Answer ALL questions.

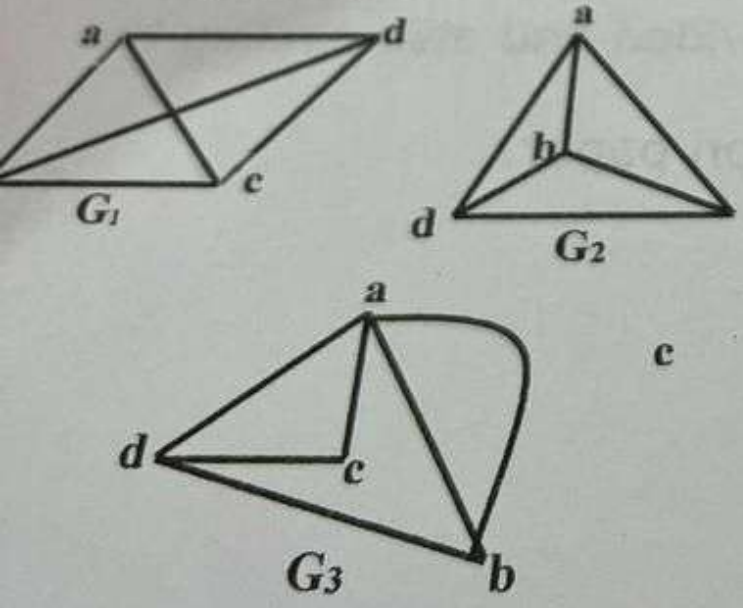
Indicate your answer by circling the appropriate letter on the question paper.

1. Let G=(V, E) be a graph, where V = set of vertices and E = set of edges. If E = {}, then G is called _____
   A. Isolated graph
   B. Complete graph
   C. Null graph
   D. Euler graph

2. Let V_1 be a vertex in a graph G. If the degree of V_1 is equal to zero, then V_1 is called _____
   A. loop
   B. Isolated graph
   C. isolated edge
   D. isolated vertex

3. An edge with the same starting and terminal vertex is said to be _____
   A. parallel
   B. simple
   C. directed
   D. loop

Use the diagram below to answer questions 4 – 7.



Which of the graph(s) above is (are)

4. Simple?
   A. G_1, G_2 and G_3
   B. G_1 and G_2 only
   C. G_1 and G_3 only
   D. G_2 and G_3 only
   E. None of the above

5. Plane?
   A. G_1, G_2 and G_3
   B. G_1 and G_2 only
   C. G_1 and G_3 only
   D. G_2 and G_3 only
   E. None of the above

6. Planar?
   A. G_1, G_2 and G_3
   B. G_1 only
   C. G_1 and G_3 only
   D. G_1 and G_2 only
   E. None of the above

7. Isomorphic?
   A. G_1 and G_2 only
   B. G_1 and G_3 only
   C. G_2 and G_3 only
   D. G_1 only
   E. None of the above

8. Which of the following about simple graph is **not true?**
   A. Loops are not allowed
   B. Parallel edges are not allowed
   C. Isolated vertices are no allowed
   D. None of the above

9. A vertex of degree one is called _____.
   A. simple vertex
   B. pendant vertex
   C. adjacent vertex
   D. initial vertex

10. Which of the following is **not** a graph?
   A. • a
   B. • a —
   C. • a • b
   D. None of the above

11. Which of the following about graph, G is **not true?**
   A. The sum of the degrees of the vertices of G is equal to twice the number of edges of G.
   B. The set of vertices of G cannot be empty.
   C. The number of vertices of odd degree is always even
   D. None of A, B and C

12. Which of the following about a complete graph with n vertices is ***not true?***
   A. The degree of each vertices is the same and is equal to $n - 1$.
   B. The number of edges is given by $\frac{1}{2}(n - 1) + (n - 2)$.
   C. Is always simple
   D. None of the above

13. A graph in which every vertex has the same degree is called _____.
   A. complete graph
   B. null graph
   C. trivalent graph
   D. regular graph

