

1. True or False? A natural number is the number 0 or any number obtained by adding 1 to a natural number.
2. True or False? The category of numbers called integers include negative numbers.
3. True or False? A rational number is any number that can be expressed without a fractional part.
4. True or False? There is one set of underlying principles governing all positional number systems.
5. True or False? The base of a number system determines the number of digits used in the system.
6. True or False? The base of a number system determines the number of digit positions that can be used for any number in the system.
7. True or False? The digits used in base 8 are 1 through 8.
8. True or False? The base of the binary number system is 2.
9. True or False? The base of the hexadecimal number system is 15.
10. True or False? The value of each position in a number system is determined by subtracting the base from the position number.
11. True or False? A value of a number in any base can be expressed as a polynomial expression.
12. True or False? An abacus uses positional notation to represent values.
13. True or False? The letter C is used to represent the number 11 in hexadecimal.
14. True or False? The number 10 represents the base value in every number system.
15. True or False? Representing a number in base 5 sometimes requires more digits than representing that same number in base 10.
16. True or False? Binary numbers can be converted to octal, but not to hexadecimal.
17. True or False? Starting from the right, every group of four binary digits can be read as one hexadecimal digit.
18. True or False? Binary numbers are important in computing because numbers in every base can be converted into them.
19. True or False? A byte is made up of eight binary digits.
20. True or False? Two hexadecimal digits can be stored in one byte.
21. True or False? Three octal digits can be stored in one byte.
22. True or False? The number of bits in a word is the same on all machines.
23. True or False? Grace Murray Hopper is credited with being the first programmer.

24. True or False? Grace Murray Hopper participated in the design of the COBOL programming language.

25. Which of the following is a unit in abstract mathematical system subject to the laws of arithmetic?

- A. number
- B. natural number
- C. integer
- D. negative number
- E. rational number

26. Which of the following describes the number 0 and any number that can be obtained by repeatedly adding one to it?

- A. number
- B. natural number
- C. integer
- D. negative number
- E. rational number

27. Which of the following describes a natural number, the negative of a natural number, or zero?

- A. number
- B. imaginary number
- C. integer
- D. negative number
- E. rational number

28. Which of the following is a value less than zero, with a sign opposite to its positive counterpart?

- A. number
- B. natural number
- C. integer
- D. negative number
- E. rational number

29. Which of the following is an integer or the quotient of two integers (excluding division by zero)?

- A. number
- B. natural number
- C. integer
- D. negative number
- E. rational number

30. How many digits are there in the binary number system?

- A. 1
- B. 2
- C. 7
- D. 8
- E. 9

31. Which number represents a value in every number system?

- A. 0
- B. 1000
- C. 10
- D. 11
- E. 100

32. How many digits are there in the octal number system?

- A. 1
- B. 2
- C. 7
- D. 8
- E. 9

33. What is the largest digit in the octal number system?

- A. 1
- B. 2
- C. 7
- D. 8
- E. 9

34. How many digits are there in the decimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

35. What is the largest digit in the decimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

36. How many digits are there in the hexadecimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

37. What is the decimal value of the largest digit in the hexadecimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

38. Which of the following can be used to express the value of every number in any number system?

- A. base
- B. quotient
- C. polynomial
- D. rational number
- E. radix

39. Which number represents the value of the base in every number system?
- A. 0
  - B. 1
  - C. 10
  - D. 11
  - E. 100
40. In base 16, the digit E corresponds to what decimal value?
- A. 1
  - B. 10
  - C. 12
  - D. 14
  - E. 15
41. What is the lowest base in which the number 10 could be a valid number?
- A. binary
  - B. base 3
  - C. octal
  - D. decimal
  - E. hexadecimal
42. What is the lowest base in which the number 1000 could be a valid number?
- A. binary
  - B. base 3
  - C. octal
  - D. decimal
  - E. hexadecimal
43. What is the lowest base in which the number 987 could be a valid number?
- A. binary
  - B. base 3
  - C. octal
  - D. decimal
  - E. hexadecimal
44. What is a single binary digit called?
- A. byte
  - B. nibble
  - C. bit
  - D. word
  - E. block
45. What is a group of eight binary digits called?
- A. byte
  - B. nibble
  - C. bit
  - D. word
  - E. block
46. Which unit of binary storage has a size that is processor-dependent?
- A. byte
  - B. nibble
  - C. bit
  - D. word
  - E. block

