

This relay consists of six questions. “TAFTPQ” stands for “the answer from the previous question”. So, for example, if question 3 references TAFTPQ, that is the answer from question 2; if question 5 references TAFTPQ, that is the answer from question 4; etc.

All answers on this relay are integers.

1. Evaluate: $\lim_{x \rightarrow 3} (2x^3 - 7x^2 + 4x + 1)$

2. Let $T = \text{TAFTPQ}$. Evaluate: $\lim_{x \rightarrow 2} \left(\frac{x^2 + Tx - 3}{x^2 - Tx + 3} \right)$

3. Let $T = \text{TAFTPQ}$. Evaluate: $\lim_{x \rightarrow 3} \left(\frac{Tx^2 + 24x - T}{x^2 + T} \right)$

4. Let $T = \text{TAFTPQ}$. Evaluate: $\lim_{h \rightarrow 0} \left(\frac{(2+h)^2 + (T+2)(2+h) + 7+T}{h} \right)$

5. Let $T = \text{TAFTPQ}$. Evaluate: $\lim_{x \rightarrow \infty} \left(\frac{(T+2)^3 x^3 - 2x^2 + 10x - 5}{T^2 x^3 - 2Tx^2 + 15x - 6} \right)$

6. Let $T = \text{TAFTPQ}$. Evaluate: $\lim_{x \rightarrow -\infty} \left(\frac{-Tx + \sqrt{81x^2 - Tx + T}}{-Tx - \sqrt{81x^2 - Tx + T}} \right)$

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1. If $y = -2x^3 + 4x^2 - 3x - 1$, find the value of $\frac{dy}{dx}$ at $x = -\frac{5}{3}$.
2. Let $T = \text{TAFTPQ}$. The function $y = -2x^3 + 4x^2 - 3x - 1$ has two points where the slope of the tangent line is T . From the previous problem, the x -value of one of those points is $x = -\frac{5}{3}$. Find the x -value of the other such point.
3. Let $T = \text{TAFTPQ}$. Find the y -intercept of the tangent line to $y = -2x^3 + 4x^2 - 3x - 1$ at the point where $x = T$.
4. Let $T = \text{TAFTPQ}$. The point on $y = -2x^3 + 4x^2 - 3x - 1$ whose y -value is T has an x -value that can be found in the interval $[A-1, A]$, where A is an integer. Find the value of A .
5. Let $T = \text{TAFTPQ}$. Let $f(x) = -2x^3 + 4x^2 - 3x - 1$. According to the Mean Value Theorem, there is a number r in the interval $(0, Z)$ such that $f'(r) = T$. If the greater possible value of Z can be written in the form $\frac{B + \sqrt{C}}{D}$, where B , C , and D are positive integers, and C is not divisible by any perfect square greater than 1, find the value of $B + C + D$.
6. Let $T = \text{TAFTPQ}$. If $y = -2x^3 + 4x^2 - 3x - 1$, find the value of $\left. \frac{dy}{dx} \right|_{x=T}$.

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1. Find the maximum value of the function $f(x) = 2x + \frac{4}{x}$ on the interval $\left[\frac{1}{2}, 2\right]$.

2. Let $T = \text{TAFTPQ}$. Two roads intersect at a right angle. Car A is on one road, headed toward the intersection of the two roads at 40 miles per hour. Car B is on the other road, headed toward the intersection of the two roads at 60 miles per hour. How fast, in miles per hour, is the distance between the two cars decreasing when Car A and Car B are 12 miles and T miles, respectively, from the intersection? Note: Due to the wording of this question, your answer should be positive.

3. Let $T = \text{TAFTPQ}$. A dartboard is in the coordinate plane and is the region bounded by $y = -x^2 + 6x - 5$ and the x -axis. If every dart thrown at the dartboard hits the dartboard, the probability of a dart thrown at the dartboard landing below the line $y = \frac{T}{17} - 1$ can be written in the form $\frac{c}{d}$, where c and d are relatively prime positive integers. Find the value of $5c + 8d$.

4. Let $T = \text{TAFTPQ}$. Evaluate: $\int_{-47}^T (x) dx$

5. Let $T = \text{TAFTPQ}$. If S is the sum of the digits of T , evaluate $\int_{-1}^3 (S) dx$.

6. Let $T = \text{TAFTPQ}$. There exist integers m and n such that $Tm + 35n = k$. What is the least possible positive value of k ?

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1. Evaluate: $\int_2^5 (x^2) dx$

2. Let $T = \text{TAFTPQ}$. $\int_{2-\sqrt{3}}^{\infty} \left(\frac{1}{1+x^2} \right) dx$ can be written in the form $\frac{A\pi}{B}$, where A and B are relatively prime positive integers. Find the remainder when $(T + A)$ is divided by B .

3. Let $T = \text{TAFTPQ}$. $\int_2^T \left(\frac{4x}{1+x^2} \right) dx$ can be written in the form $\ln C$, where C is a positive integer. Find the value of C .

4. Let $T = \text{TAFTPQ}$. $\int_0^{\sqrt{T}} \left(\sqrt{T-x^2} \right) dx$ can be written in the form $\frac{D\pi}{E}$, where D and E are relatively prime positive integers. Find the value of the product $D \cdot E$.

5. Let $T = \text{TAFTPQ}$. If F is the area of the region enclosed by the graphs of $y = 12x - x^2$ and $y = x^2$, find the remainder when T is divided by F .

6. Let $T = \text{TAFTPQ}$. How many ordered pairs (G, H) of positive integers satisfy the equation $\int_G^H (x) dx = T$?

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1. If $y = f(x)$ is the solution to the differential equation $\frac{dy}{dx} = 2x$ that passes through the point $(2, -3)$, find the value of $f(1)$.

2. Let $T = \text{TAFTPQ}$. If $y = g(x)$ is the solution to the differential equation $\frac{dy}{dx} = \frac{1}{x^2}$ that passes through the point (T, T) , find the value of $g\left(-\frac{6}{31}\right)$.

3. Let $T = \text{TAFTPQ}$. Find the average value of the function $h(x) = -4x^3 + 3x^2 - 2x + 1$ on the interval $[T, 4]$

4. Let $T = \text{TAFTPQ}$. Find the sum of the infinite geometric series whose first term is T and whose common ratio is $\frac{T}{280}$.

5. Let $T = \text{TAFTPQ}$. Consider the graph with equation $x^{\frac{2}{3}} + y^{\frac{2}{3}} = T^2$, where $x, y \geq 0$. Find the length of the curve between the graph's y -intercept and the point on the graph where $x = 8$.

6. Let $T = \text{TAFTPQ}$. What is the sum of the positive integral divisors of T ?