Please Note: (E) NOTA denotes none of the above (answers are correct).

$\boxed{1}$ A unit circle is cut into 2012 pieces (all equal in arc length) by 2012 distinct points. Three of them are chosen at random. The probability that these three points form a right triangle is m/n where m and n are relatively prime integers. What is $m+n$?

(A) 673491 **(B)** 673686 **(C)** 2014 **(D)** 2013 **(E)** NOTA

$\boxed{2}$ Consider the equation of circle ω given by: $(x+1)^2+(y+1)^2=1$. Let $u=ab$ where the point (a,b) lies on the circle. Find the sum of the largest and smallest value of u.

(A) $3+2\sqrt{2}$ **(B)** $\frac{3}{2}+\sqrt{2}$ **(C)** $\sqrt{2}$ **(D)** $\frac{3}{2}$ **(E)** NOTA

$\boxed{3}$ There are two distinct lines tangent to circle ω (see question (3)) which pass through $(5,3)$. The larger of the slopes of these two lines can be expressed in the form $\frac{x+\sqrt{y}}{z}$ where $x,y,z\in\mathbb{Z}$ and where y isn't divisible by the square of any prime. Find the sum of x, y, and z.

(A) 120 **(B)** 110 **(C)** 100 **(D)** 90 **(E)** NOTA

$\boxed{4}$ What is the area of the triangle formed by connecting the points $(0,0,0)$, $(1,1,2)$, and $(3,4,2)$?

(A) $\sqrt{61}$ **(B)** $\sqrt{53}$ **(C)** $\sqrt{61}/2$ **(D)** $\sqrt{53}/2$ **(E)** NOTA

$\boxed{5}$ The vectors $\langle 1,1\rangle$ and $\langle 7,k\rangle$ will be orthogonal for which value(s) of k?

(A) 7 **(B)** -7 **(C)** 7 and -7 **(D)** -1 **(E)** NOTA

$\boxed{6}$ What is the maximum number of regions 2011 lines divide a plane into (you may assume that all the lines lie in the given plane)?

(A) $\dfrac{2011^2+2009}{2}$ **(B)** 2011^2+2011 **(C)** $\dfrac{2011^2+2011}{2}$

(D) $\dfrac{2011^2+2013}{2}$ **(E)** NOTA

$\boxed{7}$ Consider two integers, a and b, which are both randomly chosen from the interval $(0,2012)$. What is the probability that the sum of the slopes of the asymptotes of the hyperbola shown below is zero?

$$\frac{(x-b)^2}{a^2}-\frac{y^2}{4b^2}=1$$

(A) 1/2011 **(B)** 1/2012 **(C)** $\dfrac{1}{\binom{2011}{2}}$ **(D)** $\dfrac{1}{\binom{2010}{2}}$ **(E)** NOTA

$\boxed{8}$ The three points $(1,1)$, $(k,3)$, and $(2,k)$ will all lie on a circle except for t (an integer) values of k. Find the sum of the possible values of k and the value of t.

(A) $4+\sqrt{2}$ **(B)** 4 **(C)** $2+\sqrt{2}$ **(D)** $1+\sqrt{2}$ **(E)** NOTA

For Questions **(9)**, and **(10)** let $\vec{i}=\langle 1,0,0\rangle$, $\vec{j}=\langle 0,1,0\rangle$, and $\vec{k}=\langle 0,0,1\rangle$.

$\boxed{9}$ Let $\vec{u}=i\times(j\times k)$. What is $||\vec{u}||$?

(A) 0 **(B)** 1 **(C)** $\sqrt{3}$ **(D)** 3 **(E)** NOTA

$\boxed{10}$ Let $\vec{v}=i\times(j\times(k\times(i\times(j\times k\times(i\times(j\times(j\times k)))))))$. Find $||\vec{v}||$.

(A) 0 **(B)** 1 **(C)** $\sqrt{3}$ **(D)** 3 **(E)** NOTA

$\boxed{11}$ Consider the two sets: $A=\{(x,y)\mid x^2+y^2=4\}$, and $B=\{(x,y)\mid(x-3)^2+(y-4)^2=r^2\}$. If the intersection of sets A and B only has one element, what is the sum of the possible values of r (assuming they are positive)?

(A) 3 **(B)** 4 **(C)** 7 **(D)** 10 **(E)** NOTA

$\boxed{12}$ By definition, if $\vec{a}$ and $\vec{b}$ are vectors, and θ is the angle between then, then $||\vec{a}\times\vec{b}||$ is equivalent to . . .

(A) $\sin\theta$ **(B)** $\cos\theta$ **(C)** $||\vec{a}||||\vec{b}||\cos\theta$ **(D)** $||\vec{a}||||\vec{b}||\sin\theta$ **(E)** NOTA

$\boxed{13}$ Let θ be the angle, in degrees, between the two vectors $\langle 1,1,1\rangle$ and $\langle 2,4,3\rangle$. In which of the following intervals does θ lie? **NOTE:** all intervals are in degrees.

(A) $(0,20)$ **(B)** $(20,40)$ **(C)** $(40,60)$ **(D)** $(60,80)$ **(E)** NOTA

$\boxed{14}$ Consider the plane which passes through the points $(1,2,1)$, $(0,3,1)$, and $(2,5,7)$ What is the shortest distance between this plane and the point $(-1,-2,2)$?

(A) $\frac{5\sqrt{11}}{11}$ **(B)** $\frac{10\sqrt{11}}{11}$ **(C)** $\frac{5\sqrt{22}}{11}$ **(D)** $\frac{10\sqrt{22}}{11}$ **(E)** NOTA

$\boxed{15}$ Vectors, $\vec{a}$ and $\vec{b}$ are said to be orthogonal if . . . (in the following answer choices, θ is the smaller angle between the two vectors).

(A) $\sin\theta=0$ **(B)** $\cos\theta=0$ **(C)** $\tan\theta=0$

(D) $\tan\theta$ is undefined **(E)** NOTA

$\boxed{16}$ Find the area of the polar graph: $r = \dfrac{5}{3 + 2\cos\theta}$.

(A) $3\pi\sqrt{5}$ **(B)** $3\pi\sqrt{6}$ **(C)** $3\pi\sqrt{7}$ **(D)** $6\pi\sqrt{2}$ **(E)** NOTA

$\boxed{17}$ What is the eccentricity of the graph of: $2012! \cdot y^2 = \dfrac{1}{2011!}(x - 2010!)$?

(A) 0 **(B)** 1 **(C)** $2012! \cdot 2011!$ **(D)** $\dfrac{1}{2011! \cdot 2012!}$ **(E)** NOTA

$\boxed{18}$ In a certain ellipse, one of its foci lies at $(2012, 2012)$. If the point $(0, 0)$ is on the graph, and the ellipse has major axis length $2012^2\sqrt{2}$, then which of the following might be the coordinate of the other focus?

(A) $(2012, -2012)$ **(B)** $(-2012, 2012)$ **(C)** $(-2011^2 \cdot 2012^2, 0)$

(D) $(2011^2 \cdot 2012^2 \cdot 2, 0)$ **(E)** NOTA

$\boxed{19}$ What is the slope of the line tangent to the circle $(x-2)^2 + (y-3)^2 = 2$ at the point with x-coordinate 2 and y-value greater than 3?

(A) $3 + \sqrt{2}$ **(B)** $(3 + \sqrt{2})/2$ **(C)** 0 **(D)** $3 - \sqrt{2}$ **(E)** NOTA

$\boxed{20}$ The polar point $\left(2, \frac{\pi}{3}\right)$ in rectangular coordinates is . . .

(A) $(1, \sqrt{3})$ **(B)** $(\sqrt{3}, 1)$ **(C)** $(2, 2\sqrt{3})$ **(D)** $(2\sqrt{3}, 2)$ **(E)** NOTA

$\boxed{21}$ How many distinguishable permutations of the words *analytic* exist?

(A) 40,320 **(B)** 20,160 **(C)** 10,080 **(D)** 5040 **(E)** NOTA

$\boxed{22}$ The points $(1, 1)$, $(5, 3)$, and (a, b) form an equilateral triangle. Find the minimum value of ab.

(A) $-4 - 3\sqrt{3}$ **(B)** $-4\sqrt{3}$ **(C)** $3\sqrt{3} - 4$ **(D)** 1 **(E)** NOTA

$\boxed{23}$ What is the angle between the space diagonal of a cube and one of its face diagonals?

(A) $\sqrt{3}/2$ **(B)** $\sqrt{6}/2$ **(C)** $\arccos\left(\frac{\sqrt{6}}{2}\right)$ **(D)** $\arccos\left(\frac{\sqrt{3}}{2}\right)$ **(E)** NOTA

$\boxed{24}$ Let R be the circumradius and r be the in-radius of a generic triangle ABC. The law of sines says that:

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} = \frac{1}{X}$$

Which of the following is X?

(A) R **(B)** $2R$ **(C)** r **(D)** $2r$ **(E)** NOTA

$\boxed{25}$ Consider the graph f defined parametrically by: $x = \sin(2t)$ and $y = \cos t$. What kind of graph is this?

(A) Parabola **(B)** Circle **(C)** Ellipse **(D)** Hyperbola **(E)** NOTA

$\boxed{26}$ The area of one of the "petals" on the graph of the rose $r = 12\cos(6\theta)$ is 6π. What is the area of the entire graph?

(A) 12π **(B)** 24π **(C)** 36π **(D)** 72π **(E)** NOTA

$\boxed{27}$ The circle which passes through the points $(1, 1)$, $(0, 2)$, and $(4, 0)$ can be expressed in the form $x^2 + y^2 + Ax + By + C = 0$. Compute ABC.

(A) -1280 **(B)** -128 **(C)** 128 **(D)** 1280 **(E)** NOTA

$\boxed{28}$ The solutions to $x^3 - 1 = 0$, when graphed in the complex plane, form an equilateral triangle. Find this triangle's area.

(A) $3\sqrt{3}/4$ **(B)** $\sqrt{3}/4$ **(C)** $3/4$ **(D)** $\sqrt{3}$ **(E)** NOTA

$\boxed{29}$ The graph of $\pm(x^2 + y^2)^{\frac{3}{2}} = 2xy$ is that of a . . .

(A) *rose* **(B)** *lemniscate* **(C)** *cardioid* **(D)** *spiral* **(E)** NOTA

$\boxed{30}$ Suppose the centroid of triangle EFG, where the vertices have coordinates $E(1, 1)$, $F(2, 3)$, and $G(4, 7)$, is $C(m, n)$. Find the sum $m + n$.

(A) 9 **(B)** $17/2$ **(C)** $17/3$ **(D)** 6 **(E)** NOTA