

# **PRECALCULUS MATHEMATICS 12**

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- **118 PROBLEMS**

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- **165 PROBLEMS**
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- **194 PROBLEMS**

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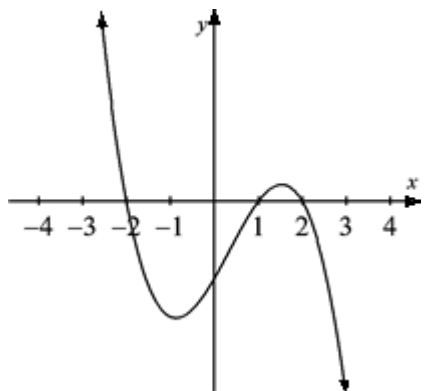
Infinite geometric series and summation notation.

- **121 PROBLEMS**

# POLYNOMIALS

# JAN 1991

1. Which one of the following functions could describe the graph illustrated?



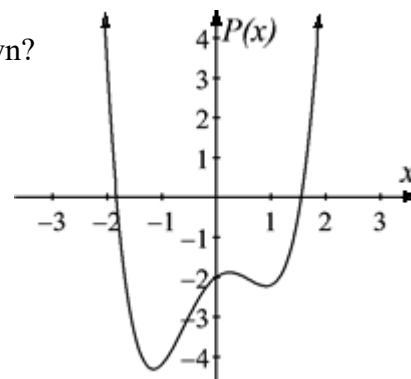
- A.  $f(x) = (x - 2)(x + 1)(x + 2)$
- B.  $f(x) = -(x - 2)(x + 1)(x + 2)$
- C.  $f(x) = (x + 2)(x - 1)(x - 2)$
- D.  $f(x) = -(x + 2)(x - 1)(x - 2)$

2. If  $2x + 1$  is a factor of a polynomial  $P(x)$ , which of the following must have a value of zero?

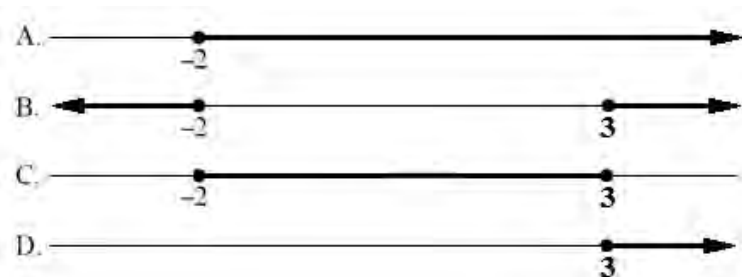
- A.  $P(1)$
- B.  $P(-1)$
- C.  $P\left(\frac{1}{2}\right)$
- D.  $P\left(-\frac{1}{2}\right)$

3. Which of the following approximates the zeros of the function shown?

- A. -2.2, 1.6
- B. -1.8, 1.6
- C. -2.2, -2, 1.6
- D. -1.8, -2, 1.6



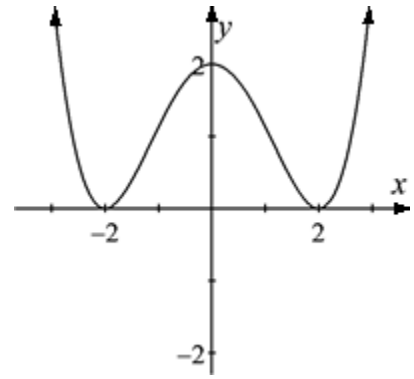
4. Which graph below illustrates the solution set for the inequality  $(x + 2)(x - 3)^2 \geq 0$  ?



5. Given the graph of the function  $y = P(x)$ , how many positive zeros does the function  $y = P(x - 2) - 1$  have?

A. 0                      B. 2                      C. 3                      D. 4

6. Solve:  $3x^3 - 2x^2 - 7x - 2 = 0$



## JUNE 1991

7. Which of the following is a possible root of the equation  $4x^4 + 2x^3 + kx + 7 = 0$ , where  $k$  is an integer?

A. 2                      B. 4                      C.  $\frac{7}{2}$                       D.  $\frac{2}{7}$

8. Given a polynomial  $P(x)$ , what condition must be true for  $x - 2$  to be factor of  $P(x)$ ?

A.  $P(2) = 0$       B.  $P(-2) = 0$       C.  $P(x) = 2$       D.  $P(x) = -2$

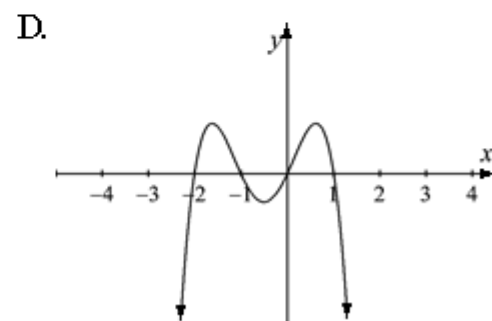
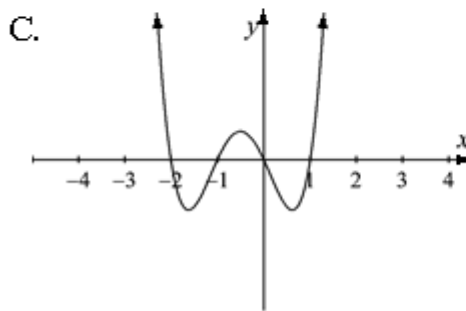
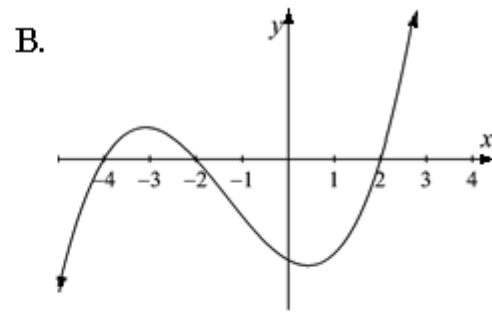
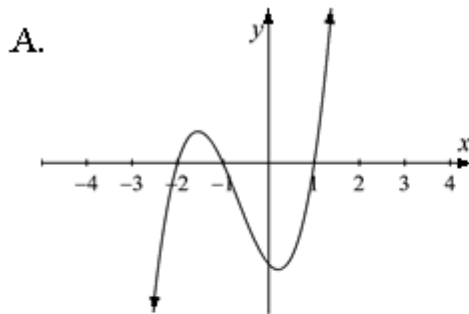
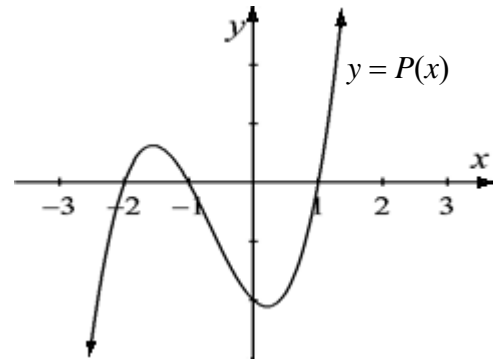
9. What is the quotient when  $5x^3 - 6x^2 + 64$  is divided by  $x + 2$ ?

A.  $5x^2 + 4x + 8$                       B.  $5x^2 - 16x + 32$   
C.  $5x^2 + 4x + 72$                       D.  $5x^2 - 16x + 96$

10. Select a cubic equation with roots  $-1$ ,  $1$  and  $\frac{2}{3}$ :

A.  $2x^3 + 3x^2 - 2x - 3$       B.  $2x^3 - 3x^2 - 2x + 3$   
C.  $3x^3 + 2x^2 - 3x - 2$       D.  $3x^3 - 2x^2 - 3x + 2$

11. Given the graph of  $y = P(x)$ , which of the following best represents  $y = xP(x)$ ?

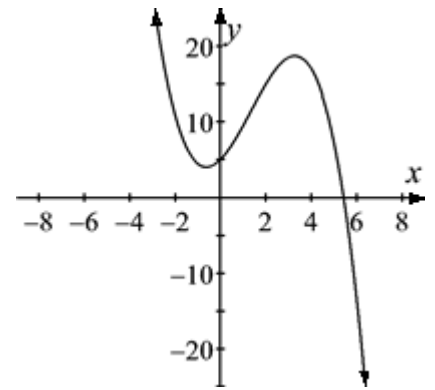


### JAN 1992

12. If  $x + 7$  is a factor of a polynomial  $p(x)$ , which of the following must be true?
- A.  $p(x) = 0$       B.  $p(7) = 0$       C.  $p(-7) = 0$       D.  $p(x) = -7$
13. Using the Rational Zero Theorem, determine all possible rational roots of  $2x^3 + x^2 - 5x + 3 = 0$ .
- A.  $\pm 1, \pm 2$       B.  $\pm 1, \pm 2, \pm 3$       C.  $\pm 1, \pm \frac{1}{2}, \pm \frac{3}{2}, \pm 3$       D.  $\pm 1, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm 2$
14. What is the remainder when  $x^{21} - 1$  is divided by  $x + 1$ ?
- A.  $-22$       B.  $-2$       C.  $-1$       D.  $0$

15. What is the minimum degree of the polynomial function shown?

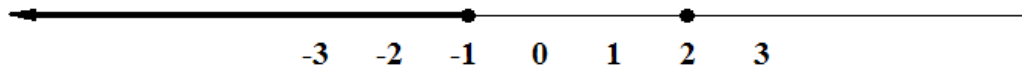
- A. 1                      B. 2                      C. 3                      D. 4



16. Which of the following is a factor of  $x^3 + 5x^2 + 2x - 8$ ?

- A.  $x^2 + 6x + 8$       B.  $x^2 + 3x + 2$       C.  $x - 2$       D.  $x - 4$

17. Determine a polynomial inequality whose solution is graphed below:



- A.  $(x-1)(x+2)^2 \leq 0$                       B.  $(x+1)(x-2)^2 \leq 0$   
 C.  $(x+1)(x-2)^2 \geq 0$                       D.  $(x-1)(x-2)^2 \geq 0$

18. Determine all real roots of the equation  $x^3 + x^2 - 5x - 5 = 0$ .

## JUNE 1992

19. Let  $p(x)$  be a polynomial such that  $p(-3) = 0$ . Which of the following must be a factor of  $p(x)$ ?

- A.  $x$                       B.  $x - 3$                       C.  $x + 3$                       D.  $x^2 - 9$

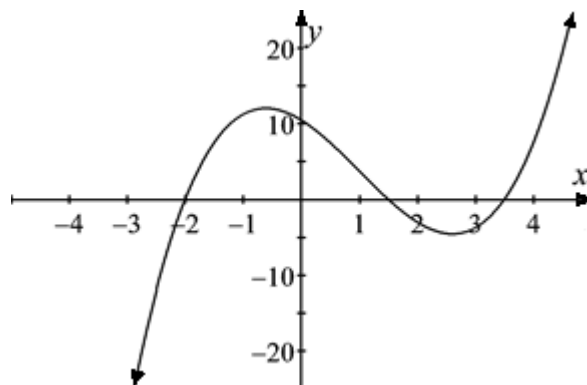
20. Determine all possible rational roots of  $2x^3 - 5x^2 + 3x - 5 = 0$ .

