

Float and the Critical Path

Start with the Network Diagram

This resource supplements the Schedule chapter of Rita Mulcahy's™ PMP® Exam Prep, 12th edition. It works one small network all the way through — forward pass, backward pass, float — using numbers that do not appear in the book, so you practice the method instead of recalling an answer.

None of this works without the picture it is calculated from. A **network diagram** is a map of the work. Each box is an activity. Each arrow says that the activity at the tail has to finish before the activity at the head can start. The number written above a box is that activity's **duration** — how long the work itself takes. That is the whole vocabulary.

Setting a fence post is a project with three activities: dig the hole, put the post in, and fill the hole with dirt. The order is not a preference. You cannot fill the hole before the post is standing in it, and you cannot stand the post in a hole you have not dug. A hard, physical relationship like that is a **mandatory dependency**, and recording it is exactly what the arrows are for.

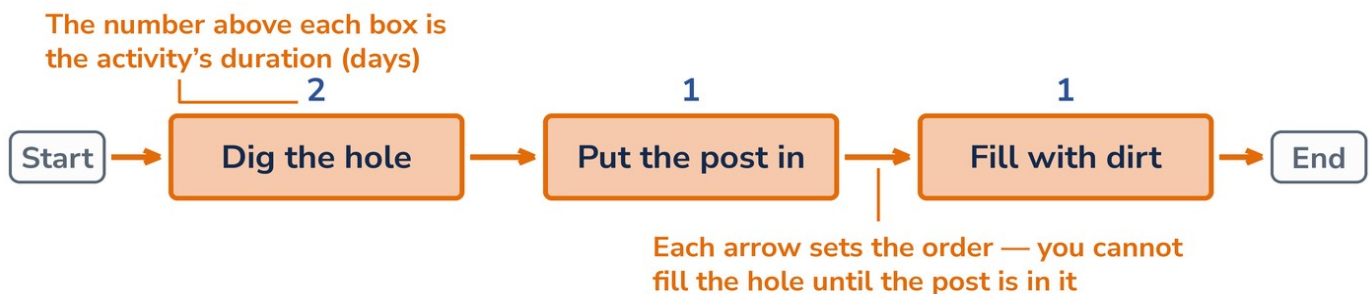


Figure 1. A three-activity network diagram for setting a fence post.

This project has only one path through it, so it takes as long as the three durations added together — four days — and there is no flexibility anywhere. Every activity has to happen on time, because every activity is holding up the one behind it. Real projects are not chains; they branch. Two or three strings of work run alongside each other, and they almost never take the same amount of time. The moment a project branches, some activities get room to move and others do not, and that difference is what everything below is about.

What Float Is, and What the Critical Path Is

Every schedule contains activities that can slip a little without anyone noticing, and activities that cannot slip

at all. **Float** is the name for that room to move: the amount of time an activity can be delayed before the delay causes a problem somewhere else. Every activity in a network has a float value, and knowing those values is what separates a project manager who reacts to every late task from one who knows which late tasks actually matter.

The **critical path** is the longest path through the network from start to finish. That sounds backward the first time you hear it, but the longest path is the shortest the project can possibly take: every other route through the network is shorter, so the long one sets the finish date. Because nothing along it has any slack, every activity on the critical path has **zero float**. Delay one of them by a week and the project finishes a week later. That is not a risk to be managed; it is arithmetic.

The Prep Book asks you to tell four float terms apart. **Total float** is how long an activity can be delayed without pushing out the project's finish date — when a question simply says “float,” this is what it means. **Free float** is how long an activity can be delayed without pushing out the early start of the activity right behind it, and it is never larger than total float. **Project float** is how long the whole project can slip before it misses a date committed to someone outside it. **Negative float** is what you get when the network cannot reach a date it has been handed; it means the plan, as drawn, does not work.

Finding any of them takes three steps: a forward pass, a backward pass, and one subtraction. The rest of this resource walks through all three on the same five-activity network.