47. A \_\_\_\_\_ is a unit of an abstract mathematical system subject to the laws of arithmetic.
48. A \_\_\_\_\_ is the number 0 or any number obtained by repeatedly adding 1 to it.
49. An \_\_\_\_\_ is a natural number, a negative of a natural number, or zero.
50. A \_\_\_\_\_ is any number that can be expressed as a fraction.
51. The \_\_\_\_\_ of a number system determines how many digits are used in the system and the value of digit positions.
52. The rightmost digit represents its value multiplied by the base raised to the \_\_\_\_\_ power.
53. The rightmost digit of a number is the \_\_\_\_\_ position in any base.
54. The value of a number in any base can be expressed as a \_\_\_\_\_ in which each term is made up of a digit multiplied by the base raised to a power.
55. The base value of the binary number system is \_\_\_\_\_.
56. The base value of the octal number system is \_\_\_\_\_.
57. The base value of the hexadecimal number system is \_\_\_\_\_.
58. The highest digit in base 2 is \_\_\_\_\_.
59. The highest digit in base 8 is \_\_\_\_\_.
60. The highest digit in base 16 is \_\_\_\_\_.
61. \_\_\_\_\_ is the lowest number system in which 372 could be a valid number.
62. \_\_\_\_\_ is the lowest number system in which 901 could be a valid number.
63. In bases higher than 10, the letter A is used to represent the decimal value \_\_\_\_\_ using only one symbol.
64. In base 16, the digit D is used to represent the decimal value \_\_\_\_\_.
65. In base 16, the digit F is used to represent the decimal value \_\_\_\_\_.
66. A single binary digit is called a \_\_\_\_\_.
67. A group of eight bits is called a \_\_\_\_\_.
68. Bytes can be grouped together into a \_\_\_\_\_, the size of which is machine-dependent.
69. The \_\_\_\_\_ is an ancient device that uses beads in columns to represent a number using positional notation.

- 71. What is a natural number?
- 72. What is a rational number?
- 73. What is the base of a number system?
- 74. How does positional notation determine the value of a number?
- 75. How many digits are there in the base  $X$  number system (for any positive integer  $X$ )?
- 76. What is the value of the largest digit in the base  $X$  number system (for any positive integer  $X$ )?
- 80. Express 508 as a polynomial, assuming it is a base-10 number.
- 81. Express 528 as a polynomial, assuming it is a base-8 number.
- 82. Express 841 as a polynomial, assuming it is a base-9 number.
- 83. Express 395 as a polynomial, assuming it is a base-11 number.
- 84. Express 9999 as a polynomial, assuming it is a base-13 number.

In all remaining problems, **show all your work**, not only the final answers:

85. What is the decimal equivalent of the base-5 number 135?
86. What is the decimal equivalent of the octal number 135?
87. What is the decimal equivalent of the base-11 number 135?
88. What is the decimal equivalent of the number  $135_{20}$  (base is 20)?
89. What is the decimal equivalent of the number  $135_{20}$  (base 20)?
90. What is the decimal equivalent of the hexadecimal number 1C9F?
91. What symbol is used in hexadecimal to represent the decimal value 9?
92. What symbol is used in hexadecimal to represent the decimal value 10?
93. What symbol is used in hexadecimal to represent the decimal value 12?
94. What symbol is used in hexadecimal to represent the decimal value 16?
95. Convert the following binary number to decimal: 11011011
96. Convert the following binary number to octal: 11011011
97. Convert the following binary number to hexadecimal: 11011011
98. Convert the following octal number to binary: 476
99. Convert the following octal number to decimal: 476
100. Convert the following octal number to hexadecimal: 476
101. Convert the following octal number to base 13: 476
102. Convert the following hexadecimal number to octal: 9CB
103. Convert the following hexadecimal number to binary: 9CB
104. Convert the following base 13 number to octal: 998
105. Convert the following base 13 number to binary: 998
106. Convert the following base 13 number to decimal: 998
107. Convert the following base 13 number to hexadecimal: 998
108. Convert the following decimal number to binary: 297
109. Convert the following decimal number to octal: 297
110. Convert the following decimal number to hexadecimal: 297

111. Convert the following decimal number to base 13: 297
112. Perform the following binary addition:  $11001 + 1110011$
113. Perform the following octal addition:  $665 + 771$
114. Perform the following binary subtraction:  $1000110110 - 111111110$
115. Perform the following octal subtraction:  $126 - 32$
116. Perform the following hexadecimal addition:  $ABC + ABC$
117. Perform the following hexadecimal subtraction:  $CBA - ABC$
118. Perform the following base 13 addition:  $2CB + ABC$
120. In what ways are all positional number systems similar?
122. Describe the relationship among bases that are powers of 2.
123. Describe the process of converting a number in base 10 to any other base.
124. Why are binary digits used to represent information on a computer?
125. Summarize Grace Murray Hopper's contributions to computing.



## Chapter 2      Review Quiz - **ANSWERS**

1. True or False? A natural number is the number 0 or any number obtained by adding 1 to a natural number.

Answer: True

2. True or False? The category of numbers called integers include negative numbers.

Answer: True

3. True or False? A rational number is any number that can be expressed without a fractional part.

Answer: False

4. True or False? There is one set of underlying principles governing all positional number systems.

Answer: True

5. True or False? The base of a number system determines the number of digits used in the system.

Answer: True

6. True or False? The base of a number system determines the number of digit positions that can be used for any number in the system.

Answer: False

7. True or False? The digits used in base 8 are 1 through 8.

Answer: False

8. True or False? The base of the binary number system is 2.

Answer: True

9. True or False? The base of the hexadecimal number system is 15.

Answer: False

10. True or False? The value of each position in a number system is determined by subtracting the base from the position number.

Answer: False

11. True or False? A value of a number in any base can be expressed as a polynomial expression.

Answer: True

12. True or False? An abacus uses positional notation to represent values.

Answer: True

13. True or False? The letter C is used to represent the number 11 in hexadecimal.

Answer: False

14. True or False? The number 10 represents the base value in every number system.

Answer: True

15. True or False? Representing a number in base 5 sometimes requires more digits than representing that same number in base 10.

Answer: True

16. True or False? Binary numbers can be converted to octal, but not to hexadecimal.

Answer: False

17. True or False? Starting from the right, every group of four binary digits can be read as one hexadecimal digit.

Answer: True

18. True or False? Binary numbers are important in computing because numbers in every base can be converted into them.

Answer: False

19. True or False? A byte is made up of eight binary digits.

Answer: True

20. True or False? Two hexadecimal digits can be stored in one byte.

Answer: True

21. True or False? Three octal digits can be stored in one byte.

Answer: False

22. True or False? The number of bits in a word is the same on all machines.

Answer: False

23. True or False? Grace Murray Hopper is credited with being the first programmer.

Answer: False

24. True or False? Grace Murray Hopper participated in the design of the COBOL programming language.

Answer: True

25. Which of the following is a unit in abstract mathematical system subject to the laws of arithmetic?
- A. number
  - B. natural number
  - C. integer
  - D. negative number
  - E. rational number

Answer: A

26. Which of the following describes the number 0 and any number that can be obtained by repeatedly adding one to it?
- A. number
  - B. natural number
  - C. integer
  - D. negative number
  - E. rational number

