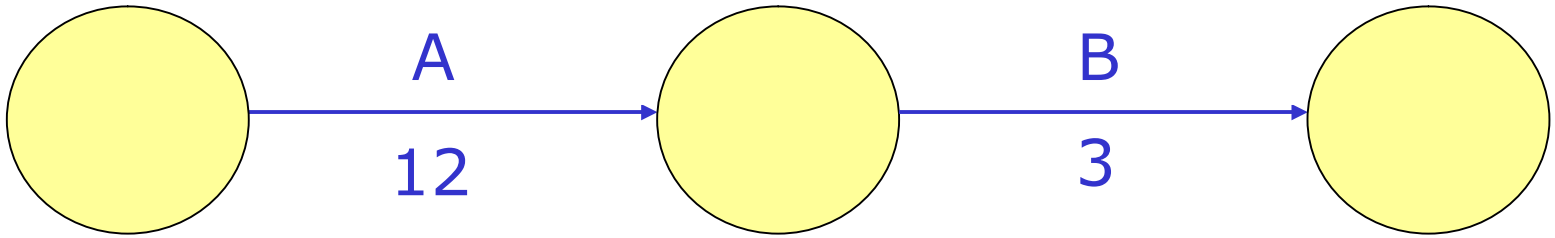
Parts of the Network

- A network consists of 2 things:
  - An **ACTIVITY**
    - This requires time and/or resources
    - They are drawn as **ARROWS** from left to right
    - The length of the arrow is **NOT** important
  - A **Node**
    - These represent the start and the end of an activity
    - They are represented by **CIRCLES**
    - Every network **MUST** start and end with a node



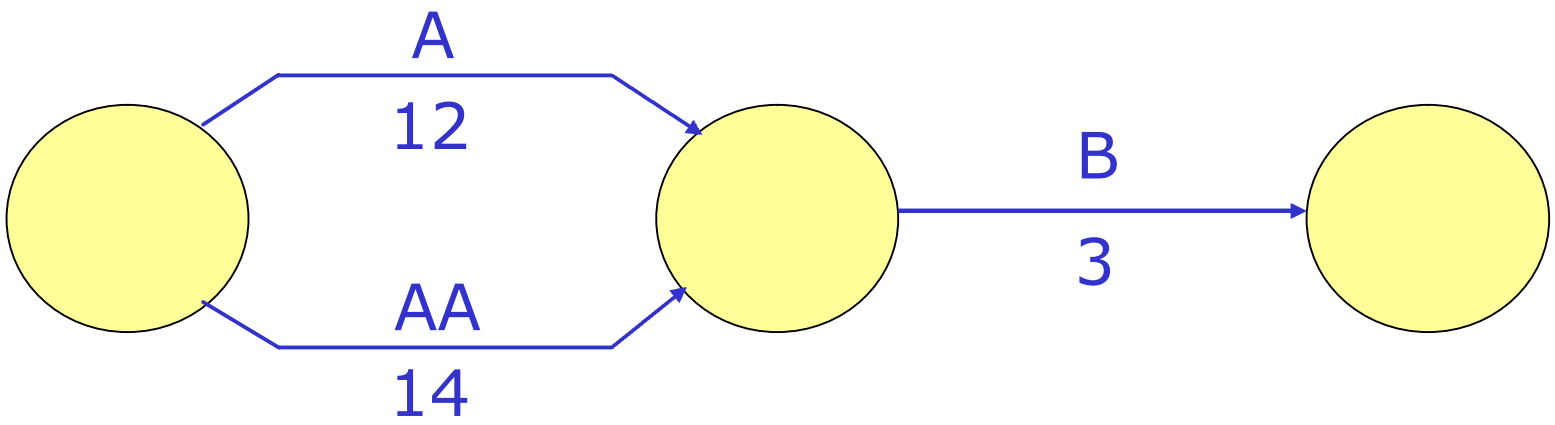
A Simple Network Diagram

- A business wishes to build a new factory
- Before it can do so it needs to:
  - Buy the land (Activity A – will take 12 weeks)
  - Draw up Plans (Activity B – will take 3 weeks)
- A simple network may be drawn to illustrate this scenario:



Illustrating Simultaneous Activities

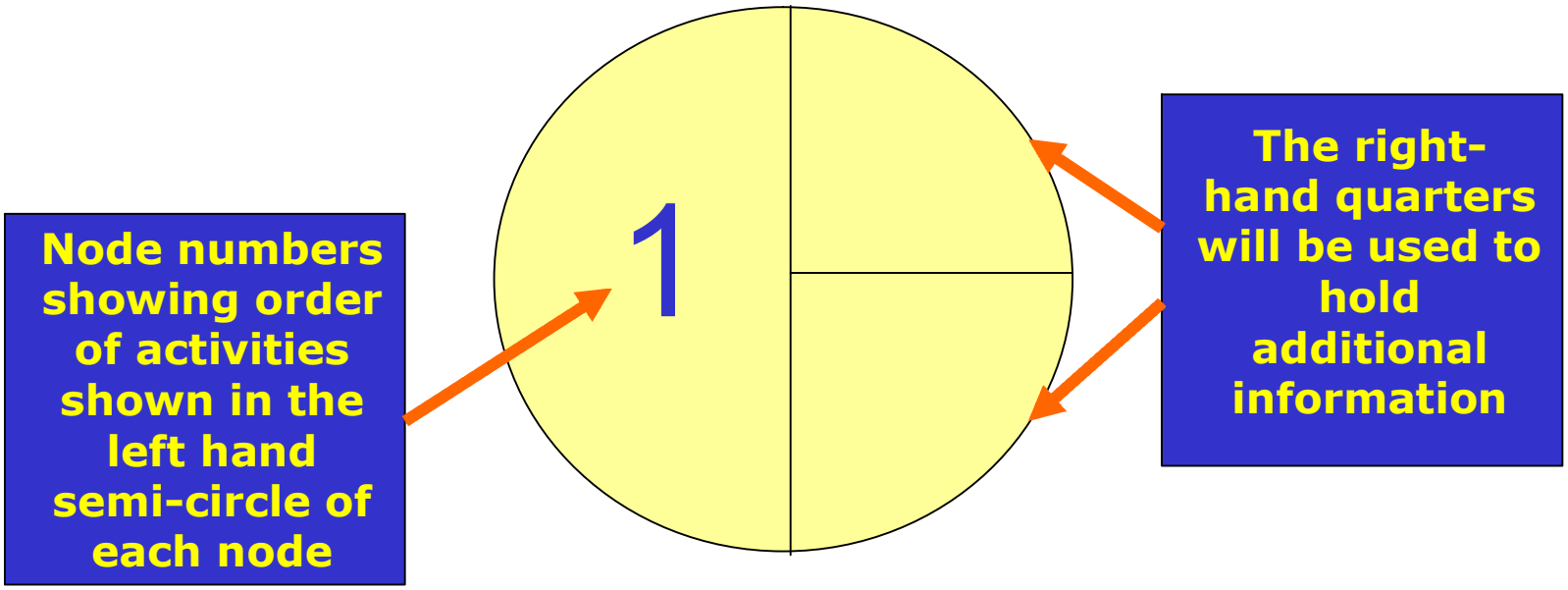
- Of course in reality some activities can be carried out simultaneously
- Using the previous example:
  - Assume that whilst in the process of buying the land the firm wants to apply for planning permission (Activity AA – will take 14 weeks)



- Try drawing a network using your instructions for making a cup of coffee

Developing The Network

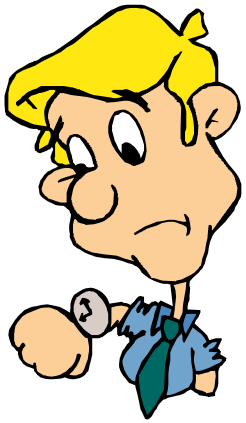
- There are a number of problems with our previous example:
  - There is no way of identifying the nodes
  - It doesn't help us identify the crucial activities
- In order to do this the nodes can be developed in order to show more information:



Calculating The Earliest Start Time

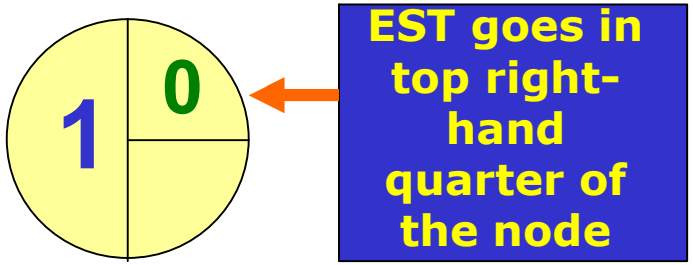
- The main reason for drawing a network is to identify the CRITICAL activities
- To do this we must calculate the earliest time at which any given activity can start
  - This is called the **Earliest Start Time (EST)** of the activity
- It is calculated using the following formula:

EST = EST of Previous activity + Duration of previous activity

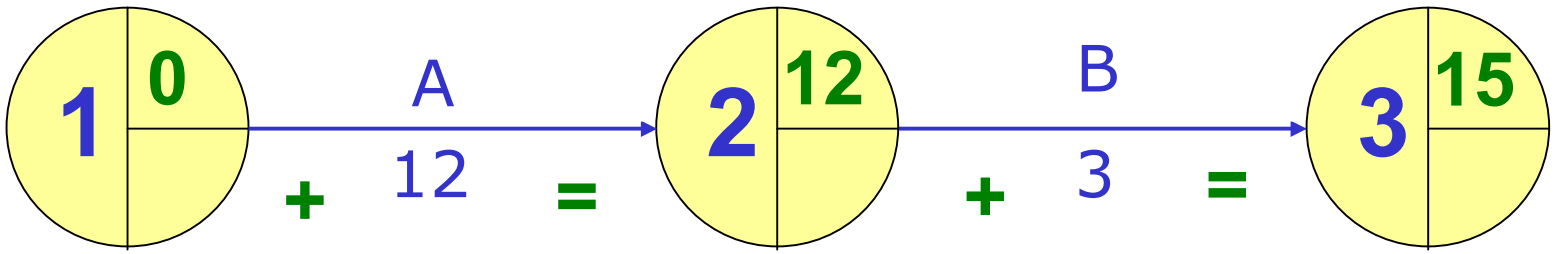


Calculating The Earliest Start Time

- This information is then placed in the top right-hand quarter of the node
- The first node will ALWAYS have an EST of zero

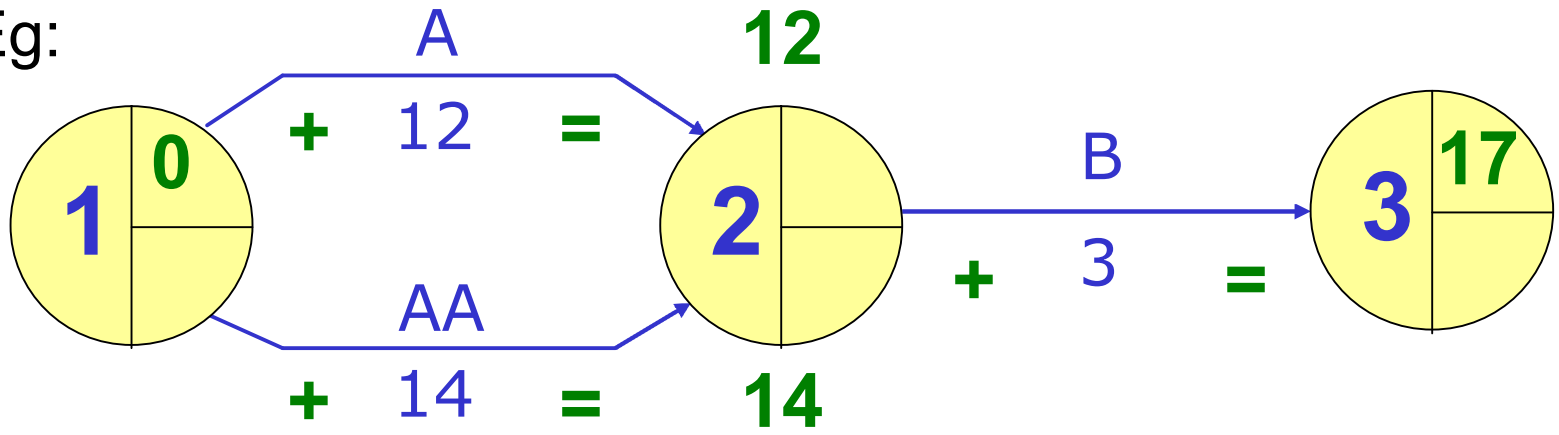


- Using our first simple example, the EST for each activity would be calculated as follows:



The EST and Simultaneous Activities

- When there are simultaneous activities there may be more than one value for the EST
- Eg:



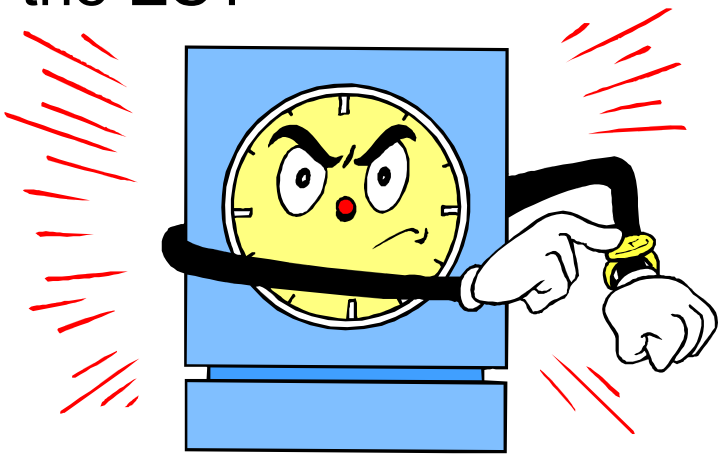
- Since Activity B is DEPENDENT on both Activities A and AA, it cannot start until both are complete
- So we must take the HIGHEST figure
- This means that the EST is 14 weeks

