Time limit: 60 minutes.
Instructions: This test contains 10 short answer questions. All answers must be expressed in simplest form unless specified otherwise. Only answers written inside the boxes on the answer sheet will be considered for grading.
No calculators.

1. An airplane accelerates at 10 mph per second, and decelerates at 15 mph/sec. Given that its takeoff speed is 180 mph, and the pilots want enough runway length to safely decelerate to a stop from any speed below takeoff speed, what's the shortest length that the runway can be allowed to be? Assume the pilots always use maximum acceleration when accelerating. Please give your answer in miles.

2. If there is only 1 complex solution to the equation
$$8x^3 + 12x^2 + kx + 1 = 0$$
what is k?

3. If f is a polynomial, and $f(-2) = 3$, $f(-1) = -3 = f(1)$, $f(2) = 6$, and $f(3) = 5$, then what is the minimum possible degree of f?

4. Find
$$\sum_{i=1}^{i=2016} i(i+1)(i+2) \pmod{2018}$$

5. Find the product of all values of d such that $x^3 + 2x^2 + 3x + 4 = 0$ and $x^2 + dx + 3 = 0$ have a common root.

6. Let $x, y, z \in \mathbf{R}$ and
$$7x^2 + 7y^2 + 7z^2 + 9xyz = 12$$
The minimum value of $x^2 + y^2 + z^2$ can be expressed as $\frac{a}{b}$ where $a, b \in \mathbf{Z}$, $gcd(a, b) = 1$. What is $a + b$?

7. Let
$$h_n := \sum_{k=0}^{k=n} \binom{n}{k} \frac{2^{k+1}}{(k+1)}$$
Find
$$\sum_{n=0}^{\infty} \frac{h_n}{n!}.$$

8. Compute
$$\sum_{k=1}^{1009} (-1)^{k+1} \binom{2018-k}{k-1} 2^{2019-2k}$$

9. Suppose
$$\frac{1}{3}\frac{(x+1)(x-3)}{(x+2)(x-4)} + \frac{1}{4}\frac{(x+3)(x-5)}{(x+4)(x-6)} - \frac{2}{11}\frac{(x+5)(x-7)}{(x+6)(x-8)} = \frac{53}{132}$$
Also, suppose $x > 0$. Then x can be written as $a + \sqrt{b}$ where a, b are integers. Find $a + b$.

10. Let a,b,c be the roots of the equation $x^3 - 2018x + 2018 = 0$. Let q be the smallest positive integer for which there exists an integer p, $0 < p \leq q$, such that

$$\frac{a^{p+q} + b^{p+q} + c^{p+q}}{p+q} = \left(\frac{a^p + b^p + c^p}{p}\right)\left(\frac{a^q + b^q + c^q}{q}\right)$$

Find $p^2 + q^2$.