OJEE MCA Sample Paper 01

A) Mode and Time: The exam is a Computer Based Test (CBT) lasting 120 minutes.
B) Total Questions: The exam contains 120 questions.
C) Marking Scheme & Rules:

- +4 marks for each correct answer and -1 mark for every incorrect response.

Q1. Which of the following is considered the brain of the computer?

A. ALU

B. Memory

C. CPU

D. Control Unit

Q2. A byte consists of how many bits?

A. 4

B. 8

C. 16

D. 32

Q3. Which type of memory is volatile?

A. ROM

B. Flash Memory

C. RAM

D. Hard Drive

Q4. What is the base of the hexadecimal number system?

A. 8

B. 10

C. 16

D. 2

Q5. What is the binary equivalent of the decimal number 10?

A. 1001

B. 1010

C. 1100

D. 1110

Q6. Which logic gate produces a low output only when all inputs are high?

A. AND

B. OR

C. NAND

D. XOR

Q7. Which of the following is known as a universal gate?

A. AND

B. NOT

C. XOR

D. NOR

Q8. Linux is an example of which type of software?

A. Application Software

B. System Software

C. Utility Software

D. Firmware

Q9. In an Operating System, which of the following is a condition for deadlock?

A. Mutual Exclusion

B. No Preemption

C. Circular Wait

D. All of the above

Q10. Virtual memory provides the illusion of:

A. Large secondary storage

B. Large main memory

C. Faster CPU

D. Faster I/O devices

Q11. Which network topology features a central hub?

A. Ring

B. Bus

C. Star

D. Mesh

Q12. How many layers are there in the OSI model?

A. 4

B. 5

C. 6

D. 7

Q13. What is the length of an IPv4 address?

A. 16 bits

B. 32 bits

C. 64 bits

D. 128 bits

Q14. Which port does HTTP primarily use?

A. 21

B. 25

C. 80

D. 443

Q15. In a relational database, a primary key must be:

A. Unique and Not Null

B. Unique and Nullable

C. Not Null and Duplicate

D. Numeric only

Q16. SQL stands for:

A. Structured Query Language

B. Standard Query Language

C. Simple Query Language

D. System Query Language

Q17. Which of the following is NOT an ACID property in DBMS?

A. Atomicity

B. Consistency

C. Isolation

D. Data-independence

Q18. Which SQL command is used to modify the structure of a table?

A. UPDATE

B. ALTER

C. MODIFY

D. CHANGE

Q19. Who is the creator of the 'C' programming language?

A. James Gosling

B. Bjarne Stroustrup

C. Dennis Ritchie

D. Guido van Rossum

Q20. In C, arrays use what type of indexing?

A. 1-based

B. 0-based

C. -1-based

D. Memory-based

Q21. A pointer is a variable that stores:

A. A value

B. A memory address

C. A character

D. A string

Q22. Which data structure follows the LIFO principle?

A. Queue

B. Linked List

C. Stack

D. Tree

Q23. Which data structure follows the FIFO principle?

A. Stack

B. Queue

C. Graph

D. Heap

Q24. What is the maximum number of children a node can have in a binary tree?

A. 1

B. 2

C. 3

D. Any number

Q25. Which sorting algorithm has an average time complexity of $O(n \log n)$?

A. Bubble Sort

B. Insertion Sort

C. Selection Sort

D. Merge Sort

Q26. Which algorithm is used for traversing a graph level by level?

A. Depth First Search

B. Breadth First Search

C. Binary Search

D. Linear Search

Q27. A compiler translates:

A. High-level language to machine code

B. Machine code to high-level language

C. Assembly to machine code

D. High-level language to assembly

Q28. Cache memory is located between the CPU and:

A. Hard Disk

B. Main Memory (RAM)

C. Optical Drive

D. Network Card

Q29. The ALU performs:

A. Data storage

B. Arithmetic and logical operations

C. Process scheduling

D. Memory management

Q30. What does ASCII stand for?

A. American Standard Code for Information Interchange

B. American Scientific Code for Information Interchange

C. Asian Standard Code for Information Interchange

D. American Standard Character for Information Interchange

Q31. In Boolean algebra, $A + A'$ is equal to:

A. 0

B. 1

C. A

D. A'

Q32. According to De Morgan's Law, $(A + B)'$ is equal to:

A. A' + B'

B. A' . B'

C. A . B

D. A + B

Q33. A page fault occurs when:

A. The page is corrupted

B. The page is in main memory

C. The page is not in main memory

D. The process terminates

Q34. Thrashing in an OS refers to:

A. High CPU utilization

B. Excessive paging activity

C. Fast I/O operations

D. Deadlock resolution

Q35. What is the length of a MAC address?

