Name: ________________________ Class: ___________________ Date: __________ ID: A

Module 3 Test Polynomials

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Identify the parent function for $g(x) = (x+3)^3$ and describe what transformation of the parent function it represents.

A The parent function is the cubic function, $f(x) = x^3$.
$g(x) = (x+3)^3$ represents a vertical translation of the parent function 3 units up.

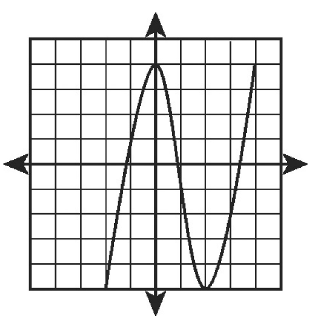
B The parent function is the cubic function, $f(x) = x^3$.
$g(x) = (x+3)^3$ represents a horizontal translation of the parent function 3 units to the left.

C The parent function is the cubic function, $f(x) = x^3$.
$g(x) = (x+3)^3$ represents a horizontal translation of the parent function 3 units to the right.

D The parent function is the cubic function, $f(x) = x^3$.
$g(x) = (x+3)^3$ represents a vertical translation of the parent function 3 units down.

____ 2. Which is a graph of an even function with a positive leading coefficient?

A



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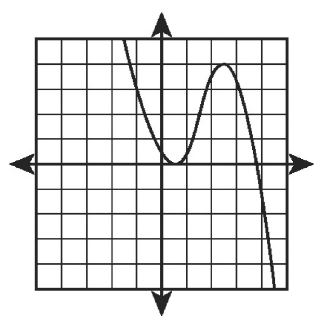

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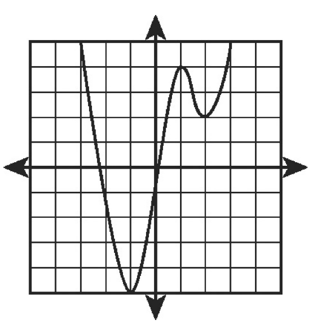

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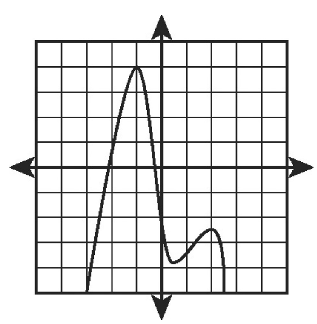
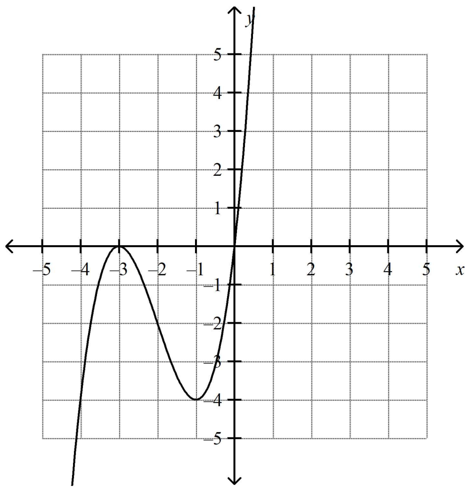


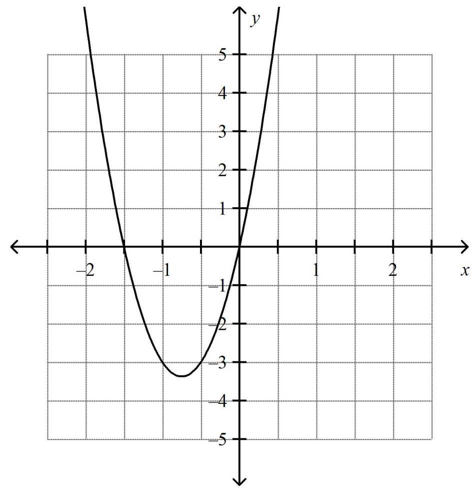
____ 3. Graph $f(x) = x^3 + 6x^2 + 9x$. Identify the intercepts and give the domain and range.