14. If a graph G is a complete graph with 6 vertices then, the number of edges is _____.
   A. 6
   B. 10
   C. 15
   D. 20

15. Let G be a graph with 4 vertices in which every vertex has the same degree of 3, then the graph has _____ edges.
   A. 24
   B. 12
   C. 8
   D. 6

16. Let G be a graph. Which of the following is **not true** about the sub-graph of G?
   A. G is a sub-graph G.
   B. An edge in G is a sub-graph of G.
   C. Every vertex in a graph G is a sub-graph of G.
   D. None of A, B and C

17. A set of vertices of a graph G whose deletion disconnects G is called _____.
   A. cut–set
   B. disconnecting set
   C. separating set
   D. articulation vertex

18. The number of edges in the smallest cut–set is called _____.
   A. edge–connectivity
   B. edge–bridge
   C. bridge–connectivity
   D. none of the above

19. A graph whose ***vertex–connectivity is one*** is called _____.
A. vertex–graph
B. separable–graph
C. connectivity–graph
D. articulation–graph

20. Which of the following is true?
A. All tournaments are transitive
B. Any Eulerian Graph is orientable
C. All orientable digraphs contains a **bridge**
D. None of the above

21. Let $D = (V_1, E_1)$ be a directed graph. If the sum of the out-valence of the vertices is 6 then the number of edges is equal to _____.
A. 3
B. 6
C. 12
D. 18

22. Let D be a directed graph. If for any pair of vertices U and V, there is either a directed edge from U to V or from V to U but not both then, D is called _____.
A. symmetric
B. oriented
C. connected
D. tournament

23. The number of edges in a K_1 is _____.
A. 0
B. 1
C. 2
D. 3

24. A wheel, W_3 is isomorphic to the complete graph _____.
A. K_2
B. K_4
C. K_3
D. K_{33}

Use the preamble below to answer questions 25 to 29

Let W_n be a wheel where n is the number of vertices in W_n, then

25. The number of vertices of degree n-1 is _____.
A. one
B. two
C. n
D. n-1

26. The number of vertices of degree 3 is _____.
A. one
B. two
C. n
D. n-1

27. The sum of the degrees of all the vertices is given by _____.
A. n-1
B. 2n-2
C. 3n-3
D. 4n-4

28. The number of edges is given by _____.
A. n-1
B. 2n-2
C. 3n-3
D. 4n-4

29. If n=9 then the highest degree of a vertex is _____.
A. 9
B. 8

C. 10
D. 18

30. In a simple path of n vertices, the number of vertices of degree 2 is _____.
A. 2n
B. n
C. n-1
D. n-2

31. If G' is the complement of a simple graph, G with n vertices, then the sum of the degree of any vertex in G and G' is always given by _____.
A. n-1
B. n
C. n+1
D. None of the above

32. In a simple asymmetric digraph of n vertices, the sum of the indegree and outdegree of any vertex is given by _____.
A. n-1
B. n
C. n+1
D. n(n-1)

33. In a digraph, if a directed path exists from the vertex U to V, then _____.
A. U is reachable from V
B. U is reachable from U
C. V is reachable from U
D. V is reachable from V

34. If a graph G with n vertices contains a Euler path, then the number of vertices of even degree given by _____.
A. n
B. n+1
C. (n+1)/2
D. n-2

35. The number of connected sub-graphs in a disconnected graph is called _____.
A. length of the graph
B. component of the graph
C. vertex-connectivity of the graph
D. none of the above

36. A complete asymmetric digraph of 6 vertices contains _____ edges.
A. 6
B. 15
C. 30
D. 36

37. A complete symmetric digraph of 6 vertices contains _____ edges.
A. 6
B. 15
C. 30
D. 36

38. If G is a **PETERSEN GRAPH,** then the sum of the degree of all its vertices is equal to _____.
A. 10
B. 20
C. 30
D. 40