The Forward Pass

The forward pass answers one question: how soon can each activity happen? You work left to right, from Start to End, following the arrows.

The network in Figure 2 has five activities. Read it the same way you read the fence post: **the number above each box is that activity's duration**, measured in weeks this time. Activity A runs first, and takes 4 weeks. When A is finished the work splits in two: Activity B and then Activity C on one branch, Activity D on the other. Both branches have to be complete before Activity E, the final activity, can begin.

Two numbers go in the top row of each box. The **early start (ES)** is the soonest the activity can begin; the **early finish (EF)** is the soonest it can be done. Four rules produce them. The first activity starts at zero — this resource uses zero, the same convention the Prep Book uses, though some sources begin at Day 1 instead; either is correct as long as you do not mix them inside one problem. Early finish equals early start plus duration. An activity's early start is the early finish of the activity before it. And where two or more arrows come together, **take the largest early finish**, because the activity cannot begin until everything feeding it is done.

That last rule is the only place this gets interesting, and it is where most mistakes happen. Activity C finishes at week 13 and Activity D finishes at week 11. Activity E has to wait for both, so E starts at 13, not at 11. Carry the pass through to the end, and the early finish of the last activity — 15 weeks — is the duration of the project.

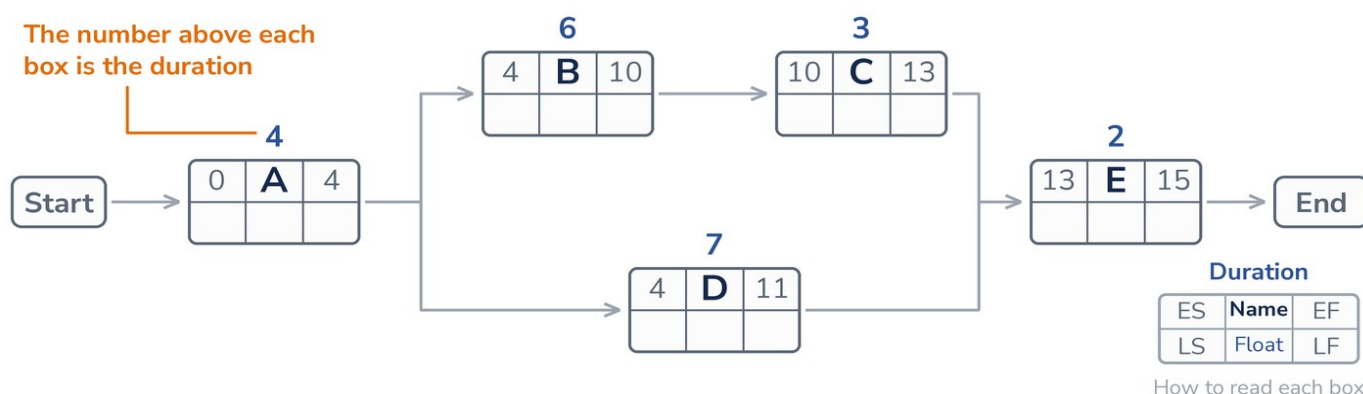


Figure 2. The forward pass fills the top row of every box.

The Backward Pass

The backward pass answers the opposite question: how late can each activity happen without making the project late? You work right to left, from End back to Start, against the arrows.

Two numbers go in the bottom row of each box. The **late finish (LF)** is the latest the activity can end without delaying the project; the **late start (LS)** is the latest it can begin. The rules mirror the forward pass. The last activity's late finish is the project duration you just calculated, 15 weeks. Late start equals late finish minus duration. An activity's late finish is the late start of the activity after it. And where two or more arrows leave one activity, **take the smallest late start**, because that activity has to be finished in time for whichever successor needs it first.

Watch Activity A in Figure 3. Activity B cannot start later than week 4, and Activity D cannot start later than week 6. Activity A has to satisfy both, so A's late finish is 4 — the earlier of the two, not the later. Take the wrong one here and every number that follows is wrong.

