

# American Computer Science League

2023-2024 • Contest 4: Short Problems Solutions • Junior Division

## 1. Graph Theory

The adjacency matrix raised to the 2nd power for paths of length 2 is as follows:

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}^2 = \begin{bmatrix} 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

There are 15 entries of 0.

C. 15

## 2. Graph Theory

By inspection, there are 3 cycles: BDB, ACEA, ABDA.

B. 3

## 3. Digital Electronics

The Boolean expression for the digital circuit is:  $\overline{\overline{A} + \overline{AB} + \overline{BC}}$

$$\begin{aligned} \overline{\overline{A} + \overline{AB} + \overline{BC}} &= \overline{\overline{A} + \overline{AB} \overline{BC}} \\ &= (A + AB)(BC) \\ &= ABC + ABC \\ &= ABC \end{aligned}$$

D.  $ABC$

## 4. Digital Electronics

The Boolean expression for the digital circuit is:  $\overline{\overline{AB} \overline{BC} + C}$

$$\begin{aligned} &= \overline{\overline{AB} + \overline{BC} + C} \\ &= \overline{AB} + \overline{BC} + C \\ &= \overline{A} + \overline{B} + \overline{B} + \overline{C} + C \\ &= 1 \end{aligned}$$

Therefore all ordered triples make it TRUE, which is 8 of them.

E. 8

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## 5. What Does This Program Do? (Strings)

This program builds a string with either double the value or half the value using integer division so the final value of ans is “648346022844463”.

A. 648346022844463

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