

# MATHEMATICS

## 1. MATHEMATICS

Toss Up: Short Answer

How many non empty subsets are there of the set  $\{1,2,6,9\}$ ?

Bonus Answer: 15

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Bonus: Short Answer

What are the roots of  $x^4-5x^2+4$ ?

Bonus Answer: 1,-1,4,-4

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## 2. MATHEMATICS

Toss Up: Short Answer

What number is a factor of  $y^3 + 10y^2 + 123y + 5$ ?

Bonus Answer: 1, -1

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Bonus: Short Answer

What is the area of a equilateral triangle inscribed in a circle with a radius of 6?

Bonus Answer:  $(27(\text{radical } 3))$

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## 3. MATHEMATICS

Toss Up: Multiple Choice

What is the height of an equilateral triangle with side length 4?

W) 8

X) 4

Y)  $2\text{rad}3$

Z)  $4\text{rad}3$

Toss Up Answer: Y

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Bonus: Short Answer

What is the area of an isosceles right triangle with hypotenuse  $10\text{rad}2$ ?

Bonus Answer: 50

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## 4. MATHEMATICS

Toss Up: Multiple Choice

Which of the following has the largest amplitude?

W)  $9\sin(x) - 2$

X)  $2\cos(6x) + 5$

Y)  $\cos(2x)$

Z)  $4\sin(10x)$

Toss Up Answer: W

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Bonus: Short Answer

What power of 10 is closest to 255?

Bonus Answer: 10 to the 16

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## 5. MATHEMATICS

Toss Up: Short Answer

What is the derivative of  $x^2$ ?

Bonus Answer:  $2x$

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**Bonus: Short Answer**

What is the derivative of  $42x^2$

**Bonus Answer:  $84x$**

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**6. MATHEMATICS****Toss Up: Short Answer**

For all positive integers  $n$ , what is the degree of the polynomial  $(x^2 - 3)^{(2n)}$  in terms of  $n$ .

**Bonus Answer:  $4n$**

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**Bonus: Short Answer**

State the solutions, in increasing value, for the equation  $(x+1)^3 - x^3 - x^2 = 0$

**Bonus Answer: (Only accept the answers read in this order):  $-1$ ,  $-1/2$**

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**7. MATHEMATICS****Toss Up: Short Answer**

Compute  $100^2 - 98 \cdot 102$

**Bonus Answer:  $4$**

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**Bonus: Multiple Choice**

The absolute value of  $n^2 - (n+x)(n-x)$ , where  $n$  and  $x$  are positive integers, is always:

W)  $-(x^2)$

X)  $n^2$

Y)  $2 \cdot x \cdot n$

Z)  $x^2$

**Bonus Answer: Z**

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**8. MATHEMATICS****Toss Up: Short Answer**

Find the product of all primes less than 11.

**Bonus Answer:  $210$**

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**Bonus: Multiple Choice**

Find the number of triangular numbers less than 2016.

W) 58

X) 60

Y) 62

Z) 64

**Bonus Answer: Y**

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**9. MATHEMATICS****Toss Up: Multiple Choice**

Which three numbers satisfy the Pythagorean Theorem?

W) 1, 1, and  $\sqrt{3}$

X) 3, 4, and 5.01

Y)  $\pi/3$ ,  $\pi/4$ ,  $\pi/5$

Z)  $1/3$ ,  $1/4$ ,  $5/12$

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Triangle ABC has side lengths of 10, 10, and  $10\sqrt{2}$ . State all distinct median lengths of the triangle in increasing value.

**Bonus Answer:**  $5\sqrt{2}$ ,  $5\sqrt{5}$  (only accept the numbers said in that order).

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**10. MATHEMATICS****Toss Up: Short Answer**

What is the full name of the French mathematician who invented the Cartesian coordinate plane?

**Bonus Answer:** Rene Descartes (You may also accept Descartes Rene, but do not accept Descartes or Rene)

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**Bonus: Short Answer**

What is the name of the value of  $x$  in the ordered pair  $(x,y)$

**Bonus Answer:** Abscissa

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**11. MATHEMATICS****Toss Up: Short Answer**

Find the limit of  $(x^2 - x - 2)/(x + 1)$  as  $x$  approaches  $-1$ .

**Bonus Answer:**  $-3$

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**Bonus: Short Answer**

Find the limit of  $(x^2 + 6x + 5)/x^3$  as  $x$  approaches infinite

**Bonus Answer:** 0

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**12. MATHEMATICS****Toss Up: Short Answer**

There are 27 people in a party. If 16 people wanted ice cream and 17 people wanted chocolate, at most how many people wanted only ice cream?

**Bonus Answer:** 10

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**Bonus: Short Answer**

How many non congruent rectangles are there with an area of 324 and positive integer side lengths?

**Bonus Answer:** 8

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**13. MATHEMATICS****Toss Up: Short Answer**

If  $x^5 - 4x^4 + 3x^2 - 2x + 1 = 0$ , find the sum of all five of the roots.

**Bonus Answer:** 4

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**Bonus: Short Answer**

If polynomial  $P(x)$  leaves a remainder of 5 when divided by  $x-1$  and a remainder of 7 when divided by  $x+1$ , find the remainder when  $P(x)$  is divided by  $x^2-1$ .

**Bonus Answer:**  $-x+6$

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**14. MATHEMATICS****Toss Up: Multiple Choice**

Which of the following shapes is always cyclic?

W) A parallelogram

X) A rhombus

Y) An obtuse triangle

Z) A pentagon

**Toss Up Answer: Y**

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**Bonus: Short Answer**

In a triangle with side lengths 10,  $10\sqrt{3}$ , and 20, find the length of the angle bisector which intersects the side of length  $10\sqrt{3}$ .

**Bonus Answer:  $20\sqrt{3}/3$**

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## 15. MATHEMATICS

**Toss Up: Short Answer**

In what type of triangle is the angle bisector, the altitude and the median the same line?

