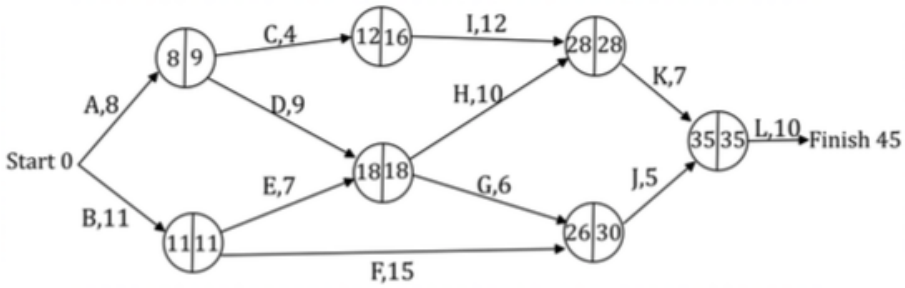
Answers

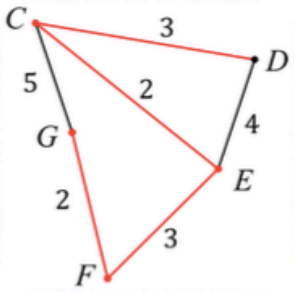
1.

A path is a walk with no repeated vertices. ∴ S–T–U–V	1 Mark: B

2.

 Float time = 16 − 12 = 4	1 Mark: A

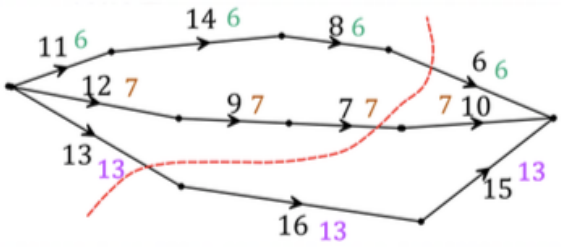
3.

Find the minimum spanning tree.  Length = 2 + 3 + 2 + 3 = 10 km ∴ Minimum length of pipes is 10 km.	2 Marks: Correct answer. 1 Mark: Shows some understanding

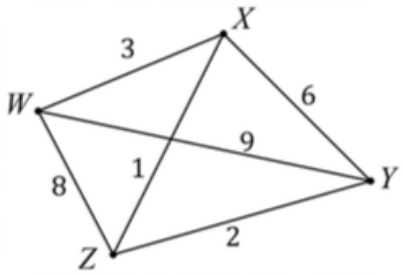
4.

<table><tr><td>Vertex</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr><tr><td>Degree</td><td>1</td><td>4</td><td>1</td><td>1</td><td>3</td><td>2</td></tr></table>	1 mark: Correct answer.
No. Path (Eulerian trail) only exists if the graph has exactly two vertices with an odd degree. There are 4 vertices with odd degree.	1 mark: Correct answer.

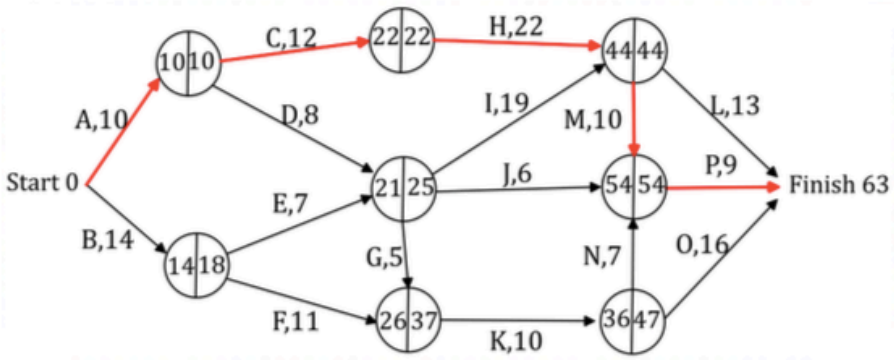
5.

Maximum flow = 13 + 7 + 6 = 26  	3 Marks: Correct answer. 2 Marks: Finds the minimum cut. 1 Mark: Shows understanding.