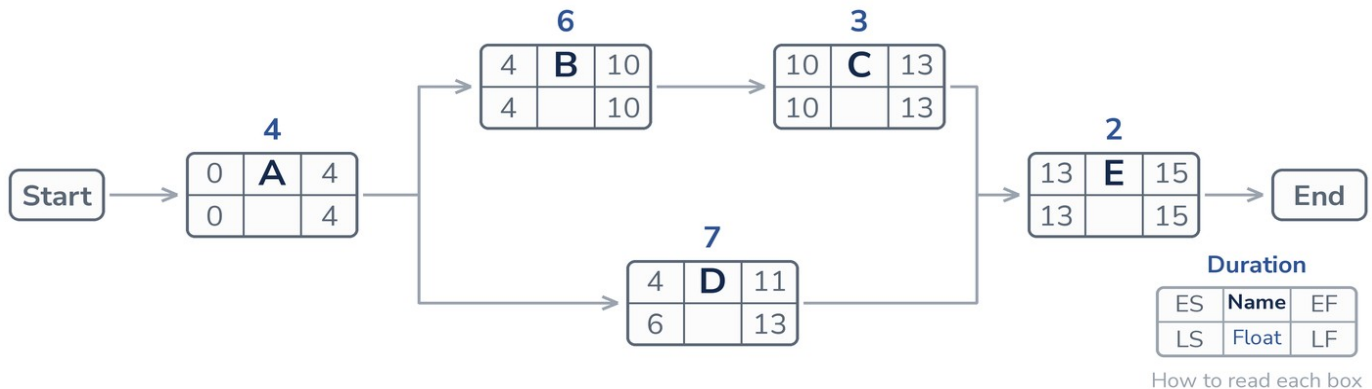


Figure 3. The backward pass. Late start and late finish now fill the bottom row.

Calculating Float

With both passes done, float is a single subtraction, and the Prep Book gives two formulas that are interchangeable: **float equals late start minus early start**, or **float equals late finish minus early finish**. Both begin with the late figure and subtract the matching early one. Use two starts or two finishes — never one of each. Which formula you reach for depends only on which numbers the question hands you. If a question tells you the late start is 30 and the early start is 18, you have two starts, so the float is 12.

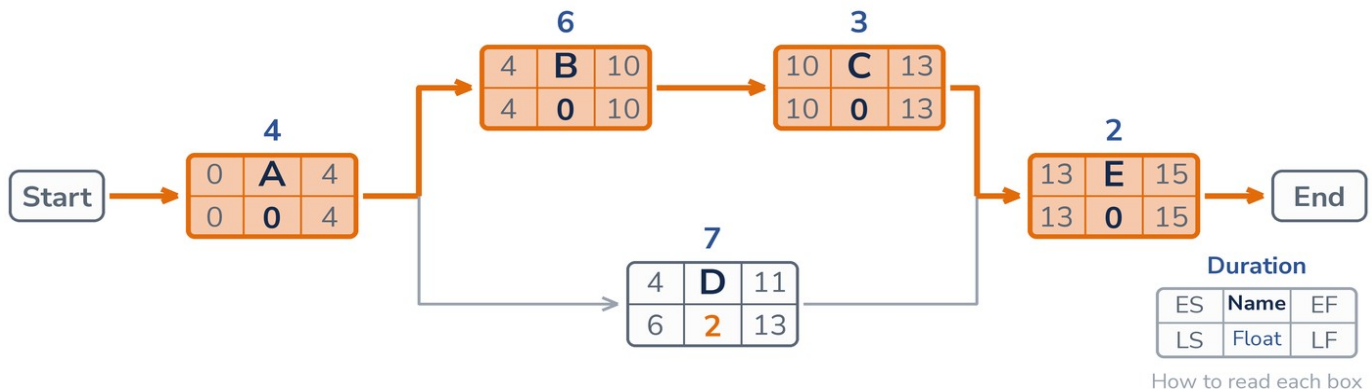


Figure 4. Float sits in the middle of the bottom row. The zero-float activities are the critical path: 15 weeks.