A. 16 bits

B. 32 bits

C. 48 bits

D. 64 bits

Q36. TCP and UDP operate at which layer of the OSI model?

A. Network

B. Transport

C. Data Link

D. Application

Q37. Database normalization is primarily used to:

A. Increase redundancy

B. Decrease redundancy

C. Encrypt data

D. Index data

Q38. A foreign key in a database table establishes a link to:

A. A primary key in another table

B. A random column in the same table

C. An index

D. A view

Q39. In C, what is the usual size of an 'int' on a 32-bit system?

A. 1 byte

B. 2 bytes

C. 4 bytes

D. 8 bytes

Q40. The 'malloc()' function in C returns a:

A. Null pointer

B. Integer pointer

C. Void pointer

D. Character pointer

Q41. A node in a singly linked list contains:

A. Data only

B. Pointer only

C. Data and a pointer to the next node

D. Two pointers

Q42. What is the postfix form of the infix expression $A + B$?

A. +AB

B. A+B

C. AB+

D. B+A

Q43. What does URL stand for?

A. Uniform Resource Locator

B. Universal Resource Locator

C. Uniform Reference Line

D. Universal Reference Locator

Q44. The Ping command operates using which protocol?

A. TCP

B. UDP

C. ICMP

D. HTTP

Q45. What is the length of an IPv6 address?

A. 32 bits

B. 64 bits

C. 128 bits

D. 256 bits

Q46. Memory allocated at runtime is called:

A. Static allocation

B. Dynamic allocation

C. Stack allocation

D. Register allocation

Q47. What is the worst-case time complexity of Binary Search?

A. $O(1)$

B. $O(\log n)$

C. $O(n)$

D. $O(n \log n)$

Q48. An AVL tree is a type of:

A. Graph

B. Queue

C. Balanced Binary Search Tree

D. Hash Table

Q49. A context switch in an OS is performed by:

A. The user

B. The compiler

C. The operating system

D. The ALU

Q50. In Unix/Linux, the 'fork()' system call is used to:

A. Terminate a process

B. Create a new process

C. Read a file

D. Allocate memory

Q51. A semaphore is primarily used for:

A. Memory allocation

B. Process synchronization

C. Disk scheduling

D. Routing

Q52. In a relational database, a row is also referred to as a:

A. Attribute

B. Domain

C. Tuple

D. Relation

Q53. Which operation combines rows from two or more tables based on a related column?

A. SELECT

B. JOIN

C. UNION

D. INTERSECT

Q54. Which directive in C is used to define a macro?

A. include

B. define

C. pragma

D. macro

Q55. The ‘break‘ statement is used to:

A. Continue to the next iteration

B. Exit from a loop or switch

C. Terminate the program

D. Return a value

Q56. Unlike a structure, all members of a union in C:

A. Have different memory locations

B. Share the same memory location

C. Are initialized to zero

D. Must be of the same type

Q57. What is the standard size of a ‘float‘ in C?

A. 2 bytes

B. 4 bytes

C. 8 bytes

D. 10 bytes

Q58. Which traversal of a Binary Search Tree produces sorted data?

A. Pre-order

B. In-order

C. Post-order

D. Level-order

Q59. Which scheduling algorithm assigns the CPU to the process with the smallest next CPU burst?

A. FCFS

B. Round Robin

C. SJF

D. Priority Scheduling

Q60. In networking, a router operates at which OSI layer?

A. Physical Layer

B. Data Link Layer

C. Network Layer

D. Transport Layer

Q61. If a set A has 4 elements, how many subsets does it have?

A. 4

B. 8

C. 16

D. 32

Q62. What is the intersection of sets $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$?

A. $\{1, 4\}$

B. $\{1, 2, 3, 4\}$

C. $\{2, 3\}$

D. $\emptyset$

Q63. What is the domain of the function $f(x) = \frac{1}{x-1}$?

A. All real numbers

B. All real numbers except 1

C. All real numbers except 0

D. Only positive numbers

Q64. What is the value of $\log_2 16$?