**Bonus Answer: Isosceles or equilateral triangle**

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**Bonus: Short Answer**

Find the other roots of  $x^3 + 6x^2 - 13x - 42$  if one of them is -2

**Bonus Answer: -7, 3**

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## 16. MATHEMATICS

**Toss Up: Multiple Choice**

A set is countable:

W) If and only if it is finite.

X) If and only if a surjection can be made between the set and the natural numbers.

Y) If it has the same cardinality as some subset of the natural numbers.

Z) If it has the same cardinality as some subset of the real numbers.

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Who was the famous German mathematician that invented Set Theory and effectively proved the uncountableness of the reals?

**Bonus Answer: Georg Cantor (accept Cantor)**

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## 17. MATHEMATICS

**Toss Up: Short Answer**

What is  $64x^3 + 27y^3$  factored in simplest form?

**Bonus Answer:  $(4x+3y)(16x^2-12xy+9y^2)$**

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**Bonus: Short Answer**

If  $i$  is the square root of -1, what is the value of  $i^{97}$ ?

**Bonus Answer:  $i$**

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## 18. MATHEMATICS

**Toss Up: Short Answer**

If Robert can paint a fence in 12 hours and George can paint a fence in 6 hours how long will they take to paint the fence together?

**Bonus Answer: 4 hours**

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**Bonus: Multiple Choice**

What is the coefficient of the 3rd term in the expansion of  $(x+y)^7$

W) 1

X) 7

Y) 21

Z) 35

**Bonus Answer: Y**

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## 19. MATHEMATICS

**Toss Up: Multiple Choice**

Simplify the following expression:  $(x^3+27)/(x+3)$  if  $x=12$

W) 125

X) 117

Y) 136

Z) 109

**Toss Up Answer: X**

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**Bonus: Short Answer**

Find all the real solutions of  $x^4-18=-2$

**Bonus Answer:  $x=2, x=-2$**

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## 20. MATHEMATICS

**Toss Up: Short Answer**

What is the sum of the interior angles of a nonagon?

**Bonus Answer: 1260 degrees**

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**Bonus: Short Answer**

How many edges does an octahedral prism have?

**Bonus Answer: 24 edges**

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## 21. MATHEMATICS

**Toss Up: Short Answer**

Convert CD from hexadecimal to decimal

**Bonus Answer: 205**

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**Bonus: Short Answer**

Convert CD from hexadecimal to binary

**Bonus Answer: 11001101**

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## 22. MATHEMATICS

**Toss Up: Short Answer**

What is the slope of the tangent line to  $e^{(2x)}$  at  $x=3$

**Bonus Answer:  $2e^6$**

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**Bonus: Short Answer**

What is the slope of the tangent line to  $\ln(2x)$  at  $x=3$

**Bonus Answer:  $1/3$**

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## 23. MATHEMATICS

**Toss Up: Short Answer**

What is the area of the circle  $x^2+y^2=6/\pi^2$  in terms of  $\pi$

**Bonus Answer:  $6/\pi$**

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**Bonus: Short Answer**

What is the area of the circle  $x^2-4x+y^2-6y-2=0$  in terms of  $\pi$

**Bonus Answer:  $15\pi$**

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**24. MATHEMATICS**

**Toss Up: Short Answer**

How many distinct roots does  $x^3-6x^2+32$  have

**Bonus Answer: 2**

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**Bonus: Short Answer**

What is the remainder when  $x^3-6x^2+32$  is divided by  $x-1$

**Bonus Answer: 27**

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**25. MATHEMATICS**

**Toss Up: Short Answer**

How many seconds are in a day

**Bonus Answer: 86400**

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**Bonus: Multiple Choice**

How many days are in a second

W)  $1.16 \cdot 10^{-3}$

X)  $1.16 \cdot 10^{-4}$

Y)  $1.16 \cdot 10^{-5}$

Z)  $1.16 \cdot 10^{-6}$

**Bonus Answer: Y**

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**26. MATHEMATICS**

**Toss Up: Short Answer**

What is  $\tan(\arcsin(9/41))$

**Bonus Answer:  $9/40$**

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**Bonus: Short Answer**

What is  $\sin(\operatorname{arccot}(\tan(\arccos(3/5))))$

**Bonus Answer:  $3/5$**

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**27. MATHEMATICS**

**Toss Up: Short Answer**

What is the amplitude of  $y=4\sin(5x+3)$

**Bonus Answer: 4**

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**Bonus: Short Answer**

What is the period of  $y=4\sin(5x+3)$  rounded to the nearest 100th

**Bonus Answer: 1.26**

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**28. MATHEMATICS**

**Toss Up: Short Answer**

Prime factorize 273.

**Bonus Answer:  $3 \cdot 7 \cdot 13$**

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**Bonus: Multiple Choice**

Which of the following numbers is a root of unity?

W)  $1 + i$

X)  $\frac{1}{2} + \frac{1}{2}(\sqrt{3})(i)$

Y)  $3 + 4i$

Z)  $\frac{1}{2}(\sqrt{2}) + \frac{3}{2}(\sqrt{2})(i)$

**Bonus Answer: X**

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**29. MATHEMATICS**

**Toss Up: Short Answer**

How many ways are there to distribute 4 identical blue balls and 3 identical red balls among 3 people?

**Bonus Answer: 315 (accept  $21 \cdot 15$ )**

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**Bonus: Short Answer**

What are all possible shapes that are yielded by inverting a circle across another circle?

**Bonus Answer: circle, line**

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**30. MATHEMATICS**

**Toss Up: Multiple Choice**

How many zeroes does the equation  $x^3 + 6x^2 + 11x + 6 = 0$  have?

W) 1

X) 2

Y) 3

Z) 4

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Find the solution(s) of the following system of linear equations:  $2x + 4y = 6$ ,  $x + 2y = 5$

**Bonus Answer: No solutions**

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**31. MATHEMATICS**

**Toss Up: Multiple Choice**

If  $x$  is positive, what is the minimum value of  $2x + (2/x)$ ?