Apply that to this network and four of the five activities come out at zero: A, B, C, and E. Those four are the critical path. The connection is worth saying out loud, because it saves work on the exam — **the activities with zero float are the critical path**. You do not have to find the longest path first and check float second. The float calculation hands you the critical path for free.

Activity D is the exception, with two weeks of float. D takes 7 weeks, while the branch running alongside it — B and C together — takes 9. D can start two weeks late, or run two weeks long, and the project still finishes

in week 15. That is usable information rather than trivia: Activity D is where you assign your least experienced team member, and a two-week slip there is the one you do not escalate.

Now Work One Yourself

Figure 5 is a different project, drawn the same way, with every box left empty. Activity A starts the project and takes 3 weeks. When A finishes, the work splits in two. On the upper branch, Activity B takes 2 weeks and is followed by Activity C, which takes 4 weeks. On the lower branch, Activity D takes 9 weeks. Activity E is the last activity, takes 5 weeks, and cannot start until both C and D are finished.

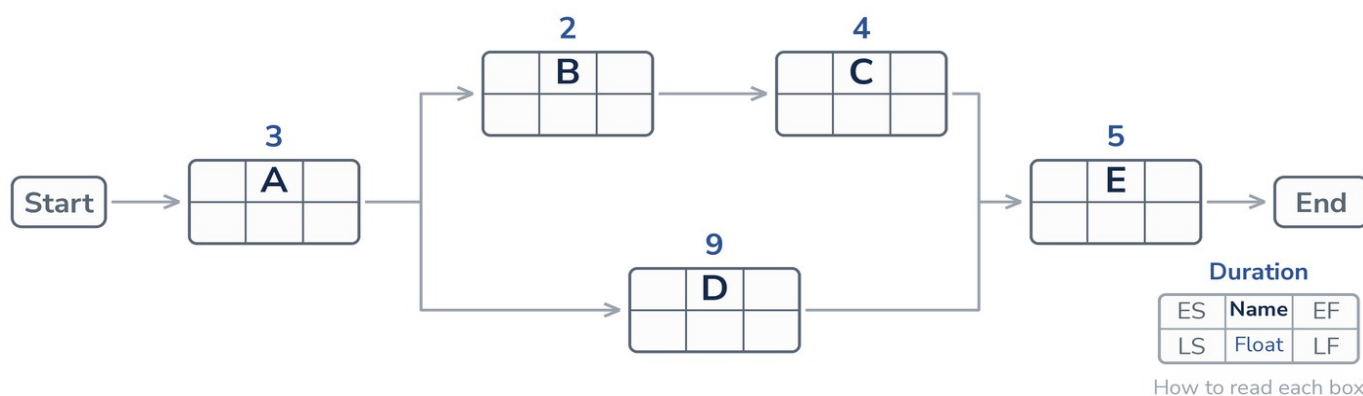


Figure 5. Your turn. Fill in the dates, calculate the float, and find the critical path.

Work it the same way. Run the **forward pass** left to right and fill in every early start and early finish, taking the larger early finish where two arrows meet. The early finish of the last activity is the project duration. Then run the **backward pass** right to left and fill in the late finishes and late starts, taking the smaller late start where two arrows leave one activity. Subtract to get each **float** — late start minus early start, or late finish minus early finish. The activities that come out at zero are the **critical path**.

Answers

The project takes **17 weeks**, and the critical path is Start, A, D, E, End. There are only two routes through this network: A–B–C–E runs $3 + 2 + 4 + 5 = 14$ weeks, and A–D–E runs $3 + 9 + 5 = 17$ weeks. The longer one sets the finish date.

