To determine the project critical path, it is necessary to perform a forward pass and a backward pass through the network. The forward pass will identify the early start and finish times. The backward pass will identify the late start and finish times. These processes are required to be able to calculate the float on each activity.

Let’s take a look at calculating the Forward Pass. A forward pass is performed from left to right through the network. This process will identify the early start and early finish for each activity. Start with 1 for the first activities on each path to get the initial early starts, and then add the duration to the early start and subtract 1 to get the early finish for each activity. In the forward-pass process, the greater value of the early finish for all predecessors is always used when multiple predecessors converge into one successor. The early finish for the last activity in the network is also the project duration; therefore, the duration for the schedule network shown is 24 days.

So the rules to remember for the forward pass are:

1. For any activity without a predecessor, its early start (ES) will be 1.
2. For all activities with a single predecessor, calculate its early start by adding 1 to its predecessor’s early finish (EF).
3. For activities with multiple predecessors, calculate its early start by adding 1 to the greatest early finish of all its predecessors.
4. To calculate the early finish date for all activities use the following equation:  
   \[ EF = ES + \text{duration} - 1 \]
A more detailed look: When doing the Forward Pass, we move from the left through the right of the network. Here we designate each activity with a letter (A through J) and we all note each activity’s duration (A’s duration is 7, B’s is 8, etc.). First we assume that any activity that has no predecessor can start at the beginning of day 1. So if we look at activity A, it has no predecessor and we show it starting on day 1. We then add its early start date (1) to its duration (7) and subtract 1 to arrive at the early finish date of 7. What this means is that we will start the project at the beginning of day 1 and, after 7 full days of work on activity A, we will complete the activity at the end of day 7. We then go to any of activity A’s successors (in this case there’s only one – activity D) and we presume that we will start work on them at the beginning of the following day – day 8. As you can see, activity D’s early start is shown as day 8. We calculate its early finish as we did activity A’s – by adding its duration to its early start and subtracting 1. This continues until we get to the first merge point H which cannot be calculated until we have calculated the early finish for both of its two predecessors, activities D and E. To do that, we need to go back to activity B and start again with an early start of day 1 plus 8 duration days minus 1 which gives us an early finish of 8. For activity E we once again take the early finish of its predecessor B (which is day 8) add 1 (so we start at the beginning of day 9) and we add the duration of 6 days to the early start date of day 9 and then we subtract 1 – which gives us an early finish of day 14. Now we can progress to H by using the latest finish date for either activity D or E. In this case 14, activity E’s early finish, is later than 13, activity D’s early finish. So activity H’s early start is day 15. The early start for activity J is determined by using the latest finish of activities H, F, and G, 21 (from activity H and using the same process as described) and adding 1. Once that is determined, just calculate the early finish for J by adding its duration (3) to its early start date (22) and subtracting 1 to arrive at the project early finish of 24.
Let’s now take a look at calculating the Backward Pass. A backward pass is performed going from right to left through the network. It will determine the late start and late finish for each activity. Start by inheriting the early finish and making it activity J’s late finish. Then subtract the duration from the late finish and add 1. The lesser value of all successor tasks that converge from a predecessor is used as the late finish for the predecessor, as in activity B.

So the rules to remember for the backward pass are:

1. Presume that the network’s critical path has zero float so that its last activity’s late finish will be the same as its early finish.
2. To calculate the late start for all activities, use the following equation:
   \[ LS = LF - \text{duration} + 1 \]
3. For any activities with a single successor, calculate its late finish by subtracting 1 from its successor’s late start.
4. For any activities with multiple successors, calculate its late finish by subtracting 1 from the greatest of its successors’ late starts.
A more detailed look: We start calculations for the backward pass by assuming that activity J’s late finish is the same as its early finish. We then calculate activity J’s late start by subtracting its duration (3) from its late start (24) and adding 1 (just the opposite of what we did on the forward pass). Therefore, activity J’s late start date will be 22. Notice that activity J’s early start and late start are the same. Notice also that its early finish and late finish are the same as well. Generally speaking, this is the case for all activities on the critical path where the path’s float is equal to zero. Continue calculating the late finish and late start dates for the remaining activities in the network as you did for activity J. Be aware, however, in backward pass when two or more successors merge into a single predecessor the lowest late start is used to determine the late finish of the predecessor activity.

Finally, let’s take a look at how the critical path is calculated. The float, denoted in parenthesis, is the amount of time you can delay a task without affecting the project end. Total Float or Total Slack (they are synonymous) can then be calculated as follows:

\[
\text{Total float} = \text{Late finish} - \text{Early finish}
\]

or

\[
\text{Total float} = \text{Late start} - \text{Early start}
\]

Calculate the total float using both formulas as a way of checking for errors. The number should be the same whether you use start or finish formulas. A difference greater than zero indicate tasks that have slack. Zero indicates no slack and a “critical activity.” Less than zero, or negative slack, are activities that do not meet the project deadline and are also critical. The critical path comprises all activities that have either zero or negative total float.