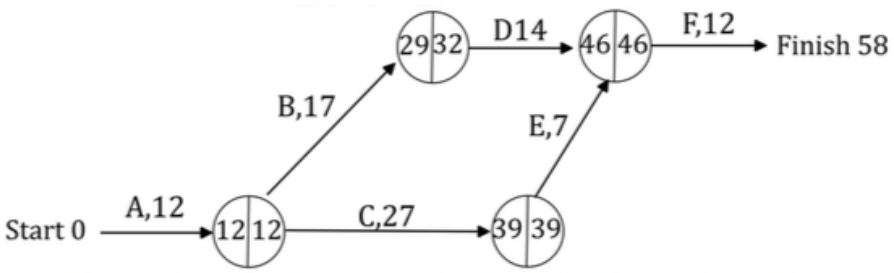
6.

Weighted edge: $WX = 3$, $WY = 9$, $WZ = 8$, $XY = 6$, $XZ = 1$, $YZ = 2$  	2 marks: Correct answer. 1 mark: Draws the vertices with at least one correct edge.

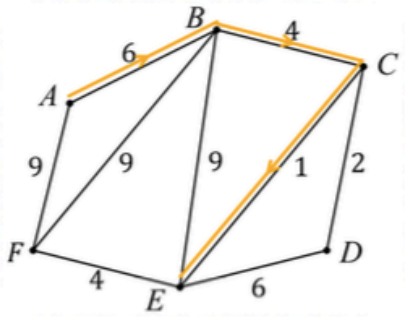
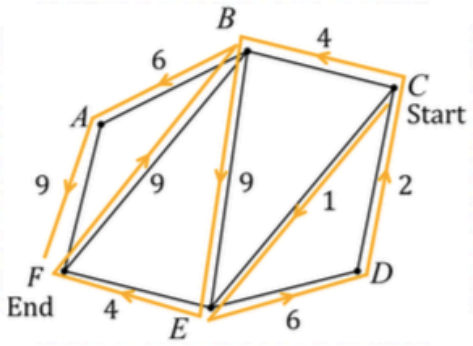
7.

 	3 Marks: Correct answer. 2 Marks: Finds the EST or LST. 1 Mark: Shows some understanding.
Critical path is A–C–H–M–P	1 mark: Correct answer.

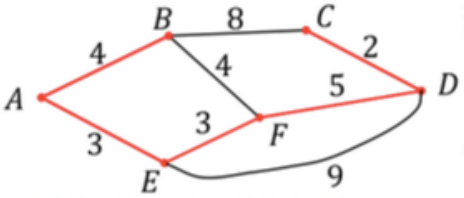
8.

 	3 Marks: Correct answer. 2 Marks: Completes the EST or LST 1 Mark: Draws a network diagram with some correct edges .

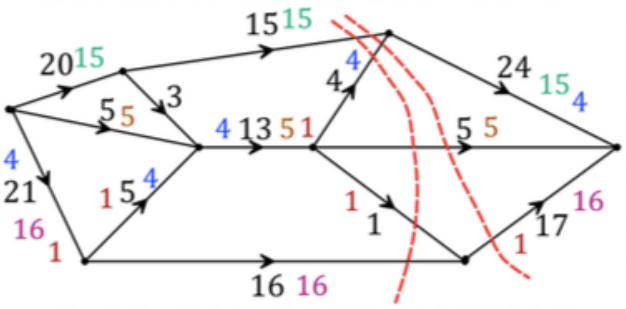
9.

Identifying the alternative routes from A to E. Shortest path is A–B–C–E Length $= 6 + 4 + 1$ $= 11$		2 Marks: Correct answer. 1 Mark: Finds the shortest path or shows some understanding.
There are two vertices with an odd degree. deg(C) = 3 and deg(F) = 3. Walk C–E–D–C–B–E–F–B–A–F Note: other answers are possible.		2 Marks: Correct answer. 1 Mark: Shows some understanding.

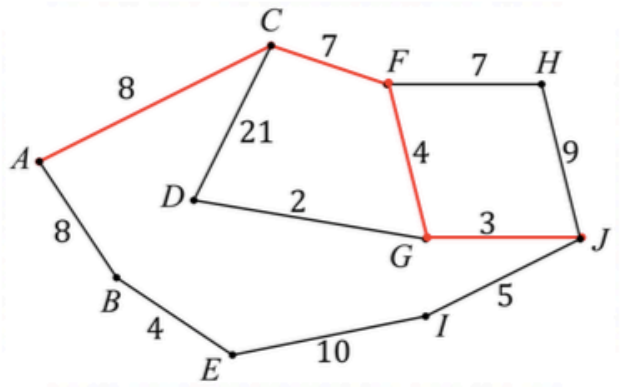
10.

