

American Computer Science League

2021-2022 • Contest 1: Short Problem Solutions • Intermediate Division

1. Computer Number Systems $\begin{aligned} 2122_{10} &= 8 * 16^2 + 4 * 16^1 + 10 * 16^0 \\ &= 84A_{16} \end{aligned}$	D. 84A
2. Computer Number Systems Fibonacci sequence 0, 1, 1, 2, 3, 5, 8, 13, ... in base 10 Fibonacci sequence 0, 1, 1, 2, 3, 5, 10, 15, ... in octal 1st: 1 from 1 2nd: 1 from 1 3rd: 10 from 8 4th: 15 from 13 5th & 6th: 131 from 89	C. 89
3. Recursive Functions $\begin{aligned} f(20) &= 2 * f(20 - 3) + 1 = 2 * f(17) + 1 = 2 * 19 + 1 = 38 + 1 \\ f(17) &= 2 * f(17 - 3) + 1 = 2 * f(14) + 1 = 2 * 9 + 1 = 18 + 1 \\ f(14) &= [f(14 + 2)/3] = [f(16)/3] = [29/3] = 9 \\ f(16) &= 2 * f(16 - 3) + 1 = 2 * f(13) + 1 = 2 * 14 + 1 = 28 + 1 \\ f(13) &= [f(13 + 2)/3] = [f(15)/3] = [43/3] = 14 \\ f(15) &= 2 * f(15 - 3) + 1 = 2 * f(12) + 1 = 2 * 21 + 1 = 42 + 1 \\ f(12) &= 2 * 12 - 3 = 24 - 3 = 21 \end{aligned}$	B. 39

4. Recursive Functions

$$\begin{aligned}f(20) &= f(18/2) - 1 = f(9) - 1 = 18 - 1 = 17 \\f(9) &= 2 * 9 = 18 \\f(17) &= 2 * 17 = 34 \\f(34) &= f(32/2) - 1 = f(16) - 1 = 13 - 1 = 12 \\f(12) &= f(10/2) - 1 = f(5) - 1 = 10 - 1 = 9\end{aligned}$$

$$\begin{aligned}\text{Therefore: } f(f(f(f(20)))) &= f(f(f(17))) \\&= f(f(34)) \\&= f(12) \\&= 9\end{aligned}$$

E. 9

5. What Does This Program Do? (Branching)

The following table can be used to trace the program:

a	b	c	d
10	4	0	6
10	4	0	4
10	4	1	4
10	4	2	4
1	4	2	4
1	4	2	2

$$\begin{aligned}x &= a - b * c + d \\&= 1 - 4 * 2 + 2 \\&= 1 - 8 + 2 \\&= -7 + 2 \\&= -5\end{aligned}$$

D. -5