A. 2

B. 3

C. 4

D. 8

Q65. What are the roots of the quadratic equation $x^2 - 5x + 6 = 0$?

A. 2, 3

B. -2, -3

C. 1, 6

D. -1, -6

Q66. For the quadratic equation $ax^2 + bx + c = 0$, the sum of the roots is:

A. c/a

B. $-c/a$

C. b/a

D. $-b/a$

Q67. What is the sum of the first 100 natural numbers?

A. 5000

B. 5050

C. 5100

D. 5500

Q68. The n^{th} term of a Geometric Progression with first term a and common ratio r is:

A. $a + (n-1)r$

B. ar^n

C. ar^{n-1}

D. ar^{n+1}

Q69. Matrix multiplication $A \times B$ is defined only if:

A. Rows of A = Rows of B

B. Cols of A = Rows of B

C. Cols of A = Cols of B

D. Rows of A = Cols of B

Q70. What is the determinant of the 2×2 identity matrix?

A. 0

B. 1

C. 2

D. -1

Q71. What is the value of $\lim_{x \to 0} \frac{\sin x}{x}$?

A. 0

B. 1

C. ∞

D. Undefined

Q72. What is the derivative of $\cos x$ with respect to x?

A. $\sin x$

B. $-\sin x$

C. $\sec^2 x$

D. $\tan x$

Q73. What is the derivative of e^x?

A. xe^{x-1}

B. e^x

C. $\ln x$

D. e^{-x}

Q74. What is the indefinite integral of $2x\,dx$?

A. $2x^2 + C$

B. $x^2 + C$

C. $x^3 + C$

D. $2 + C$

Q75. A function $f(x)$ has a local maximum at $x = c$ if $f'(c) = 0$ and:

A. $f''(c) > 0$

B. $f''(c) = 0$

C. $f''(c) < 0$

D. $f''(c)$ is undefined

Q76. What is the distance between the points $(0, 0)$ and $(3, 4)$?

A. 3

B. 4

C. 5

D. 7

Q77. What is the slope of the line given by the equation $2x + y = 5$?

A. 2

B. -2

C. 5

D. $1/2$

Q78. The equation $x^2 + y^2 = r^2$ represents a circle with center at:

A. (r, r)

B. $(0, r)$

C. $(0, 0)$

D. $(r, 0)$

Q79. The eccentricity of a parabola is exactly:

A. 0

B. 1

C. Less than 1

D. Greater than 1

Q80. The dot product of two orthogonal (perpendicular) vectors is:

A. 1

B. -1

C. 0

D. Infinity

Q81. The cross product of two parallel vectors is:

A. A unit vector

B. 0 (Zero vector)

C. 1

D. -1

Q82. What is the magnitude of the vector $3\hat{i} + 4\hat{j}$?

A. 5

B. 7

C. 25

D. 1

Q83. What is the value of $\sin^2\theta + \cos^2\theta$?

A. 0

B. 1

C. -1

D. $\tan^2\theta$

Q84. What is the exact value of $\tan 45°$?

A. 0

B. 1

C. $\sqrt{3}$

D. $1/\sqrt{3}$

Q85. What is the probability of rolling a '6' on a fair six-sided die?

A. 1/2

B. 1/3

C. 1/6

D. 1

Q86. If A and B are mutually exclusive events, then $P(A \cup B)$ equals:

A. $P(A) \times P(B)$

B. $P(A) + P(B)$

C. $P(A) - P(B)$

D. 0

Q87. What is the mean of the numbers 2, 4, 6, 8, 10?

A. 4

B. 5

C. 6

D. 8

Q88. What is the median of the data set 1, 3, 3, 6, 7, 8, 9?

A. 3

B. 6

C. 7

D. 5.3

Q89. In how many ways can the letters of the word "MATH" be arranged?

A. 4

B. 12

C. 24

D. 48

Q90. What is the value of ${}^5C_2$ (5 choose 2)?

A. 10

B. 20

C. 120

D. 5

Q91. In Boolean Algebra, the expression $1 + A$ simplifies to:

A. 0

B. 1

C. A

D. A'

Q92. Which symbol is commonly used to denote the empty set?

A. ∞

B. $\emptyset$

C. Σ

D. Δ

Q93. What is the modulus of the number -7?

A. 1/7

B. 0

C. -7

D. 7

Q94. In complex numbers, what is the value of i^2?

