

**Polynomials & Rational Functions - Theta  
2007 Mu Alpha Theta National Convention**

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For all questions, answer E. "NOTA" means none of the above answers is correct.

1. If  $f(x) = x^3 + x^2 - x + 1$ , find  $f(-1)$ .

- A. 0
- C. 2

- B. 1
- D. 4

E. NOTA

2. Find the equation of the line passing through the points (2,3) and (-6,-1).

A.  $y = x + 1$

B.  $y = \frac{x}{2} + 2$

C.  $y = -x + 5$

D.  $y = -\frac{x}{2} + 4$

E. NOTA

3. Characterize the asymptotes in the graph of  $f(x) = \frac{x^3 + 6x^2 + 3x - 10}{x^2 - 6x + 5}$

- A. 2 vertical, 2 horizontal
- C. 1 vertical, 2 horizontal

- B. 2 vertical, 1 horizontal
- D. 1 vertical, 1 horizontal

E. NOTA

4. Which of the following are even functions of  $x$ ?

I.  $f(x) = \sqrt{16 - x^2}$

II.  $f(x) = x|x|$

III.  $f(x) = x^2 - 8x + 16$

IV.  $f(x) = x^4 - 5x^2 + 2x + 3$

- A. I only
- C. III only

- B. I, II only
- D. III, IV only

E. NOTA

5. Let  $f(x) = 4x^2 - 20x + 25$ . Let ABC equal the triangle formed by connecting the endpoints of the latus rectum and the vertex of  $f(x)$ . Find the area of ABC.

- A. 1/512
- C. 1/128

- B. 1/256
- D. 1/64

E. NOTA

6. The graphs of the functions  $f(x) = x^2 - 4x + 3$  and  $g(x) = x - 1$  intersect at points  $(a, b)$  and  $(c, d)$ . Find the value of  $a + b + c + d$ .

- A. 5
- C. 7

- B. 6
- D. 8

E. NOTA

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7.  $f(x) = 2x + 5$ .  $g(x) = \frac{1}{x^2} + 3$ , for  $x > 0$ . Find  $(g^{-1} \circ f)(-1)$ .

- |      |         |
|------|---------|
| A. 1 | B. 4    |
| C. 9 | D. 16   |
|      | E. NOTA |

8. If  $f(x) = 8x^8 - Ax^7 + Bx^5 - Cx^4 - Dx^3 + 1$ , where  $A, B, C, D$  are positive values, then  $f(x)$  could have:

- |  |                                   |
|--|-----------------------------------|
| I. 4 positive, 4 non-real roots              | III. 4 negative, 4 non-real roots |
| II. 2 positive, 4 negative, 2 non-real roots | IV. 8 non-real roots              |
| A. I, II only                                | B. I, IV only                     |
| C. II, III only                              | D. II, IV only                    |
|  | E. NOTA                           |

9. If  $f(x) = x^2 + 8x + C$  and  $g(x) = -x^2 - 8x - 63/4$ , find  $C$  such that the vertex of  $f(x)$  lies on the focus of  $g(x)$ .

- |       |                    |
|-------|--------------------|
| A. 16 | B. $\frac{63}{4}$  |
| C. 0  | D. $-\frac{63}{4}$ |
|       | E. NOTA            |

10. Given that one of the roots of the equation  $Ax^2 + Bx + C = 0$  is  $2 + 3i$ , and  $A, B, C$  are relatively prime (where  $A$  is a positive number), find  $A(B + C)$ .

- |        |         |
|--------|---------|
| A. -17 | B. -4   |
| C. 5   | D. 9    |
|        | E. NOTA |

11. If  $f(x) = x^2 + 5x + 2$  and  $g(x) = 2x - 3$ , find  $(f - g)(2)$ .

- |       |         |
|-------|---------|
| A. 15 | B. 12   |
| C. -3 | D. -5   |
|       | E. NOTA |

12.  $f(x) = 2007x^{2007} + 2007x^{2006} + 2007x^{2005} + 2007x^{2004} + \dots + 2007x^2 + 2007x^1 + 2007x^0$ . Find the remainder when  $f(x)$  is divided by  $x + 1$ .