Recap of The Earliest Start Time

- The EST of the first activity is always zero
- Calculate the EST by working left to right across a network
- It is calculated using the following formula:

EST = EST of Previous activity + Duration of previous activity

- When there are 2 simultaneous activities the HIGHEST figure is used as the EST



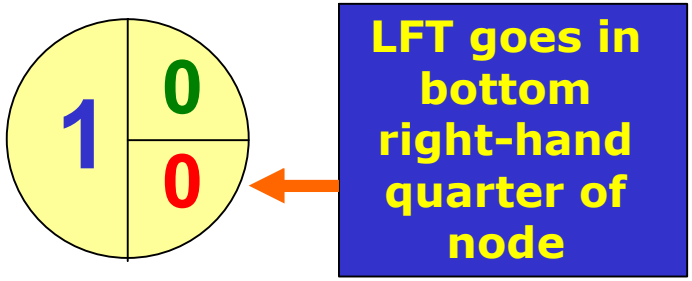
Calculating The Latest Finishing Time

- There is one final piece of information needed to complete our network diagram
- To identify the CRITICAL activities we must also know the latest time at which any given activity must end
  - This is called the **Latest Finishing Time (LFT)** of the activity
- It is calculated by working BACKWARDS across the network using the following formula:

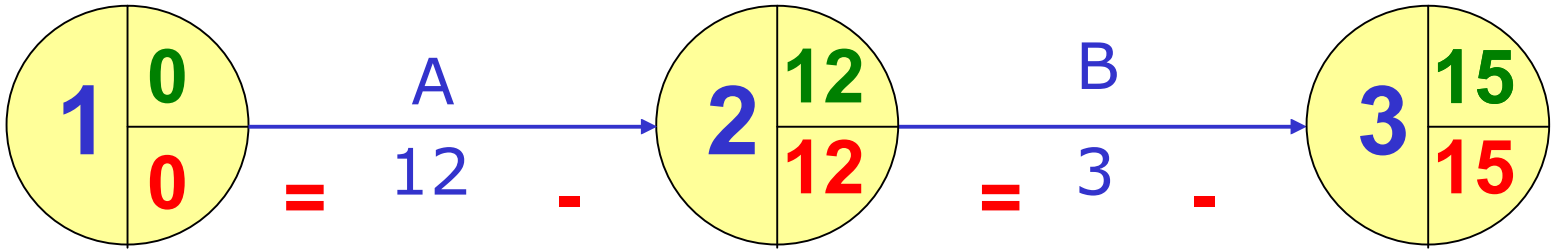
LFT = LFT at end of following activity - Duration of following activity

Calculating The Latest Finishing Time

- This information is then placed in the bottom right-hand quarter of the node
- The first node will ALWAYS have an LFT of zero



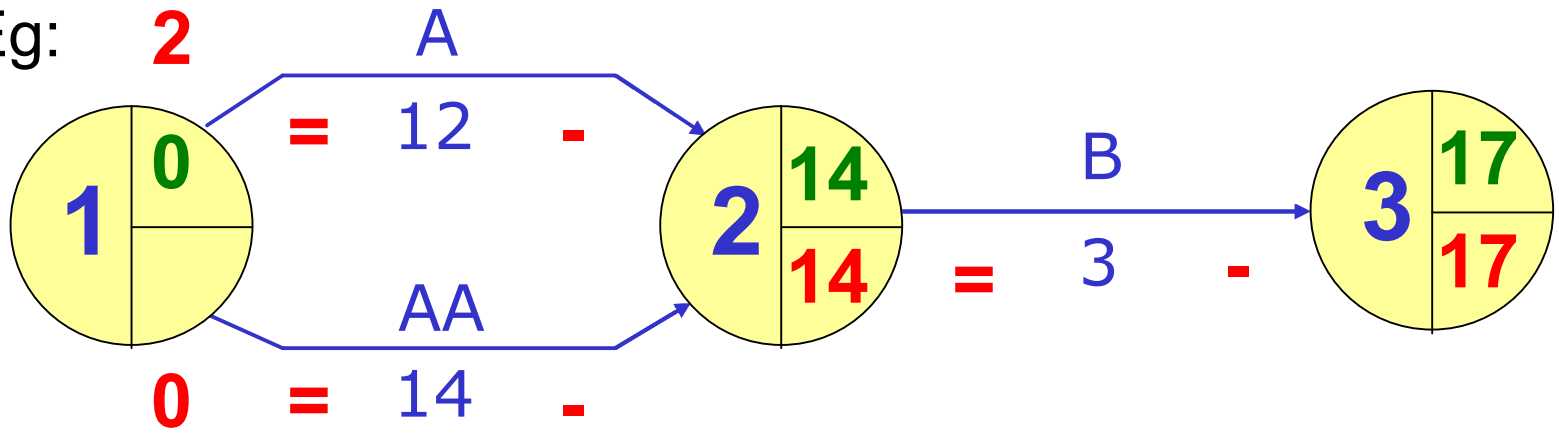
- Using our first simple example, the LFT for each activity would be calculated as follows:



Since the earliest time this project can be finished is 15 weeks then this is also the latest we would like to finish the project. As such:
The EST and LFT of the last node are ALWAYS the same

The LFT and Simultaneous Activities

- When there are simultaneous activities there may be more than one value for the LFT
- Eg:



- If Activity AA starts on week 2 it cannot be completed by week 14
- So we must take the LOWEST figure
- This means that the LFT is week 0

Recap of The Latest Finishing Time

- The LFT of the last activity is always equal to its EST
- The LFT of the first activity is always zero
- Calculate the LFT by working right to left across a network
- It is calculated using the following formula:

LFT = LFT at end of following activity - Duration of following activity

- When there are 2 simultaneous activities the LOWEST figure is used as the LFT

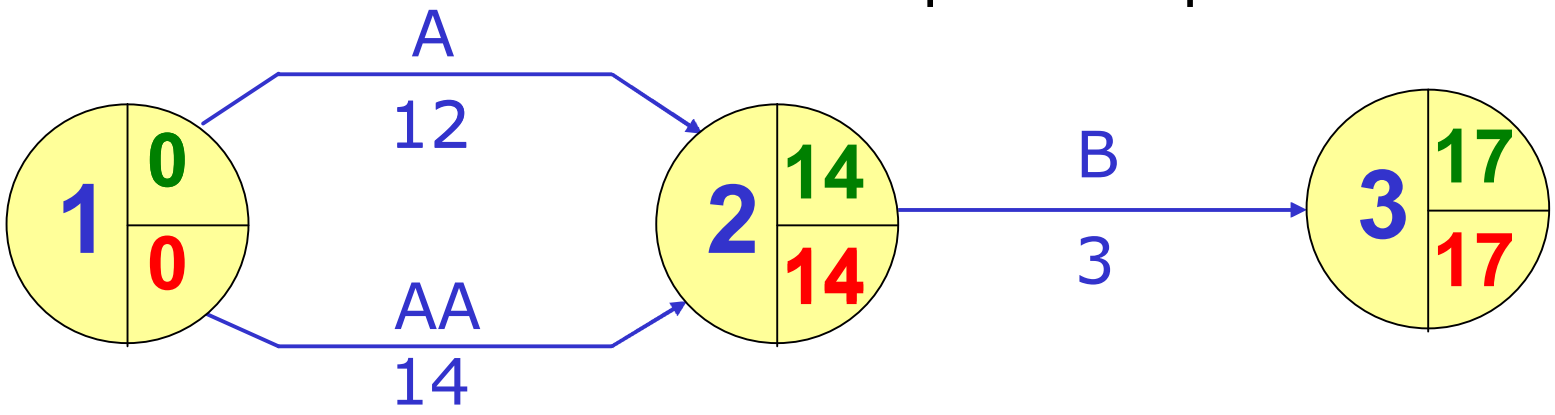
The Float

- An activity without spare time is CRITICAL
- Spare time is referred to as the FLOAT
- There are 2 types of float, each with its own formula:

FREE FLOAT	TOTAL FLOAT
This is the amount of spare time available for an activity without delaying the NEXT ACTIVITY	This is the amount of spare time available for an activity without delaying the WHOLE PROJECT
Free Float = EST at End of activity – (EST at start + Duration of activity)	Total Float = Activity's LFT – (Activity's EST + Activity's Duration)

Calculating The Float

- The free and total float for our simple example would be:



Free Float =
EST at End of activity –
(EST at start + Duration of activity)

Total Float =
Activity's LFT –
(Activity's EST + Activity's Duration)

Activity	Duration (Weeks)	EST	LFT	Free Float	Total Float
A	12	0	14	2	2
AA	14	0	14	0	0
B	3	14	17	0	0