A. 1

B. -1

C. i

D. -i

Q95. What is the complex conjugate of $3 + 4i$?

A. $3 - 4i$

B. $-3 + 4i$

C. $-3 - 4i$

D. $4 + 3i$

Q96. What is the exact value of $\sin 90°$?

A. 0

B. 1

C. -1

D. ∞

Q97. An angle inscribed in a semicircle is always:

A. 45 degrees

B. 60 degrees

C. 90 degrees

D. 180 degrees

Q98. The area of a triangle with base b and height h is:

A. bh

B. $2bh$

C. $\frac{1}{2}bh$

D. $\frac{1}{3}bh$

Q99. The locus of a point in a plane that is equidistant from a fixed point forms a:

A. Line

B. Parabola

C. Hyperbola

D. Circle

Q100. What is the geometric mean of 4 and 9?

A. 6.5

B. 6

C. 36

D. 5

Q101. What is the sum of the infinite geometric series $1 + \frac{1}{2} + \frac{1}{4} + \ldots$?

A. 1.5

B. 2

C. ∞

D. 0

Q102. What is the value of 0! (zero factorial)?

A. 0

B. 1

C. Undefined

D. Infinity

Q103. What is the derivative of $\ln x$ with respect to x?

A. e^x

B. x

C. $\frac{1}{x}$

D. $\ln(x^2)$

Q104. What is the indefinite integral of $\sin x\, dx$?

A. $\cos x + C$

B. $-\cos x + C$

C. $\sin x + C$

D. $-\sin x + C$

Q105. What is the value of the definite integral $\int_0^1 2x\, dx$?

A. 0

B. 1

C. 2

D. 0.5

Q106. What is the order of the differential equation $\frac{d^2y}{dx^2} + y = 0$?

A. 0

B. 1

C. 2

D. 3

Q107. What is the degree of the differential equation $\left(\frac{dy}{dx}\right)^2 + y = x$?

A. 1

B. 2

C. 3

D. Undefined

Q108. What is the perpendicular distance from the origin to the plane $x + 2y + 2z = 6$?

A. 1

B. 2

C. 3

D. 6

Q109. In statistics, variance is the square of the:

A. Mean

B. Median

C. Mode

D. Standard Deviation

Q110. If two fair dice are rolled, what is the probability that the sum is 7?

A. 1/6

B. 1/12

C. 7/36

D. 1/36

Q111. What is the probability that a leap year has exactly 53 Sundays?

A. 1/7

B. 2/7

C. 3/7

D. 53/366

Q112. How many elements are in the power set of the empty set?

A. 0

B. 1

C. 2

D. ∞

Q113. The operation $A \times B$ on two sets is known as the:

A. Union

B. Intersection

C. Cartesian Product

D. Difference

Q114. Any non-zero real number raised to the power of 0 is:

A. 0

B. 1

C. Undefined

D. Infinity

Q115. What are the roots of the equation $x^2 - 1 = 0$?

A. 1

B. 0

C. 1, -1

D. -1

Q116. What is the factorial of 5 (5!)?

A. 20

B. 60

C. 120

D. 720

Q117. What is the sum of the interior angles of a regular hexagon?

A. 360 degrees

B. 540 degrees

C. 720 degrees

D. 900 degrees

Q118. The area of an equilateral triangle with side length a is:

A. $\frac{1}{2}a^2$

B. $\frac{\sqrt{3}}{4}a^2$

C. $\frac{\sqrt{3}}{2}a^2$

D. a^2

Q119. What is the surface area of a sphere of radius r?

A. $2\pi r^2$

B. $3\pi r^2$

C. $4\pi r^2$

D. $\frac{4}{3}\pi r^3$

Q120. What is the volume of a cylinder with radius r and height h?

A. $\pi r^2 h$

B. $\frac{1}{3}\pi r^2 h$

C. $2\pi r h$

D. $4\pi r^2 h$

Solutions

1. C
Explanation: The CPU (Central Processing Unit) acts as the brain of the computer, processing all instructions.

2. B
Explanation: A standard byte consists of 8 bits.

3. C
Explanation: RAM (Random Access Memory) is volatile; its data is lost when power is removed.

4. C
Explanation: Hexadecimal is a base-16 number system using digits 0-9 and letters A-F.

5. B
Explanation: The decimal number 10 is equal to 8 + 2, which is 1010 in binary.

6. C
Explanation: A NAND gate produces a low (0) output only if all its inputs are high (1).

7. D
Explanation: NOR and NAND gates are universal gates because they can be used to implement any boolean function.

8. B
Explanation: Linux is an operating system, which is a type of system software.

9. D
Explanation: The four Coffman conditions for deadlock are mutual exclusion, hold and wait, no preemption, and circular wait.