W) 1

X) 2

Y) 3

Z) 4

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

What is  $f(15)$  if  $f(x) = 2\sin(x)\cos(x)$ , where  $x$  is in degrees?

W)  $(\sqrt{3})/2$

X)  $1/(\sqrt{3})$

Y)  $1/2$

Z) 1

**Bonus Answer: Y**

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### 32. MATHEMATICS

Toss Up: Short Answer

$$(mn)^2 - p^2$$

Bonus Answer:  $(mn - p)(mn + p)$

Difference of Squares

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Bonus: Short Answer

Factor  $a^4 + 4b^4$

Bonus Answer:  $(a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)$

Solution:

$$a^4 + 4b^4 = a^4 + 4a^2b^2 + 4b^4 - 4a^2b^2$$

$$(a^2 + 2b^2)^2 - (2ab)^2 = (a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)$$

Difference of Squares

(This is also the Sophie Germain Identity)

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### 33. MATHEMATICS

Toss Up: Multiple Choice

$f(x) = x^4 + 5x^8 + 7x^6 + 5$  Which of the following is true about  $f(x)$ ?

W)  $f(x)$  is odd, only

X)  $f(x)$  is even, only

Y)  $f(x)$  is neither odd nor even

Z)  $f(x)$  is both even and odd

Toss Up Answer: X

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Bonus: Short Answer

Simplify:  $\cos(\sin^{-1}(3/5))$

Bonus Answer:  $4/5$

Solution:

Draw a 3-4-5 right triangle and find the angle that  $\sin^{-1}(3/5)$  is equal to. Then, take its cosine.

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### 34. MATHEMATICS

Toss Up: Multiple Choice

Which of the following types of symmetry does  $x^2 + (y-1)^2 = 36$  have?

W) Y-axis symmetry, only

X) X-axis symmetry, only

Y) Both x and y axis symmetry

Z) Neither x nor y axis symmetry

Toss Up Answer: Y

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Bonus: Multiple Choice

Which of the following types of symmetry does  $x^2 - y^2 = 36$  have?

W) Y-axis symmetry, only

X) X-axis symmetry, only

Y) Both x and y axis symmetry

Z) Neither x nor y axis symmetry

Bonus Answer: Y

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### 35. MATHEMATICS



**Toss Up: Multiple Choice**

What is the area of an equilateral triangle with side lengths 2?

- W) 1
- X)  $\sqrt{3}$
- Y)  $\sqrt{6}$
- Z) 2

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

If the roots of  $P(x) = 64x^2 - 24x + 2$  are A and B, what is the harmonic mean of A and B in simplest fractional form?

- W)  $\frac{1}{3}$
- X)  $\frac{1}{6}$
- Y)  $\frac{1}{12}$
- Z)  $\frac{1}{24}$

**Bonus Answer: X**

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**36. MATHEMATICS****Toss Up: Multiple Choice**

Given  $P(x) = x^2 + ax + b$  and  $P(1) = 9$ , what is  $a + b$ ?

- W) 8
- X) 10
- Y) 9
- Z) 1

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Factor the following completely:  $(4x^4) - (20x^2) + 16$

- W)  $(x+1)(x-1)(x+2)(x-2)$
- X)  $(x+1)(x+1)(x-2)(x-2)$
- Y)  $4(x+1)(x-1)(x+2)(x-2)$
- Z)  $4(x+1)(x+1)(x-2)(x-2)$

**Bonus Answer: Y**

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**37. MATHEMATICS****Toss Up: Multiple Choice**

Simplify:  $(24 \cdot 63) / (72 \cdot 21)$

- W) 1
- X) 3
- Y) 7
- Z)  $\frac{1}{3}$

**Toss Up Answer: W**

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**Bonus: Short Answer**

Simplify  $(333(x^4 - x^2)) / (9(x^2 + 2x + 1)(x^2))$

**Bonus Answer:  $(x-1) / ((37)(x+1))$**

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## 38. MATHEMATICS

**Toss Up: Short Answer**

Compute:  $\sqrt{(3 \cdot 4 \cdot 5 - 60)^2}$

**Bonus Answer: 0**

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**Bonus: Short Answer**

Compute  $(\frac{34}{17} - 2 + 5) \cdot (96 + -144) \cdot (\frac{1}{46 - \frac{130}{5}})$

**Bonus Answer: -12**

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## 39. MATHEMATICS

**Toss Up: Short Answer**

What is the slope of a line parallel to  $45x = 9y + 5$ ?

**Bonus Answer: 5**

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**Bonus: Multiple Choice**

How many vertical asymptotes does  $f(x) = \frac{(x^2 + 2x + 1)}{(x^3 - x)}$  have?

W) 0

X) 1

Y) 2

Z) 3

**Bonus Answer: Y**

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## 40. MATHEMATICS

**Toss Up: Multiple Choice**

Which of the following is true?

W) -1 is congruent to 1 modulo 5

X) -1 is congruent to 2 modulo 5

Y) -1 is congruent to 3 modulo 5

Z) -1 is congruent to 4 modulo 5

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which is larger,  $8^{10}$  or  $3^{30}$ ?

**Bonus Answer:  $3^{30}$**

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## 41. MATHEMATICS

**Toss Up: Short Answer**

What is the solution for square root of the quantity  $x+5$  equals  $x+3$ ?

**Bonus Answer: -1**      **\*(do not except: [-1 and -4] or [-3])**

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**Bonus: Short Answer**

In a certain language of a certain people of a certain world, to frack a number is to find the average of the number and its square. For example, the frack of 2 is 3 since it is the average of 2 and 2 squared. what is the frack of 100?

**Bonus Answer: 2020**

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## 42. MATHEMATICS

**Toss Up: Multiple Choice**

The sum  $(1+3+3^2+\dots+3^n)$  is equal to which of the following?

