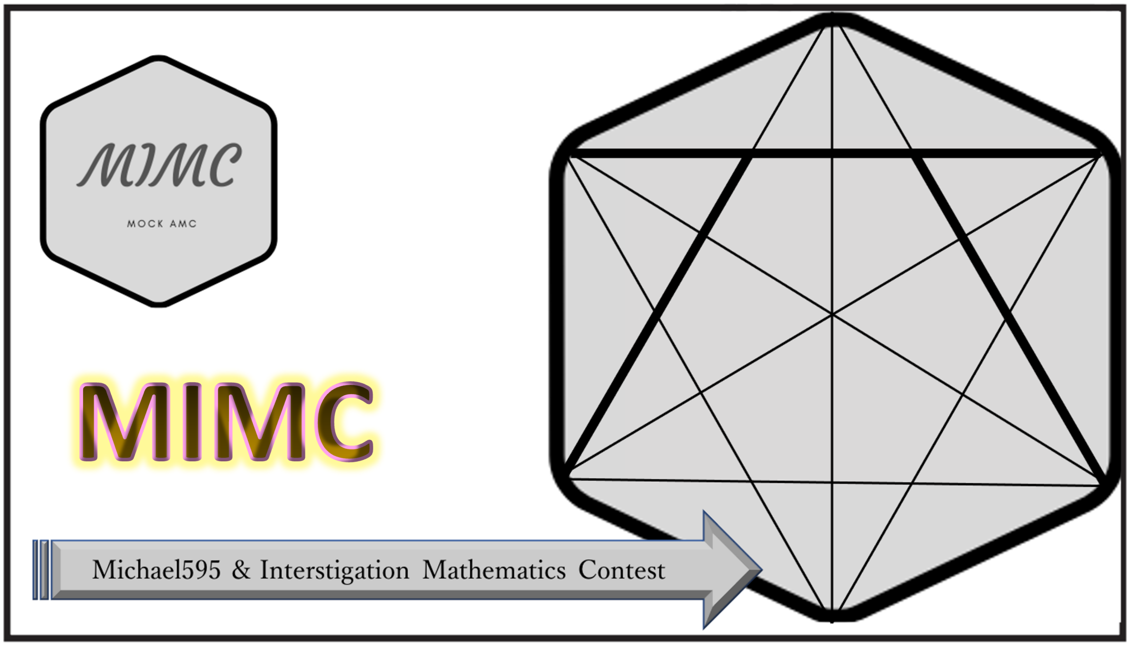


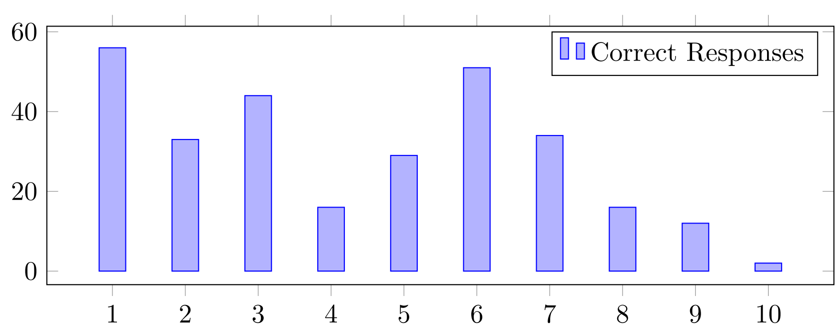
ANSWERS

#1	#2	#3	#4	#5
16393	$\frac{16\pi\sqrt{3}}{3}$	$\frac{10}{7}$	$4\sqrt{2+2\sqrt{2}}$	3

#6	#7	#8	#9	#10
384	1	\$25	$k(1, 10, 25, -134, -774, 5945),\ k \in \mathbb{R}$	926640

STATISTICS

Number of Responses:	59	Minimum:	0
Mean:	4.95	First Quartile:	4
Standard Deviation:	2.08	Median:	5
Mode:	5	Third Quartile:	6
Range:	10	Maximum:	10