39. Let G be a graph with one vertex, V, and one edge, then the degree of the vertex, V, is_____.
A. 1
B. 2
C. 3
D. 4

40. How many different graph(s) can be drawn with two (2) vertices and one (1) edge?
A. 1
B. 2

C. 3
D. 4

41. A graph G has 4 edges, 2 vertices of degree 1 and all other vertices are of degree 2. How many vertices does the graph have?
A. 2
B. 3
C. 4
D. 5

42. Let G be a connected graph with n vertices. Then G must have at least _____ edges.
A. n-1
B. n
C. n+1
D. None of the above

43. Which of the following about the directed graph is **not** true?
A. Edges are directed.
B. Multiple (parallel) edges are allowed.
C. Loops are allowed.
D. None of the above.

44. Which of the following about simple graph is **not** true?
A. Edges are directed
B. Multiple (parallel) edges are not allowed
C. Loops are not allowed
D. None of the above

45. A weighted digraph is also known as a _____.
A. Network
B. Tournament
C. Non-transitive digraph
D. None of the above

46. G is a graph with three vertices. Which of the following is **not** a valid degrees of the vertices, V_1, V_2 and V_3 respectively?
A. 2, 2 and 2
B. 2, 1 and 2
C. 0, 4 and 0
D. None of the above

47. Any graph's number of vertices of odd degree is always _____.
A. odd
B. even
C. prime
D. greater the 2

48. A graph G consists of 15 vertices and 15 edges. If the sum of the degree of 10 vertices is 10, then the average of the degree of the remaining vertices is _____.
A. 1
B. 2
C. 3
D. 4

Use the preamble below to answer questions 49 and 50.

Let G be a digraph with 4 vertices and 4 edges. If G is strongly connected then,

49. The sum of outdegree of the vertices is _____.
A. 1
B. 2
C. 3
D. 4

50. The number of vertices with indegree of two (2) is _____.
A. 0
B. 1
C. 2
D. 4

51. In order to form a wheel, W_n from the cycle, C_n where $n \geq 3$, the number of vertices in C_n, we need additional _____ vertices.
A. 1
B. 2
C. 3
D. 4

52. In order to form a wheel, W_n from the cycle, C_n where $n \geq 3$, the number of vertices in C_n, we need additional _____ edges.
A. n
B. 2n
C. 3n
D. 4n

53. An edge whose removal disconnects a graph is called a _____.
A. disconnecting set
B. separating set
C. cut-node
D. bridge

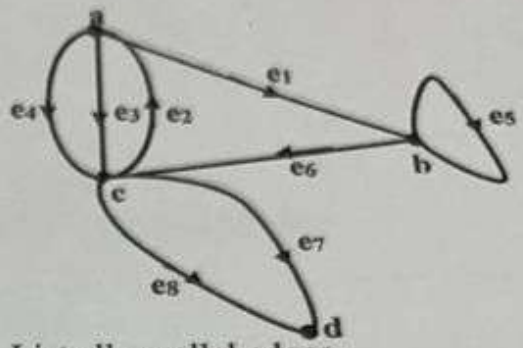
54. A graph in which for every distinct pair of vertices there is a path is called a _____.
A. complete graph
B. cycle
C. connected graph
D. wheel

55. The minimum number of vertices whose removal disconnects a graph is called a _____.
A. separating set
B. cut-node
C. vertex–connectivity
D. edge-connectivity

56. A graph has a separating set that contains only one vertex. This graph is said to have a _____.
A. separating set
B. cut-node
C. vertex–connectivity
D. edge-connectivity

57. A set of edges whose removal disconnects a graph is called a _____.
A. disconnecting set
B. separating set
C. cut-node
D. bridge

Use the digraph below to answer questions 58 to 60.



58. List all parallel edges.
A. {e4,e3,e2}, {e8,e7}
B. {e8,e7}
C. {e4,e3}
D. B and C

59. What is the indegree of vertex, **b**?
A. 0
B. 1
C. 2
D. 3

60. What is the outdegree of vertex **a**?
A. 0
B. 1
C. 2
D. 3

Oliver