



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:

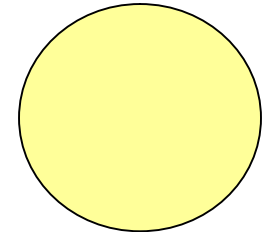
➤ An **ACTIVITY**

- 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**

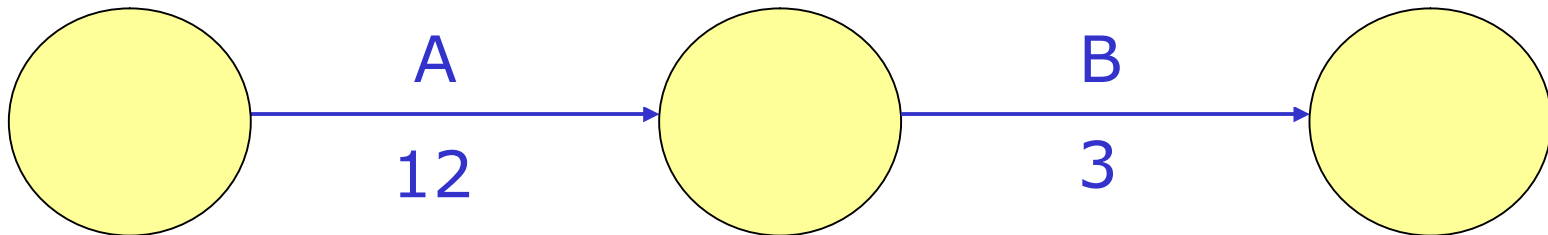
- These represent the start and the end of an activity
- They are represented by **CIRCLES**
- Every network **MUST** start and end with a node





A Simple Network Diagram

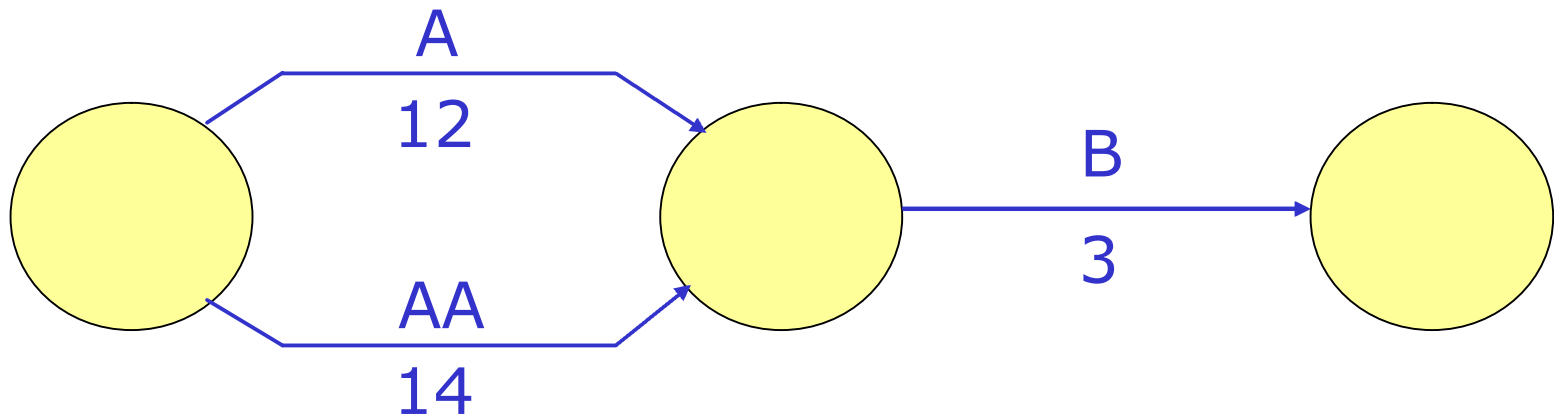
- A business wishes to build a new factory
- Before it can do so it needs to:
 - Buy the land (Activity A – will take 12 weeks)
 - Draw up Plans (Activity B – will take 3 weeks)
- A simple network may be drawn to illustrate this scenario:





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)