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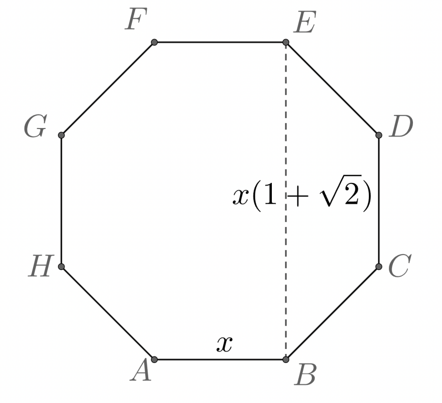
1. The answer is just
$$3 \oplus 4 = 3^2 + 4^7 = 9 + 16384 = \boxed{16393}.$$

2. Divide 16 on both sides to get
$$\frac{x^2}{16/3} + \frac{y^2}{16} = 1,$$
which is an ellipse. The area of the ellipse is πab where a and b are the length of semi-major and minor axes of the ellipse, respectively. Therefore, $a = \sqrt{16} = 4$ and $b = \sqrt{16/3} = \frac{4}{\sqrt{3}}$, so the area of the ellipse is
$$\pi ab = \pi(4)\left(\frac{4}{\sqrt{3}}\right) = \frac{16\pi}{\sqrt{3}} = \boxed{\frac{16\pi\sqrt{3}}{3}}.$$

3. Start by solving the first equation. Cross-multiply to get $a + \sqrt{3} = 3a - 3\sqrt{3}$, so $a = 2\sqrt{3}$.

   In the second equation, we can do a bit of simplification by factoring out $\sqrt{3}$ to get $\frac{2+k}{2-k} = 6$, which $2 + k = 12 - 6k \Longrightarrow k = \boxed{\frac{10}{7}}$.

4. Let the side length of the octagon be x. Then $BE = x + \frac{\sqrt{2}}{2}x + \frac{\sqrt{2}}{2}x = x(1+\sqrt{2})$.



We can break up the image into two trapezoids and a rectangle. Each trapezoid has area

$$\frac{1}{2}\left[x + x(1+\sqrt{2})\right]\left(\frac{x\sqrt{2}}{2}\right) = \frac{(2+\sqrt{2})\sqrt{2}}{4}x^2 = \frac{2\sqrt{2}+2}{4}x^2 = \frac{1+\sqrt{2}}{2}x^2,$$

and the rectangle has area

$$x\left[x(1+\sqrt{2})\right] = (1+\sqrt{2})x^2.$$

Therefore, the total area is

$$(1+\sqrt{2}+1+\sqrt{2})x^2 = 64,$$

solving for x, we get

$$x^2 = \frac{32}{1+\sqrt{2}} \Longrightarrow x = \frac{4\sqrt{2}}{\sqrt{1+\sqrt{2}}},$$

which means that $BE = x(1+\sqrt{2}) = \frac{4\sqrt{2}}{\sqrt{1+\sqrt{2}}}(1+\sqrt{2}) = 4\sqrt{2}\sqrt{1+\sqrt{2}} = \boxed{4\sqrt{2+2\sqrt{2}}}$.

5. (a): This obviously works because $1 > 0.9999$.
(b): This does not work because 1.7 is barely less than the longest distance between any two points within the unit cube since the space diagonal is $\sqrt{1+1+1} = \sqrt{3}$, which is about 1.72, and all these space diagonals passes through the center, so it wouldn't be possible to form a triangle with these three lengths.
(c): It is easy to prove that it is possible to include a tetrahedral with side length $\sqrt{2}$ when all the sides are one of the diagonal on a surface, which is a unit square.
(d): Notice that the base radius of 0.001 is very small, so we can treat the cynlinder as a line of length 1.7. The longest diagonal in a unit cube is $\sqrt{3} > 1.7$, so it is possible.

Overall, $\boxed{3}$ of the four options can fit inside a unit cube.

6. We can either brute force calculate the problem:

$$2^2 + 3^2 + \cdots + 10^2 = 4 + 9 + 16 + 25 + 36 + 49 + 64 + 81 + 100 = \boxed{384}.$$

Or we can use the formula that $1^2 + 2^2 + \cdots + n^2 = \frac{n(n+1)(2n+1)}{6}$. That is,

$$2^2 + 3^2 + \cdots + 10^2 = 1^2 + 2^2 + \cdots + 10^2 - 1^2 = \frac{10 \cdot 11 \cdot 21}{6} - 1 = 385 - 1 = \boxed{384}.$$