- A.  $\pm 1, \pm 2$                       B.  $\pm 1, \pm 5$                       C.  $\pm 1, \pm 5, \pm \frac{1}{2}, \pm \frac{5}{2}$                       D.  $\pm 1, \pm 2, \pm \frac{1}{5}, \pm \frac{2}{5}$



21. Estimate the real zeros of the function shown:

- A. 10
- B.  $-2, 1.5, 3.5$
- C.  $2, -1.5, -3.5$
- D.  $10, -2, 1.5, 3.5$

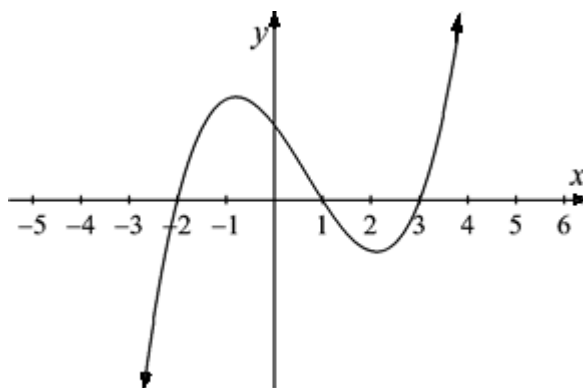


22. Determine the remainder when  $p(x) = x^{28} - 2x^5 + 3$  is divided by  $x + 1$ .

- A. 2
- B. 3
- C. 4
- D. 6

23. Using the graph of the polynomial function  $f(x)$  shown, determine all values of  $x$  such that  $f(x + 3) > 0$ .

- A.  $-5 < x < -2$  or  $x > 0$
- B.  $x < -5$  or  $-2 < x < 0$
- C.  $-2 < x < 1$  or  $x > 3$
- D.  $1 < x < 4$  or  $x > 6$

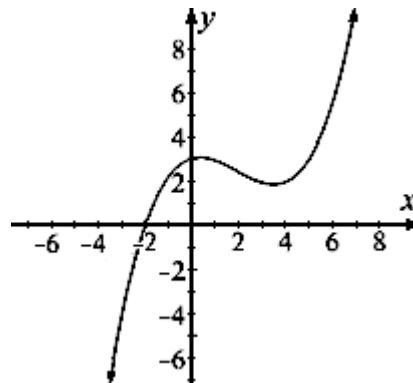


24. A polynomial function  $p(x)$ , of degree 3, has the real zeros  $-2$ ,  $1$  and  $4$ , and a  $y$ -intercept of  $24$ . Determine the value of  $p(6)$ .

**JAN 1993**

25. Determine a real zero of the function shown:

- A.  $-2$
- B.  $2$
- C.  $3$
- D.  $4$



26. Determine all possible rational roots of  $6x^3 - 5x^2 - 7x - 3 = 0$ .

A.  $\pm 1, \pm 3$

B.  $\pm 1, \pm 2, \pm 3, \pm 6$

C.  $\pm \frac{1}{3}, \pm \frac{2}{3}, \pm 1, \pm 2, \pm 3, \pm 6$

D.  $\pm \frac{1}{6}, \pm \frac{1}{3}, \pm \frac{1}{2}, \pm 1, \pm \frac{3}{2}, \pm 3$

27. Determine the remainder if  $x^3 - 2x^2 + 3x - 7$  is divided by  $x + 1$ .

A.  $-13$

B.  $-9$

C.  $-5$

D.  $5$

28. Solve:  $x^3 + 5x^2 + 6x = 0$

A.  $-2, -3$

B.  $1, -6$

C.  $0, -2, -3$

D.  $0, 1, -6$

29. Determine a polynomial equation that has roots  $\pm 3$  and  $2$ .

A.  $x^3 - 2x^2 - 9x + 18 = 0$

B.  $x^3 + 2x^2 - 9x - 18 = 0$

C.  $x^3 + 2x^2 - 9x + 18 = 0$

D.  $x^3 - 2x^2 + 9x - 18 = 0$

30. How many real roots are there for the polynomial equation  $x(x^2 - 4)(x + 3)(x^2 + 5) = 0$ ?

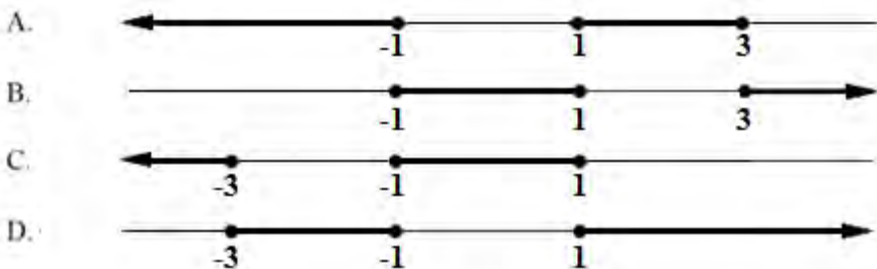
A.  $3$

B.  $4$

C.  $5$

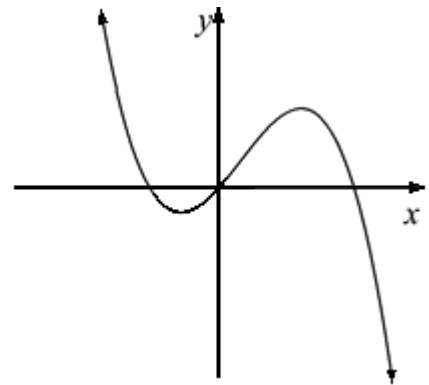
D.  $6$

31. Graph the solution of the inequality for  $(x - 3)(x + 1)(x - 1) \geq 0$



32. If the graph of the polynomial function shown is of the form  $y = ax^3 + bx^2 + cx + d$  (where  $a$ ,  $b$ ,  $c$ , and  $d$  are constants), what are the conditions on  $a$  and  $d$ ?

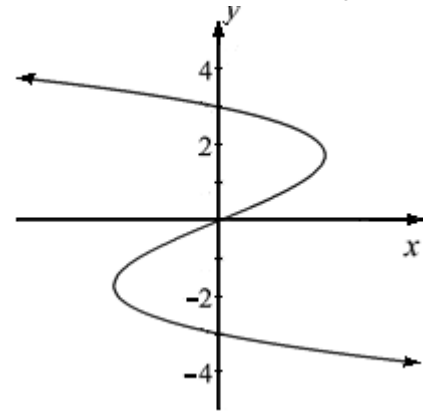
A.  $a > 0, d \neq 0$                       B.  $a > 0, d = 0$   
 C.  $a < 0, d \neq 0$                       D.  $a < 0, d = 0$



### JUNE 1993

33. Determine a possible equation of the inverse of the relation shown.

A.  $y = x^3 - 3x$                       B.  $y = 3x - x^3$   
 C.  $y = x^3 - 9x$                       D.  $y = 9x - x^3$

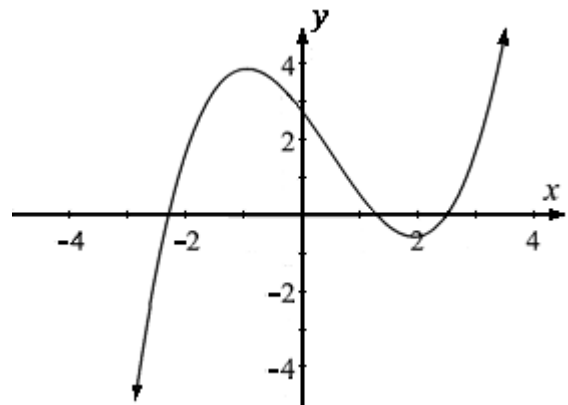


34. If a polynomial  $p(x)$  is divided by  $x + 5$ , what is the remainder?

A.  $p(-5)$                       B.  $p(5)$                       C.  $p(x - 5)$                       D.  $p(x + 5)$

35. Estimate the real zeros of the function shown:

A.  $-2.3, 1.3, 2.5$   
 B.  $2.3, -1.3, -2.5$   
 C.  $-2.7, 1.3, 2.5$   
 D.  $2.7, -1.3, -2.5$



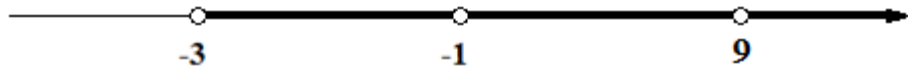
36. Determine a polynomial equation that has roots  $\sqrt{2}$ ,  $-\sqrt{2}$  and 1.