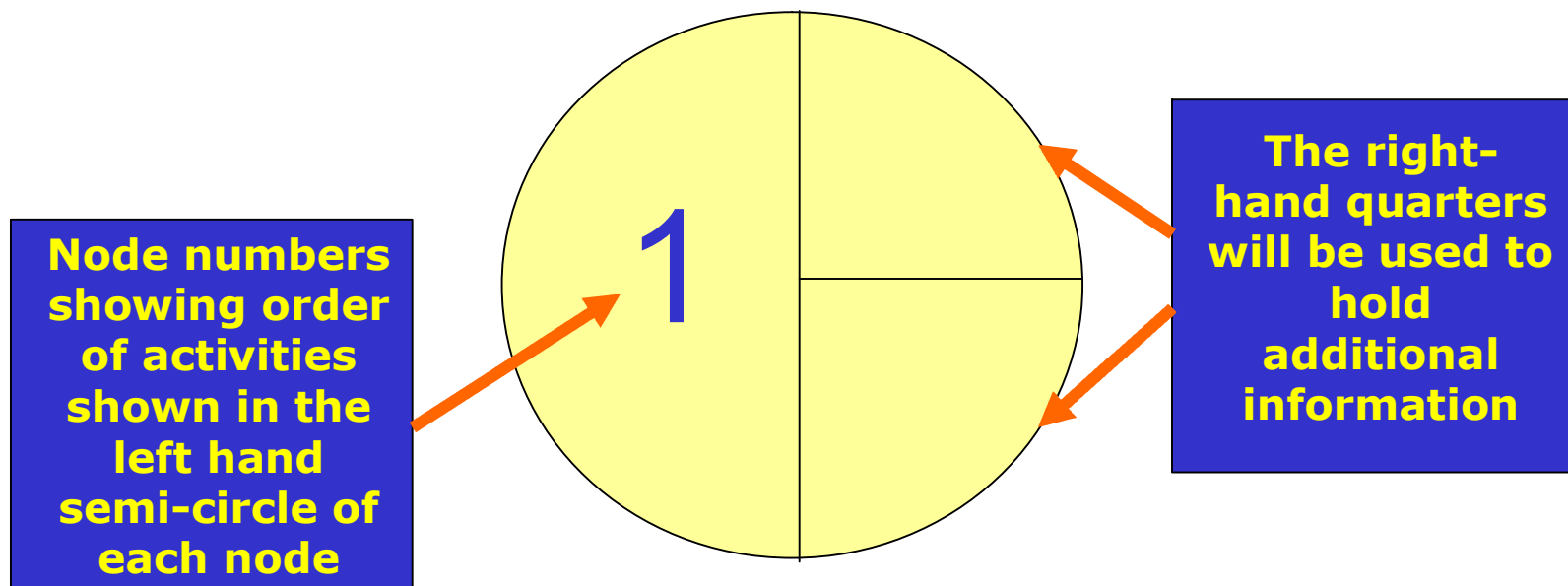


- Try drawing a network using your instructions for making a cup of coffee



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:

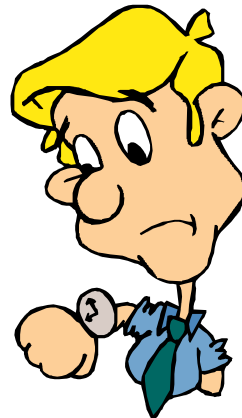




Calculating The Earliest Start Time

- 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:

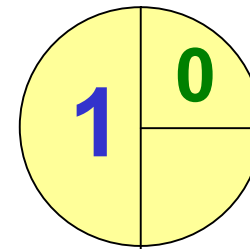
$$\text{EST} = \text{EST of Previous activity} + \text{Duration of previous activity}$$