- |         |          |
|---------|----------|
| A. 2007 | B. 1     |
| C. -1   | D. -2007 |
|         | E. NOTA  |



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18. The domain of  $f(x) = \frac{\sqrt{(x+1)(x-2)(x-3)}}{1-x^2}$  is:

A.  $(-\infty, -1) \cup (1, 3]$

B.  $(-\infty, -1) \cup (1, 2] \cup [3, \infty)$

C.  $(-1, 2] \cup [3, \infty)$

D.  $(-1, 1) \cup (1, 2] \cup [3, \infty)$

E. NOTA

19. The sum of the reciprocals of the solutions of the equation  $x^5 - 45x^4 - 8x^2 - 450x + 27 = 0$  is:

A.  $\frac{50}{3}$

B. 15

C.  $\frac{5}{3}$

D.  $-\frac{5}{3}$

E. NOTA

20. What is the product of the solutions of the equation  $9^x - 4(3^{(x+1)}) + 27 = 0$ ?

A. 27

B. 12

C. 9

D. 2

E. NOTA

21. What is the minimum value of  $f(x) = (x+1)(x+3)(x-1)(x-3)$ ?

A. -34

B. -16

C. 16

D. 34

E. NOTA

22. If  $2x^3 + 9x^2 - 6x - 5$  is factored into the form  $(ax+b)(cx+d)(ex+f)$ , where  $a, b, c, d, e, f$  are integers, and  $a, c, e$  are positive. Find  $a+b+c+d+e+f$ .

A. 12

B. 9

C. 7

D. -2

E. NOTA

23. Find the value of the discriminant of  $x^2 - 5x + 4 = 0$

A. 12

B. 9

C. 3

D. -3

E. NOTA

24. If  $f(x) = 4^x - 10$ , what is the domain of  $f^{-1}(x)$ ?

A. Real Numbers

B.  $x > -16$

C.  $x > -10$

D.  $x > 0$

E. NOTA

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25.  $f(x) = \frac{-x^3 + 6x^2 - 11x + 6}{1 - x^2}$ . The graph of  $f(x)$  has a vertical asymptote and another removable discontinuity (or "hole") at  $x=c$ . What is the  $y$ -value that the graph approaches near  $x=c$ ?

- A. -6  
C. 1  
B. -5  
D. 7  
E. NOTA

26. If  $f(x+1) = \frac{x^2 + 9x + 12}{2x + 7}$ , what is  $f(3-x)$ ?

- A.  $\frac{x^2 - 13x + 34}{-2x + 11}$   
C.  $\frac{x^2 + 17x + 64}{2x + 15}$   
B.  $\frac{x^2 + x - 8}{2x - 1}$   
D.  $\frac{x^2 + 4x + 28}{2x + 12}$   
E. NOTA

27. The sum of the roots of the equation  $x^2 + bx + c = 0$  is 9. One of the roots is also twice the other. What is the value of  $c$ ?

- A. -20  
C. 18  
B. 14  
D. 20  
E. NOTA

28. Let  $P^{-1}$  be a relation such that  $P^{-1}$  is the following:  $\{(3,3), (1,4), (2,3), (4,4)\}$ . Is  $P$  a function? If so, which is the correct set of ordered pairs for  $P$ ?

- A) Yes,  $P$  is a function.  $(3,3), (4,1), (3,2), (4,4)$ .  
B) Yes,  $P$  is a function.  $(3,3), (1,4), (2,3), (4,4)$ .  
C) Yes,  $P$  is a function.  $(3,3), (4,1), (3,2), (4,4)$ .  
D) No,  $P$  is not a function.  
E) NOTA

29.  $u(x) = x^2 - 4$ ,  $v(x) = x + 3$ ,  $w(x) = \frac{1}{x-1}$ . Find  $v(w^{-1}(u(-2)))$ .

- A. undefined  
C.  $\frac{31}{8}$   
B. 3  
D. 4  
E. NOTA

30. The sum of the coefficients in the binomial expansion of  $(4x^3 - 6y^3)^3$  is:

- A. -512  
C. 8  
B. -8  
D. 512  
E. NOTA