Select an answer that is within 10<sup>-4</sup> of the exact answer. If no such value appears, select "None of the above."

1)  $f(x) = 3x^2 - \frac{4}{2x-1} - 2.9$ . Give  $f(\pi)$ . a) 25.95262 b) 25.95169 c) 25.95049 d) 25.95353 e) 25.95437 f) None of the above 2) Give the positive root of  $f(x) = 3x^2 - \frac{4}{2x-1} - 2.9$ . a) 1.33637 b) 1.33346 c) 1.33491 d) 1.33122 e) 1.33027 f) None of the above 3) Give the sum of the roots of  $f(x) = 3x^2 - \frac{4}{2x-1} - 2.9$ . a) 0.49 c) 0.56 d) 0.51 b) 0.50 e) 0.53 f) None of the above 4) Let  $f(x) = 3x^2 - \frac{4}{2x-1} - 2.9$ , and define  $g(x) = f(x^2)$ . Give the smallest root of g(x). a) -1.15126b) -1.15671c) -1.15923d) -1.15337 e) -1.15449f) None of the above 5) The line l passes through the points (-2, 1) and (4, 5). Give the distance from this line to the point (-11, -32). b) 25.49043 c) 25.49721 d) 25.49436 a) 25.49117 e) 25.49251 f) None of the above 6) Give the acute angle of intersection (in radians) of the lines 31x + 23y = -12 and 43x - 29y = 17. b) 1.23167 c) 1.23257 d) 1.23022 e) 1.23955 f) None of the above a) 1.23731 7) The function  $f(x) = 2x^5 + 15x^3 + 12x$  is invertible. Give  $f^{-1}(1340.27)$ . a) 3.28611 b) 3.28742 c) 3.28223 d) 3.28487 e) 3.28942 f) None of the above 8) Give the sum of the x-coordinates at which the graph of the function  $f(x) = \frac{1}{6}x^4 - 3x^3 - 10x + 7$  passes through the smallest possible integer value.

d) 27.16282

e) 27.16717

f) None of the above

a) 27.16633

b) 27.16036

c) 27.16156

9) Let  $g(x) = \frac{x+1}{2} + \frac{3x-1}{x+4}$ . Give the 23<sup>rd</sup> value in the sequence g(0), g(g(0)), g(g(g(0))), ...

a) 3.54737 b) 3.53144 c) 3.55292 d) 3.54369 e) 3.55481 f) None of the above

**10**) Give the average of the numbers  $1, \left(\frac{2}{3}\right)^2, \left(\frac{4}{5}\right)^2, \left(\frac{6}{7}\right)^2, \left(\frac{8}{9}\right)^2, \dots, \left(\frac{100}{101}\right)^2$ .

a) 0.93170 b) 0.92763 c) 0.93021 d) 0.92810 e) 0.92968 f) None of the above

11) Give the value of y associated with the solution to the system  $\begin{pmatrix} 13x - 12y = 6500\\ 37x + 41y = 5100 \end{pmatrix}$ .

a) -178.27854 b) -178.30737 c) -178.30092 d) -178.30136 e) -178.31421 f) None of the above

**12**) Many years ago, in a land far away, a powerful kingdom suddenly faced an incredible threat. The ruler of the kingdom gathered their advisors to find a solution, but no solution was found. So, the ruler sent a message to the people stating that any person who could find a solution would be paid any reasonable request. After many days, a person came forward and offered their solution, and the kingdom was saved. When this person appeared before the ruler, they referenced a 1 kilometer square chess board that everyone knew the ruler had constructed within the kingdom. Then the person said, "Please place 1 grain of rice on the first square, 2 grains on the 2<sup>nd</sup> square, 4 on the 3<sup>rd</sup> square, 8 on the 4<sup>th</sup> square, etc. until you have used 32 squares on the chess board." If a grain of rice weighs 0.029 grams, give the number of kilograms of rice that this person is requesting being placed on the chess board.

a) 124553047.2 b) 124551342.5 c) 124553541.3 d) 124552111.1 e) 124554051.6 f) None of the above

13) A particle begins its movement at the point (-7, 6), and moves along a line towards the point (5, 3). When it arrives at (5, 3), it encounters a wall represented by the line  $y = \frac{x}{5} + 2$ , and reflects off of the wall so that the angle of incidence is equal to the angle of reflection. The particle's subsequent motion is along a line. Give the slope of this line.

a) 0.74418 b) 0.74029 c) 0.74146 d) 0.74574 e) 0.74313 f) None of the above

14) A parabola passes through the points (-111, 13), (14, -27) and (51, 31). Give the *x*-coordinate of the vertex of this parabola.

a) -34.76723 b) -34.76856 c) -34.76712 d) -34.76704 e) -34.76804 f) None of the above