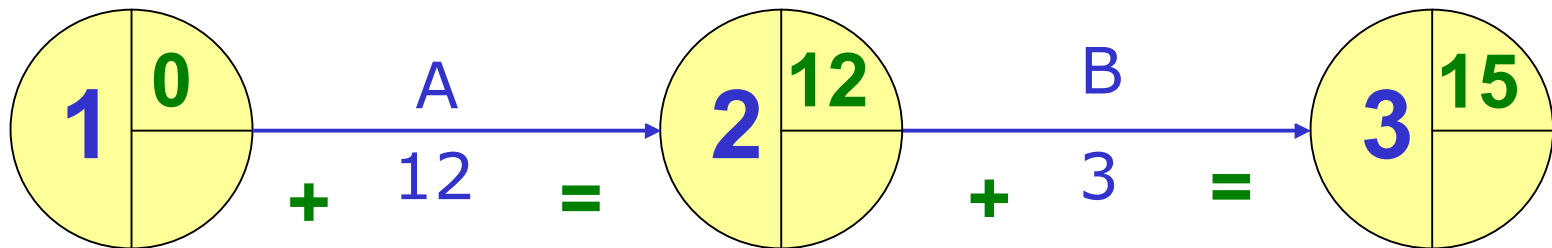
Calculating The Earliest Start Time

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



EST goes in top right-hand quarter of the node

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

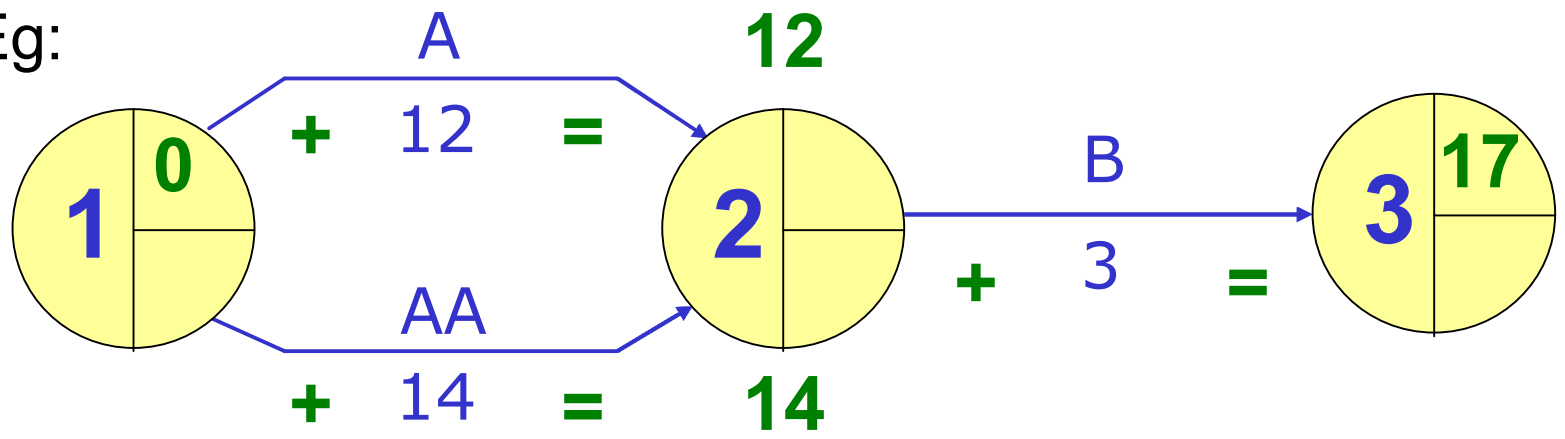




The EST and Simultaneous Activities

- 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

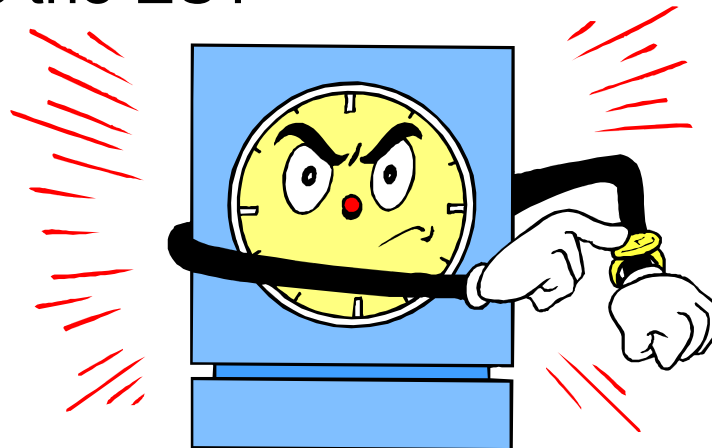


Recap of The Earliest Start Time

- 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:

$$\text{EST} = \text{EST of Previous activity} + \text{Duration of previous activity}$$