W)  $2 \cdot 3^n$

X)  $4 \cdot 3^n$

Y)  $(3^{(n+1)}+1)/2$

Z)  $(3^{(n+1)}-1)/2$

**Toss Up Answer: Z**

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**Bonus: Short Answer**

In space, what is the graph of the equation  $x^2 = y$ ?

**Bonus Answer: A parabolic cylinder**

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## 43. MATHEMATICS

**Toss Up: Short Answer**

What is the name for the rule that states that when you have a limit of indeterminate form as a fraction, it is equal to the limit of the derivative of the numerator over the derivative of the denominator?

**Bonus Answer: L'hospital's rule**

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**Bonus: Short Answer**

What famous function, named after a mathematician, takes the infinite sum of the reciprocals of the natural numbers raised to an argument?

**Bonus Answer: Riemann zeta function**

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## 44. MATHEMATICS

**Toss Up: Multiple Choice**

A statement about a relationship between natural quantities. The statement has been tested many times, and has not been contradicted. What is it?

W) Fact

X) Hypothesis

Y) Law

Z) Theory

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

A framework that includes many well-tested and verified hypotheses about one or more aspects of the natural world.

W) Fact

X) Hypothesis

Y) Law

Z) Theory

**Bonus Answer: Z**

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## 45. MATHEMATICS

**Toss Up: Short Answer**

The surface area of a sphere is how many times the area of a circle?

**Bonus Answer: 4**

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**Bonus: Short Answer**

What is the area of a cone?

**Bonus Answer:  $(\pi)r^2h$**

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## 46. MATHEMATICS

### Toss Up: Short Answer

What type of number is defined as a number that is not a root of a polynomial with rational coefficients?

**Bonus Answer:** Transcendental numbers

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### Bonus: Short Answer

Of the following, which of these numbers of transcendental?  $\pi$ ,  $e$ ,  $i$ ,  $\phi$ ,  $e \text{ times } i$ ,  $2^{\sqrt{2}}$

**Bonus Answer:**  $\pi$ ,  $e$ ,  $e \text{ times } i$ ,  $2^{\sqrt{2}}$

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## 47. MATHEMATICS

### Toss Up: Short Answer

Given  $y = |x - 6|$ , what is the derivative at  $x = 6$ ?

**Bonus Answer:** The derivative does not exist

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### Bonus: Short Answer

Find the derivative of  $x^3 / x^2$

**Bonus Answer:** 1

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## 48. MATHEMATICS

### Toss Up: Short Answer

Find the derivative of:  $4x^3 + 18x + 2$

**Bonus Answer:**  $8x^2 + 18$

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### Bonus: Short Answer

At what point is the slope of the tangent line to the parabola  $y = 3x^2 + 5x + 23$  equal to 0?

**Bonus Answer:**  $(-5/6, 441/36)$

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## 49. MATHEMATICS

### Toss Up: Short Answer

Write an equation for a sine function with an amplitude of  $5/3$ , a period of  $\pi/2$ , and a vertical shift of 4 units up.

**Bonus Answer:**  $y = (5/3)\sin(4x) + 4$

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### Bonus: Short Answer

Two large and 1 small pumps can fill a swimming pool in 4 hours. One large and 3 small pumps can also fill the same swimming pool in 4 hours. How many hours will it take 4 large and 4 small pumps to fill the swimming pool.

**Bonus Answer:** 1 hour and 40 minutes

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## 50. MATHEMATICS

### Toss Up: Multiple Choice

If a regular hexagon has a side length of 2, what is its area?

W)  $3\sqrt{6}$

X)  $6\sqrt{3}$

Y)  $\sqrt{18}$

Z)  $6\sqrt{2}$

**Toss Up Answer:** X

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### Bonus: Multiple Choice

If  $f(x)$  is  $(\ln(x^2))/(e^x)$ , what is  $f'(x)$  in simplest form?

W)  $((x^2)/2x) + \ln(x^2)/(e^{2x})$

X)  $((2/x) - \ln(x^2))/(e^2)$   
Y)  $(\ln(4/x))/(e^{2x})$   
Z)  $((2x/(x^2)) - \ln(x^2))/(e^{2x})$

**Bonus Answer: X**

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## 51. MATHEMATICS

**Toss Up: Multiple Choice**

$3^{12} = 27^x$ . What is the value of x?

W)  $x=12$

X)  $x=4$

Y)  $x=6$

Z)  $x=3$

**Toss Up Answer: X**

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**Bonus: Short Answer**

$3^{12} + 3^{11} + 3^{10} = b \cdot 3^a$  What is the positive difference between the product and the sum of a and b?

**Bonus Answer: 107**

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## 52. MATHEMATICS

**Toss Up: Multiple Choice**

Donald Trump has  $10x+5$  apples where  $x=3$ . How many apples does he have if he eats two of them?

W) 35

X) 39

Y) 30

Z) 33

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Donald Trump has a tower consisting of  $0.00405 \cdot 10^{45}$  grams of gold. How many kilograms of gold is in his tower?  
Express in scientific notation.

**Bonus Answer:  $4.05 \cdot 10^{39}$  (kilograms of gold)**

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## 53. MATHEMATICS

**Toss Up: Short Answer**

What is the volume of a sphere of radius "R"?

**Bonus Answer:  $(\frac{4}{3}) \pi R^3$**

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**Bonus: Short Answer**

Using an x-y coordinate axis, a parabola is given by the equation  $y = x^2$ . Give the x-y coordinates of the focal point for this parabola.

**Bonus Answer: (0, 1/4)**

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## 54. MATHEMATICS

**Toss Up: Short Answer**

Using an x-y coordinate axis, a parabola is represented by the equation  $x^2 = 6y$ . The vertex of this parabola is at what coordinate point?

**Bonus Answer:** (0,0)

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**Bonus: Short Answer**

For a right triangle, the  $\sin(A)$  is  $3/5$ . To what value is the  $\tan(A)$  equal?