 Minimal spanning tree is shown above, last vertex was C.	1 Mark: B

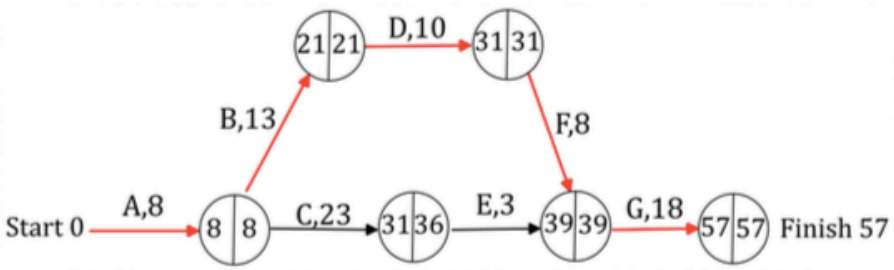
11.

 Maximum flow equals the value of the minimum cut. Maximum flow $= 15 + 4 + 5 + 17$ $= 41$	1 Mark: B

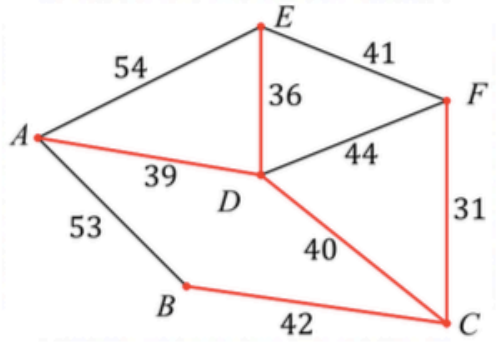
12.

Vertices with an odd degree are *C*, *F*, *G* and *J*.	1 mark: Correct answer.
 Shortest path is *A–C–F–G–J* Length $= 8 + 7 + 4 + 3$ $= 22$	2 marks: Correct answer. 1 mark: Finds the shortest path or shows some understanding.

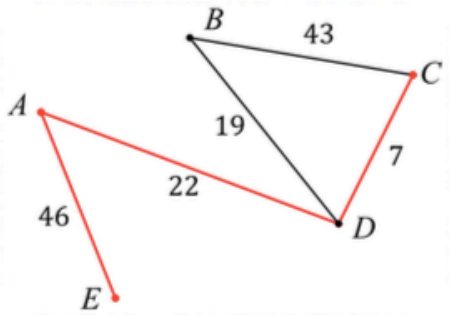
13.

	3 Marks: Correct answer. 2 Marks: Completes the EST or LST 1 Mark: Draws a network diagram with some correct edges .
Critical path is A–B–D–F–G Minimum completion time is 57 minutes.	2 Marks: Correct answer. 1 Mark: Finds the critical path or minimum completion time.

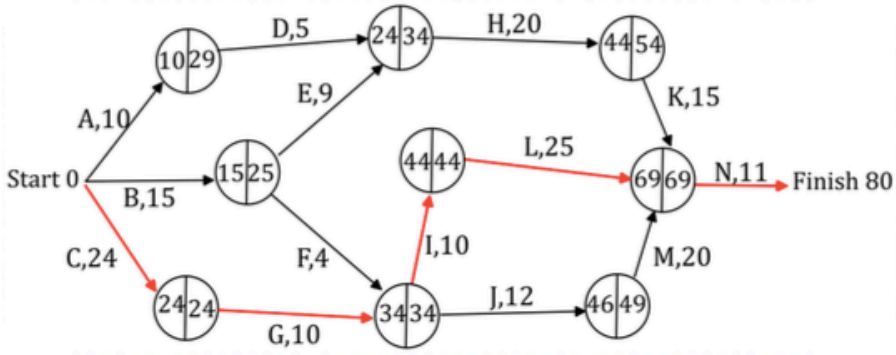
14.

	2 marks: Correct answer. 1 mark: Shows some understanding.
Length $= 39 + 36 + 40 + 42 + 31$ $= 188$ km $\therefore$ Minimum length of pipes is 188 km.	1 mark: Correct answer.