Answer: B

27. Which of the following describes a natural number, the negative of a natural number, or zero?
- A. number
  - B. imaginary number
  - C. integer
  - D. negative number
  - E. rational number

Answer: C

28. Which of the following is a value less than zero, with a sign opposite to its positive counterpart?
- A. number
  - B. natural number
  - C. integer
  - D. negative number
  - E. rational number

Answer: D

29. Which of the following is an integer or the quotient of two integers (excluding division by zero)?
- A. number
  - B. natural number
  - C. integer
  - D. negative number
  - E. rational number

Answer: E

30. How many digits are there in the binary number system?
- A. 1
  - B. 2
  - C. 7

- D. 8
- E. 9

Answer: B

31. Which number represents a value in every number system?

- A. 0
- B. 1000
- C. 10
- D. 11
- E. 100

Answer: A

32. How many digits are there in the octal number system?

- A. 1
- B. 2
- C. 7
- D. 8
- E. 9

Answer: D

33. What is the largest digit in the octal number system?

- A. 1
- B. 2
- C. 7
- D. 8
- E. 9

Answer: C

34. How many digits are there in the decimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

Answer: C

35. What is the largest digit in the decimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

Answer: B

36. How many digits are there in the hexadecimal number system?

- A. 0

- B. 9
- C. 10
- D. 15
- E. 16

Answer: E

37. What is the decimal value of the largest digit in the hexadecimal number system?

- A. 0
- B. 9
- C. 10
- D. 15
- E. 16

Answer: D

38. Which of the following can be used to express the value of every number in any number system?

- A. base
- B. quotient
- C. polynomial
- D. rational number
- E. radix

Answer: C

39. Which number represents the value of the base in every number system?

- A. 0
- B. 1
- C. 10
- D. 11
- E. 100

Answer: C

40. In base 16, the digit E corresponds to what decimal value?

- A. 1
- B. 10
- C. 12
- D. 14
- E. 15

Answer: D

41. What is the lowest base in which the number 10 could be a valid number?

- A. binary
- B. base 3
- C. octal
- D. decimal
- E. hexadecimal

Answer: A

42. What is the lowest base in which the number 1000 could be a valid number?

- A. binary
- B. base 3
- C. octal
- D. decimal
- E. hexadecimal

Answer: A

43. What is the lowest base in which the number 987 could be a valid number?

- A. binary
- B. base 3
- C. octal
- D. decimal
- E. hexadecimal

Answer: D

44. What is a single binary digit called?

- A. byte
- B. nibble
- C. bit
- D. word
- E. block

Answer: C

45. What is a group of eight binary digits called?

- A. byte
- B. nibble
- C. bit
- D. word
- E. block

Answer: A

46. Which unit of binary storage has a size that is processor-dependent?

- A. byte
- B. nibble
- C. bit
- D. word
- E. block

Answer: D

47. A \_\_\_\_\_ is a unit of an abstract mathematical system subject to the laws of arithmetic.

Answer: Number

48. A \_\_\_\_\_ is the number 0 or any number obtained by repeatedly adding 1 to it.

Answer: natural number

49. An \_\_\_\_\_ is a natural number, a negative of a natural number, or zero.

Answer: Integer

50. A \_\_\_\_\_ is any number that can be expressed as a fraction.

Answer: rational number

51. The \_\_\_\_\_ of a number system determines how many digits are used in the system and the value of digit positions.

Answer: Base

52. The rightmost digit represents its value multiplied by the base raised to the \_\_\_\_\_ power.

Answer: Zero

53. The rightmost digit of a number is the \_\_\_\_\_ position in any base.

Answer: Ones

54. The value of a number in any base can be expressed as a \_\_\_\_\_ in which each term is made up of a digit multiplied by the base raised to a power.