**Bonus Answer:**  $3/4$

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## 55. MATHEMATICS

**Toss Up: Short Answer**

Describe the expression  $2 \log_3 x + \log_3 5$  as a single logarithmic expression

**Bonus Answer:**  $\log_3 (5x^2)$

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**Bonus: Short Answer**

Solve the equation  $2|3x - 2| - 3 = 7$

**Bonus Answer:**  $x = (7/3), -1$

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## 56. MATHEMATICS

**Toss Up: Multiple Choice**

How many roots (real or complex) does  $x^4 - x^3 - 9x^2 + 7x + 14 = 0$  have?

W) 1

X) 2

Y) 3

Z) 4

**Toss Up Answer:** Z

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**Bonus: Short Answer**

Find all real roots of  $x^4 - x^3 - 9x^2 + 7x + 14 = 0$

**Bonus Answer:** -1, 2,  $\pm\sqrt{7}$

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## 57. MATHEMATICS

**Toss Up: Multiple Choice**

If the diameter of a circle is 6 inches, what is the area of the circle?

W)  $36\pi$

X)  $9\pi$

Y)  $12\pi$

Z)  $6\pi$

**Toss Up Answer:** X

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**Bonus: Short Answer**

Find the equation of the line that passes through the point (3,4) and is perpendicular to the line  $y = 3x - 2$ ?

**Bonus Answer:**  $y = -(1/3)x + 5$

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## 58. MATHEMATICS

**Toss Up: Short Answer**

What is the imaginary unit "i" when raised to the power 30?

**Bonus Answer:** -1

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**Bonus: Short Answer**

What is the sum of the first 50 positive integers?

**Bonus Answer:** 1275

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## 59. MATHEMATICS

### Toss Up: Short Answer

What is the 5th term in the geometric progression whose first three terms are 64, 16, 4?

**Bonus Answer: 1/4 or 0.25**

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### Bonus: Short Answer

Giving your answer in centimeters to the nearest whole number, if one leg of an isosceles right triangle is 100 centimeters long, how long is the hypotenuse?

**Bonus Answer: 141**

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## 60. MATHEMATICS

### Toss Up: Short Answer

Solve the following equation for x:  $-3|x| = -15$  (read as: minus 3 times the absolute value of x equals minus 15).

**Bonus Answer: 5 and -5**

---

### Bonus: Short Answer

One-half of a number added to one third of the same number is 68 less than the number. What is the number?

**Bonus Answer: 408**

---

## 61. MATHEMATICS

### Toss Up: Short Answer

If a 6-foot tall person who is standing next to a vertical pole casts a shadow of 8 feet and the pole casts a shadow of 40 feet, how many feet tall is the pole?

**Bonus Answer: 30**

---

### Bonus: Short Answer

Solve the following equation for x:  $(x+9) / (x+10) = 20 / 18$  (read as: the quantity x plus nine over the quantity x plus ten is equal to twenty over eighteen)

**Bonus Answer: -19**

---

## 62. MATHEMATICS

### Toss Up: Multiple Choice

Which of the following numbers is evenly divisible by 4?

W) 1722

X) 2636

Y) 4114

Z) 6126

**Toss Up Answer: X**

---

### Bonus: Short Answer

Rounded to the nearest centimeter, if side A of a right triangle measures 2 centimeters and side B measures 10 centimeters, what is the length of the hypotenuse?

**Bonus Answer: 10**

---

## 63. MATHEMATICS

### Toss Up: Multiple Choice

What is the product of the following 2 values: (1) the greatest common divisor of 7 and 14; and (2) the least common multiple of 7 and 14?

W) 21

X) 49

Y) 98

Z) 196

**Toss Up Answer: Y**

---

**Bonus: Short Answer**

Multiply the following complex numbers, giving your answer in standard

a + bi form:  $(6 + 3i)(4 + i)$

**Bonus Answer:  $21 + 18i$**

---

## 64. MATHEMATICS

**Toss Up: Short Answer**

By words or number, name all of the following 3 statements that are

TRUE for the function,  $f(x) = -3x^2 - 2x - 2 = 0$ :

1) there are no real zeros

2) the graph is a parabola opening downward

3) the graph has no x-intercepts

**Bonus Answer: All or 1,2,3**

---

**Bonus: Short Answer**

Factor the following expression completely over integers:  $x^4 - 16$

**Bonus Answer:  $(x - 2)(x + 2)(x^2 + 4)$**

---

## 65. MATHEMATICS

**Toss Up: Multiple Choice**

What trigonometric ratio is equal to  $1/2$ ?

W)  $\sin 60$

X)  $\sin 30$

Y)  $\cos 30$

Z)  $\sin 30$  degrees

**Toss Up Answer: Z**

---

**Bonus: Short Answer**

What is the probability of rolling a 1 on 3 die rolls?

**Bonus Answer:  $1/216$**

---

## 66. MATHEMATICS

**Toss Up: Short Answer**

What is the probability of rolling a even number on an 8 sided die labeled 1 through 8?

**Bonus Answer:  $1/2$**

---

**Bonus: Short Answer**

What is the probability of rolling an even number on an 8 sided die labeled 1 through 8 and rolling an odd number on a 7 sided die labeled 1 through 7 in simplest fractional form?

**Bonus Answer:  $2/7$**

---

## 67. MATHEMATICS



**Toss Up: Short Answer**

Given a rectangular box with side lengths of 5, 5, and 5, what is the surface area of the box?

**Bonus Answer: 150 units squared (ACCEPT: 150)**

---

**Bonus: Multiple Choice**

The length, in inches, of a box is 3 inches less than twice its width, in inches. Which of the following gives the length, L inches, in terms of the width, W inches, of the box?

W)  $L = .5W + 3$

X)  $L = W - 3$

Y)  $L = 2W + 3$

Z)  $L = 2W - 3$

**Bonus Answer: Z**

---

**68. MATHEMATICS****Toss Up: Short Answer**

What is the value of x when  $2x + 3 = 3x - 4$  ?

**Bonus Answer: 7**

---

**Bonus: Multiple Choice**

What is the greatest common factor of 42, 126, and 210?

