American Computer Science League

2020-2021 ● Contest 1: Shorts Solutions ● Senior Division

1. Computer Number Systems

$675_{10} = 1234_8$ and $700_{10} = 1274_8$

The octal numbers in the range are: 1246, 1256, 1260, 1261, 1262, 1263, 1264, 1265, 1266, and 1267. Therefore, there are 11 6's.

1. 11 (C)

2. Computer Number Systems

Approach A: $13_{16} * 74F_{16} = (10_{16} + 1_{16} + 1_{16} + 1_{16}) * 74F_{16}$
$= 74F0_{16} + 74F_{16} + 74F_{16} + 74F_{16}$
$= 8ADD_{16}$

Approach B: $13_{16} * 74F_{16} = (10_{16} + 3_{16}) * (750_{16} - 1_{16})$
$= 7500_{16} - 10_{16} + 3_{16} * 750_{16} - 3_{16}$
$= 74F0_{16} + 15F0_{16} - 3_{16}$
$= 8AE0_{16} - 3_{16}$
$= 8ADD_{16}$

Approach C: $13_{16} * 74F_{16} = (1*16+3) * (7*256+4*16+15)$
$= 19_{10} * 1871_{10} = 35549_{10}$
$= 8*4096 + 10*256 + 13*16 + 13 = 8ADD_{16}$

2. $8ADD_{16}$ (B)

3. Recursive Functions

The function can be evaluated as follows:

$f(24) = 24 + f(24 - 5) = 24 + f(19) = 24 + 56 = 80$
$f(19) = 19 + f(19 - 5) = 19 + f(14) = 19 + 37 = 56$
$f(14) = 14 + f(14 - 5) = 14 + f(9) = 14 + 23 = 37$
$f(9) = f(9 + 3) - 4 = f(12) - 4 = 27 - 4 = 23$
$f(12) = 12 + f(12 - 5) = 12 + f(7) = 12 + 15 = 27$
$f(7) = f(7 + 3) - 4 = f(10) - 4 = 19 - 4 = 15$
$f(10) = 10 + f(10 - 5) = 10 + f(5) = 10 + 9 = 19$
$f(5) = 2 \cdot 5 - 1 = 10 - 1 = 9$

3. 80 (E)

4. Recursive Functions

The function evaluates as follows:

$f(3, 18) = f(18 - 1, 3 + 1) - 5 = f(17, 4) - 5 = 148 - 5 = 143$

$f(17, 4) = f(17 - 2, 4 + 3) + 3 = f(15, 7) + 3 = 145 + 3 = 148$

$f(15, 7) = f(15 - 2, 7 + 3) + 3 = f(13, 10) + 3 = 142 + 3 = 145$

$f(13, 10) = f(13 - 2, 10 + 3) + 3 = f(11, 13) + 3 = 139 + 3 = 142$

$f(11, 13) = f(13 - 1, 11 + 1) - 5 = f(12, 12) - 5 = 144 - 5 = 139$

$f(12, 12) = 12 \cdot 12 = 144$

4. 143 (C)

5. What Does This Program Do?

The following table traces the program:

a	**b**	**c**	**d**
16	4		12
16	4	4	12
16	4	20	12
20	4	16	12
20	4	16	28

The largest value of a variable is 28.

5. 28 (A)