Answer: Polynomial

55. The base value of the binary number system is \_\_\_\_\_.

Answer: 2

56. The base value of the octal number system is \_\_\_\_\_.

Answer: 8

57. The base value of the hexadecimal number system is \_\_\_\_\_.

Answer: 16

58. The highest digit in base 2 is \_\_\_\_\_.

Answer: 1

59. The highest digit in base 8 is \_\_\_\_\_.

Answer: 7

60. The highest digit in base 16 is \_\_\_\_\_.

Answer: F

61. \_\_\_\_\_ is the lowest number system in which 372 could be a valid number.

Answer: octal or base-8

62. \_\_\_\_\_ is the lowest number system in which 901 could be a valid number.

Answer: decimal or base-10

63. In bases higher than 10, the letter A is used to represent the decimal value \_\_\_\_\_ using only one symbol.

Answer: 10

64. In base 16, the digit D is used to represent the decimal value \_\_\_\_\_.

Answer: 13

65. In base 16, the digit F is used to represent the decimal value \_\_\_\_\_.

Answer: 15

66. A single binary digit is called a \_\_\_\_\_.

Answer: Bit

67. A group of eight bits is called a \_\_\_\_\_.

Answer: Byte

68. Bytes can be grouped together into a \_\_\_\_\_, the size of which is machine-dependent.



Answer: Word

69. The \_\_\_\_\_ is an ancient device that uses beads in columns to represent a number using positional notation.

Answer: Abacus

71. What is a natural number?

Answer: The number 0 or any number that can be obtained by repeatedly adding 1 to it.

72. What is a rational number?

Answer: An integer or the quotient of two integers (excluding division by zero).

73. What is the base of a number system?

Answer: The foundational value that dictates the number of digits and the value of digit positions.

74. How does positional notation determine the value of a number?

Answer: The value of each digit in a number is obtained by multiplying the digit by the base raised to the position number (rightmost digit position is 0). The value of a number is the sum of each digit value.

75. How many digits are there in the base X number system (for any positive integer X)?

Answer: X

76. What is the value of the largest digit in the base X number system (for any positive integer X)?

Answer: X-1

80. Express 508 as a polynomial, assuming it is a base-10 number.

Answer:  $5 * 10^2 + 0 * 10 + 8$

81. Express 528 as a polynomial, assuming it is a base-8 number.

Answer: 528 is not a valid number in base 8 because it contains an invalid digit (8).

82. Express 841 as a polynomial, assuming it is a base-9 number.

Answer:  $8 * 9^2 + 4 * 9 + 1$

83. Express 395 as a polynomial, assuming it is a base-11 number.

Answer:  $3 * 11^2 + 9 * 11 + 5$

84. Express 9999 as a polynomial, assuming it is a base-13 number.

Answer:  $9 * 13^3 + 9 * 13^2 + 9 * 13 + 9$

In all remaining problems, **show all your work**, not only the final answers:

85. What is the decimal equivalent of the base-5 number 135?

Answer: 135 is not a valid number in base 5 because it contains an invalid digit (5).

86. What is the decimal equivalent of the octal number 135?

Answer: 93

87. What is the decimal equivalent of the base-11 number 135?

Answer: 159

88. What is the decimal equivalent of the number  $135_{20}$  (base is 20)?

Answer: 213

89. What is the decimal equivalent of the number  $135_{20}$  (base 20)?

Answer: 465

90. What is the decimal equivalent of the hexadecimal number 1C9F?

Answer: 7327

91. What symbol is used in hexadecimal to represent the decimal value 9?

Answer: 9

92. What symbol is used in hexadecimal to represent the decimal value 10?

Answer: A

93. What symbol is used in hexadecimal to represent the decimal value 12?

Answer: C

94. What symbol is used in hexadecimal to represent the decimal value 16?

Answer: There is no single symbol (digit) to represent 16 in hexadecimal. The hexadecimal number 10 corresponds to the decimal value 16.