A



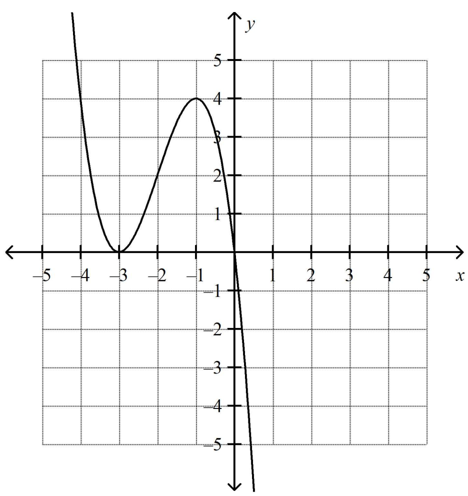
The x-intercepts are –3 and 0. The y-intercept is 0. The domain and range are all real numbers.

C



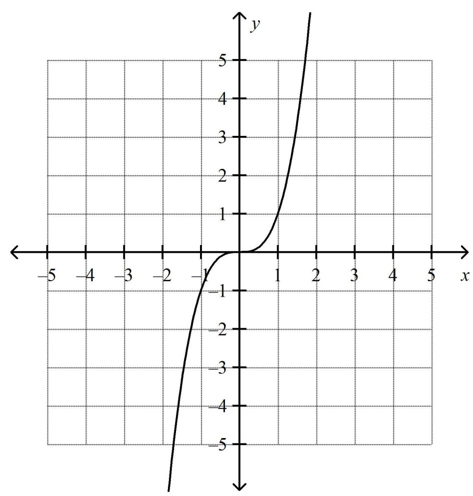
The x-intercepts are –1.5 and 0. The y-intercept is 0. The domain is all real numbers. The range is approximately $y \geq -3.25$.

B



The x-intercepts are –3 and 0. The y-intercept is 0. The domain and range are all real numbers.

D



The x- and y-intercepts are both zero. The domain and range are all real numbers.

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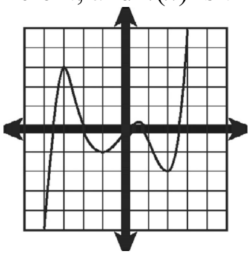
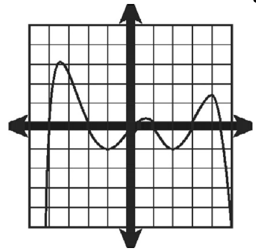
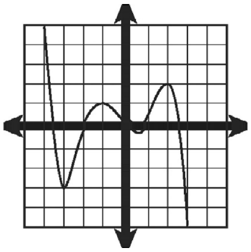
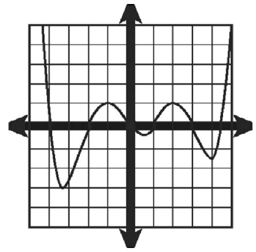
____ 4. If $f(x)$ is an odd function with a negative leading coefficient, $g(x)$ is an even function with a negative leading coefficient, and $h(x)$ is the product of $f(x)$ and $g(x)$, which of the following could be the graph of $h(x)$?