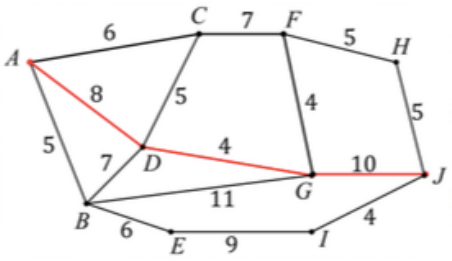
15.

Weight edge: $AD = 22$, $AE = 46$, $BC = 43$, $BD = 19$, $CD = 7$ 	2 marks: Correct answer. 1 mark: Draws the vertices with at least one correct edge.
Shortest path from E to C. E–A–D–C	1 mark: Correct answer.
Longest path $= 46 + 22 + 19 + 43$ $= 130$ km $\therefore$ Distance of the longest path is 130 km.	1 mark: Correct answer.

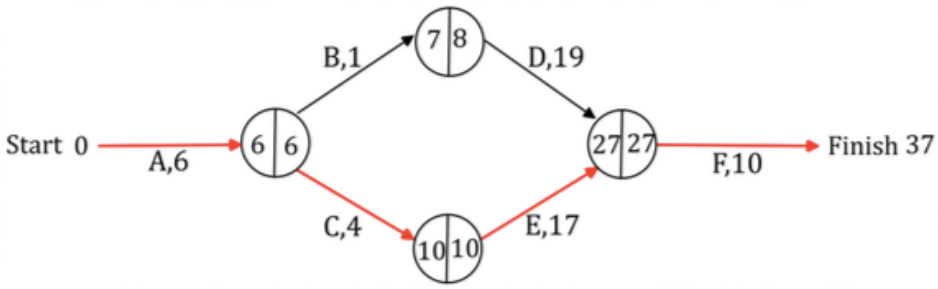
16.

	3 Marks: Correct answer. 2 Marks: Finds the EST or LST. 1 Mark: Shows some understanding.
Critical path is C–G–I–L–N $\therefore$ Minimum completion time is 80 days.	1 mark: Correct answer.

17.

Shortest path is A–D–G–J Length = 8 + 4 + 10 = 22 km 	1 Mark: B

18.

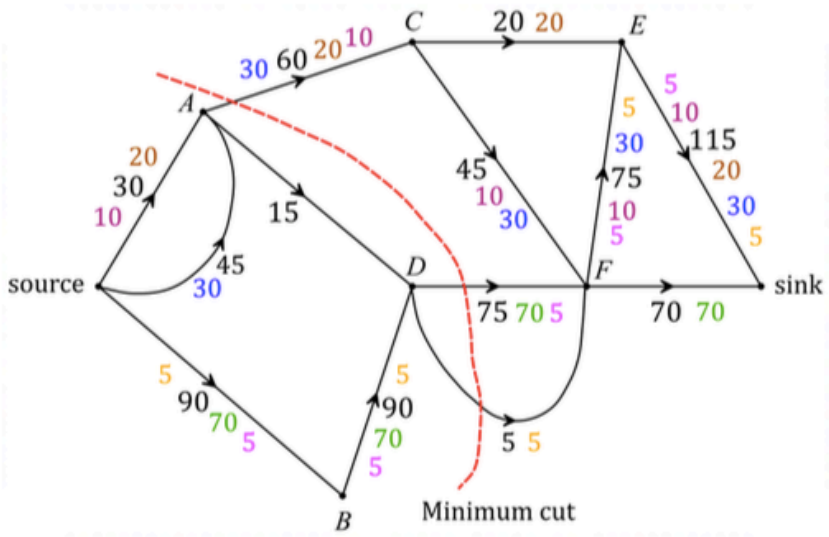
 ∴ Critical path is *ACEF*	1 Mark: D

19.

There are 8 edges: *AB, AC, BC, BE, CE ,EF ,BD, DE*	1 mark: Correct answer.
One vertex with degree 3 (vertex *C*)	1 mark: Correct answer.
Yes, it is a connected graph. Connected graph if every vertex in the graph is accessible from every other vertex in the graph along a path formed by the edges of the graph.	1 mark: Correct answer.
Cycle is a walk with no repeated vertices or edges that starts and ends at the same vertex. Cycles: *DEBD, DECBD, DECABD*	1 mark: Correct answer.