A.  $x^3 - x^2 - 4x + 4 = 0$                       B.  $x^3 + x^2 - 4x - 4 = 0$   
 C.  $x^3 + x^2 - 2x - 2 = 0$                       D.  $x^3 - x^2 - 2x + 2 = 0$

37. Determine the remainder when  $6x^3 - 11x^2 + 14x - 5$  is divided by  $2x^2 - 7x + 3$ .

A.  $-107x - 53$                       B.  $-107x + 43$                       C.  $40x - 20$                       D. 20

38. What is the minimum degree of a polynomial inequality whose solution is shown below?



- A. 3                      B. 4                      C. 5                      D. 6
39. Solve:  $2x^3 + 3x^2 - 11x - 6 = 0$

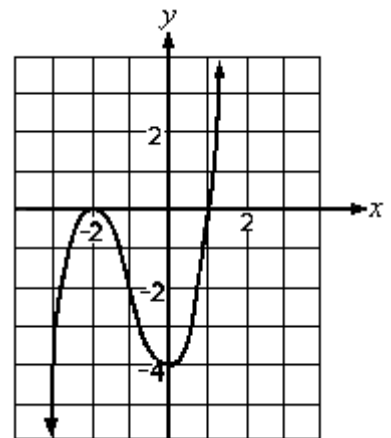
### JAN 1994

40. According to the Rational Root Theorem, what are the possible rational roots of  $2x^4 + 3x^2 - 7x + 3 = 0$ ?

- A.  $\pm 1, \pm 3$               B.  $\pm 1, \pm 2, \pm \frac{1}{3}, \pm \frac{2}{3}$               C.  $\pm 1, \pm 3, \pm \frac{1}{2}, \pm \frac{3}{2}$               D.  $\pm 1, \pm 2, \pm 3, \pm \frac{1}{2}, \pm \frac{3}{2}$

41. Which equation could represent the following graph?

- A.  $y = (x + 2)^2 (x - 1)$   
 B.  $y = (x + 2)^2 (x + 1)$   
 C.  $y = (x - 2)^2 (x - 1)$   
 D.  $y = (x - 2)^2 (x + 1)$



42. Determine the quotient when  $x^3 - 2x^2 - 9$  is divided by  $x - 3$ .

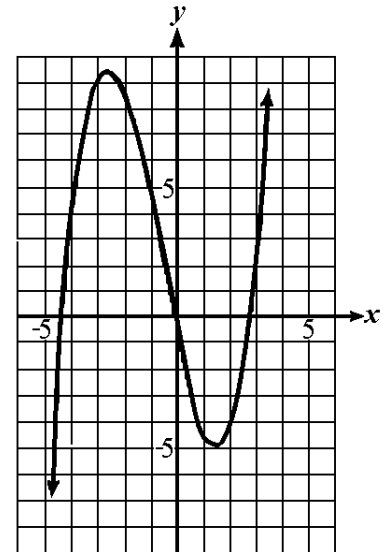
- A.  $x^2 + 5x + 15$               B.  $x^2 + x - 6$               C.  $x^2 - 5x + 6$               D.  $x^2 + x + 3$

43. What value of  $k$  would make  $x + 2$  a factor of  $2x^3 - 5x^2 - 2kx + 8$ ?

- A. -7                      B. -1                      C. 1                      D. 7

44. From the graph of  $y = f(x)$  shown, find the approximate solutions to  $f(x) = 2$ .

- A.  $-4.2$   
 B.  $8.6$   
 C.  $-4.5, 0.3, 2.5$   
 D.  $-4.2, -0.5, 3.0$



45. Determine the graph of the solution set of the inequality  $x(x-1)^n(x+2)^m \leq 0$ , if  $n$  is an even positive integer and  $m$  is an odd positive integer.

- A.
- B.
- C.
- D.

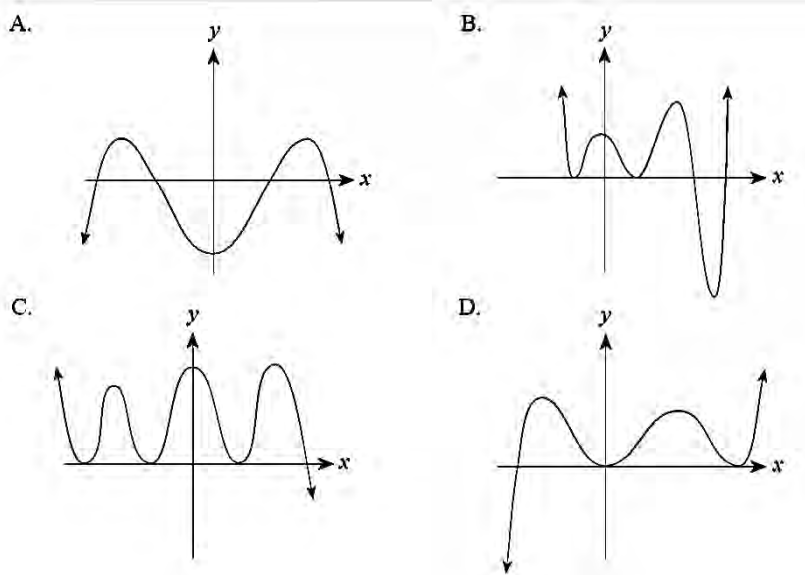
46. Solve:  $2x^3 - x^2 - 8x + 4 = 0$

### JUNE 1994

47. According to the Rational Root Theorem, which one of the following is a possible root of the equation  $8x^4 + 19x^3 - 13x^2 + 7x - 3 = 0$ ?

- A. 2                      B. 3                      C. 4                      D. 8

48. Which graph could represent a polynomial function of degree 5?



49. When  $4x^2 + 2kx - 5$  is divided by  $x + 2$  the remainder is 3. What is the value of  $k$ ?

- A. -6                      B. -2                      C. 2                      D.  $\frac{11}{4}$

50. Solve:  $x^3 - 2x^2 - 5x + 6 = 0$

- A. 1, 2, -3              B. 1, -2, 3              C. -1, 2, -3              D. -1, -2, 3

51. Determine the remainder when  $p(x) = 4x^3 - 6x^2 + 4x - 3$  is divided by  $2x - 1$ .

- A. -7                      B. -4                      C. -3                      D. -2

52. Determine a polynomial equation that has roots of  $\sqrt{3}$ ,  $-\sqrt{3}$  and 2.

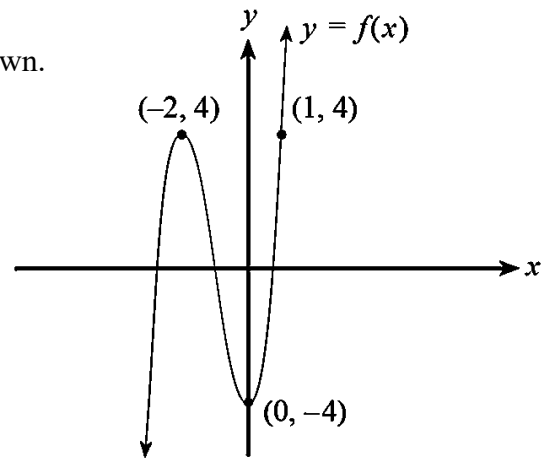
- A.  $x^3 - 2x^2 - 3x + 6 = 0$                       B.  $x^3 + 2x^2 - 3x - 6 = 0$   
C.  $x^3 - 2x^2 - 9x + 18 = 0$                       D.  $x^3 + 2x^2 - 9x - 18 = 0$

53. Which polynomial inequality has the solution  $-3 < x < -2$  or  $x > 1$ ?

- A.  $(x + 3)(x + 2)(x - 1) < 0$                       B.  $(x + 3)(x + 2)(x - 1) > 0$   
C.  $(x - 3)(x - 2)(x + 1) < 0$                       D.  $(x - 3)(x - 2)(x + 1) > 0$

54. The graph of a cubic polynomial function,  $y = f(x)$ , is shown. Determine the equation of  $y = f(x) - 4$ .

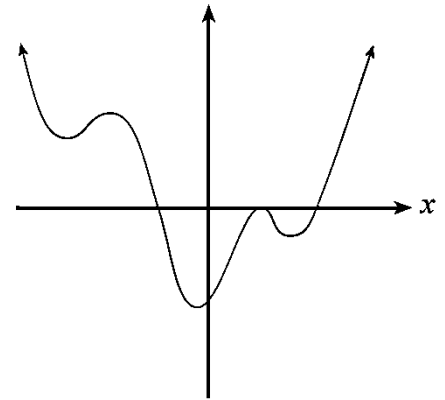
- A.  $y = (x + 2)^2(x + 1)$   
 B.  $y = (x + 2)^2(x - 1)$   
 C.  $y = 2(x + 2)^2(x + 1)$   
 D.  $y = 2(x + 2)^2(x - 1)$



### JAN 1995

55. Determine the minimum degree of the polynomial function shown.

- A. 3                      B. 4                      C. 5                      D. 6



56. If  $p(x) = x^3 - 3x^2 + kx + 1$ , determine  $k$  if  $p(3) = -5$ .

- A. -12                      B. -2                      C. 4                      D. 16

57. Determine all real roots of the equation  $(x^2 - 4)(x^2 + 9)(x - 5)^2 = 0$ .

- A. 2, 3, 5                      B.  $\pm 2$ , 5                      C.  $\pm 2$ ,  $\pm 3$ , 5                      D.  $\pm 2$ ,  $\pm 3$ ,  $\pm 5$

58. The polynomial equation  $x^3 - ax^2 + bx - c = 0$ , where  $a$ ,  $b$  and  $c$  are integers, has 6 as one of its roots. According to the Rational Root Theorem, which of the following could be a value of  $c$ ?

- A. 2                      B. 3                      C. 9                      D. 18




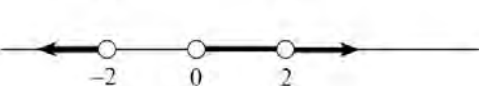
59. Determine the quotient and remainder:  $(t^4 + 3t^3 + 5t^2 + 21t - 14) \div (t^2 + 3t - 2)$

- A. quotient:  $t^2 + 7$ , remainder: 0                      B. quotient:  $t^2 + 7$ , remainder: -28  
 C. quotient:  $t^2 + 3$ , remainder:  $12t - 8$                       D. quotient:  $t^2 + 3$ , remainder:  $30t - 20$

60. Determine the remainder when  $x^{39} - 3x^{15} - 2x + 1$  is divided by  $x - 1$ .

- A. -3                      B. -1                      C. 1                      D. 5

61. Solve the inequality:  $x(x - 2)(x^2 - 4) < 0$

- A. 
- B. 
- C. 
- D. 

62a. A sheet of paper 12 cm long and 8 cm wide is used to make a box with no lid. Equal squares of side length  $x$  cm are cut from each of the corners and the sides are folded up to make the box. Which of the following expresses the volume of the box?

A.  $V(x) = x(12 + x)(8 + x)$

B.  $V(x) = x(12 - x)(8 - x)$

C.  $V(x) = x(12 + 2x)(8 + 2x)$

D.  $V(x) = x(12 - 2x)(8 - 2x)$

62b. A square piece of cardboard 10 cm by 10 cm will have equal squares with sides of length  $x$  cm cut from each corner. The sides will then be folded up to create a box with no top. Determine the value of  $x$  that will give the box a maximum volume.



## JUNE 1995

63. If  $x + 8$  is a factor of the polynomial  $P(x)$ , which of the following must be true?

A.  $P(-8) = 0$

B.  $P(8) = 0$

C.  $P(x) = 8$

D.  $P(x) = -8$

64. What is the maximum number of real roots that a polynomial equation can have if its degree is 6?

A. 3

B. 5

C. 6

D. 7



65. According to the Rational Zero Theorem, which number is a possible zero of the function  $f(x) = 6x^3 + 7x^2 - 3x + 4$ ?