- 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:

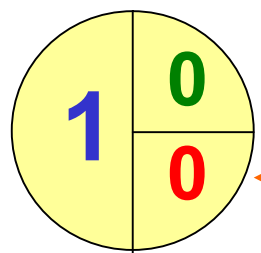
$$\text{LFT} = \text{LFT at end of following activity} - \text{Duration of following activity}$$





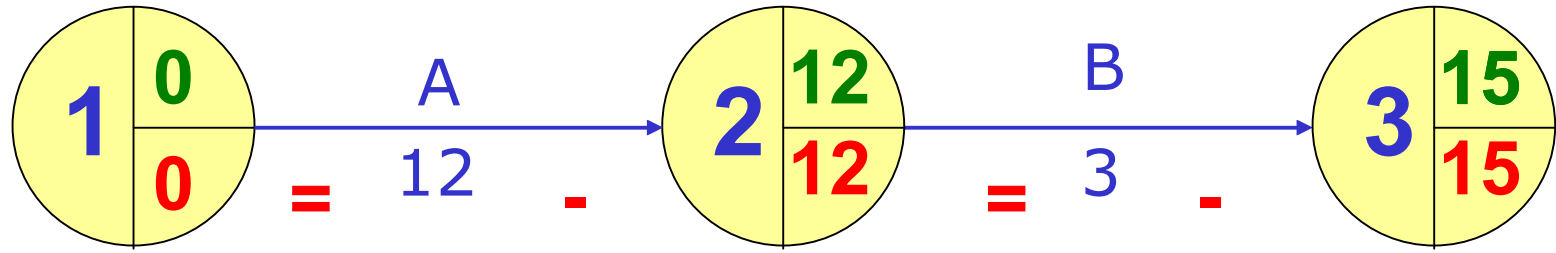
Calculating The Latest Finishing Time

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



LFT goes in bottom right-hand quarter of node

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

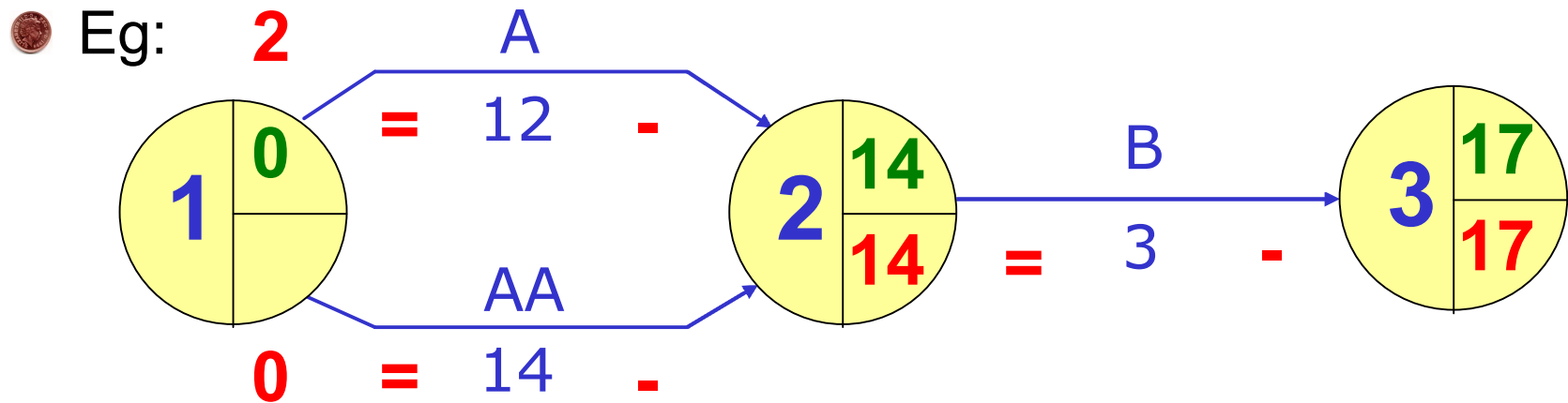


**Since the earliest time this project can be finished is 15 weeks then this is also the latest we would like to finish the project. As such:
The EST and LFT of the last node are ALWAYS the same**