W) 2

X) 6

Y) 21

Z) 42

**Bonus Answer: Z**

---

**69. MATHEMATICS****Toss Up: Multiple Choice**

How many irrational numbers are there between 1 and 6?

W) 3

X) 7

Y) 10

Z) infinitely many

**Toss Up Answer: Z**

---

**Bonus: Short Answer**

In the standard (x,y) coordinate plane, 3 vertices of a rectangle are (2,1), (-1,-1), and (6,5). What is the last vertex of the rectangle?

**Bonus Answer: (3, -7)**

---

**70. MATHEMATICS****Toss Up: Short Answer**

What is the tangent of  $(27(\pi)/4)$

**Bonus Answer: -1**

---

**Bonus: Short Answer**

With a 5 percent compound interest rate, how long, to the nearest year, will it take a sum of money to double?

**Bonus Answer: 14 years**

---

## 71. MATHEMATICS

### Toss Up: Short Answer

What is the probability of, in no particular order, flipping exactly 2 heads and 2 tails when flipping 4 coins?

**Bonus Answer:**  $\frac{3}{8}$  (accept .375 or 37.5%)

---

### Bonus: Short Answer

Given a circle centered at 1,2 what is the slope of a tangent line which passes through the point (3,3)

**Bonus Answer:** -2

---

## 72. MATHEMATICS

### Toss Up: Multiple Choice

What is the derivative of the curve  $y = x^3$  at the origin?

- W) 0
- X) 3
- Y) 2
- Z)  $\frac{3}{2}$

**Toss Up Answer:** W

---

### Bonus: Short Answer

Find  $dy/dx$  of  $y = \sin^2 x$

**Bonus Answer:**  $2 (\sin x) (\cos x)$

---

## 73. MATHEMATICS

### Toss Up: Multiple Choice

For the function  $f(x) = (x^2)/(x)$ , what is the limit as  $x$  approaches 0?

- W) 0
- X) 1
- Y) infinity
- Z) There exist no limit.

**Toss Up Answer:** W

---

### Bonus: Short Answer

What is the line called that connects two points of a function, generally associated with average rate of change?

**Bonus Answer:** Secant line

---

## 74. MATHEMATICS

### Toss Up: Short Answer

What is the equation for the axis of symmetry of  $(3x^2) - 6x + 4$ ?

**Bonus Answer:**  $x = 1$  (Don't accept 1 by itself)

---

### Bonus: Multiple Choice

Which of the following is equivalent to  $3 \pmod{4}$ ?

- W)  $32 \pmod{4}$
- X)  $-16 \pmod{4}$
- Y)  $-13 \pmod{4}$
- Z)  $0 \pmod{4}$

**Bonus Answer:** Y

---

## 75. MATHEMATICS

### Toss Up: Multiple Choice

An angle must lie in which two quadrants of the Cartesian coordinate plane for its cosecant to be negative?

- W) one and two
- X) two and three
- Y) three and four
- Z) four and one

Toss Up Answer: Y

---

### Bonus: Short Answer

According to the Fundamental Theorem of Algebra, how many roots in the complex number system must a 7th degree polynomial have?

Bonus Answer: At least 1 (accept 1 as an answer)

---

## 76. MATHEMATICS

### Toss Up: Multiple Choice

For which of the following values of  $x$  is  $(x^2+x+4)/(x)$  an integer?

- W) 1
- X) 4
- Y) 3
- Z) 5

Toss Up Answer: X

---

### Bonus: Short Answer

Find the remainder when  $343x^3+49x^2+14x+1$  is divided by  $7x - 1$ .

Bonus Answer: 5

---

## 77. MATHEMATICS

### Toss Up: Multiple Choice

What do the numbers in the  $n$ th row of Pascal's Triangle sum to?

Give your answer in terms of  $n$ .

- W)  $2n$
- X)  $2^n$
- Y)  $n^2$
- Z)  $n^3$

Toss Up Answer: X

---

### Bonus: Multiple Choice

Find the number of ordered pairs  $(a,b)$ , where  $a$  and  $b$  are nonnegative integers, such that  $a+b=10$ .

- W) 100
- X) 10
- Y) 11
- Z) 12

Bonus Answer: Y

---

## 78. MATHEMATICS

### Toss Up: Short Answer

Factor the following equation:  $x^3 + 8 ( x^2 ) + 8x + 64$

**Bonus Answer:**  $(x + 8)(x + 8)(x^2 + 8)$  or  $(x^2 + 8)[(x + 8)^2]$

---

**Bonus: Multiple Choice**

Which of the following is a primitive Pythagorean triple?

W) 9 , 12 , 15

X) 10 , 24 , 26

Y) 3 , 4 , 5

Z) 16 , 30 , 34

**Bonus Answer:** Y

---

**79. MATHEMATICS**

**Toss Up: Multiple Choice**

Which of the following are prime factors of the number 5304?

W) 19

X) 7

Y) 5

Z) 13

**Toss Up Answer:** Z

---

**Bonus: Short Answer**

What integer satisfies the equation  $y = x^3 - 1$  [Read as: x to the third power subtracted by 1] when  $y = 0$  ?

**Bonus Answer:**  $x = 1$

(Explanation: The factors of the equation is  $y = (x - 1)(x^2 + x + 1)$ . We want to find an integer solution, so we take the factor  $x - 1$  and set it to zero. By adding one to both sides, we see that  $x = 1$ .)

---

**80. MATHEMATICS**

**Toss Up: Short Answer**

On which point does  $y = 10x + 8$  and  $y = x + 5$  intersect?

**Bonus Answer:**  $(-1/3, 14/3)$

---

**Bonus: Short Answer**

How many roots does the cubic equation  $y = x^3 - 4x^2 + 4x$  have?

**Bonus Answer:** It has 2 roots.

(Explanation: It intersects the x-axis twice, once at  $x = 0$  and once at  $x = 2$ .)