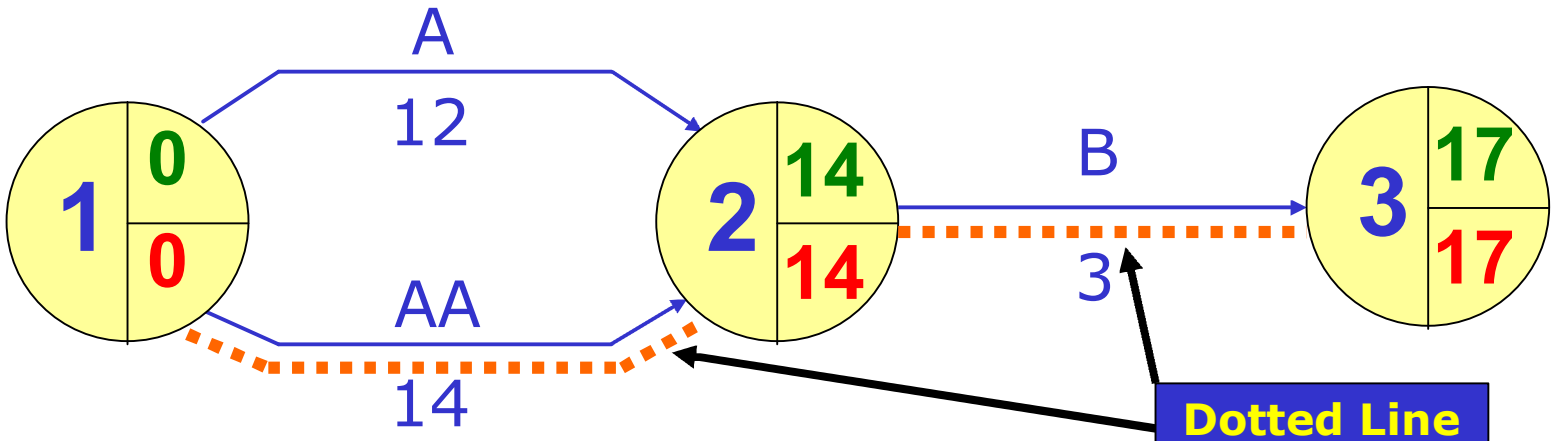
What Does This Mean?

Activity	Duration (Weeks)	EST	LFT	Free Float	Total Float
A	12	0	14	2	2
AA	14	0	14	0	0
B	3	14	17	0	0

- This data tells us:
  - That Activity A can be delayed 2 weeks without delaying Activity B
  - That Activity A can be delayed 2 weeks without delaying the whole project
  - That Activity AA is **CRITICAL** – any delay will hold up the project
  - That Activity B is **CRITICAL** – any delay will hold up the project

Identifying The Critical Path

- The critical path identifies the activities that have no float time
- It is usually identified on a diagram as follows:



Note:
A quick visual check can be made that the critical path is correct, since any node on the critical path should have equal EST and LFTs

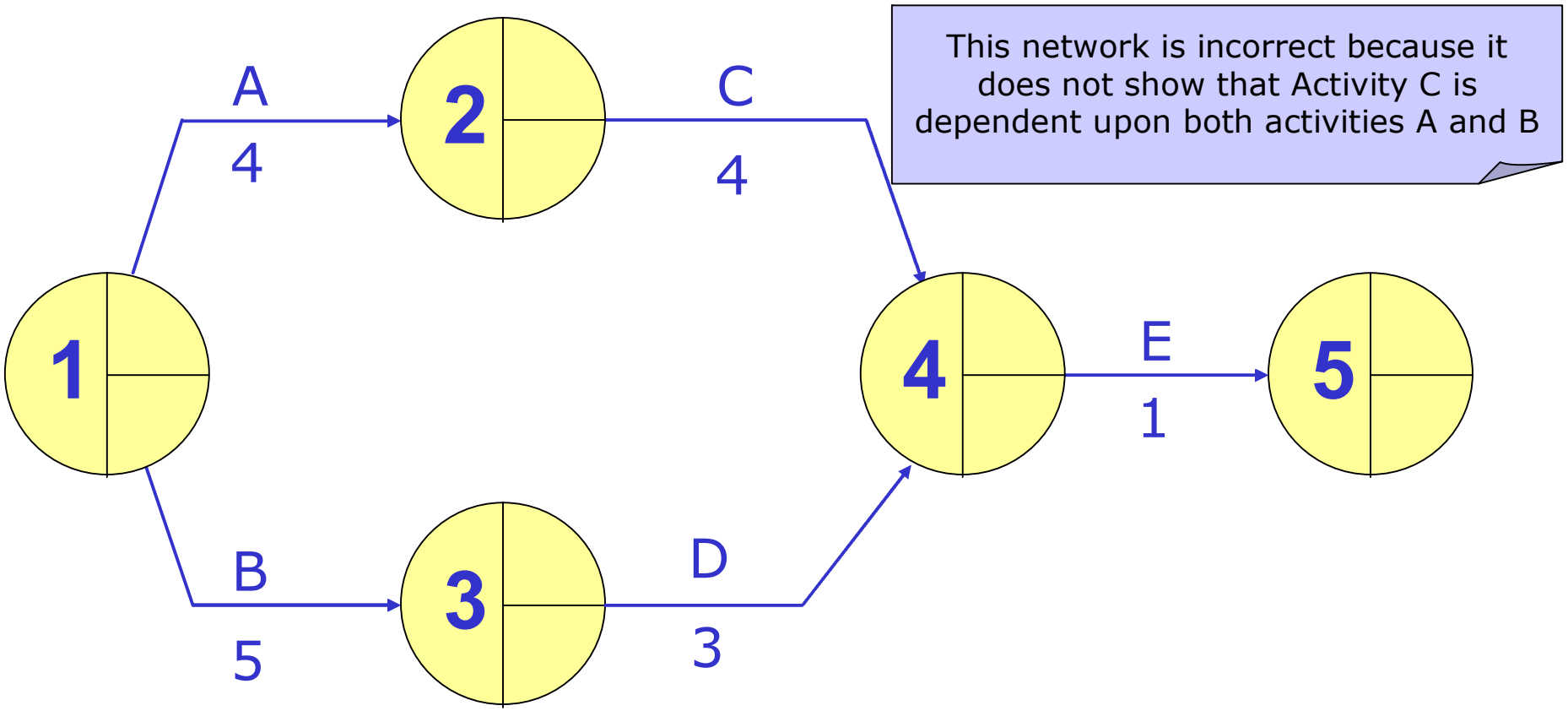
However – this example shows that this method alone does not identify the critical activities