10. B
Explanation: Virtual memory uses disk space to provide the illusion of a larger main memory (RAM) than physically exists.

11. C
Explanation: A Star topology connects all devices to a central network hub or switch.

12. D
Explanation: The OSI (Open Systems Interconnection) model consists of 7 layers.

13. B
Explanation: IPv4 addresses are 32 bits long, typically written as four dotted decimals.

14. C
Explanation: HTTP (HyperText Transfer Protocol) primarily runs on TCP port 80.

15. A
Explanation: A primary key uniquely identifies each record and cannot contain

NULL values.

16. A
Explanation: SQL stands for Structured Query Language, used for managing relational databases.

17. D
Explanation: The ACID properties are Atomicity, Consistency, Isolation, and Durability.

18. B
Explanation: The ALTER table command is a DDL command used to change a table's structure.

19. C
Explanation: Dennis Ritchie developed the C programming language at Bell Labs.

20. B
Explanation: In C, array indexing begins at 0.

21. B
Explanation: A pointer is a special variable that stores the memory address of another variable.

22. C
Explanation: A Stack operates on the LIFO (Last-In, First-Out) principle.

23. B
Explanation: A Queue operates on the FIFO (First-In, First-Out) principle.

24. B
Explanation: In a binary tree, every node can have at most 2 children (left and right).

25. D
Explanation: Merge Sort guarantees a time complexity of $O(n \log n)$ in all cases.

26. B
Explanation: Breadth First Search (BFS) traverses a graph or tree level by level.

27. A
Explanation: A compiler converts human-readable high-level language source code into executable machine code.

28. B
Explanation: Cache is ultra-fast memory placed directly between the CPU and the Main Memory (RAM).

29. B
Explanation: The ALU (Arithmetic Logic Unit) performs all mathematical calculations and logical comparisons.

30. A
Explanation: ASCII stands for American Standard Code for Information Interchange.

31. B
Explanation: In Boolean algebra, ORing a variable with its complement $(A + A')$

always results in 1.

32. B
Explanation: De Morgan's law states that the complement of a sum is the product of the complements: $(A + B)' = A' \cdot B'$.

33. C
Explanation: A page fault is triggered when a program attempts to access a memory page that is not currently loaded in RAM.

34. B
Explanation: Thrashing occurs when a computer spends more time paging (swapping memory) than executing processes.

35. C
Explanation: A MAC (Media Access Control) address is a unique 48-bit hardware identifier.

36. B
Explanation: TCP and UDP are fundamental protocols operating at the Transport layer (Layer 4) of the OSI model.

37. B
Explanation: Normalization organizes database tables to minimize data redundancy and dependency.

38. A
Explanation: A foreign key is a column that refers to the primary key of another table to establish a relationship.

39. C
Explanation: On most standard 32-bit and 64-bit systems, a C 'int' occupies 4 bytes (32 bits).

40. C
Explanation: The 'malloc()' function returns a void pointer ('void *'), which can be cast to any other pointer type.

41. C
Explanation: A node in a singly linked list contains a data field and exactly one pointer to the next node.

42. C
Explanation: In postfix (Reverse Polish) notation, operators follow their operands: $AB+$.

43. A
Explanation: URL stands for Uniform Resource Locator, commonly known as a web address.

44. C
Explanation: The 'ping' command uses the Internet Control Message Protocol (ICMP) echo request and reply messages.

45. C
Explanation: IPv6 addresses are 128 bits long to accommodate a vastly larger

number of devices than IPv4.

46. B
Explanation: Dynamic memory allocation occurs at runtime using functions like ‘malloc()‘ or ‘new‘.

47. B
Explanation: Binary search repeatedly divides the sorted search interval in half, leading to a worst-case time complexity of $O(\log n)$.

48. C
Explanation: An AVL tree is a self-balancing Binary Search Tree where heights of two child subtrees differ by at most one.

49. C
Explanation: The Operating System’s kernel performs context switches to multi-task between processes.

50. B
Explanation: The ‘fork()‘ system call is used to create a new (child) process, duplicating the calling (parent) process.