20.

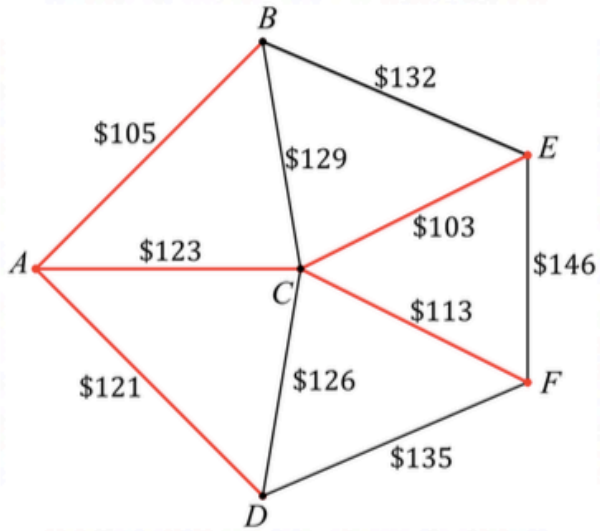
Inflow for vertex *C* = 60 L Possible outflow for vertex C = 20 + 45 = 65 L Inflow is less than the possible outflow. ∴ Outflow for vertex *C* is 60 L	1 mark: Correct answer.

	2 marks: Correct answer. 1 mark: Shows some understanding.
Maximum flow equals the minimum cut. Maximum flow $= 60 + 75 + 5$ $= 140$ L	1 mark: Correct answer.

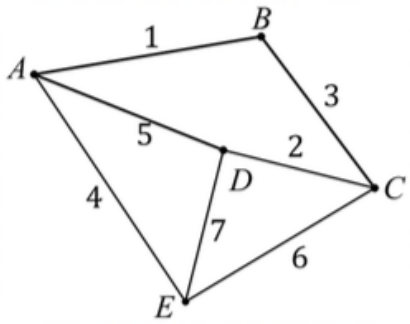
21.

	1 mark: Correct answer.

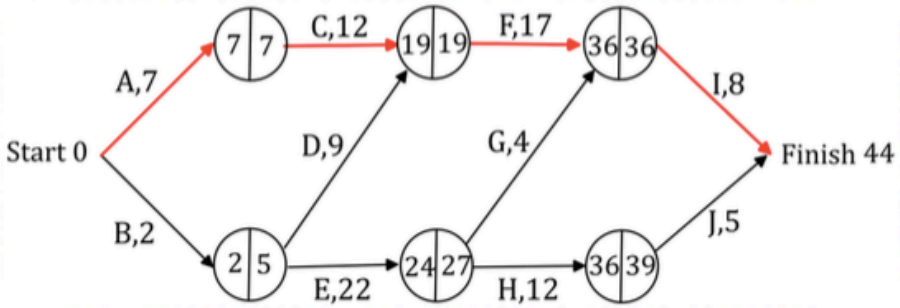
	A	B	C	D	E	F
A	–	105	123	121	–	–
B	105	–	129	–	132	–
C	123	129	–	126	103	113
D	121	–	126	–	–	135
E	–	132	103	–	–	146
F	–	–	113	135	146	–

	2 marks: Correct answer. 1 mark: Draws a spanning tree or shows some understanding.
Minimum cost $= 121 + 123 + 105 + 103 + 113$ $= \$565$ $\therefore$ Minimum cost to lay pipes to the garden is \$565.	1 mark: Correct answer.

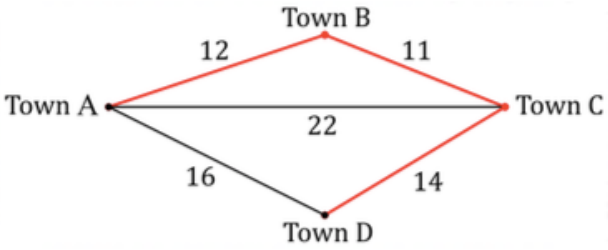
22.

Weighted edges: $AB = 1, AD = 5, AE = 4, BC = 3, CD = 2, CE = 6, DE = 7$  	2 marks: Correct answer. 1 mark: Draws the vertices with at least one correct edge.