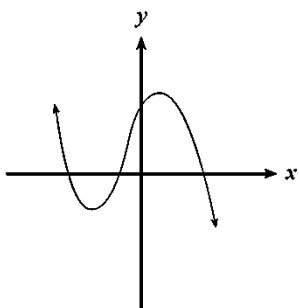
A.  $-\frac{3}{2}$       B.  $\frac{1}{4}$       C.  $\frac{1}{3}$       D. 3

66. Determine the remainder when  $2x^4 + 4x^3 - 5x^2 + 8$  is divided by  $x - 2$ .

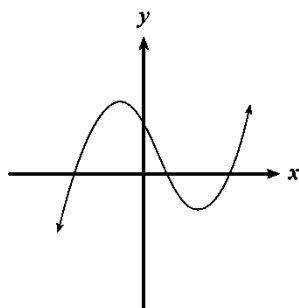
A. -12      B. 18      C. 30      D. 52

67. Which graph is the best representation of  $y = ax^3 + bx^2 + cx - 24$  where  $a > 0$ ?

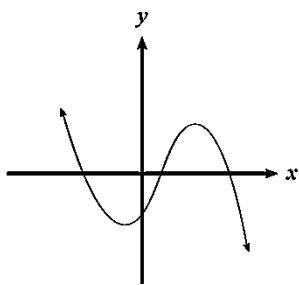
A.



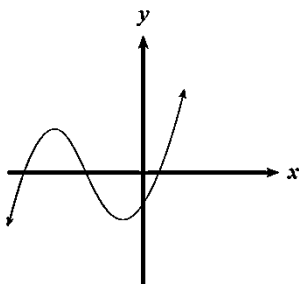
B.



C.



D.



68. Determine all the real zeros of the function  $P(x) = 2x(x^2 + 9)(x^2 - 2)$ .

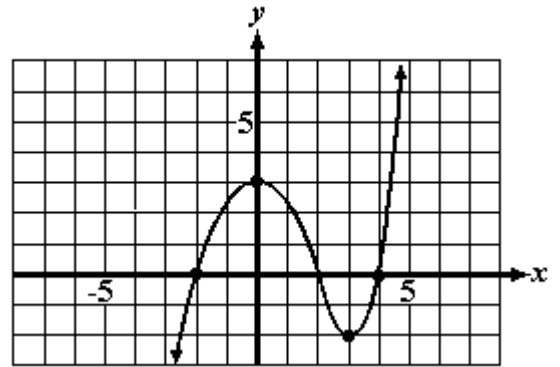
A.  $0, \pm\sqrt{2}$       B.  $0, \pm 3$       C.  $0, \sqrt{2}, 3$       D.  $0, \pm\sqrt{2}, \pm 3$

69. Solve the inequality:  $(x + 2)^2(x - 2)(x - 4) < 0$

A.  $x < -2$       B.  $-2 < x < 4$       C.  $2 < x < 4$       D.  $x < 2$  or  $x > 4$

70. The graph of the function  $f(x)$  is shown.  
If  $g(x) = 3f(x)$ , determine the zeros of  $g(x)$ .

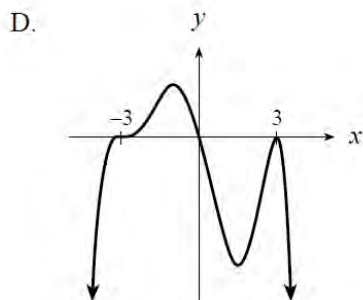
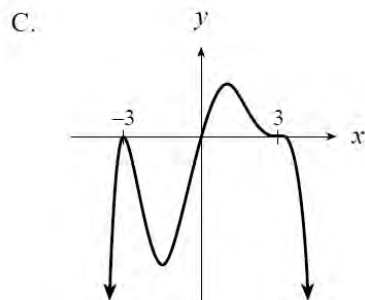
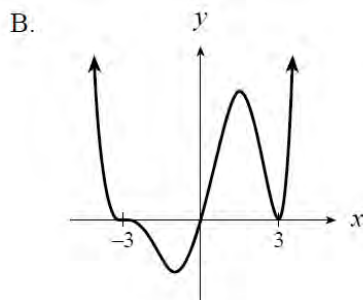
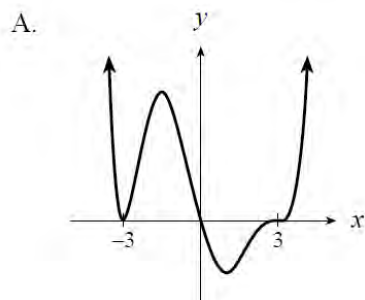
A.  $-2, 2, 4$                       B.  $-6, 6, 12$   
C.  $-6, 9$                         D.  $-2, 3$



### JAN 1996

71. According to the Rational Root Theorem, determine all possible rational roots of  $3x^3 - 8x^2 + 16x - 4 = 0$ .
- A.  $\pm 1, \pm 3$                       B.  $\pm 1, \pm 2, \pm 4$   
C.  $\pm 1, \pm \frac{1}{2}, \pm \frac{1}{4}, \pm 3, \pm \frac{3}{2}, \pm \frac{3}{4}$                       D.  $\pm 1, \pm \frac{1}{3}, \pm 2, \pm \frac{2}{3}, \pm 4, \pm \frac{4}{3}$
72. If  $p(x)$  is a polynomial function where  $p(-2) = 5$ , then which of the following could not be a zero of this function?
- A.  $-5$                       B.  $-2$                       C.  $2$                       D.  $5$
73. Find the remainder when  $x^3 - 2x^2 + 5$  is divided by  $x^2 + x - 1$ .
- A.  $4$                       B.  $2x + 2$                       C.  $2x + 4$                       D.  $4x + 2$
74. Determine the value of  $k$  such that  $x + 2$  is a factor of the polynomial  $2x^3 + 5x^2 + kx - 12$ .
- A.  $-12$                       B.  $-4$                       C.  $4$                       D.  $12$

75. Which graph best represents  $y = -x(x + 3)^2(x - 3)^3$ ?



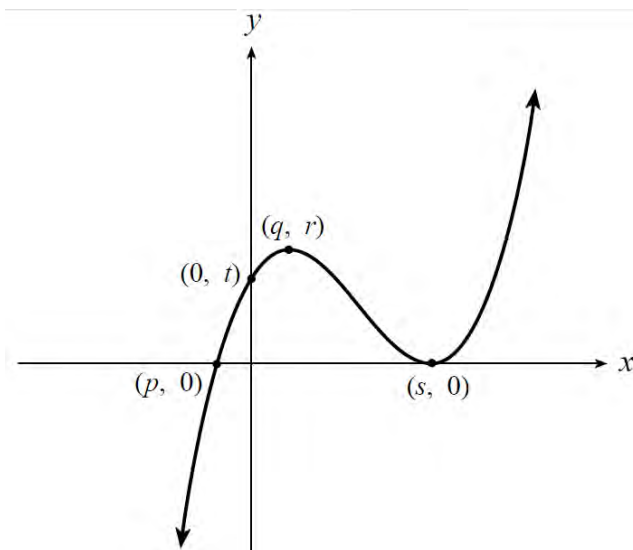
76. Given that  $p(x)$  and  $f(x)$  are polynomial functions such that  $p(x) = xf(x) + c$ , determine  $c$  if the graph of  $p(x)$  is shown.

A.  $p$

B.  $t$

C.  $r$

D.  $s$



**JUNE 1996**

77. If the polynomial  $p(x)$  is divided by  $x - 6$ , which of the following represents the remainder?

A.  $p(6)$

B.  $p(-6)$

C.  $p(x) + 6$

D.  $p(0)$

78. Determine the value of  $k$  if 2 is a zero of the function  $p(x) = x^3 - 7x^2 + kx + 12$ .

A.  $k = -16$

B.  $k = 4$

C.  $k = 5$

D.  $k = 16$

79. Determine the quotient when  $x^3 - 12x^2 + 9x - 5$  is divided by  $x - 3$ .

- A.  $x^2 - 9x - 16$     B.  $x^2 - 9x - 18$     C.  $x^2 - 15x + 54$     D.  $x^2 + 9x + 36$

80. If  $x + 4$  is a factor of the polynomial  $mx^3 - 11x^2 - 10x + n$ , where  $m$  and  $n$  are integers, according to the Rational Root Theorem, which of the following could be a value for  $n$ ?

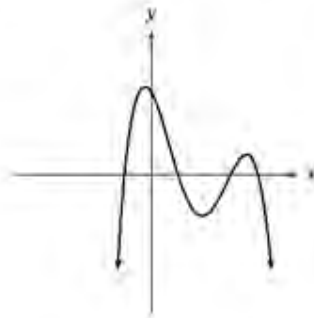
- A. 2    B. 6    C. 8    D. 10

81. Solve:  $x^3 - 4x^2 > 12x$

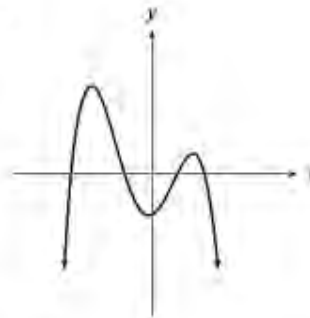
- A.  $-2 < x < 6$     B.  $x < -2$  or  $x > 6$   
C.  $-2 < x < 0$  or  $x > 6$     D.  $-6 < x < 0$  or  $x > 2$

82. Which graph is a possible representation of  $y = ax^4 + bx^3 + cx - 6$ , where  $a$  is a negative integer?

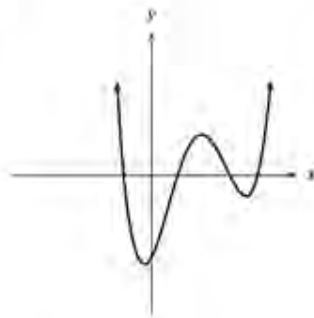
**A.**



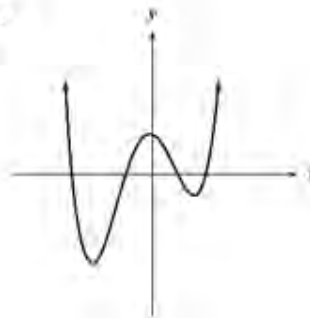
**B.**



**C.**



**D.**

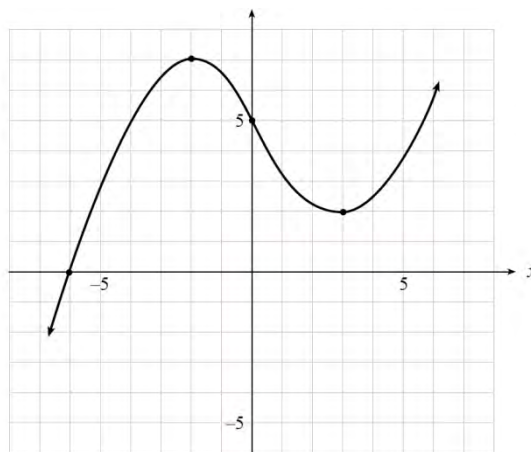


83. Determine a polynomial equation that has the following roots:  $2, \pm\sqrt{5}$

- A.  $x^3 + 2x^2 - 5x - 10 = 0$     B.  $x^3 - 2x^2 + 5x - 10 = 0$   
C.  $x^3 - 2x^2 - 5x + 10 = 0$     D.  $x^3 + 2x^2 + 5x + 10 = 0$

84. The graph of the cubic polynomial function  $p(x)$  is given below. Which of the following functions must have 3 unequal real zeros?