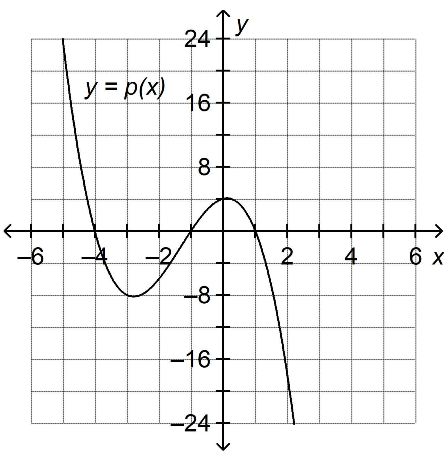
A 

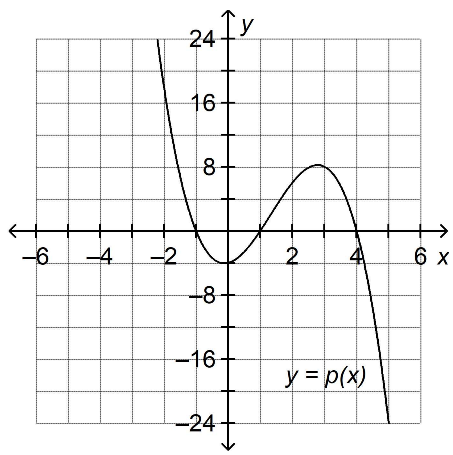
C 

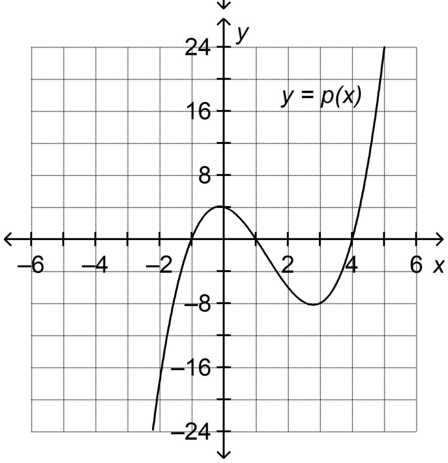
B 

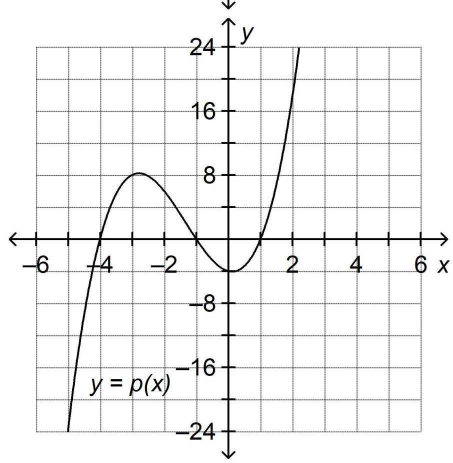
D 

____ 5. Which is the graph of the polynomial function $p(x) = (x-1)(x+1)(x-4)$?

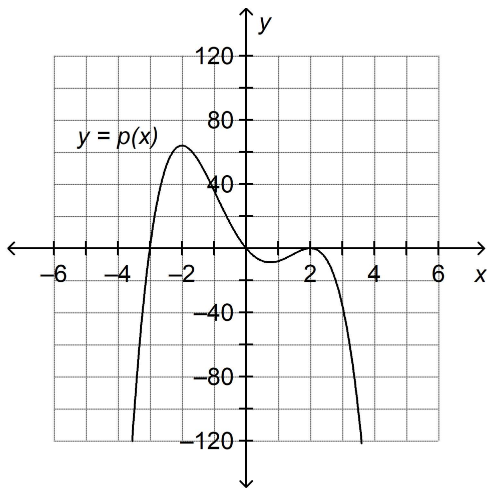
A 

C 

B 

D 

____ 6. The graph of the polynomial function $p(x)$ is shown. What are the zeros of $p(x)$? (Assume that the zeros of $p(x)$ are integers and that the graph of $p(x)$ does not cross the x-axis at places other than those shown.)



A $x = -3$ and $x = 2$
B $x = -3$, $x = 0$, and $x = 2$
C $x = 0$
D $x = -2$, $x = 0$, and $x = 3$

____ 7. Subtract $2xy^3 - 3xy^3$.

A xy^3
B $-6xy^3$
C $-xy^3$
D -1

____ 8. Multiply $(x+2)(3x^2 - 4x + 5)$.

A $3x^3 + 2x^2 - 3x + 10$
B $3x^3 - 4x^2 + 5x + 10$
C $3x^3 - 2x^2 - 3x + 10$
D $3x^3 + 10x^2 + 13x + 10$

____ 9. Multiply $(b+3)(b^2 + 2b + 1)$.

A $b^3 + 6b^2 + 6b + 3$
B $b^3 + 5b^2 + 7b + 3$
C $3b^3 + 6b^2 + 3b$
D $4b^3 + 8b^2 + 3b$