7. We just set $f(x) = 1$:

$$\begin{aligned}
\frac{-x^2 + 2x + 1}{1 - x^2} + 2x\sqrt{1 - x^2} &= 1 \\
\frac{-x^2 + 2x + 1 - 1 + x^2}{1 - x^2} + 2x\sqrt{1 - x^2} &= 0 \\
\frac{2x}{1 - x^2} + 2x\sqrt{1 - x^2} &= 0 \\
2x\left(\frac{1}{1 - x^2} + \sqrt{1 - x^2}\right) &= 0
\end{aligned}$$

The only case for this equation to hold is when $2x = 0 \implies x = 0$ because the expression $\frac{1}{1-x^2} + \sqrt{1 - x^2} = 0$ is impossible to achieve: $\frac{1}{1-x^2} > 1$ and $\sqrt{1 - x^2}$ is always greater than or equal to 0, so 0 is the only solution, which there is only $\boxed{1}$ zero.

8. Let H denote a head and T denote a tail. Note that if HT, TH, TT occur during any time, then Newton is guaranteed to win because Newton has already won with THH in order for two heads in a row to appear to make the HHT in Farad's winning position as there is always a tail before a head. Only when HH is the first two flips would Farad be guaranteed to win.

Thus the probability of Farad to win is $\frac{1}{4}$, and since he would get \$100 per win, he would be willing to pay $\frac{1}{4}(\$100) = \boxed{\$25}$.

9. We will use the well-known point-distance formula that the distance between (x_1, y_1) and a line $ax + by + c = 0$ is

$$\frac{|ax_1 + by_1 + c|}{\sqrt{a^2 + b^2}}$$

From the definition of a parabola, let the coordinates of the focus be (p_1, p_2), then the distance from the focus to a point on the parabola is equal to the distance from that point to the directrix.

Thus, the equation below holds:

$$\begin{aligned}
\sqrt{(x-2)^2 + (y-15)^2} &= \frac{|5x - y + 3|}{\sqrt{5^2 + 1^2}} \\
(x-2)^2 + (y-15)^2 &= \frac{(5x - y + 3)^2}{26} \\
26(x^2 - 4x + 4 + y^2 - 30y + 225) &= (5x - y)^2 + 3^2 + 6(5x - y) \\
26x^2 - 104x + 104 + 26y^2 - 780y + 5850 &= 25x^2 + y^2 - 10xy + 9 + 30x - 6y \\
x^2 - 10xy + 25y^2 - 134x - 774y + 5945 &= 0
\end{aligned}$$

Therefore, the answer is $\boxed{(1, 10, 25, -134, -774, 5945)}$. Note that the equation is set to zero on the right side, so any multiple of this sextuple would work. Thus any answer here would work:

$$k(1, 10, 25, -134, -774, 5945), \qquad k \in \mathbb{R}.$$

10. We need to make sure that

1,2,3	2,4,6	3,6,9
4,8,12	5,10	6,12

are in this specific ordering. Note that we can group the thirteen numbers into five groups:

$$(1, 2, 3, 4, 6, 8, 9, 12) \quad (5, 10) \quad (7) \quad (11) \quad (13)$$

such that there are no requirements between two different groups. After ordering the numbers internally within each group, there are $\frac{13!}{8!2!1!1!1!} = 77220$ ways to order the five groups into an overall ordering.

There are 12 ways to order the first group:

$$\begin{array}{ll}
(1, 2, 3, 4, 6, 8, 9, 12) & (1, 2, 4, 3, 6, 8, 12, 9) \\
(1, 2, 3, 4, 6, 8, 12, 9) & (1, 2, 4, 3, 6, 9, 8, 12) \\
(1, 2, 3, 4, 6, 9, 8, 12) & (1, 2, 4, 3, 8, 6, 9, 12) \\
(1, 2, 3, 4, 8, 6, 9, 12) & (1, 2, 4, 3, 8, 6, 12, 9) \\
(1, 2, 3, 4, 8, 6, 12, 9) & (1, 2, 4, 8, 3, 6, 9, 12) \\
(1, 2, 4, 3, 6, 8, 9, 12) & (1, 2, 4, 8, 3, 6, 12, 9)
\end{array}$$

There is 1 way to order each of the last four groups, so overall there are $77220 \cdot 12 = \boxed{926640}$ orderings.