The LFT and Simultaneous Activities

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



- 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:

$$\text{LFT} = \text{LFT at end of following activity} - \text{Duration of following activity}$$

- 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

This is the amount of spare time available for an activity without delaying the **NEXT ACTIVITY**

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

TOTAL FLOAT

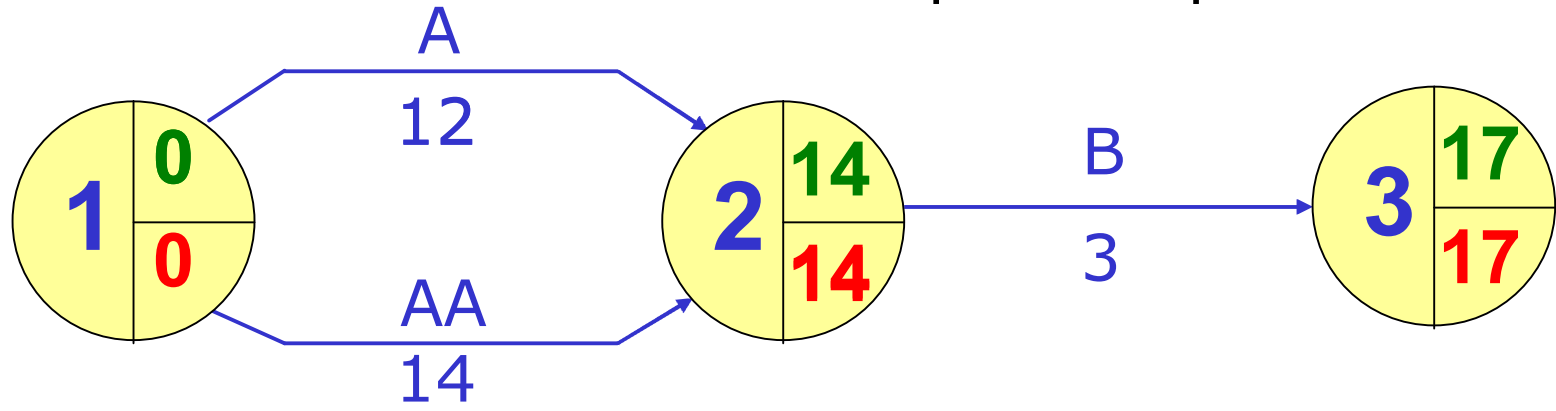
This is the amount of spare time available for an activity without delaying the **WHOLE PROJECT**

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?

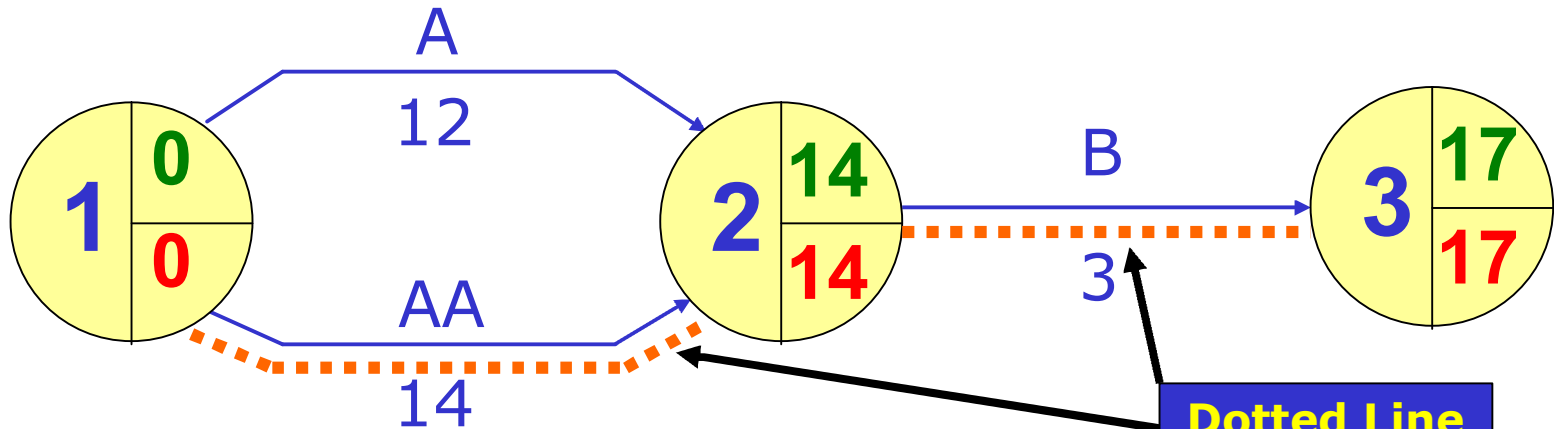
Activity	Duration (Weeks)	EST	LFT	Free Float	Total Float
A	12	0	14	2	2
AA	14	0	14	0	0
B	3	14	17	0	0