Question

- Create and complete a network diagram to represent the following project:
  - Activities A (4 days) and B (5 days) can start simultaneously
  - Activitiy C (4 days) can begin once activities A and B are complete
  - Activity D (3 days) can begin once activity B is complete
  - Activity E (1 day) ends the project and can begin once activities C and D are complete

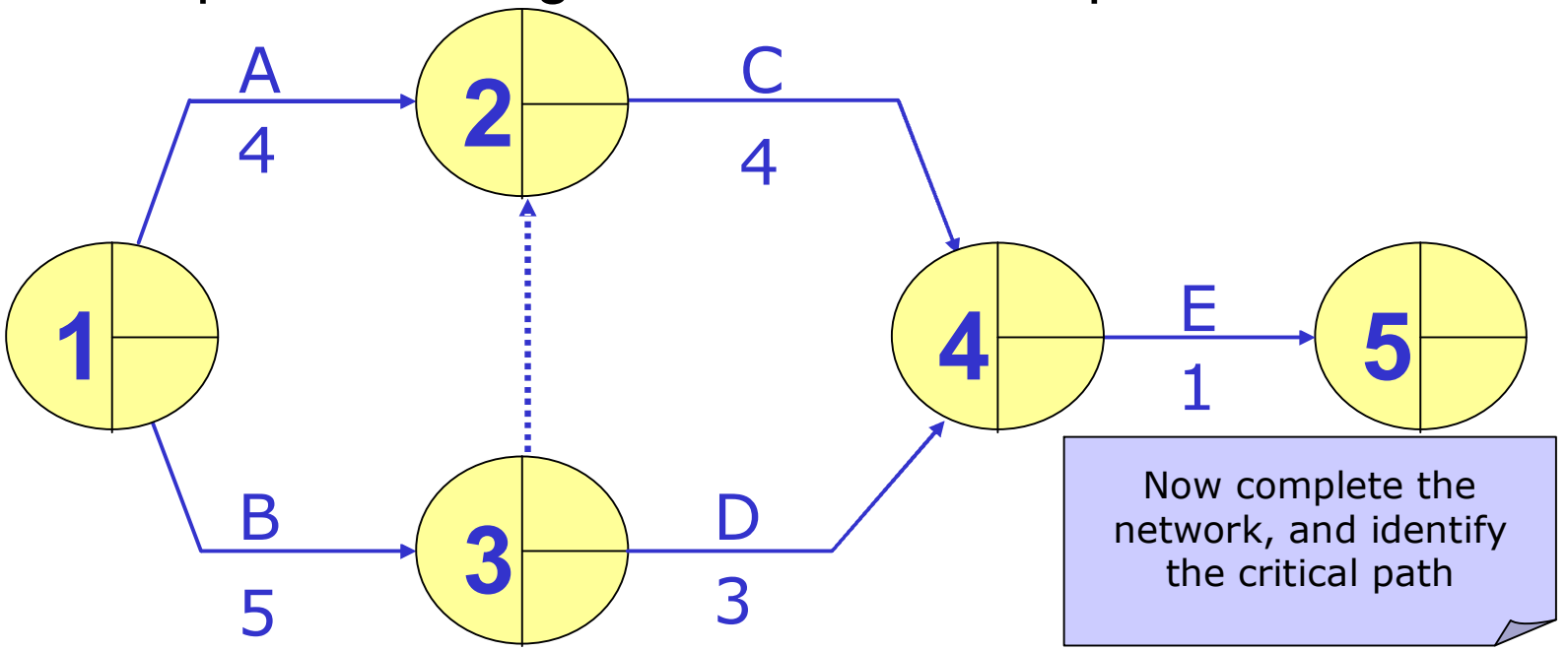
Answer

- It is not possible…
- ….unless a DUMMY ACTIVITY is used
- You may have drawn something like this…