- A.  $p(x) - 7$   
 B.  $p(x) - 3$   
 C.  $p(x - 3)$   
 D.  $p(x - 7)$



**JAN 1997**

85. If  $x + 4$  is a factor of the polynomial  $p(x)$ , then which of the following must be true?

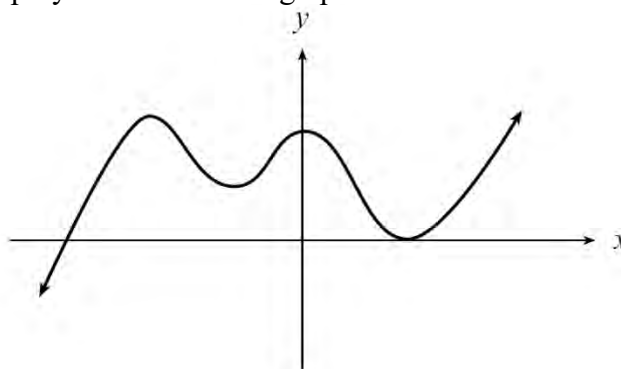
- A.  $p(-4) = 0$       B.  $p(4) = 0$       C.  $p(0) = -4$       D.  $p(0) = 4$

86. According to the Rational Root Theorem, which number could not be a root of the equation  $4x^3 + kx^2 + 3x - 3 = 0$ , where  $k$  is an integer?

- A.  $-3$       B.  $-1$       C.  $\frac{4}{3}$       D.  $\frac{3}{2}$

87. What is the minimum degree of the polynomial function graphed below?

- A. 3  
 B. 4  
 C. 5  
 D. 7



88. When  $x^3 + x^2 - kx - 5$  is divided by  $x - 2$ , the remainder is 1. Find the value of  $k$ .

- A. 3      B. 3.5      C. 4.5      D. 5

89. Determine a polynomial equation that has the roots  $\pm 2, \pm \sqrt{7}$ .

- A.  $x^4 - 11x^2 + 28 = 0$       B.  $x^4 + 11x^2 + 28 = 0$   
 C.  $x^4 - 9x^2 + 14 = 0$       D.  $x^4 + 9x^2 + 14 = 0$

90. Find the remainder for the following division.  $x^2 + 2x - 4 \overline{) x^4 + 2x^3 - 3x^2 + 2x + 6}$

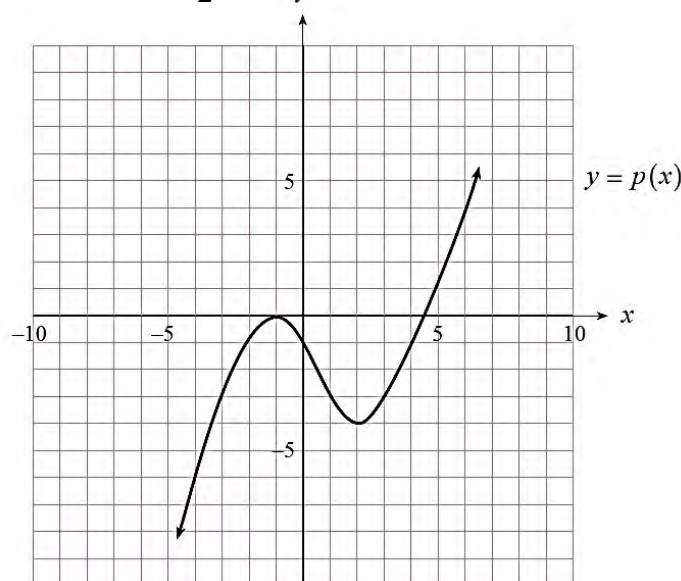
- A. 2                      B. 10                      C.  $4x + 2$                       D.  $16x - 22$

91. Determine the real root(s):  $2x^3 - 3x^2 + 6x - 9 = 0$

- A.  $-\frac{3}{2}$                       B.  $\frac{3}{2}$                       C.  $-\frac{3}{2}, \pm\sqrt{3}$                       D.  $\frac{3}{2}, \pm\sqrt{3}$

92. Use the graph of the function  $y = p(x)$  shown to solve the equation  $p(x - 5) + 6 = 0$ .

- A. -4  
B. -1  
C. 1  
D. 4



### JUNE 1997

93. According to the Rational Root Theorem, list all possible rational roots of  $2x^8 - 5x^3 + 6x^2 - 4 = 0$ .

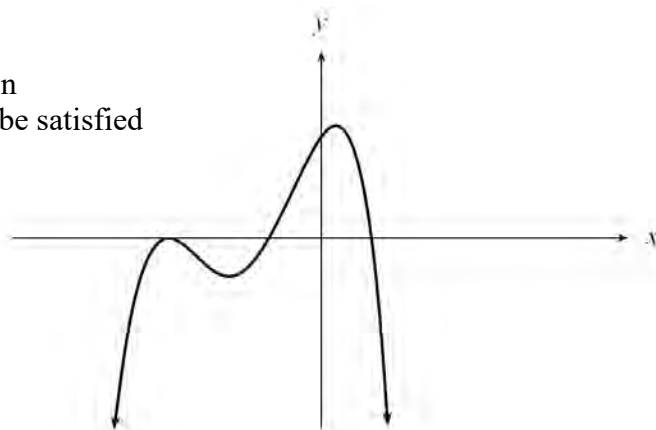
- A.  $\pm 1, \pm 2, \pm 4$                       B.  $\pm \frac{1}{2}, \pm 1, \pm 2, \pm 4$                       C.  $\pm \frac{1}{4}, \pm \frac{1}{2}, \pm 1, \pm 2$                       D.  $\pm \frac{1}{2}, \pm 1, \pm 2, \pm 4, \pm 8$

94. Determine the remainder when  $6x^3 - 11x^2 + 14x - 5$  is divided by  $2x^2 - 7x + 3$ .

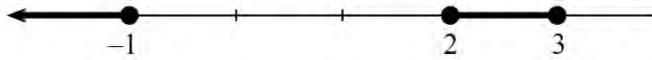
- A.  $-107x - 53$                       B.  $-107x + 43$                       C.  $40x - 20$                       D. 20

95. The following graph represents the polynomial function  $y = Ax^4 + Bx^3 + Cx^2 + Dx + E$ . What conditions must be satisfied by  $A$  and  $E$ ?

- A.  $A < 0$  and  $E < 0$   
B.  $A < 0$  and  $E > 0$   
C.  $A > 0$  and  $E < 0$   
D.  $A > 0$  and  $E > 0$



96. Which polynomial inequality describes the solution shown?



- A.  $(x - 1)(x + 2)(x + 3) \geq 0$       B.  $(x - 1)(x + 2)(x + 3) \leq 0$   
 C.  $(x + 1)(x - 2)(x - 3) \geq 0$       D.  $(x + 1)(x - 2)(x - 3) \leq 0$

97. For the polynomial function  $p(x) = ax^3 + bx - 3$ ,  $p(-1) = 4$ . Determine the value of  $p(1)$ .

- A. -10      B. -4      C. 4      D. 10

98. If  $-2$  is a root of  $2x^3 + kx^2 - 11x + 6 = 0$ , determine the other two roots.

## JAN 1998

99. Given a polynomial  $p(x)$ , what condition must be true for  $x - 2$  to be a factor of  $p(x)$ ?

- A.  $p(2) = 0$       B.  $p(-2) = 0$       C.  $p(x) = 2$       D.  $p(x) = -2$

100. According to the Rational Root Theorem, determine all possible rational roots of  $2x^3 - 5x^2 + 12x - 6 = 0$ .

- A.  $\pm 1, \pm 2, \pm 3, \pm 6$       B.  $\pm \frac{1}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{1}{6}$   
 C.  $\pm 1, \pm 2, \pm 3, \pm 6, \pm \frac{1}{2}, \pm \frac{3}{2}$       D.  $\pm 1, \pm 2, \pm \frac{1}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{1}{6}$

101. What is the quotient when  $5x^3 - 6x^2 + 64$  is divided by  $x + 2$ ?

- A.  $5x^2 + 4x + 8$       B.  $5x^2 - 16x + 32$       C.  $5x^2 + 4x + 72$       D.  $5x^2 - 16x + 96$

102. Determine the remainder when  $3x^{45} + 4x^8 - 5x^3 + 2$  is divided by  $x + 1$ .

- A. -10      B. -2      C. 4      D. 8

103. What is the least number of real zeros that a polynomial function can have if its degree is 5 ?

- A. 0                      B. 1                      C. 3                      D. 5

104. Determine the real roots:  $x^3 + 3x^2 - 6x - 8 = 0$

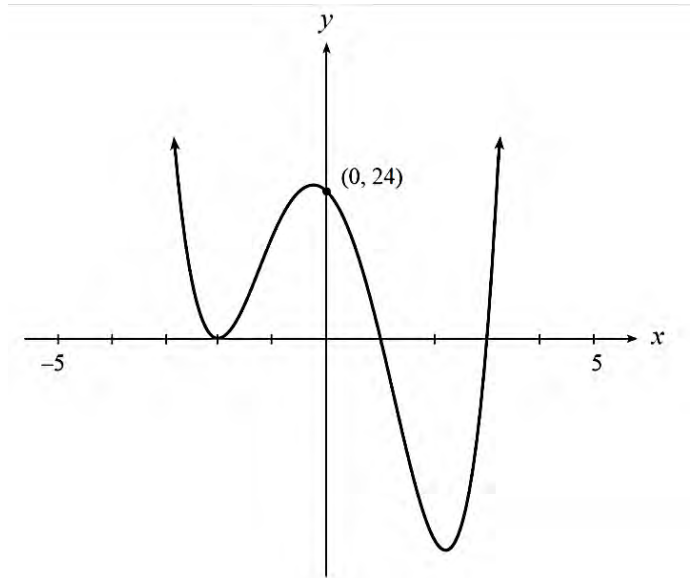
- A.  $-4, -1, 2$               B.  $-4, 1, 2$               C.  $-2, 1, 4$               D.  $-1, 2, 4$