51. B
Explanation: Semaphores are synchronization tools used to manage concurrent processes accessing shared resources.

52. C
Explanation: In relational database terminology, a table is a relation, a column is an attribute, and a row is a tuple.

53. B
Explanation: The JOIN clause combines rows from two or more tables based on a related column between them.

54. B
Explanation: The ‘define‘ preprocessor directive is used to create macros and symbolic constants in C.

55. B
Explanation: The ‘break‘ statement immediately terminates the innermost enclosing loop or switch statement.

56. B
Explanation: A union allows storing different data types in the same memory location, but only one member can contain a value at any given time.

57. B
Explanation: In the IEEE 754 standard used by C, a single-precision ‘float‘ is 4 bytes (32 bits) long.

58. B
Explanation: An in-order traversal (Left-Root-Right) of a Binary Search Tree yields values in ascending sorted order.

59. C
Explanation: Shortest Job First (SJF) schedules the process with the shortest

expected CPU burst next.

60. C
Explanation: Routers operate at the Network Layer (Layer 3) to forward data packets between different computer networks.

61. C
Explanation: The number of subsets for a set with n elements is 2^n. Here, $2^4 = 16$.

62. C
Explanation: The intersection contains elements present in both sets: $\{2, 3\}$.

63. B
Explanation: The denominator cannot be zero. Thus, $x - 1 \neq 0$, meaning $x \neq 1$.

64. C
Explanation: $\log_2 16 = 4$ because $2^4 = 16$.

65. A
Explanation: Factoring the equation yields $(x - 2)(x - 3) = 0$, so the roots are $x = 2$ and $x = 3$.

66. D
Explanation: By Vieta's formulas, the sum of the roots of $ax^2 + bx + c = 0$ is $-b/a$.

67. B
Explanation: The sum of the first n natural numbers is $n(n+1)/2$. For $n = 100$, $100(101)/2 = 5050$.

68. C
Explanation: The n^{th} term of a GP is given by the formula $a_n = ar^{n-1}$.

69. C
Explanation: Matrix multiplication requires the number of columns in the first matrix to equal the number of rows in the second matrix.

70. B
Explanation: An identity matrix has 1s on the diagonal and 0s elsewhere; its determinant is exactly 1.

71. B
Explanation: It is a standard fundamental calculus limit: $\lim_{x \to 0} \frac{\sin x}{x} = 1$.

72. B
Explanation: The derivative of the cosine function is negative sine: $\frac{d}{dx}(\cos x) = -\sin x$.

73. B
Explanation: The derivative of the natural exponential function e^x is itself, e^x.

74. B
Explanation: Using the power rule for integration, $\int 2x\,dx = \frac{2x^2}{2} + C = x^2 + C$.

75. C
Explanation: By the Second Derivative Test, a point is a local maximum if the first derivative is 0 and the second derivative is strictly negative.

76. C
Explanation: By the distance formula: $\sqrt{(3-0)^2+(4-0)^2} = \sqrt{9+16} = \sqrt{25} = 5$.

77. B
Explanation: Rearranging $2x+y=5$ to slope-intercept form $y=-2x+5$ reveals the slope $m=-2$.

78. C
Explanation: The standard equation $x^2+y^2=r^2$ describes a circle centered at the origin $(0,0)$.

79. B
Explanation: By definition in conic sections, the eccentricity of any parabola is precisely 1.

80. C
Explanation: Orthogonal vectors have an angle of $90°$ between them. Since $\cos 90° = 0$, their dot product is 0.

81. B
Explanation: Parallel vectors have an angle of $0°$ (or $180°$). Since $\sin 0° = 0$, their cross product is the zero vector.

82. A
Explanation: The magnitude of a vector $a\hat{i}+b\hat{j}$ is $\sqrt{a^2+b^2}$. Here, $\sqrt{3^2+4^2}=5$.

83. B
Explanation: By the Pythagorean trigonometric identity, $\sin^2\theta+\cos^2\theta=1$ for all θ.

84. B
Explanation: In a right isosceles triangle (45-45-90), the opposite and adjacent sides are equal, so their ratio (tangent) is 1.

85. C
Explanation: A fair die has 6 faces. The probability of rolling any specific face is $1/6$.

86. B
Explanation: For mutually exclusive events, there is no intersection, so the addition rule simplifies to $P(A\cup B)=P(A)+P(B)$.