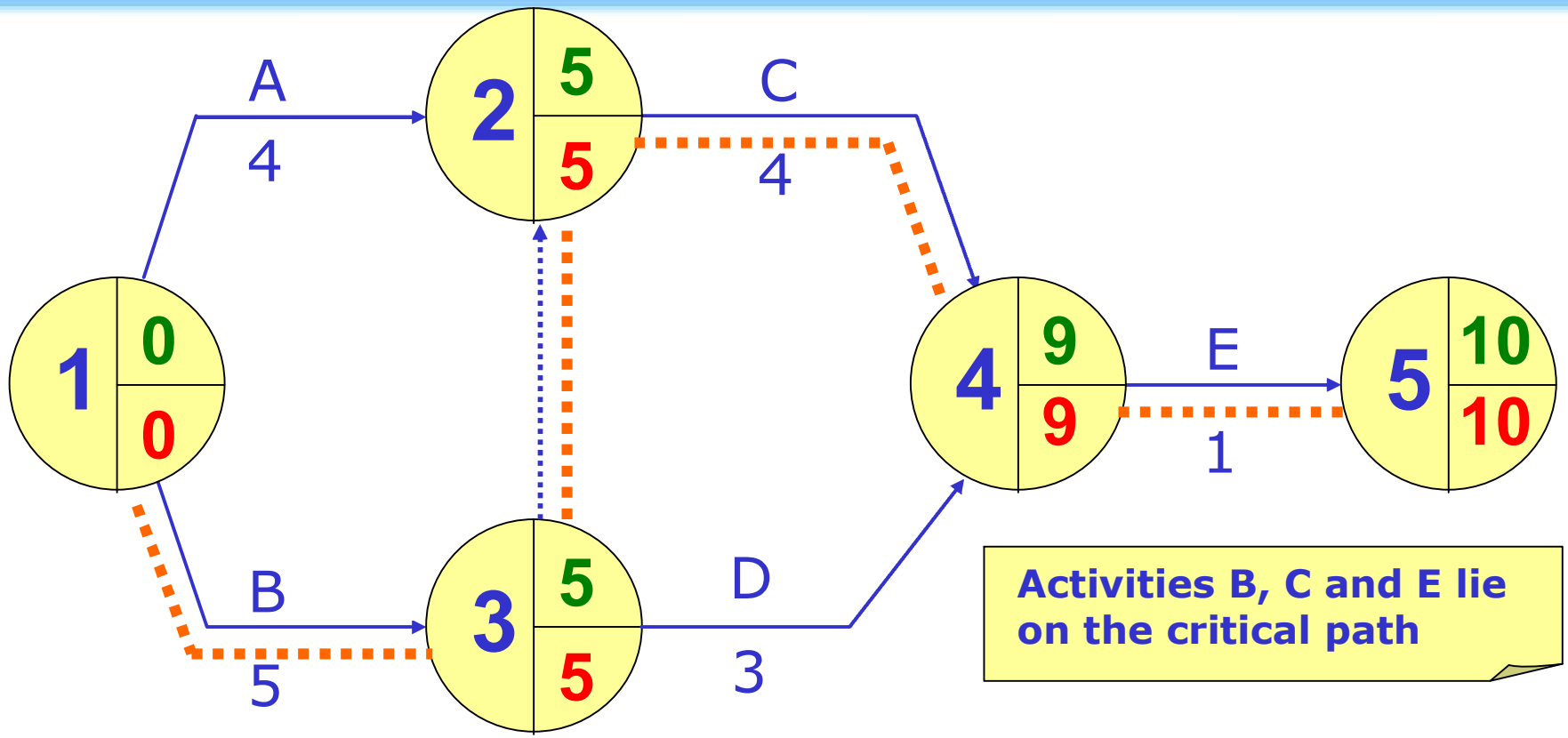


Dummy Activities

- A dummy activity is one that is created purely to illustrate dependency
- They are not labelled and take up no time
- They are represented by a dotted arrow:
- So our previous diagram would be completed as follows:



Correct Answer To Original Question



Activity	Duration (Days)	EST	LFT	Free Float	Total Float
A	4	0	5	1	1
B	5	0	5	0	0
C	4	5	9	0	0
D	3	5	9	1	1
E	1	9	10	0	0

Advantages of Using CPA

- It requires careful planning
  - so projects should run smoothly
- Improves efficiency and cash flow
  - Materials can be ordered to arrive only as they are needed
- If problems occur the implications can be identified quickly
  - This means informed decisions can be made

Disadvantages of CPA

- Diagrams can become unmanageable
  - Although software is available to help produce networks
- Plan will only work if relevant staff have been consulted
  - E.g. timescales need to be realistic
- Gantt charts tend to be preferred since they visually show the time-span of activities