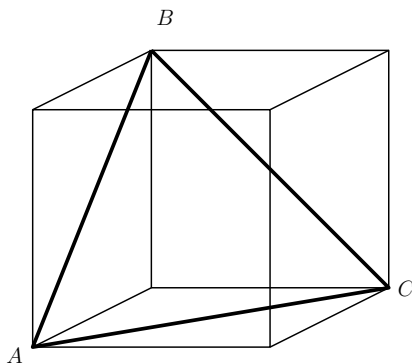


Multiple Choice: Indicate your answer in the box to the right of each question.

<p>1. Which of the following is closest to $\frac{1}{2}$? (A) $\frac{2}{3}$ (B) $\frac{7}{13}$ (C) $\frac{9}{19}$ (D) $\frac{10}{21}$ (E) $\frac{23}{48}$</p>	
<p>2. If $4^{2x} = 4$ and $4^{-5y} = 32$, then what is the value of $(-4)^{x-y}$? (A) -4 (B) -2 (C) $-\frac{1}{4}$ (D) $\frac{1}{4}$ (E) 4</p>	
<p>3. On an analog clock, how many times do the hour and minute hands coincide between 11:30am on Monday and 11:30am on Tuesday? (A) 12 (B) 13 (C) 22 (D) 23 (E) 24</p>	
<p>4. If $-1 \leq a \leq 2$ and $-2 \leq b \leq 3$, find the minimum value of ab. (A) -6 (B) -5 (C) -4 (D) -3 (E) -2</p>	
<p>5. A fair coin is tossed 5 times. What is the probability that it will land tails at least half the time? (A) $\frac{3}{16}$ (B) $\frac{5}{16}$ (C) $\frac{1}{2}$ (D) $\frac{11}{16}$ (E) $\frac{13}{16}$</p>	
<p>6. Let $f(x) = 5 - 2x$. If the domain of $f(x)$ is $(-3, 3]$, what is the range of $f(x)$? (A) $[-1, 11)$ (B) $[0, 11)$ (C) $[2, 8)$ (D) $[1, 11)$ (E) None of these</p>	
<p>7. When $(a+b)^{2018} + (a-b)^{2018}$ is fully expanded and all the like terms are combined, how many terms are there? (A) 1008 (B) 1009 (C) 1010 (D) 2018 (E) 2019</p>	
<p>8. How many factors does $10!$ have? (A) 64 (B) 80 (C) 120 (D) 240 (E) 270</p>	
<p>9. How many x-intercepts does the graph of $x - 1 - 2 + y - 1 - 2 = 1$ have? (A) 0 (B) 1 (C) 2 (D) 3 (E) 4</p>	

Short Answer: Write your answer and show your work in the space below each question. Clearly indicate your final answer by drawing a *BOX* around it.

1. If the 3D-shape below is a cube with edge length 1, what is the area of $\triangle ABC$?



2. An analog clock shows 7:45. In how many minutes will the hour and minute hands coincide?

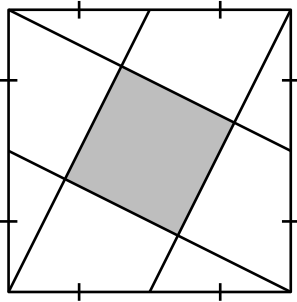
3. John is leaving his house in the morning, but his lightbulb broke so he has to select his clothes in complete darkness. He wants to select same color socks and t-shirt. In his bottom drawer, he has 5 pairs each of **unpaired** black, white and brown socks and in the top drawer he has 2 black, 3 white and 4 brown t-shirts. He first takes socks one by one from the bottom drawer and then t-shirts from the top drawer and then walks into another room to put on the clothes. What is the minimum number of items John needs to take from the drawers in order to guarantee that he will have same color socks and t-shirt?

4. Find the largest integer k such that 2^k is a factor of $100 \cdot 101 \cdot \dots \cdot 200$.

5. How many 9's are there in the product

$$\underbrace{999 \dots 9}_{1000} \times 9$$

6. If the area of the large square is 1, find the area of the shaded region:



7. What are the last two digits of 3^{2018} ?

8. In $\triangle ABC$ the inscribed circle is tangent to \overline{AB} , \overline{BC} , \overline{AC} at P , Q , R , respectively. If $AB = 13$, $BC = 14$, $AC = 15$, find AP .

Long Answer: Write your solution in the space below each question. Make sure you include sufficient justification.

1. A k -digit number $\overline{a_k a_{k-1} a_{k-2} \dots a_1 a_0}_n$ is a number base n where each a_i represents a digit base n . For example,

$$1234_{10} = 1 \cdot 10^3 + 2 \cdot 10^2 + 3 \cdot 10^1 + 4 \cdot 10^0 \quad 1234_5 = 1 \cdot 5^3 + 2 \cdot 5^2 + 3 \cdot 5^1 + 4 \cdot 5^0$$

and so on. A repunit prime base n is a number of the form $11 \dots 1_n$ that is prime. For example, 11_{10} is a repunit prime base 10, but $11_5 = 6_{10}$ is not a repunit prime base 5.

- (a) Find all $n < 20$ such that 11_n is a repunit prime.
- (b) Find a repunit prime base 3 and a repunit prime base 5.
- (c) Find, with proof, all repunit primes base 4.