15) The vertices of a triangle are the centers of the circles  $x^2 + x + y^2 + 2y = 6$ ,  $2x^2 - 3x + 2y^2 - 4y = 7$  and  $x^2 + y^2 - 5x - 7y = 2$ . Give the area of the triangle.

a) 0.1829 b) 0.1891 c) 0.1863 d) 0.1882 e) 0.1875 f) None of the above

16) A point (x, y) is called an integer point if both x and y are integers. Give the number of integer points that lie strictly above the x-axis, and on or below the parabola given by  $y = -x^2 + 37x + 163$ .

a) 15,427 b) 15,321 c) 15,254 d) 15,136 e) 15,103 f) None of the above

17) Give the y-coordinate of the y-intercept of the line that passes through the point (-7.1, 5.2) and is parallel to the line that passes through the points (4.2, 7.3) and (-11.3, 21.7).

a) -1.39522 b) -1.39612 c) -1.39701 d) -1.39423 e) -1.39154 f) None of the above

**18**) Give the number of positive integers that are less than or equal to 2,000, and are integer multiples of at least one of 2, 3, 5, 7 or 11.

a) 1,584 b) 1,646 c) 1,621 d) 1,687 e) 1,522 f) None of the above

**19**) Give the sum of the reciprocals of the prime factors of 2,021.

a) 0.04562 b) 0.04121 c) 0.04316 d) 0.04453 e) 0.04349 f) None of the above

**20**) A number is written in base 3 as 1200121021. Give this number in base 10.

a) 33,244 b) 33,251 c) 33,227 d) 33,236 e) 33,292 f) None of the above

21) A rectangle has one vertex at (0, 0), and the opposite vertex in the first quadrant along the line y = 17 - 3x. Give the largest possible area for this rectangle.

a) 24.0792 b) 25.0921 c) 25.0846 d) 25.0817 e) 24.0833 f) None of the above

**22**) Sarah and Mason are counting sheep, and Sarah remarks that they are through counting, and that the number of sheep is the sum of the prime numbers between 450 and 500. Mason immediate writes the sum on a piece of paper. What number did Mason write?

a) 3,852 b) 3,804 c) 3,821 d) 3,837 e) 3,783 f) None of the above

23) A business partner asks a banker for a cash loan of 5,000, and the banker tells them that they will lend them the money, provided they are willing to make equal quarterly payments (every 1/4 of a year) for twelve quarters on the loan, with an interest rate of 8% annually, compounded quarterly, to pay the money back. The partner agrees, the money is lent on 01-01-2021, and the first payment is due at the end of the first quarter of 2021. Give the amount of the first payment, rounded to the nearest cent.

a) \$472.78 b) \$472.80 c) \$472.79 d) \$472.81 e) \$472.77 f) None of the above

24) A particle moves in the direction of increasing x values, along the line y = 63 - x, starting from the point associated with x = 0, until it comes to a point on the line whose x coordinate is the first integer multiple of 13. Then it changes direction and moves on a line of slope 1, until it reaches a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope -1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope -1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope 1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope 1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope 1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope 1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope -1 until it comes to a point where the x coordinate is the next integer multiple of 13. It then changes direction and moves on a line of slope -1 until it comes to a point where the x coordinate is the next integer multiple of 13. This pattern continues until the x coordinate is 2021, and the particle stops. What is the total distance traveled by the particle?

a) 1414.21462 b) 1414.21014 c) 1414.21243 d) 1414.21356 e) 1414.21627 f) None of the above

25) Determine the number of points of intersection of the functions  $f(x) = 43 \cos(17x - 21) + 10x$  and  $g(x) = 21 \sin(14 - 13x) - 5x$ .

a) 33 b) 35 c) 32 d) 34 e) 36 f) None of the above

**26**) Let  $C_1$  be the circle of radius 1 centered at the origin. 64 equally spaced points are placed on  $C_1$ , with the first point  $P_1 = (1, 0)$ , and the other 63 points  $P_2, \ldots, P_{64}$  ordered in such a way that they are placed in a counter clockwise fashion around the circle. Give the sum of the absolute values of the differences of the x and y coordinates for these 64 points.

a) 57.57138 b)	57.57395	c) 57.57227	d) 57.57216	e) 57.57482	f) None of the above
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**27**) **Tie Breaker:** Give the average of the selected answer values to problems 1-26. Use the value -1 for every selection of <u>None of the above</u>. The answer that is closest to the actual answer breaks the tie.

a) 4792677.451 b) 4792678.413 c) 4792679.532 d) 4792680.618 e) 4792679.449 f) 4792683.252 g) 4792678.993 h) 4792677.738 i) 4792682.116 j) 4792680.763 k) 4792683.473 1) 47926479.326 m) 4792681.247 n) 4792678.321 o) 4792680.618 p) None of the above