---

**81. MATHEMATICS**

**Toss Up: Short Answer**

What is the volume of a sphere if the radius is 7 inches? (use  $22/7$  for pi) You may either use fractions or decimals rounded to the nearest hundredth as your answer.

**Bonus Answer:**  $V = 4312/3$  cubic inches

or  $V = 1437.33$  cubic inches

(they must include the correct units)

---

**Bonus: Short Answer**

Find the surface area of a rectangular prism if the length is 2 inches, the width is 3 inches, and the height is 2 inches.

**Bonus Answer:**  $V = 32$  square inches

(they must include the correct units)

---

**82. MATHEMATICS**

**Toss Up: Multiple Choice**

A card is randomly drawn from a 52 card deck , what is the probability that the card is either a spade or a 4?

W)  $4/13$

X)  $7/52$

Y)  $17/52$

Z)  $2/13$

**Toss Up Answer: W**

---

**Bonus: Short Answer**

What is the value of  $(10! / 3!) \times 0!$

**Bonus Answer: 604,800**

---

**83. MATHEMATICS**

**Toss Up: Multiple Choice**

What is the range of  $f(x) = x^2$

W) All real numbers greater than 0

X) All real numbers

Y) All real numbers greater than or equal to 0

Z) All real numbers except -1

**Toss Up Answer: Y**

---

**Bonus: Short Answer**

$1/3$  of a number plus twice half of a number equals 36. What is the number?

**Bonus Answer: 27**

---

**84. MATHEMATICS**

**Toss Up: Multiple Choice**

What is the sum of  $5 - 3i$  and the conjugate of  $3 + 2i$  ?

W)  $2-i$

X)  $2-5i$

Y)  $8-i$

Z)  $8-5i$

**Toss Up Answer: Z**

---

**Bonus: Short Answer**

Multiply the following complex numbers, giving the product in  $a+bi$  form:  $(2 + 3i)$  and  $(4 + 5i)$

**Bonus Answer:  $-7 + 22i$**

---

**85. MATHEMATICS**

**Toss Up: Short Answer**

What is the quadratic formula?

**Bonus Answer:  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$**

---

**Bonus: Short Answer**

Solve for  $y$  if  $x = \frac{5}{6}y + \frac{116}{3}y + \frac{4}{2}$  in terms of  $x$

**Bonus Answer:  $y = \frac{(x-2)}{78}$**

---

**86. MATHEMATICS**

**Toss Up: Short Answer**

A 1081 degree angle will lie in which quadrant in the Cartesian coordinate system?

Bonus Answer: Quadrant 1 (also accept 1 or first)

---

Bonus: Short Answer

Multiply  $3x^2 - 4xy + y^2$  by  $-3xy^2$

Bonus Answer:  $-9x^3 y^2 + 12x^2 y^3 - 3xy^4$

---

## 87. MATHEMATICS

Toss Up: Multiple Choice

If an arc of  $60^\circ$  on circle 1 has the same length as an arc of  $45^\circ$  on circle 2, what is the ratio of the area of circle 1 to the area of circle 2?

W) 9:16

X) 9:15

Y) 4:3

Z) 2:5

Toss Up Answer: W

---

Bonus: Short Answer

What is the reciprocal of the complex number  $2 + i$ ?

Bonus Answer:  $(2/5) - (1/5)i$

---

## 88. MATHEMATICS

Toss Up: Multiple Choice

A function with the zero  $1 + 23i$  must have a multiplicity of at least?

W) 1

X) 23

Y) 4

Z) 2

Toss Up Answer: Z

---

Bonus: Short Answer

Find the zeros of the function:  $0 = x^4 - 81$

Bonus Answer:  $3i, -3i, 3, -3$

---

## 89. MATHEMATICS

Toss Up: Short Answer

A square is inscribed within a circle with a radius of 2.5 cm. To the nearest tenths place what is the area of the square?

Bonus Answer:  $12.5 \text{ cm}^2$

---

Bonus: Multiple Choice

Given the parabola  $y = 4x^2 + 2x - 10$  what is the equation of the line tangent to it at the point  $(0, -10)$ ?

W)  $y = 2x + 10$

X)  $y = 2x - 5$

Y)  $y = 5x - 8$

Z)  $y = 2x - 10$

Bonus Answer: Z

---

## 90. MATHEMATICS

Toss Up: Multiple Choice

How many roots does the equation  $x^4 + 3x^3 + 2x^2 + 9x + 14 = 0$  have?

- W) 1
- X) 2
- Y) 3
- Z) 4

**Toss Up Answer: Z**

---

**Bonus: Short Answer**

What is the limit of  $(1 - 1/n)$  as  $n$  goes to infinity?

**Bonus Answer: 1**

---

## 91. MATHEMATICS

**Toss Up: Short Answer**

In simplest form, express the surface area to volume ratio of a cube with side length  $s$ .

**Bonus Answer:  $6:s$**

---

**Bonus: Short Answer**

Calculate the harmonic mean of the first two perfect numbers and 10.

**Bonus Answer:  $4 * \sqrt{105}$**

---

## 92. MATHEMATICS

**Toss Up: Multiple Choice**

In the Christmas carol "The 12 Days of Christmas", the singer says that for every day of Christmas, their significant other gives them a quantity of a new gift equal to the current day of Christmas, plus the previous gifts given. For example, on the second day onward, the singer receives 2 turtledoves on each day until the end of Christmas. What is the greatest quantity of a single gift given during the 12 days?

- W) 36
- X) 40
- Y) 42
- Z) 48

**Toss Up Answer: Y**

---

**Bonus: Short Answer**

How many total gifts are given in the 12 days of Christmas?

**Bonus Answer: 364**

---

## 93. MATHEMATICS

**Toss Up: Short Answer**

What is the value of  $\sqrt{20 + \sqrt{20 + \sqrt{20 + \dots}}}$ ?

[Read as "the nested radical expression square root 20 plus square root 20 + square root 20 repeating"]

**Bonus Answer: 5**

---

**Bonus: Short Answer**

How many asymptotes are in the graph of  $y = (x^4 + 1)/(x^3 + 3x^2 - 9x - 27)$ ?

