

**#1 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the value of the sum:

$$\sum_{n=1}^{\infty} \frac{1^n - 2^n + 3^n}{6^n}$$

Answer: \_\_\_\_\_

Round:    1    2    3    4    5

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**#2 Precalculus – Hustle**  
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Suppose  $8^{a_1} = 9, 9^{a_2} = 10, \dots$   
 $127^{a_{120}} = 128$ . Find the product  
 $a_1 a_2 a_3 \dots a_{120}$ .

Answer: \_\_\_\_\_

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**#3 Precalculus – Hustle**  
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Find the area interior to the parallelogram with side lengths  $2\sqrt{6}$  and  $3\sqrt{2}$  and interior angle  $60^\circ$ .

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**#4 Precalculus – Hustle**  
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Find the product of all values of  $x$  that make the matrix singular:

$$\begin{bmatrix} x + 2 & 9 \\ 4 & x + 2 \end{bmatrix}.$$

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**#5 Precalculus – Hustle**  
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Find the product of the slopes of the asymptotes of the graph of  $x(t) = 2\tan(t)$ ,  $y(t) = \sec(t)$ .

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**#6 Precalculus – Hustle**  
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Find the domain in interval notation:

$$f(x) = \log_{2022} \left( 4 - \left| \frac{x}{2} \right| \right).$$

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The side lengths of a triangle are in arithmetic progression. If its largest angle is  $120^\circ$ , find the ratio of the largest to smallest sides.

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Find the sum of solutions on  $[0, 2\pi)$  to

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**#12 Precalculus – Hustle**  
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If  $\frac{x^3+5x^2+ax+b}{x+1} = x^2 + cx + 2$  for values  $a, b, c$ , find the value of  $a + b + c$ .

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Where defined, simplify the expression to one single trig function:

$$\frac{1}{\tan x(\csc x - \sin x)}$$

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**#14 Precalculus – Hustle**  
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$z = \sqrt[6]{2}(\cos \frac{\pi}{8} + i \sin \frac{\pi}{8})$  where  
 $i = \sqrt{-1}$ . Let  $z^{12} = a + bi$  for real  
 $a, b$ . Find  $a + b$ .

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**#15 Precalculus – Hustle**  
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Chris owns 4 purple shirts and 4 green shirts. Shirts of the same color are identical. If he selects 2 shirts at random, what is the probability of getting one of each color? Write as a reduced fraction.

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Let  $f(x) = \sin(x)$  and  $g(x) = 2x$ .  
How many solutions on  $[0, 2\pi)$  are  
there to  $(f \circ g)(x) = (g \circ f)(x)$ ?

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**#17 Precalculus – Hustle**  
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Let  $\mathbf{u} = 3\mathbf{i} - 4\mathbf{j}$  and  $\mathbf{v} = 2\mathbf{i} + 3\mathbf{j}$ . Find the dot product  $\mathbf{u} \cdot \mathbf{v}$ .

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**#18 Precalculus – Hustle**  
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Let  $S$  be the sum of the first 20 positive odd integers. Let  $T$  be the sum of the first 20 positive integer multiples of 3. How much more is  $T$  than  $S$ ?

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Let  $f(x) = \frac{1+x}{1-x}$ . Where defined, if  $f(f(f(f(x)))) = ax + b$  for real numbers  $a, b$ , find  $a + b$ .

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If  $4^x = 8 + 2^{x+1}$ , find the product of all real solutions.

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Emily starts with the number 100 and Barb starts with the number 1. At each turn, Emily adds 10 to her number and Barb doubles her number. What is the least number of turns needed for Barb's number to be greater than or equal to Emily's?

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**MAO National Convention 2022**

Emily starts with the number 100 and Barb starts with the number 1. At each turn, Emily adds 10 to her number and Barb doubles her number. What is the least number of turns needed for Barb's number to be greater than or equal to Emily's?

Answer: \_\_\_\_\_

Round:    1    2    3    4    5

**#23 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the exact area enclosed by the polar curve  $r = 2 \sin \theta - 6 \cos \theta$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#23 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the exact area enclosed by the polar curve  $r = 2 \sin \theta - 6 \cos \theta$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#23 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the exact area enclosed by the polar curve  $r = 2 \sin \theta - 6 \cos \theta$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#23 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the exact area enclosed by the polar curve  $r = 2 \sin \theta - 6 \cos \theta$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#24 Precalculus – Hustle**  
**MAO National Convention 2022**

Evaluate  $\cos(2 \operatorname{Arctan}(\frac{3}{4}))$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#24 Precalculus – Hustle**  
**MAO National Convention 2022**

Evaluate  $\cos(2 \operatorname{Arctan}(\frac{3}{4}))$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#24 Precalculus – Hustle**  
**MAO National Convention 2022**

Evaluate  $\cos(2 \operatorname{Arctan}(\frac{3}{4}))$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5

**#24 Precalculus – Hustle**  
**MAO National Convention 2022**

Evaluate  $\cos(2 \operatorname{Arctan}(\frac{3}{4}))$ .

Answer: \_\_\_\_\_

Round: 1 2 3 4 5



**#25 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the maximum value of  
 $f(x) = 3 \sin(x) - 4 \cos(x)$ .

Answer: \_\_\_\_\_

Round:    1    2    3    4    5

**#25 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the maximum value of  
 $f(x) = 3 \sin(x) - 4 \cos(x)$ .

Answer: \_\_\_\_\_

Round:    1    2    3    4    5

**#25 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the maximum value of  
 $f(x) = 3 \sin(x) - 4 \cos(x)$ .

Answer: \_\_\_\_\_

Round:    1    2    3    4    5

**#25 Precalculus – Hustle**  
**MAO National Convention 2022**

Find the maximum value of  
 $f(x) = 3 \sin(x) - 4 \cos(x)$ .

Answer: \_\_\_\_\_

Round:    1    2    3    4    5