87. C
Explanation: The mean is the sum divided by the count: $(2+4+6+8+10)/5 = 30/5 = 6$.

88. B
Explanation: The median is the middle value of an ordered set. For 7 items, it is the 4th value, which is 6.

89. C
Explanation: The word "MATH" has 4 distinct letters. The number of permutations is $4! = 24$.

90. A

Explanation: ${}^5C_2 = \frac{5!}{2!(5-2)!} = \frac{120}{2\times6} = 10$.

91. B
Explanation: In Boolean algebra, ORing any variable with 1 always results in 1 (Annulment law).

92. B
Explanation: The empty set, containing no elements, is conventionally denoted by $\emptyset$.

93. D
Explanation: The modulus (absolute value) indicates distance from zero, thus $|-7| = 7$.

94. B
Explanation: By definition of the imaginary unit $i = \sqrt{-1}$, squaring it gives $i^2 = -1$.

95. A
Explanation: The complex conjugate of $a + bi$ is $a - bi$. Thus, the conjugate of $3 + 4i$ is $3 - 4i$.

96. B
Explanation: On the unit circle, the point at 90° (or $\pi/2$ radians) is $(0, 1)$, so the sine (y-value) is 1.

97. C
Explanation: Thales's theorem states that any angle inscribed in a semicircle is a right angle (90°).

98. C
Explanation: The standard geometric formula for the area of a triangle is $\frac{1}{2} \times$ base $\times$ height.

99. D
Explanation: A circle is defined geometrically as the locus of all points in a plane equidistant from a fixed center point.

100. B
Explanation: The geometric mean of two numbers a and b is $\sqrt{ab}$. $\sqrt{4 \times 9} = \sqrt{36} = 6$.

101. B
Explanation: For an infinite geometric series with $a = 1$ and $r = 1/2$, the sum is $\frac{a}{1-r} = \frac{1}{1-0.5} = 2$.

102. B
Explanation: By mathematical convention and combinatorial logic (number of ways to arrange zero items), $0! = 1$.

103. C
Explanation: The derivative of the natural logarithm function $\ln x$ is $\frac{1}{x}$.

104. B
Explanation: The derivative of $-\cos x$ is $\sin x$, so the indefinite integral of $\sin x$ is $-\cos x + C$.

105. B
Explanation: $\int_0^1 2x\,dx = [x^2]_0^1 = 1^2 - 0^2 = 1$.

106. C
Explanation: The order of a differential equation is the highest derivative present, which here is the second derivative (d^2y/dx^2).

107. B
Explanation: The degree is the power of the highest order derivative. Here, the highest derivative is dy/dx, and it is squared, so degree is 2.

108. B
Explanation: Distance $= \frac{|Ax_1+By_1+Cz_1-D|}{\sqrt{A^2+B^2+C^2}} = \frac{|-6|}{\sqrt{1^2+2^2+2^2}} = \frac{6}{3} = 2$.

109. D
Explanation: Variance is mathematically defined as the square of the standard deviation (σ^2).

110. A
Explanation: There are 6 ways to roll a 7 out of 36 total outcomes, so $6/36 = 1/6$.

111. B
Explanation: A leap year has 366 days (52 weeks and 2 extra days). The 2 days can be 7 possible pairs; 2 of these include Sunday (Sat-Sun, Sun-Mon).

112. B
Explanation: The empty set has exactly one subset (itself), so its power set contains 1 element.

113. C
Explanation: $A \times B$ represents the Cartesian Product, the set of all ordered pairs (a, b) where $a \in A$ and $b \in B$.

114. B
Explanation: Any non-zero real number raised to the power of 0 evaluates strictly to 1.

115. C
Explanation: $x^2 - 1 = 0 \implies x^2 = 1 \implies x = \pm 1$.

116. C
Explanation: $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$.

117. C
Explanation: The sum of interior angles is $(n-2) \times 180°$. For a hexagon ($n = 6$), $(6-2) \times 180° = 720°$.

118. B
Explanation: The area of an equilateral triangle with side a is uniquely given by the formula $\frac{\sqrt{3}}{4}a^2$.

119. C
Explanation: Archimedes established that the surface area of a sphere of radius r is exactly $4\pi r^2$.

120. A
Explanation: The volume of a cylinder is the base area times height, which trans-

lates to $\pi r^2 h$.