February 26, 1999

The first 15 problems count 6 points each and the final one counts 20 points. Problems 2 through 11 are multiple choice and 12 through 15 are fill-in-the-blank. In the multiple choice section, circle the correct choice. You do not need to show your work on problems 2 through 15.

1. Fill in the three character code you received via email in the box ______

2. Simplify: $2x - 3[x + 3 - (2x - 1)]$
   (A) $-3x - 12$  (B) $-3x - 8$  (C) $5x - 8$  (D) $2x - 12$  (E) $5x - 12$

3. Find the radius $r$ of the circle with equation $(x - 2)^2 + y^2 + 10y = 11$.
   (A) $\sqrt{11}$  (B) 4  (C) 5  (D) 6  (E) 11

4. Find all solutions of $3x^3 - 13x^2 + 14x = 0$
   (A) $x = 2, x = \frac{7}{3}$  (B) $x = 0, x = -2, x = -\frac{7}{3}$  (C) $x = 0, x = 2$
   (D) $x = -2, x = -\frac{7}{3}$  (E) $x = 0, x = 2, x = \frac{7}{3}$

5. If $(5x + 2)(3x - 5) = 0$ for some number $x$, then $3x - 5$ equals
   (A) $\frac{5}{3}$ only  (B) 0 or $\frac{5}{3}$  (C) 0 or $-\frac{64}{9}$
   (D) $-\frac{2}{5}$ or $\frac{5}{3}$  (E) 0 only

6. After rationalizing the numerator of $\frac{\sqrt{3} - \sqrt{2}}{\sqrt{3}}$, the denominator in simplest form is
   (A) $\sqrt{3}(\sqrt{3} + \sqrt{2})$  (B) $\sqrt{3}(\sqrt{3} - \sqrt{2})$  (C) $3 - \sqrt{3}\sqrt{2}$  (D) $3 + \sqrt{6}$
   (E) none of these answers

7. A line $L$ is parallel to the line whose equation is $2x + 3y = 6$ and passes through the point $(4, -7)$. What is the slope of $L$?
   (A) $-7$  (B) $-\frac{2}{3}$  (C) 2  (D) $\frac{3}{2}$  (E) 3
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8. \((3^{-1} - 6^{-1})^{-1} = \)

\(\text{(A) } -6 \quad \text{(B) } -3 \quad \text{(C) } \frac{1}{6} \quad \text{(D) } 3 \quad \text{(E) } 6\)

9. Circle all the listed values of \(x\) that satisfy the inequality \(1 \leq |2x - 5.5| \leq 6.\)

\(\text{(A) } -2 \quad \text{(B) } 2 \quad \text{(C) } 3 \quad \text{(D) } 4 \quad \text{(E) } 6\)

10. Erica went on a long hike. She walked 4 miles north, then 3 miles east, then 2 miles north, and finally 5 miles west. How far was she from her starting point? (Assume the earth is flat, and her hike takes place in North Carolina.)

\(\text{(A) } \sqrt{10} \quad \text{(B) } \sqrt{17} \quad \text{(C) } 3\sqrt{3} \quad \text{(D) } 5 \quad \text{(E) } 2\sqrt{10}\)

11. The function \(F = \frac{9}{5}C + 32\) can be used to find the temperature on the Fahrenheit scale when the Celsius temperature is known. Which of the following formulas can be used to find the Celsius temperature when the Fahrenheit temperature is known?

\(\text{(A) } C = \frac{9}{5}F - 32 \quad \text{(B) } C = \frac{5}{9}F - 32 \quad \text{(C) } C = \frac{9}{5}F + 32 \quad \text{(D) } C = \frac{5}{9}F + 32 \quad \text{(E) } C = \frac{5}{9}(F - 32)\)

12. The number \(12^4 \cdot 41^2 \cdot 12^{12} \cdot 4^4\) can be written as \(A^B\), where \(A\) and \(B\) are integers (whole numbers). Write \(A^B\) in the blank.

\(48^{16}\)

13. Suppose \(a\) is a real number such that \((a - 2)(a^2 + 3) = 0\). What is the value of \(|a - a^2|\)?

\(|2 - 4| = 2\)

14. Find a value of \(y\) so that the point \((-2, y)\) is exactly 5 units away from the point \((-3, -4)\).

\(y = -4 \pm \sqrt{24}\)

15. There are two solutions to \(|4x + 7| = 9\). What is their sum?

\(-3.5\)
16. Explain how you can describe the graph of the quadratic equation

\[ y = ax^2 + bx + c \]

based on the coefficients \( a, b, \) and \( c \). Hint: it may be useful to define the discriminant \( D \) to be \( b^2 - 4ac \). In particular, address the questions (a) does the curve open upwards or downwards, and (b) does it have \( x \)-intercepts?

Solution. Your job on this problem is to tell someone how they can easily find out about the nature of the parabola. You don’t know \( a, b, \) and \( c \), so the best you can do is give a method for finding out based on these three numbers.

Compute \( D = b^2 - 4ac \). If \( a > 0 \), the parabola opens upward, and if \( a < 0 \) it opens downward. If \( D > 0 \) there are two intercepts, if \( D = 0 \), there is just one intercept, and if \( D < 0 \), there are no intercepts.