**Bonus Answer: 3**

---

## 94. MATHEMATICS

**Toss Up: Multiple Choice**

What is the smallest positive 'taxicab' number?

- W) 87

- X) 91
- Y) 95
- Z) 100

**Toss Up Answer: X**

---

**Bonus: Short Answer**

To what power do you have to raise any number for it to be 0, 1, or -1 in mod 7?

**Bonus Answer: 3**

---

**95. MATHEMATICS**

**Toss Up: Short Answer**

How many degrees are in a 79-gon

**Bonus Answer: 13860 degrees**

---

**Bonus: Multiple Choice**

The sum of the measures of the exterior angles of n-gon is \_\_\_\_\_

- W) 720 degrees
- X) 360 degrees
- Y) 1440 degrees
- Z) non of the above

**Bonus Answer: X**

---

**96. MATHEMATICS**

**Toss Up: Short Answer**

What is the integral from 1 to 4 of  $4x^3$ ?

**Bonus Answer: 255**

---

**Bonus: Multiple Choice**

What is  $d/dx \tan x / \sec x$ , in simplest form?

- W)  $\sec^2 x - \tan x$
- X)  $\sec^2 x - \tan^2 x$
- Y)  $\sec^3 x - \tan^2 x \sec x$
- Z)  $(\sec x - \tan x)^2$

**Bonus Answer: X**

---

**97. MATHEMATICS**

**Toss Up: Multiple Choice**

Which of the following the derivative with the highest degree?

- W)  $X^2$  (x squared)
- X) 20
- Y) 104
- Z)  $3x$

**Toss Up Answer: W**

---

**Bonus: Short Answer**

Find  $y' = dy/dx$  for  $x^3 + y^3 = 4$ . (x cubed + y cubed)

**Bonus Answer:  $-x^2/y^2$  (negative x squared over y squared)**

---



## 98. MATHEMATICS

### Toss Up: Short Answer

In interval notation, find the domain of  $1/\sqrt{x^2+5x+4} \geq 0$  (1 over the square root of  $x^2+5x+4$  is greater than or equal to 0.)

**Bonus Answer:**  $(-\infty, -4) \cup (-1, \infty)$

---

### Bonus: Short Answer

If  $x^2+7x-5=0$ , find  $(\sqrt{1} + \sqrt{2})^2$

**Bonus Answer:** 49

---

## 99. MATHEMATICS

### Toss Up: Short Answer

Compute the number of diagonals in a convex 30-sided polygon.

**Bonus Answer:** 435

---

### Bonus: Short Answer

Find the number of way 30 people can shake hands if each person shakes hands with everyone else, excluding themselves.

**Bonus Answer:** 435

---

## 100. MATHEMATICS

### Toss Up: Short Answer

An arithmetic progression has 10 terms. Find the maximum distance between any 2 terms if the minimum value for any term is 0 and the maximum is 100, inclusive.

**Bonus Answer:** 99

---

### Bonus: Short Answer

Find the number of factors of  $967 \cdot 515$

**Bonus Answer:** 8

---

## 101. MATHEMATICS

### Toss Up: Short Answer

If  $2x+y=5$  and  $2y+x=6$ , find  $(x-y)^2$

**Bonus Answer:** 1

---

### Bonus: Short Answer

Given a 3-4-5 right triangle, find the area of its inscribed circle.

**Bonus Answer:**  $\pi$

---

## 102. MATHEMATICS

### Toss Up: Short Answer

Express 122121 base 3 in base 9.

**Bonus Answer:** 577

---

### Bonus: Short Answer

1011101 base 2 is what in base 7?

**Bonus Answer:** 151

---

## 103. MATHEMATICS

### Toss Up: Multiple Choice

Which of the following sets has the greatest cardinality?

W) The set of all real numbers

X) The set of all integers

Y) The set of all rational numbers

Z) They all have the same cardinality

**Toss Up Answer: Z**

---

**Bonus: Short Answer**

If set A has a cardinality of 5, set B has a cardinality of 6, and set A and B are disjoint sets, what is the cardinality of the union of set A and B?

**Bonus Answer: 11**

---

## 104. MATHEMATICS

**Toss Up: Short Answer**

What is the area of an isosceles triangle with legs 15 and altitude 12?

**Bonus Answer: 108**

---

**Bonus: Short Answer**

Find the area of a triangle if 2 of its sides are 3 and 6, and its included angle is 30 degrees.

**Bonus Answer:  $9\sqrt{3}/2$**

---

## 105. MATHEMATICS

**Toss Up: Short Answer**

If Bill can come up with 5 math questions in 1 hour, how many math questions can he come up with in 12 minutes?

**Bonus Answer: 1**

---

**Bonus: Short Answer**

Find the area of a triangle with side lengths 9, 7, and 6.

**Bonus Answer:  $2\sqrt{110}$**

---

## 106. MATHEMATICS

**Toss Up: Short Answer**

Factor  $x^2 + y^2 + z^2 + 2xy + 2yz + 2xz$

**Bonus Answer:  $(x+y+z)^2$**

---

**Bonus: Short Answer**

Factor  $x^2(z-y) + y^2(x-z) + z^2(y-x)$

**Bonus Answer:  $(x-y)(y-z)(z-x)$  (or any other answer involving multiplying 2 of the binomials by -1)**

---

## 107. MATHEMATICS

**Toss Up: Short Answer**

Find the sum of the first 6 Fibonacci numbers

**Bonus Answer: 20**

---

**Bonus: Short Answer**

Find the sum of all the numbers in the first 7 rows of the Pascal Triangle

**Bonus Answer: 127**

---

## 108. MATHEMATICS

**Toss Up: Short Answer**

What was the first name of the person who discovered the Fibonacci Sequence?

**Bonus Answer: Leonardo**

---

**Bonus: Short Answer**

What is the full name of the man who invented the Power of a Point?

**Bonus Answer: Jacob Steiner**

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