December 2010

⋆ National Level ⋆

The Mandelbrot Competition

Round Two Test

Time Limit: 40 minutes

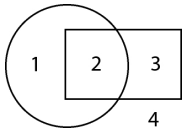
Name: _____

1. Sonia is standing in a line. To pass the time, she determines that 32% of the people in the line are standing in front of her, while 64% of the people are standing behind her. How many people are there in the line all together? (1)

2. Recall that quadrant *II* consists of all points (x, y) with $x < 0$ and $y > 0$. Suppose that a line $y = mx + b$ does not pass throught quadrant *II*. Which *must* be true of this line? (Write A, B, 'both', or 'neither' as your answer.) (1)

A. The slope m is positive B. The y-intercept b is negative.

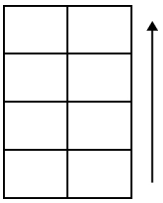
3. What is the maximum number of regions into which a circle and a rectangle can divide the plane? For instance, the configuration at right creates four regions. (2)



4. Let l_1 be the line passing through $(5, 3)$ making an angle of inclination of $17°$ with the horizontal, and let l_2 be the line passing through $(5, 3)$ making an angle of inclination of $107°$ with the horizontal. Reflect point $P(1, 1)$ over line l_1 to obtain A, and reflect P over l_2 to obtain B. Compute distance AB. (2)

5. Let a, b, c and d be positive real numbers satisfying the condition that each of the products ab, bc and cd is equal to one of the numbers 1, 2, 3, 4, 5, 6, 7, 8 or 9. Determine the minimum possible value of $a + 4d$. (2)

6. Eight students are about to board a roller coaster car with eight seats, grouped into four pairs as shown. However, Casey and Stacey refuse to sit next to one another; Kelly and Shelley won't sit together; and Jenny and Lenny also will not sit side by side. In how many ways can the students fill the seats? (3)



7. Let z_1, z_2 and z_3 be three complex numbers in geometric progression. Suppose that the average of these numbers is 10, while the average of their squares is $20i$. Determine the value of z_2, the middle term. (3)

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SCORE: