To proceed with the project management analysis, I must first define the activity schedule, precedence relationships, and durations, as this essential input was not provided in the prompt. The following hypothetical but representative schedule is established for calculation purposes:

Activity	Predecessor(s)	Duration (Time Units)
A	-	5
B	-	6
C	A	4
D	A	7
E	B	3
F	C, D	5
G	E	8
H	F, G	6

Construction of a Network Diagram (Activity-On-Node Convention)

The precedence relationships dictate the flow of the project. Activities A and B begin immediately. Activities F and H represent major integration points, requiring multiple prior tasks to conclude before they can commence.

```
+---[A:5]---+---[C:4]---+
| | |
START -+ +---[D:7]---+---[F:5]---+
| |
+---[B:6]---+---[E:3]---+---[G:8]---+---[H:6]--- END
```

Determination of the Critical Path and Project Completion Time

Using the Forward Pass (Early Start, Early Finish) and Backward Pass (Late Start, Late Finish) methodology, we calculate the slack for each activity. The Critical Path is defined by the sequence of activities where the total slack (Late Finish - Early Finish, or Late Start - Early Start) equals zero, meaning any delay in these tasks will directly delay the entire project completion.

Act	Dur	ES	EF	LS	LF	Slack	Critical?
A	5	0	5	0	5	0	Yes
B	6	0	6	0	6	0	Yes
C	4	5	9	8	12	3	No
D	7	5	12	5	12	0	Yes
E	3	6	9	6	9	0	Yes
F	5	12	17	12	17	0	Yes
G	8	9	17	9	17	0	Yes
H	6	17	23	17	23	0	Yes

The Critical Paths of the project are:

1. **A -> D -> F -> H** (Duration: 5 + 7 + 5 + 6 = 23)
2. **B -> E -> G -> H** (Duration: 6 + 3 + 8 + 6 = 23)

The shortest time required for the project to be completed is 23 time units.

Gantt Chart Representation

The Gantt chart visually displays the scheduling for each activity, highlighting the critical activities and the available float (slack) for non-critical activities (like C).

Key: [---] = Task execution period. (Slack) = Available float.

```
Time Unit Scale: 0----+----5----+----10----+----15----+----20----+----25
A (CP): [-----]
```

B (CP): [------]
C: [----].....(Slack 3)
D (CP): [-------]
E (CP): [---]
F (CP): [-----]
G (CP): [--------]
H (CP): [------]
```

### Limitations of the Critical Path Method (CPM)
While indispensable for identifying critical sequences and minimum duration, CPM possesses several inherent limitations that project management must actively address:
1. **Deterministic Nature:** CPM is inherently a deterministic model, meaning it assumes that the duration estimates for each activity are fixed and certain. It does not account for the probabilistic variation or uncertainty surrounding real-world task execution times, unlike related methods such as PERT (Program Evaluation and Review Technique). This reliance on fixed estimates can lead to project schedule compression risks if actual durations exceed projections.
2. **Ignores Resource Constraints:** Traditional CPM fundamentally focuses only on precedence relationships and time. It fails to consider resource availability (manpower, equipment, materials). An activity might be non-critical in terms of time slack but become critical if the necessary resources are bottlenecked or shared with a simultaneously scheduled critical path activity, necessitating resource leveling techniques outside the core CPM calculation.
3. **Dependency on Accurate Estimation:** The accuracy of the resulting critical path and total project duration is entirely contingent upon the accuracy of the input duration estimates. Poor or overly optimistic estimates can render the entire CPM analysis misleading, leading to unrealistic deadlines and inadequate contingency planning.
4. **Static Model:** CPM creates a fixed schedule baseline. It is not designed to dynamically adjust to ongoing changes, scope creep, or unexpected external events. Effective project execution requires continuous monitoring and frequent recalculation (or updating) of the network model to maintain relevance.
```