105. Solve the inequality:  $(x + 5)(x - 2)(6 - x) > 0$

- A.  $x < -5$  or  $x > 6$                       B.  $x < -5$  or  $x > 2$   
C.  $-5 < x < 2$  or  $x > 6$                       D.  $x < -5$  or  $2 < x < 6$

106. Determine a possible equation of the polynomial function  $y = f(x)$  shown:

- A.  $f(x) = 2(x + 2)^2(x - 1)(x - 3)$   
B.  $f(x) = 4(x + 2)^2(x - 1)(x - 3)$   
C.  $f(x) = 2(x - 2)^2(x + 1)(x + 3)$   
D.  $f(x) = 4(x + 2)(x - 1)(x - 3)$



## JUNE 1998

107. According to the Rational Root Theorem, determine all possible rational roots of  $5x^3 - 4x^2 + 15 = 0$ .

- A.  $\pm 1, \pm 5$                       B.  $\pm 1, \pm 3, \pm 5, \pm 15$   
C.  $\pm 1, \pm 3, \pm 5, \pm 15, \pm \frac{1}{5}, \pm \frac{3}{5}$                       D.  $\pm 1, \pm 5, \pm \frac{1}{3}, \pm \frac{5}{3}, \pm \frac{1}{5}, \pm \frac{1}{15}$

108. If  $3x - 1$  is a factor of  $p(x)$ , which of the following must have a value of 0 ?

- A.  $p\left(\frac{1}{3}\right)$               B.  $p\left(-\frac{1}{3}\right)$               C.  $p(-1)$               D.  $p(1)$



109. How many real roots are there for the polynomial equation  $x(x^2 - 4)(x^2 + 9) = 0$  ?

- A. 1                      B. 2                      C. 3                      D. 5

110. Factor:  $x^3 - 2x^2 - 5x + 6$

- A.  $(x + 1)(x - 2)(x + 3)$                       B.  $(x + 1)(x + 2)(x - 3)$   
C.  $(x - 1)(x - 2)(x + 3)$                       D.  $(x - 1)(x + 2)(x - 3)$

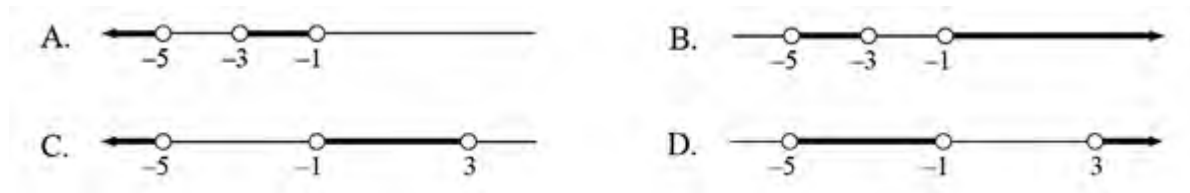
111. Determine the quotient when  $2x^3 - 5x^2 + 7x + 3$  is divided by  $2x + 1$  .

- A.  $x^2 - 3x + 4$               B.  $x^2 - 3x + 5$               C.  $x^2 - 2x - 2$               D.  $x^2 - 2x + 2$

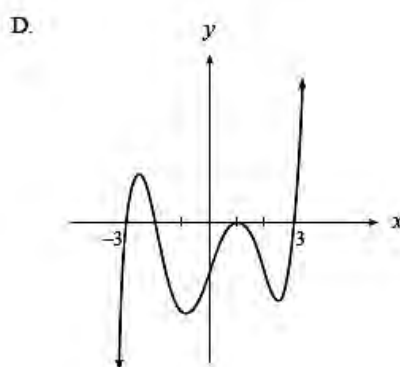
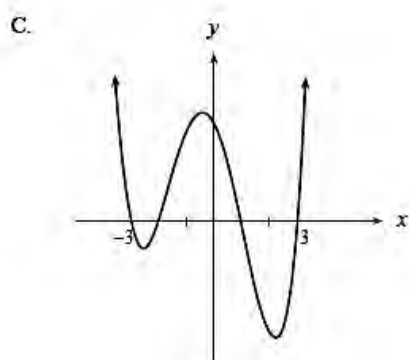
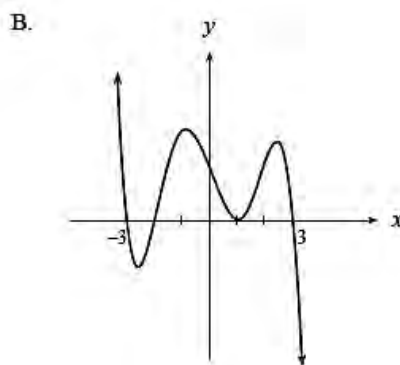
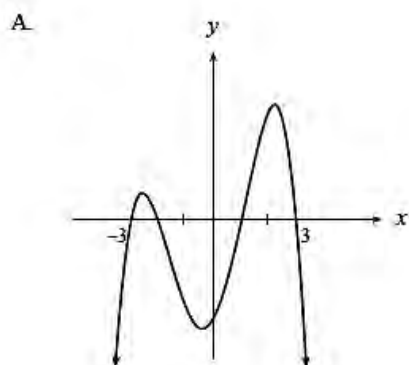
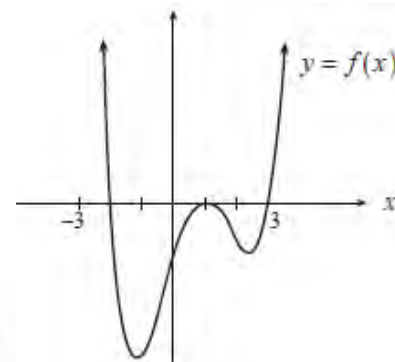
112. If the cubic polynomial function  $f(x) = k(x - 1)(x + 2)(x - 3)$  passes through the point (2, 6), determine the value of  $k$ .

- A.  $-\frac{3}{2}$                       B.  $-\frac{2}{3}$                       C.  $\frac{2}{3}$                       D.  $\frac{3}{2}$

113. Solve:  $(x + 5)(x + 1)(3 - x) < 0$



114. Given the graph of  $y = f(x)$ , which of the following best represents the graph of  $y = (x + 3)f(x)$ ?



### JAN 1999

115. If 5 is a zero of the polynomial  $P(x)$ , then which of the following must be true?

A.  $P(x) = 5$       B.  $P(5) = 0$       C.  $P(0) = 5$       D.  $P(-5) = 0$

116. According to the Rational Root Theorem, determine all possible rational roots of  $4x^5 - 3x^3 + 6x - 2 = 0$ .

A.  $\pm 1, \pm 2$       B.  $\pm 1, \pm 2, \pm 4, \pm \frac{1}{2}$   
 C.  $\pm 1, \pm 2, \pm \frac{1}{2}, \pm \frac{1}{4}$       D.  $\pm 1, \pm 2, \pm 4, \pm \frac{1}{2}, \pm \frac{1}{4}$

117. Determine the remainder when  $x^{12} - 2x^7 + 6x^2 - 4$  is divided by  $x + 1$ .

A. 0      B. 1      C. 4      D. 5



124. According to the Rational Root Theorem, which of the following equations has possible rational roots of  $\pm 1, \pm 2, \pm \frac{1}{3}, \pm \frac{2}{3}$ ?

A.  $3x^3 - 4x^2 + 5x + 1 = 0$

B.  $6x^3 - 4x^2 + 5x + 1 = 0$

C.  $2x^3 - 4x^2 + 5x + 3 = 0$

D.  $3x^3 - 4x^2 + 5x + 2 = 0$

125. Which of the following is a polynomial function with zeros of  $-\sqrt{2}, \sqrt{2}$  and  $-1$ ?

A.  $P(x) = x^3 - x^2 - 2x + 2$

B.  $P(x) = x^3 + x^2 - 2x - 2$

C.  $P(x) = x^3 - x^2 - 4x + 4$

D.  $P(x) = x^3 + x^2 - 4x - 4$

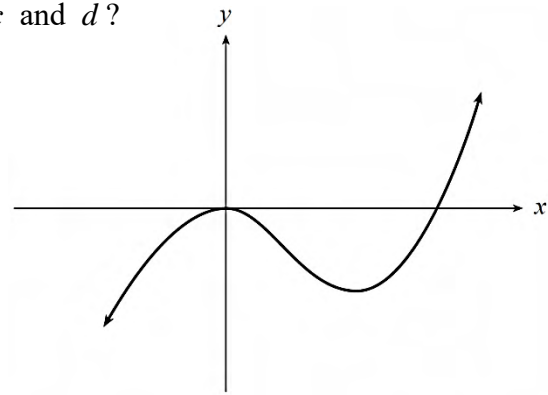
126. The graph of the polynomial function  $P(x) = ax^3 + bx^2 + cx + d$ , where  $a, b, c$  and  $d$  are constants, is shown. What are the conditions on  $c$  and  $d$ ?

A.  $c = 0, d = 0$

B.  $c = 0, d > 0$

C.  $c > 0, d = 0$

D.  $c \neq 0, d = 0$



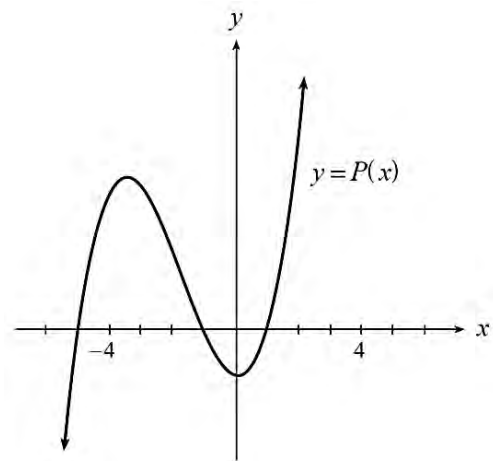
127. The graph of the cubic polynomial function  $y = P(x)$  is shown below. Determine the zeros of  $y = xP(-x)$ .

