

American Computer Science League

2022-2023 • Contest 1 : Short Problems Solution • Intermediate Division

1. Computer Number Systems

Decimal	Binary
8	1000
9	1001
10	1010
11	1011
12	1100

Decimal	Binary
13	1101
14	1110
15	1111
16	10000

B. 21

You get a total of 21 when you count all of the 1s from 8 to 16, inclusive.

2. Computer Number Systems

$$\begin{aligned}78B_{16} &= 11110001011_2 = 3613_8, \\ACE_{16} &= 101011001110_2 = 5316_8, \\F4A_{16} &= 111101001010_2 = 7512_8, \\2EF_{16} &= 1011101111_2 = 1357_8, \\BAD_{16} &= 101110101101_2 = 5655_8\end{aligned}$$

The most odd digits is 4 in 1357_8 which is $2EF_{16}$.

D. 2EF

3. Recursive Functions

$$\begin{aligned}f(1) &= 2 \\f(2) &= 4 \\f(3) &= 2 * f(2)/f(1) = 2 * 4/2 = 4 \\f(4) &= 2 * f(3)/f(2) = 2 * 4/4 = 2 \\f(5) &= 2 * f(4)/f(3) = 2 * 2/4 = 1 \\f(6) &= 2 * f(5)/f(4) = 2 * 1/2 = 1 \\f(7) &= 2 * f(6)/f(5) = 2 * 1/1 = 2 \\f(8) &= 2 * f(7)/f(6) = 2 * 2/1 = 4\end{aligned}$$

So the sequence of numbers produced is: 2 4 4 2 1 1 2 4 4 2 1 1 ...
This repeats in a cycle of 6 so $f(25) = 2$.

A. 2

<p>4. Recursive Functions</p> $f(9) = f(9 + 1) - 1 = f(10) - 1 = 7 - 1 = 6$ $f(10) = 10 - 3 = 7$ $f(6) = f(6 + 1) - 1 = f(7) - 1 = 4 - 1 = 3$ $f(7) = 7 - 3 = 4$ $f(3) = f(4) - 1 = 0$ $f(4) = f(2) + 2 = -1 + 2 = 1$ $f(2) = 2 - 3 = -1$ <p>So $f(f(f(9))) = f(f(6))$ $\quad\quad\quad = f(3)$ $\quad\quad\quad = 0$</p>	<p>E. 0</p>
<p>5. What Does This Program Do? (Branching)</p> <p>A) The values 3, 6, 9 don't form a triangle. B) The values 4, 5, 6 form an ACUTE and SCALENE triangle. D) The values 6, 6, 6 form an EQUILATERAL triangle (as well as ISOSCELES) which are always ACUTE. E) Though the other 2 both form an OBTUSE triangle, the values 6, 6, 10 (E) form an ISOSCELES triangle. Only a=5, b=6, and c=10 form an OBTUSE and SCALENE triangle.</p>	<p>C. a=5, b=6, c=10</p>