95. Convert the following binary number to decimal: 11011011

Answer: 219

96. Convert the following binary number to octal: 11011011

Answer: 333

97. Convert the following binary number to hexadecimal: 11011011

Answer: DB

98. Convert the following octal number to binary: 476

Answer: 100111110

99. Convert the following octal number to decimal: 476

Answer: 318

100. Convert the following octal number to hexadecimal: 476

Answer: 13E

101. Convert the following octal number to base 13: 476

Answer: 1B6

102. Convert the following hexadecimal number to octal: 9CB

Answer: 4713

103. Convert the following hexadecimal number to binary: 9CB

Answer: 100111001011

104. Convert the following base 13 number to octal: 998

Answer: 3156

105. Convert the following base 13 number to binary: 998

Answer: 11001101110

106. Convert the following base 13 number to decimal: 998

Answer: 1646

107. Convert the following base 13 number to hexadecimal: 998

Answer: 66E

108. Convert the following decimal number to binary: 297

Answer: 100101001

109. Convert the following decimal number to octal: 297

Answer: 451

110. Convert the following decimal number to hexadecimal: 297

Answer: 129

111. Convert the following decimal number to base 13: 297

Answer: 19B

112. Perform the following binary addition:  $11001 + 1110011$

Answer: 10001100

113. Perform the following octal addition:  $665 + 771$

Answer: 1656

114. Perform the following binary subtraction:  $1000110110 - 11111110$

Answer: 111000

115. Perform the following octal subtraction:  $126 - 32$

Answer: 74

116. Perform the following hexadecimal addition:  $ABC + ABC$

Answer: 1578

117. Perform the following hexadecimal subtraction:  $CBA - ABC$

Answer: 1FE

118. Perform the following base 13 addition:  $2CB + ABC$

Answer: 10BA

120. In what ways are all positional number systems similar?

Answer: All number systems use positional notation to determine the value represented by a number. Each position's value is determined by the base value of the number system, raised to increasing powers from right to left. Each number system has a set number of digits, determined by the base value. The value of any number in any base can be expressed as a polynomial.

122. Describe the relationship among bases that are powers of 2.

Answer: Values in number systems with a base that is a power of two, such as binary, octal, and hexadecimal, can be converted quickly among each other. For example, the octal equivalent of a binary number can be obtained by grouping the binary digits in groups of three starting at the right. Each group of three, read as an octal digit, make up the binary number's octal equivalent. The same can be done to convert a binary number into hexadecimal by grouping the bits into groups of four. In reverse, octal and hexadecimal numbers can be expanded into groups of three and four bits, respectively, to convert them to binary. The number in the group corresponds to the power relationship between the two bases. Since  $2^3$  equals 8, the bits are separated into groups of three to convert to octal.

123. Describe the process of converting a number in base 10 to any other base.

Answer: The **repeated division** algorithm: First, divide the base-10 number by the new base. The remainder represents the first digit in the answer, and the quotient represents the value still left to be

represented. If the quotient is not zero, divide the quotient by the new base. The remainder is the next digit in the answer, and the quotient again represents the value still left to be represented. Continue with this process until the quotient becomes zero.

124. Why are binary digits used to represent information on a computer?

Answer: The devices used to store and manage data on a computer are **cheaper, faster** and **more reliable** if they only have to represent two possible states. Also, they consume **less power**. Every electrical signal is considered to be either "low" or "high" that map to the binary digits 0 and 1.

125. Summarize Grace Murray Hopper's contributions to computing.

Answer:

- She wrote the first compiler
- She worked on the Mark I, Mark II and Mark III computers
- She worked with Eckert and Mauchly on the UNIVAC I
- She was active in the design, implementation, and use of the COBOL programming language
- She was the “mother” of computerized data automation within the Navy
- She gave many talks to students over the years, handing out colored “nanosecond” wires to demonstrate the distance light travels in a nanosecond.