A.  $-5, -1, 0, 1$

B.  $-5, -1, 1$

C.  $-1, 0, 1, 5$





D.  $-1, 1, 5$

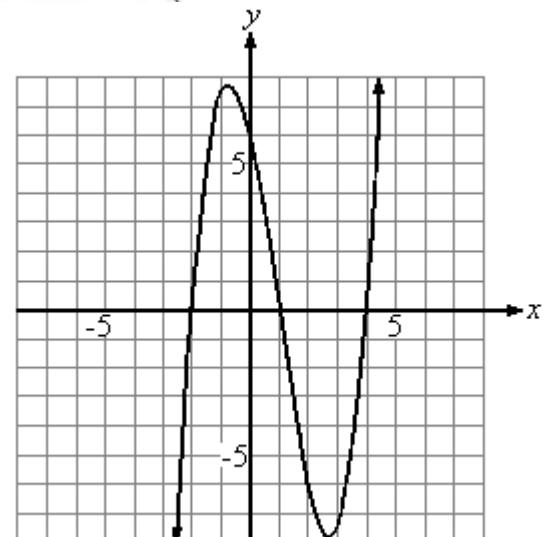


128. Solve:  $x^3 - 8x^2 > 18x - 20$



**JAN 2000**

129. According to the Rational Root Theorem, determine all possible rational roots of  $5x^3 - 3x^2 + x - 2 = 0$ .
- A.  $\pm 1, \pm 2$       B.  $\pm 1, \pm 5$       C.  $\pm 1, \pm 2, \pm \frac{1}{2}, \pm \frac{5}{2}$       D.  $\pm 1, \pm 2, \pm \frac{1}{5}, \pm \frac{2}{5}$
130. How many different real roots are there for the polynomial equation  $x(x - 3)(x^2 + 6) = 0$ ?
- A. 1      B. 2      C. 3      D. 4
131. Determine the remainder when  $3t^3 - 7t^2 - 11t + 20$  is divided by  $t^2 + 2t - 4$
- A.  $3t - 13$       B.  $-25t + 24$       C.  $-25t + 72$       D.  $27t - 32$
132. A cubic polynomial function that passes through the point  $(3, 24)$  has zeros at 5,  $-1$  and  $-3$ . Determine an equation of this function.
- A.  $y = -2(x - 5)(x + 1)(x + 3)$       B.  $y = -\frac{1}{2}(x - 5)(x + 1)(x + 3)$
- C.  $y = \frac{1}{2}(x - 5)(x + 1)(x + 3)$       D.  $y = 2(x - 5)(x + 1)(x + 3)$
133. Solve the inequality:  $-(x - 3)(x + 2)^2 < 0$
- A.       B. 
- C.       D. 
134. The graph of the polynomial function  $y = f(x)$  is shown. Determine the remainder when  $f(x)$  is divided by  $(x - 2)$ .
- A.  $-6$       B.  $0$       C.  $1$       D.  $6$



135. Solve:  $x^3 + 10x^2 = 22 - 10x$

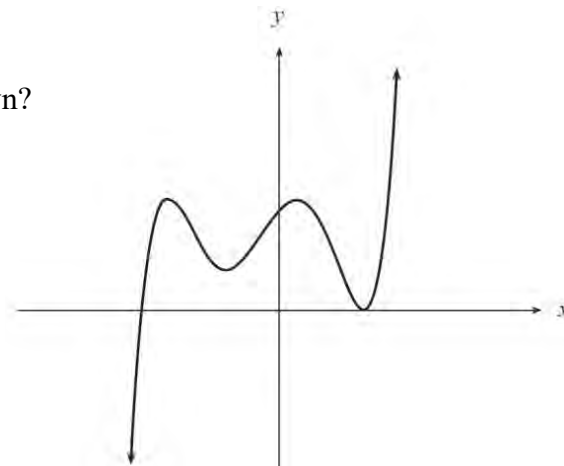
**JUNE 2000**

136. According to the Rational Root Theorem, determine all possible rational roots of  $4x^3 - 7x^2 + 3x - 2 = 0$ .

- A.  $\pm 1, \pm 2$       B.  $\pm 1, \pm 2, \pm 4$       C.  $\pm 1, \pm 2, \pm 4, \pm \frac{1}{2}$       D.  $\pm 1, \pm 2, \pm \frac{1}{4}, \pm \frac{1}{2}$

137. What is the minimum degree of the polynomial function shown?

- A. 2      B. 3      C. 4      D. 5



138. Solve:  $2x^3 + 5 = 5x^2 + 5x$



- A. -1.88      B. -0.58      C. -1.22, 0.67, 3.05      D. -1.00, 0.60, 3.00

139. Solve the following inequality for  $x$ , given that  $a, b$  and  $c$  are constants such that  $a < b < c$ .

$$(x - a)^3(x - b)^2(x - c) > 0$$

- A.  $x > c$       B.  $x < a$  or  $x > c$       C.  $x < c, x \neq a, x \neq b$       D.  $a < x < c, x \neq b$

140. Determine all values for  $k$  such that  $y = 2x^3 + 3x^2 - 12x + k$  has only one real zero.



- A.  $k < -20$       B.  $k > 7$       C.  $-20 < k < 7$       D.  $k < -20$  or  $k > 7$

141. When  $2x^3 - 8x^2 + kx + 18$  is divided by  $x + 2$ , the remainder is  $-14$ . Find  $k$ , then find all real roots of  $2x^3 - 8x^2 + kx + 18 = 0$ .



**JAN 2001**

142. Which expression represents the remainder when the polynomial  $P(x)$  is divided by  $x - 9$ ?

- A.  $P(9)$                       B.  $P(-9)$                       C.  $P(0)$                       D.  $P(x - 9)$

143. According to the Rational Root Theorem, which of the following is a possible root of the equation  $5x^3 + mx^2 + nx + 20 = 0$ , where  $m$  and  $n$  are integers?

- A.  $\frac{1}{10}$                       B.  $\frac{1}{5}$                       C.  $\frac{1}{4}$                       D.  $\frac{1}{2}$

144. Determine the quotient when  $x^4 - 8x^2 + 2x - 7$  is divided by  $x + 3$ .

- A.  $x^2 - 5x - 13$                       B.  $x^2 - 11x + 35$                       C.  $x^3 - 3x^2 + x - 1$                       D.  $x^3 + 3x^2 + x + 5$

145. Determine the value of  $k$  if  $x - 2$  is a factor of the polynomial  $x^3 - 4x^2 + kx + 6$ .

- A.  $-9$                       B.  $-1$                       C.  $1$                       D.  $9$

146. Solve  $(x + a)^2(x + b)(x + c) < 0$ , where  $a, b, c$  are real number constants and  $0 < a < b < c$ .

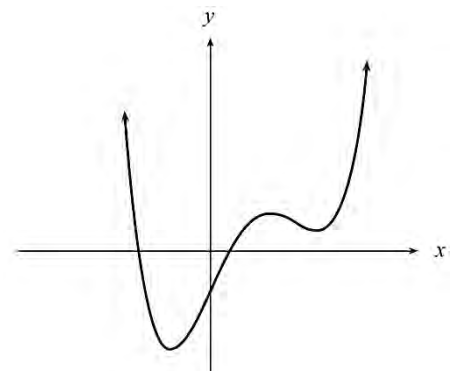
- A.  $b < x < c$                       B.  $-b < x < -c$                       C.  $-c < x < -b$                       D.  $-b < x < -a, x < -c$

147. Solve:  $x^3 - 15x^2 = -10x - 30$

**JUNE 2001**

148. Determine the number of real zeros of the function shown.

- A. 1                      B. 2                      C. 3                      D. 4



149. Find the quotient when  $2x^3 - 3x^2 + 2x - 8$  is divided by  $x + 1$ .

- A.  $x^2 - 2x$       B.  $x^2 - 4x + 6$       C.  $2x^2 - x + 1$       D.  $2x^2 - 5x + 7$

150. The polynomial equation  $mx^3 + 7x^2 - 3x + n = 0$ , where  $m$  and  $n$  are integers, has a root of  $\frac{4}{9}$ . According to the Rational Root Theorem, which of the following could be a value for  $m$ ?

- A. 2      B. 4      C. 6      D. 18

151. Solve:  $x^3 < x$

- A.  $x < 0, x > 1$       B.  $-1 < x < 1$       C.  $-1 < x < 0, x > 1$       D.  $x < -1, 0 < x < 1$

152. Solve:  $x^3 + 2x^2 - 104x + 192 = 30$



- A. 1.65, 8.24      B. 2.37, 7.73      C. -12.11, 2.37, 7.73      D. -11.89, 1.65, 8.24

153. The points  $(-2, 0)$ ,  $(0, 5)$  and  $(2, -4)$  are on the graph of a third degree polynomial function,  $y = p(x)$ . If  $p(x)$  is divided by  $x - 2$ , determine the remainder.

- A. -4      B. 0      C. 4      D. 5

154. A cubic polynomial function has a double zero at  $-2$  and a single zero at  $3$ . If this function passes through the point  $(4, -24)$ , determine an equation of the function. Answer may be left in factored form.



**ADDITIONAL QUESTIONS**

155. What numbers should replace  $p$  and  $q$  in the incomplete synthetic division shown below?

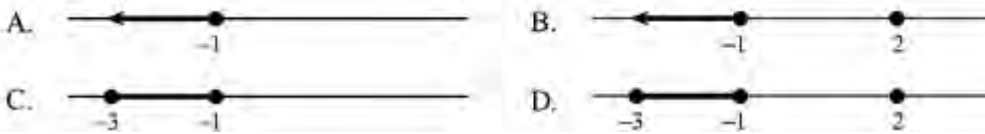
$$\begin{array}{r|rrrr} \boxed{\phantom{0}} & 2 & p & q & 2 \\ & & \boxed{\phantom{0}} & \boxed{\phantom{0}} & \boxed{\phantom{0}} \\ \hline & 2 & -7 & 4 & -2 \end{array}$$

- A.  $p = -5, q = -3$       B.  $p = -5, q = 3$       C.  $p = 5, q = -3$       D.  $p = 5, q = 3$

156. Determine the coefficient of  $x$  in the quotient when  $2x^4 - 7x^3 + 9x^2 + 2x - 8$  is divided by  $x^2 - 3x + 4$ .

- A. -13      B. -1      C. 1      D. 13

157. Graph the solution to  $(x + 1)(x - 2)^2(x + 3)^3 \leq 0$ .



158. Find a polynomial equation of lowest degree with integral coefficients such that one root of  $f(x) = 0$  is  $\sqrt{2} + \sqrt{3}$ .

159. Given the following table of values for the polynomial function  $y = f(x)$ , determine the minimum number of zeros for  $f(x)$ .