- 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

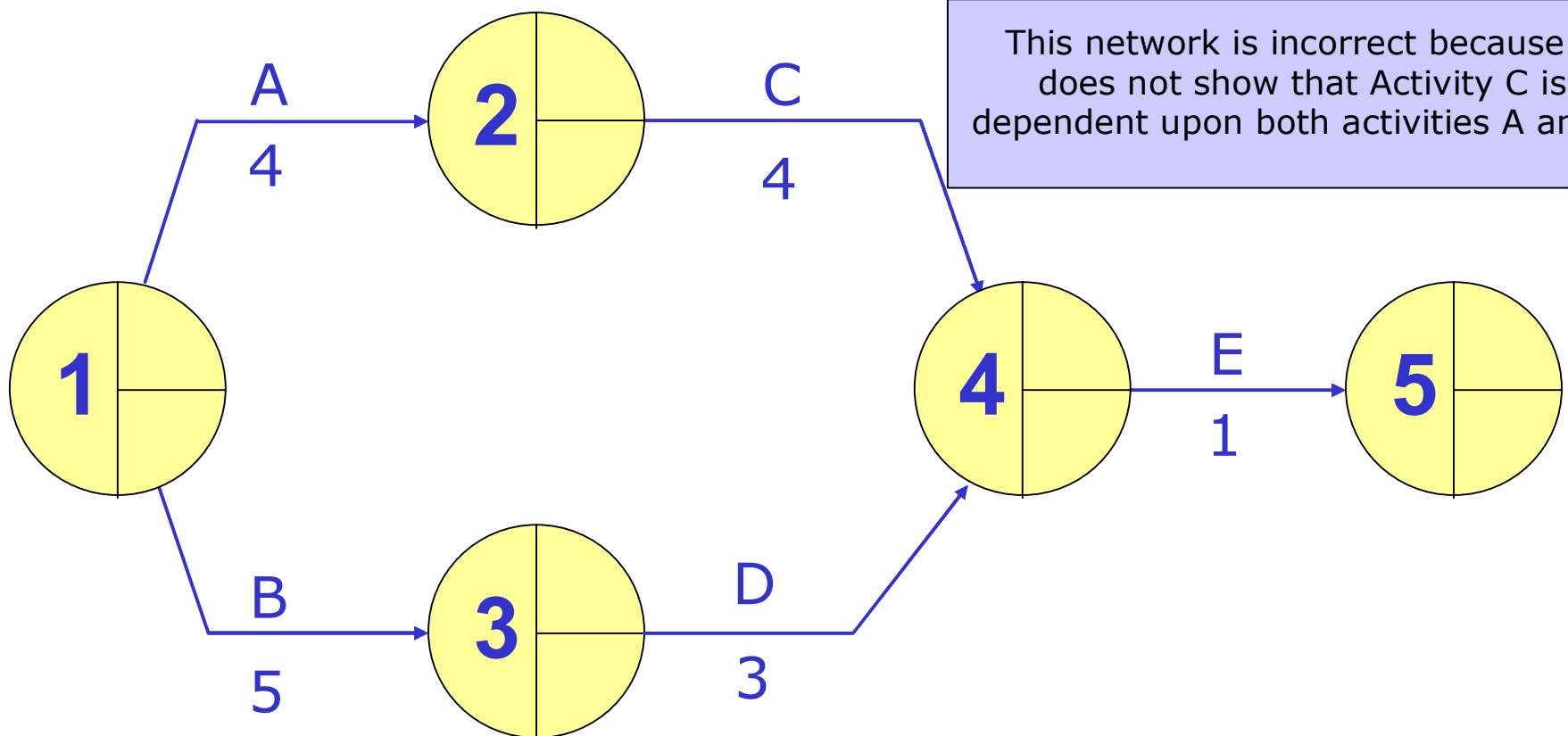
- Create and complete a network diagram to represent the following project:
 - Activities A (4 days) and B (5 days) can start simultaneously
 - Activity C (4 days) can begin once activities A and B are complete
 - Activity D (3 days) can begin once activity B is complete
 - Activity E (1 day) ends the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