____ 10. Subtract $(7a^2 - 3a) - (5a^2 - 5a)$.

A $2a^2 - 8a$
B $2a^2 + 2a$
C $12a^2 + 2a$
D $12a^2 - 8a$

____ 11. Multiply $(3x-2)(2x+6)$.

A $6x^2 + 5x + 12$
B $6x^2 - 2$
C $6x^2 + 14x - 12$
D $6x^2 + 4$

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____ 12. Subtract.
$\left(x^3-2x+3\right)-\left(3x^2+4x-3\right)$

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

____ 13. Find the product.
$\left(x^2-2x-3\right)\left(3x^2+4x-1\right)$

A $3x^4-2x^3-18x^2-10x+3$
B $3x^4-2x^3-16x^2-10x+3$
C $3x^4-x^3-18x^2-10x+3$
D $3x^4-x^3-16x^2-10x+3$

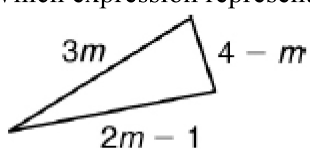
____ 14. Add.
$(-7p^5q+6pq)+(4p^5q-8pq+3)+(7pq+7)$

A $-11p^5q+13pq+10$
B $-3p^5q+21pq+10$
C $-3p^5q+5pq+10$
D $-4p^5q+5pq+9$

____ 15. Multiply.
$(6r+4s)^2$

A $36r^2+16s^2$
B $12r^2+8s^2$
C $36r^2+24rs+16s^2$
D $36r^2+48rs+16s^2$

____ 16. Which expression represents the perimeter of the triangle below?



A $3+4m$
B $3+6m$
C $5+4m$
D $5+6m$

____ 17. Which is the product $\left(x^2-x+9\right)(x-3)$?

A $x^3-4x^2+12x-27$
B $x^3-4x^2-27x+12$
C $x^3+9x-27$
D x^3-3x^2+9x-9

____ 18. A rectangular garden has a length of $5a+17$ feet and a width of $4a$ feet. Which expression represents the area of the garden in square feet?

A $20a+68$
B $20a^2+68a$
C $20a^2+17$
D $25a^2+64a$

____ 19. Find the product $-2a^3b^4(3a^3b^2+4b^4)$.

A $-2a^7b^7-2a^4b^9$
B $-6a^6b^6-8a^3b^8$
C $-6a^9b^8-8b^{16}$
D $a^6b^6+2a^3b^8$

____ 20. Find the product of $3x^2 + x - 1$ and $4x + 5$.

A $3x^2 + 5x + 4$

B $12x^3 + 4x^2 - 4x$

C $12x^3 + 19x^2 + x - 5$

D $12x^3 + 19x^2 + 9x - 5$

____ 21. If $2x^2 - 5x + 7$ is subtracted from $4x^2 + 2x - 11$, what is the coefficient of x in the result?

A 2

B 7

C −3

D −18

____ 22. Which divisor of $-2x^3 + 2x^2 - 5x - 1$ results in a remainder of 86?

A $x + 3$

B $x + 2$

C $x - 2$

D $x - 3$

____ 23. Which of the following is a factor of $3x^3 - 10x^2 + 3x + 10$?

A $x - 2$

B $x + 3$

C $x - 3$

D $x + 2$

____ 24. Which of the following is NOT a factor of $\left(x^3 - x^2 - 14x + 24\right)$?

A $x + 1$

B $x - 2$

C $x - 3$

D $x + 4$

____ 25. What is the remainder when $2x^3 + 3x^2 - x + 1$ is divided by $x + 3$?

A −25

B −23

C −8

D 25

____ 26. Which is a factor of $x^3 - 3x^2 - 4x + 12$?

A $(x + 3)$

B $(x - 2)$

C $(x + 4)$

D $(x - 4)$

____ 27. If $x - 2$ is a factor of a polynomial $f(x)$, which of the following statements does NOT have to be true?

A $f(2) = 0$

B $f(-2) = 0$

C 2 is a root of $f(x)$.