- A. 1  
B. 2  
C. 3  
D. 4

$x$	$y$
-3	-15
-2	-12
-1	2
0	3
1	5
2	-7
3	-19

160. When  $x^4 + kx^2 - 5$  is divided by  $x^2 + 1$ , the remainder is  $-6$ . Find the value of  $k$ .
- A.  $-2$                       B.  $0$                       C.  $1$                       D.  $2$
161. A polynomial function of degree 3 has zeros  $-2$ ,  $2$ ,  $4$ , and passes through the point  $(3, -25)$ . Determine an equation of the function. (Answer may be left in factored form.)
162. Determine the cubic polynomial function which has zeros of  $-1$ ,  $2$  and  $3$ , and goes through the point  $(4, 6)$ .
- A.  $f(x) = (x + 1)(x - 2)(x - 3)$                       B.  $f(x) = \frac{3}{5}(x + 1)(x - 2)(x - 3)$   
C.  $f(x) = (x - 1)(x + 2)(x + 3)$                       D.  $f(x) = \frac{1}{21}(x - 1)(x + 2)(x + 3)$
163. If  $p(x) = (x - 2)q(x) + r$ , determine  $p(2)$ .
- A.  $q(2)$                       B.  $q(-2)$                       C.  $-r$                       D.  $r$
164. A polynomial function of degree 3 has zeros  $5$ ,  $3$ ,  $-1$ , and passes through the point  $(2, -6)$ . Determine an equation of this function. (Answer may be left in factored form.)
165. Determine a factor of degree 2 of the polynomial  $p(x)$  if  $p(3) = 0$  and  $p(-4) = 0$ .
- A.  $x^2 + x - 12$                       B.  $x^2 - x + 12$                       C.  $x^2 - x - 12$                       D.  $x^2 + x + 12$

166. Determine the values of  $k$  for which  $\frac{1}{3}$  is a zero of  $p(x) = -9x^3 + 3x^2 - 3kx + k^3$ .
- A.  $-2, -1, 0$                       B.  $-2, 0, 1$                       C.  $-1, 0, 1$                       D.  $-1, 0, 2$
167. Determine the polynomial function of degree 3, with zeros of  $-2, 0$ , and  $3$ , that passes through the point  $(2, 5)$ . Answer may be left in factored form.
168. Determine the number of rational roots for the equation  $x^5 - 2x - 1 = 0$ .
- A. 1                                      B. 2                                      C. 3                                      D. 5
169. When a polynomial  $P(x)$  is divided by  $x + 4$ , the remainder is 5. Which point must be on the graph of the function  $y = P(x)$ ?
- A.  $(-4, 5)$                       B.  $(5, -4)$                       C.  $(-4, -5)$                       D.  $(-5, -4)$
170. A polynomial function of degree 3 has a zero of  $-1$  and a double zero of  $4$ . Determine this function if it passes through the point  $(1, 10)$ . Answer may be left in factored form.
171. If  $x + 2$  is a factor of the polynomial  $P(x) = 2x^3 + kx^2 - 32x - 4k^2$ , determine all possible values of  $k$ .

172. Solve the following inequality:  $x^3 - 3x^2 - x > 2x - 4$



173. Determine the range of the function  $f(x) = x^4 - 3x^3 - 8$ .



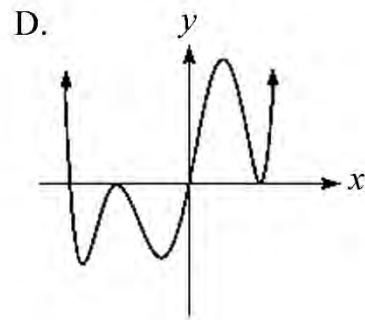
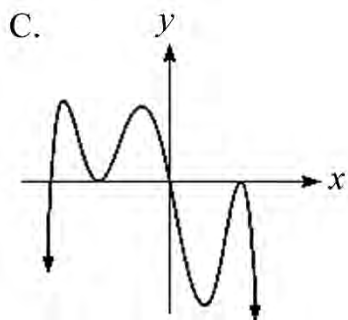
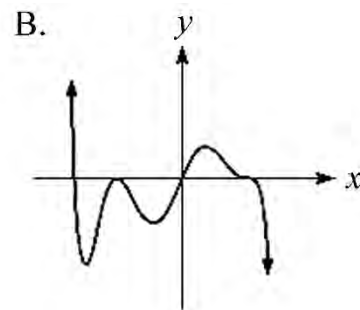
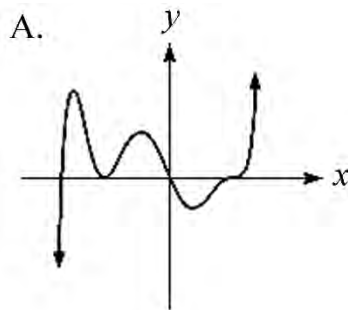
- A.  $y \geq -18.81$       B.  $y \geq -16.54$       C.  $y \geq -8$       D. all real numbers

174. Determine the cubic polynomial function with zeros 1, 2, and  $-3$  that passes through  $(3, -10)$ .  
(Answer may be left in factored form.)

175. The function  $H(x)$  is the product of a 3rd degree polynomial function and a 2nd degree polynomial function. What is the maximum number of zeros of  $H(x)$ ?

- A. 2      B. 3      C. 5      D. 6

176. Which graph could represent  $f(x) = x(a - x)(x - b)^2(x - c)^3$ , where  $a$ ,  $b$  and  $c$  are constants?



177. Solve:  $x^4 - x^3 \geq 8x^2 + 2$



178. If the polynomial  $p(x) = ax^2 + bx - 6$  is divided by  $(x - 1)$ , the remainder is  $-9$ . When  $p(x)$  is divided by  $(x + 2)$ , the remainder is  $12$ . Find the value of  $b$ .

A.  $-5$

B.  $-2$

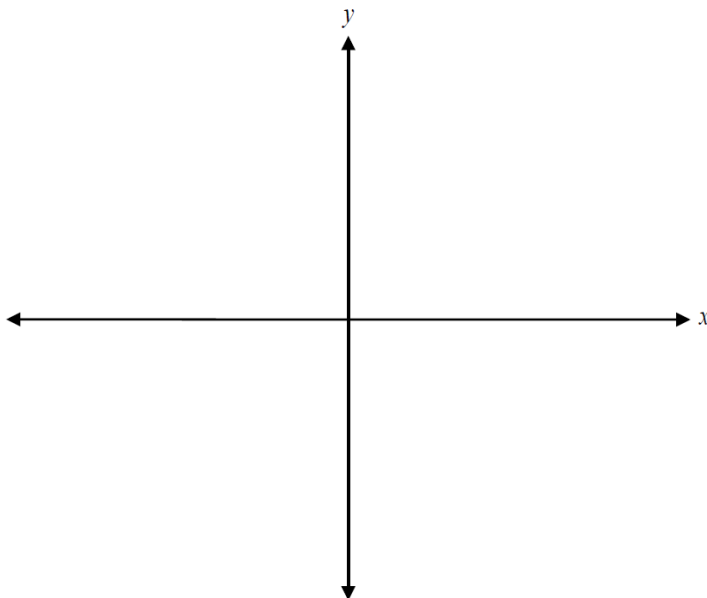
C.  $2$

D.  $5$

179. If  $2$  is a root of the polynomial equation  $6x^3 + kx^2 + x + 2 = 0$ , determine the other roots.

180. Determine all of the zeros of the function  $p(x) = x^3 - 5x^2 - 2x + 24$ , given that one of the factors of  $p(x)$  is  $(x - 3)$ .

181. Sketch the graph of  $y = -2(x - 1)(x - 3)(x + 1)$



# POLYNOMIALS ANSWER KEY

1	D	47	B	94	C	142	D
2	D	48	D	95	B	143	-1.66, 1.22, 4.44
3	B	49	C	96	C	144	A
4	A	50	B	97	B	145	B
5	C	51	D	98	D	146	C
6	$x = -1, -\frac{1}{3}, 2$	52	A	99	A	147	C
7	C	53	B	100	$k = -3, x = \frac{1}{2}, 3$	148	C
8	A	54	D	101	A	149	1.09, 1.95, 14.14
9	B	55	D	102	C	150	B
10	D	56	B	103	B	151	D
11	C	57	B	104	D	152	D
12	C	58	D	105	B	153	D
13	C	59	A	106	A	154	D
14	B	60	A	107	D	155	A
15	C	61	C	108	A	156	$y = -\frac{2}{3}(x+2)^2(x-3)$
16	A	62	A	109	C	157	A
17	B	63a)	D	110	A	158	B
18	$-1, \pm\sqrt{5}$	63b)	$x = \frac{5}{3} \text{ cm}$	111	C	159	D
19	C	64	A	112	D	160	$x^4 - 10x^2 + 1 = 0$
20	C	65	C	113	B	161	B
21	B	66	C	114	A	162	D
22	D	67	D	115	D	163	$f(x) = 5(x-2)(x+2)(x-4)$
23	A	68	D	116	D	164	B
24	240	69	A	117	B	165	D
25	A	70	C	118	C	166	$p(x) = -\frac{2}{3}(x-5)(x-3)(x+1)$
26	D	71	A	119	D	167	A
27	A	72	D	120	A	168	C
28	C	73	B	121	D	169	$y = -\frac{5}{8}x(x+2)(x-3)$
29	A	74	D	122	$x \geq 7.82$	170	A
30	B	75	C	123	A	171	A
31	B	76	B	124	A	172	$y = \frac{5}{9}(x+1)(x-4)^2$
32	D	77	C	125	C	173	4, -3
33	D	78	B	126	D	174	$-1.36 < x < 0.83 \text{ or } x > 3.53$
34	A	79	A	127	B	175	B
35	A	80	B	128	A	176	$y = -\frac{5}{6}(x-1)(x-2)(x+3)$
36	D	81	B	129	C	177	C
37	C	82	C	130	$-2.48 < x < 0.83 \text{ or } x > 9.65$	178	B
38	C	83	C	131	D	179	$x \leq -2.43 \text{ or } x \geq 3.40$
39	$x = -3, -\frac{1}{2}, 2$	84	B	132	B	180	A
40	C	85	C	133	D	181	$x = -\frac{1}{3}, \frac{1}{2}$
41	A	86	B	134	B	182	3, 4, -2
42	D	87	A	135	A		
43	D	88	C	136	A		
44	D	89	C	137	-8.52, -2.51, 1.03		
45	B	90	A	138	D		
46	$x = -2, \frac{1}{2}, 2$	91	A	139	D		
		92	B	140	C		
		93	B	141	B		