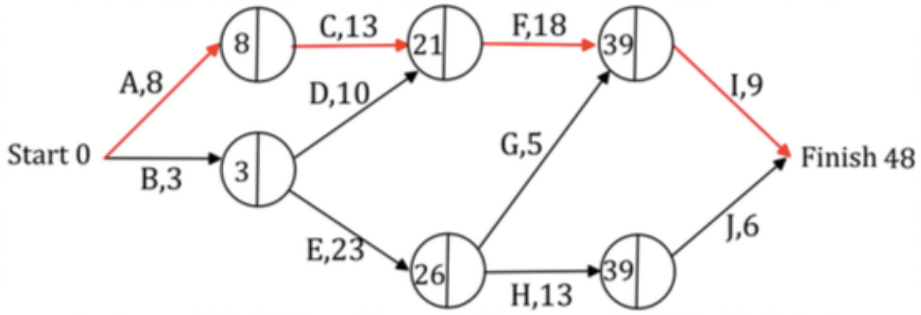
23.

 	3 marks: Correct answer. 2 marks: Completes the EST or LST. 1 mark: Draws a network diagram with some correct edges .
Critical path is *ACFI*	1 mark: Correct answer.
Minimum time for completion is 44 minutes	1 mark: Correct answer.

24.

Length $= 11 + 12 + 14$ $= 37$ km	 	1 Mark: A

25.



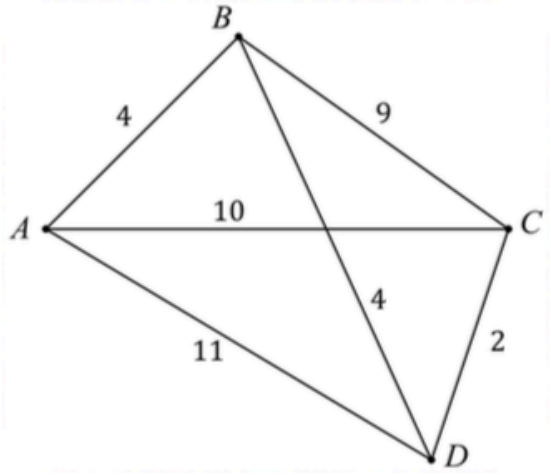
∴ Minimum completion time is 48.

1 Mark: C

26.

Weighted edges:

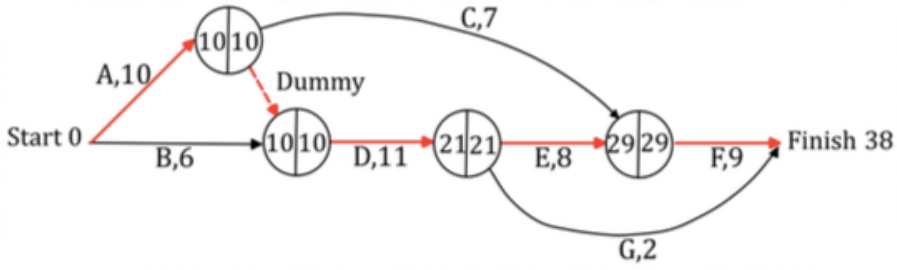
$AB = 4, AC = 10, AD = 11, BC = 9, BD = 4, DC = 2$



2 marks: Correct answer.

1 mark: Draws the vertices with at least one correct edge.

27.



3 marks: Correct answer.
2 marks: Finds the EST or LST.
1 mark: Draws a network diagram with some correct edges .

Weight $= 38 - 29$
$= 9$
∴ Weight of activity F is 9 minutes.

1 mark: Correct answer.