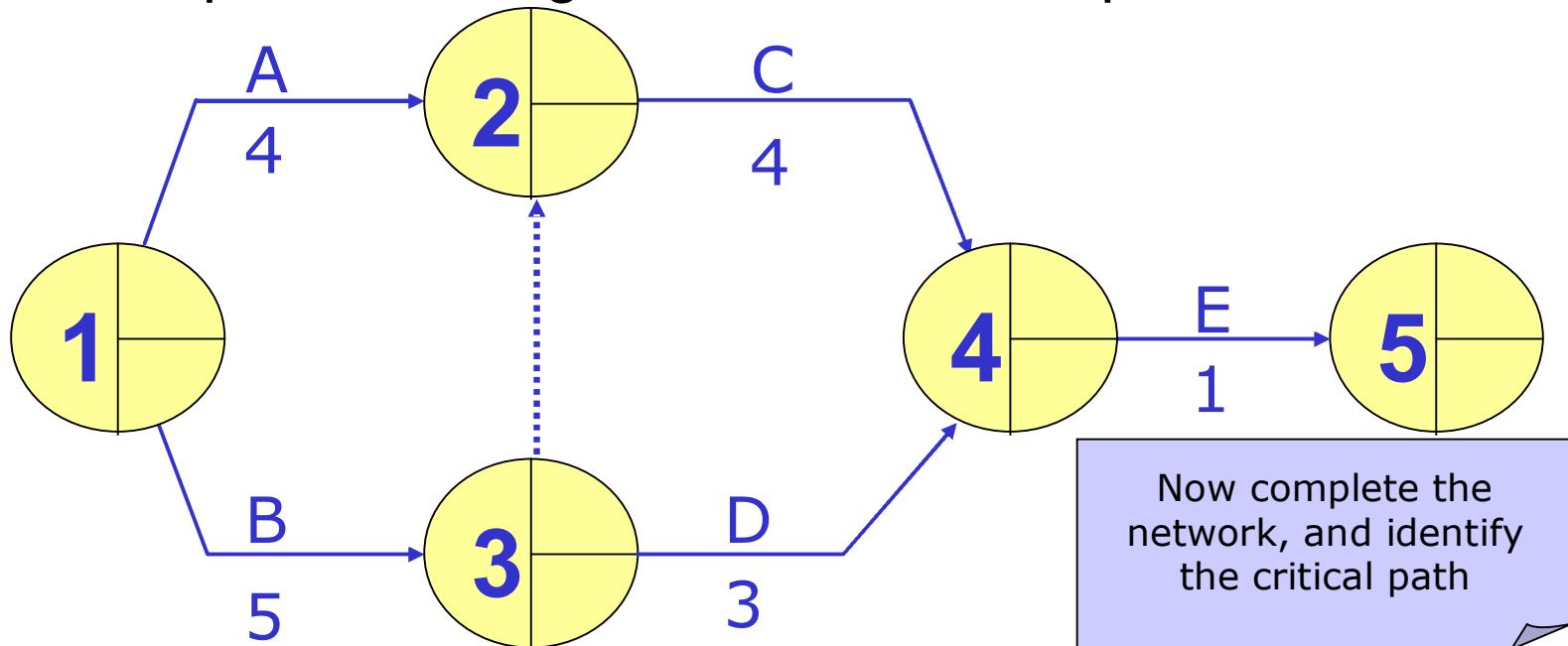


This network is incorrect because it does not show that Activity C is dependent upon both activities A and B