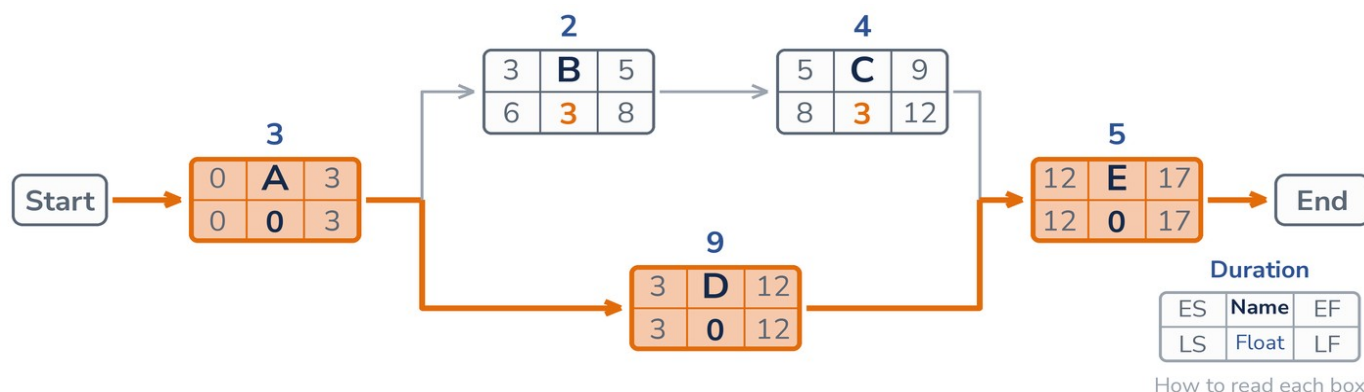


Figure 6. The completed exercise. Compare it against your own.

Activities A, D, and E come out at zero float, which is another way of saying they are the critical path. Activities B and C each carry **3 weeks** of float — exactly the difference between the 14-week branch and the 17-week one. If your numbers differ, check the two merge and split points first: Activity E takes the larger early finish coming in (12 from D, not 9 from C), and Activity A takes the smaller late start going out (3 from D, not 6 from B).

One thing worth noticing: the critical path here runs along the lower branch, not the upper one. Where a branch sits in the drawing means nothing. Only total duration decides.

How This Shows Up on the Exam

You will almost never be asked to draw a network diagram on the exam, and full forward-and-backward-pass problems are rare — the Prep Book says as much. What the exam does expect is the reasoning the diagram produces. Most schedule questions hand you two or three numbers and check whether you know which subtraction fits.

The most common form gives you a mix of starts and finishes and asks for float. Sort them before you calculate: two starts or two finishes, late minus early. A question that offers a late start, an early start, and a late finish is testing whether you will pair that late finish with something it does not belong with.

The more valuable form is a scenario in which an activity is running late and you are asked what to do. The answer turns on float. If the activity has float and the delay fits inside it, the project is not late, and the answer is usually to record the variance and keep monitoring rather than to spend money. If the activity is on the critical path, the delay is real, and the answer involves schedule compression — crashing, which adds cost, or fast tracking, which adds risk and rework. Either way, the exam expects you to analyze the options and route them through the change control process before acting, not to compress the schedule on your own authority.

Expect negative float to appear as a setup at least once. Negative float is not simply a tighter version of a tight schedule; it is a statement that the plan cannot reach a date it has already been given. The response is the same family of options — compress, reduce scope, or escalate through governance to renegotiate the date — together with the honesty to say that the current plan does not work.

Two vocabulary notes are worth carrying in. The PMBOK® Guide, Eighth Edition, covers total float, free float, and negative float, but it does not use the term project float; that term comes from the Prep Book, where it means the project's flexibility against a date promised to someone outside the project. And the PMBOK® Guide's own worked example starts the project on Day 1 while the Prep Book starts at zero — both note that other conventions are accepted. The exam will not turn on which convention you use. It will turn on whether you stayed consistent.

On the Examination Content Outline, this sits in Domain II, Task 8, “Plan and manage schedule,” whose enablers include analyzing schedule variation. “Are we behind?” is a question about the baseline; “Does it matter?” is a question about float.