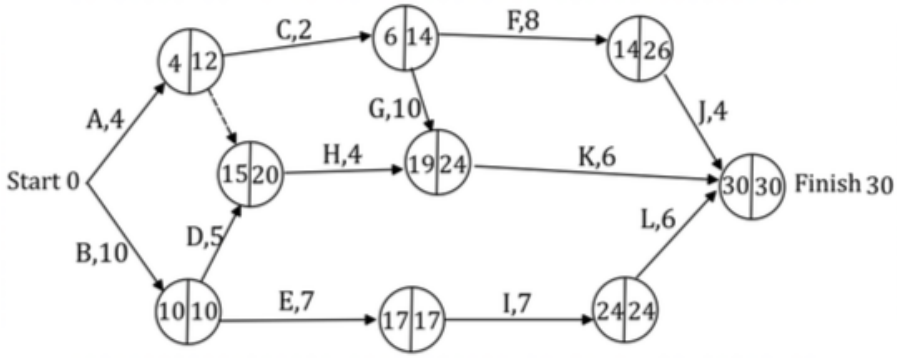
Float time $=$ LST $-$ EST
$= 36 - 21$
$= 15$ min
∴ Float time for activity G is 15 minutes.

1 mark: Correct answer.

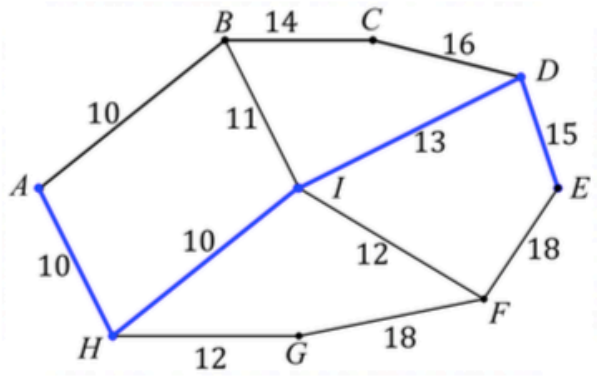
28.

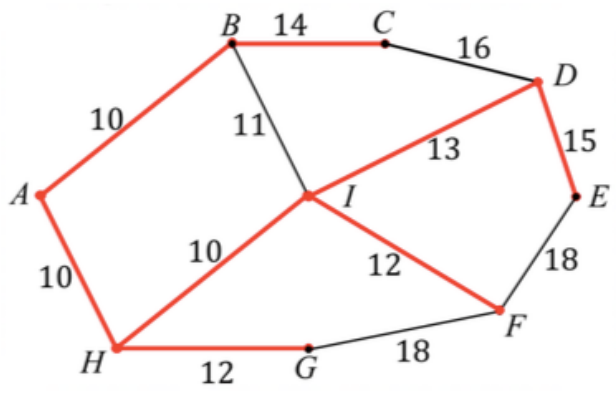
A spanning tree is a tree that connects all vertices of a graph. A tree with n vertices has $n - 1$ edges. $\therefore$ The network has 7 vertices.	1 mark: Correct answer.

29.

	2 marks: Correct answer. 1 mark: Shows some understanding.

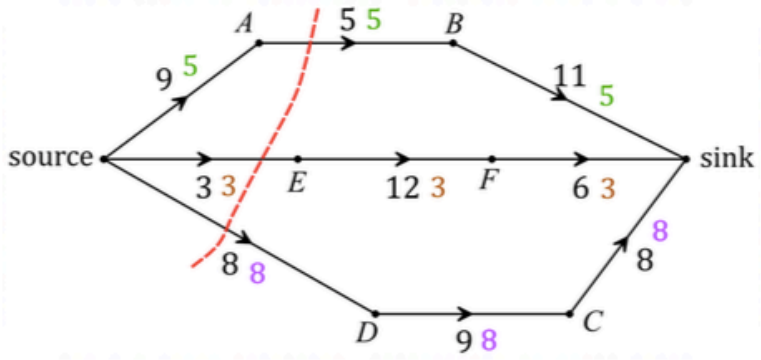
30.

Time taken $= 10 + 14 + 16 + 13$ $= 53$ mim	1 mark: Correct answer.
Vertices with an even degree are A, C, E, G and I.	1 mark: Correct answer.
There are 4 vertices that are odd (B, D, F and H) Eulerian trail exist if the graph has 2 vertices with an odd degree. $\therefore$ This network does not contain a walk that visits every edge exactly once.	1 mark: Correct answer.
 Shortest time $= 10 + 10 + 13 + 15$ $= 48$ min $\therefore$ Shortest time from A to E is 48 minutes.	2 marks: Correct answer. 1 mark: Finds the shortest path or shows some understanding.



1 mark: Correct answer.

31.



Maximum flow = 5 + 3 + 8
= 16

2 marks: Correct answer.

1 mark: Finds the minimum cut.