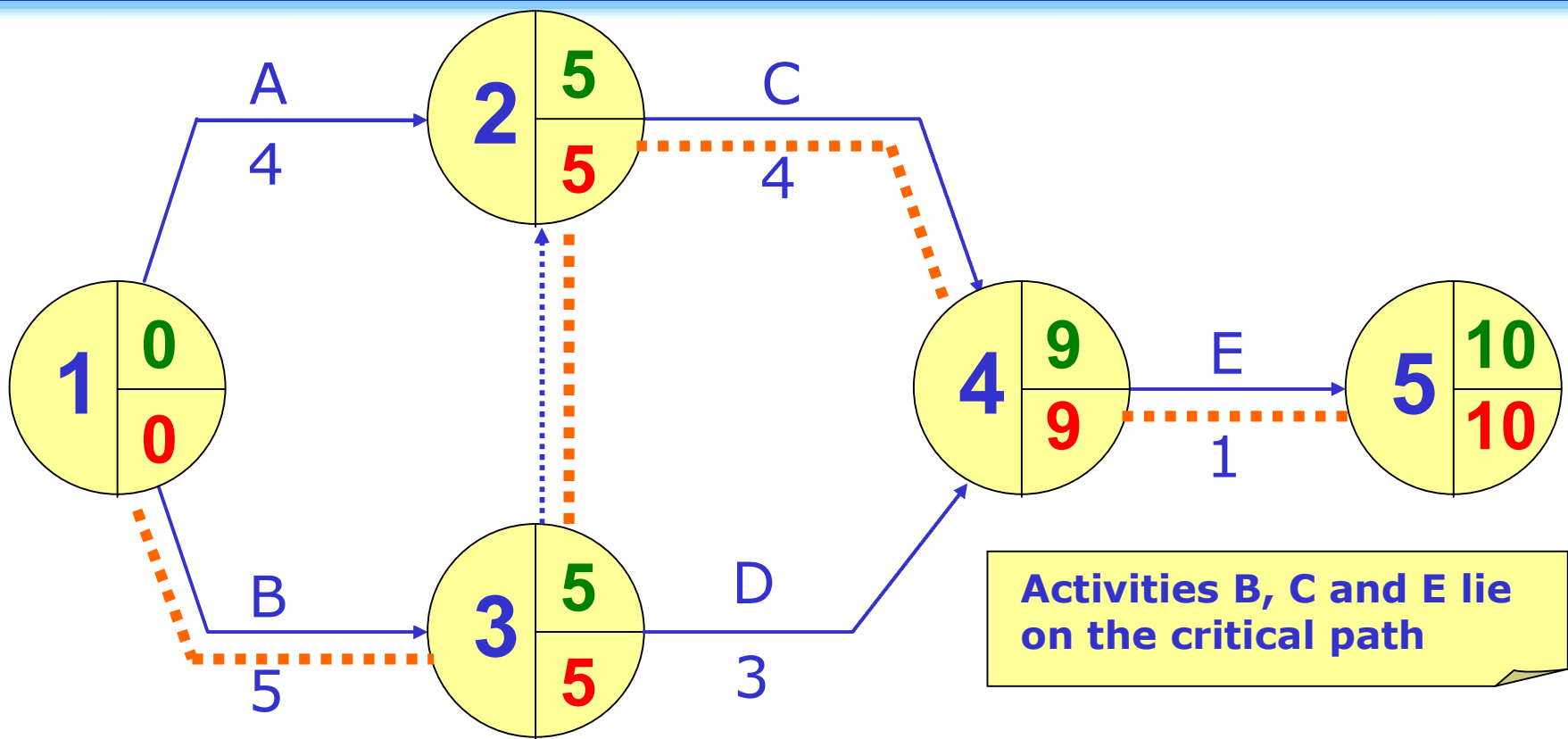
Dummy Activities

- 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