D 2 is a zero of $f(x)$

____ 28. For $p(x) = 4x^3 - 28x + 24$, $p(-3) = 0$. Which of the following must therefore be true?

A −3 is a factor of $p(x) = 4x^3 - 28x + 24$.

B $-3x$ is a factor of $p(x) = 4x^3 - 28x + 24$.

C $x - 3$ is a factor of $p(x) = 4x^3 - 28x + 24$.

D $x + 3$ is a factor of $p(x) = 4x^3 - 28x + 24$.

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____ 29. Use the remainder theorem to determine the remainder when $p(x) = x^3 + 3x^2 - 5x - 7$ is divided by $x + 5$.

A -182
B -32
C -7
D 168

____ 30. Write an equivalent expression for $a^2 + 2ab + b^2$.

A $(a+b)(a-b)$
B $a^2 + b^2$
C $(a+b)^2$
D $a^2 - b^2$

____ 31. Write an equivalent expression for $x^2 - 2xy + y^2$.

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

____ 32. Write an equivalent expression for $(a+b)\left(a^2 - ab + b^2\right)$.

A $(a+b)(a-b)^2$
B $a^3 + b^3$
C $(a-b)^3$
D $a^3 - b^3$

____ 33. If you use the polynomial identity $(a+b)(a-b) = a^2 - b^2$ and mental math to calculate $35 \bullet 25$, what subtraction expression results?

A $1000 - 125$
B $900 - 25$
C $1050 - 175$
D $1225 - 625$

____ 34. Divide.
$\left(x^3 + 5x^2 + 5x - 2\right) \div (x+2)$

A $x^2 - 3x - 1$
B $x^2 - 3x + 1$
C $x^2 + 3x - 1$
D $x^2 + 3x + 1$

____ 35. Divide.
$\left(x^3 - x + 6\right) \div (x+2)$

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

____ 36. Divide: $\dfrac{x^2 + 8x - 5}{x}$

A $x^2 + 8 - \dfrac{5}{x}$
B $x + 8 - \dfrac{5}{x}$
C $x - 5$
D $x + 8$

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____ 37. Divide: $\dfrac{b^2-3b+3}{b-5}$

A $2b-2+\dfrac{7}{b-5}$

B $b+2+\dfrac{13}{b-5}$

C $b-8+\dfrac{49}{b-5}$

D $b+2+\dfrac{-13}{b-5}$

____ 38. Divide $12x^2+4x^3+18+16x$ by $2x+4$.

A $2x^2+2x+3+\dfrac{14}{x+4}$

B $2x^2+2x+4+\dfrac{2}{2x+4}$

C $2x^2+2x+4-\dfrac{2}{x+4}$

D $2x^2+2x+3+\dfrac{5}{x+4}$

____ 39. The area of a rectangle is equal to $x^2+15x+44$ square units. If the length of the rectangle is equal to $x+11$ units, what expression represents its width?

A $x-4$

B $x+33$

C $x+4$

D $x-33$

____ 40. Simplify $\dfrac{x^3+4x^2+3x-2}{x+2}$.

A $(x+1)(x-1)$

B x^2+2x-1

C x^2+4x+3

D x^3+4x^2+2x-4

____ 41. Divide: $(5x+6x^3-8)\div(x-2)$.

A $6x^2-12x+29-\frac{64}{(x-2)}$

B $6x^2+12x+29$

C $6x^2+12x+29+\frac{50}{(x-2)}$

D $6x^2+5-\frac{8}{(x-2)}$

____ 42. Write an expression that represents the width of a rectangle with length $x+5$ and area $x^3+12x^2+47x+60$.

A x^3+7x^2+12x

B $x^2+17x-38-\frac{50}{x+5}$

C $x^2+7x+12$

D $x^2+17x+132+\frac{720}{x+5}$

____ 43. What is the result if you divide to rewrite the expression $\dfrac{3x^2-x+7}{x-1}$?

A $3x+\dfrac{2x+7}{x-1}$

B $3x+11$

C $3x+2$

D $3x+2+\dfrac{9}{x-1}$

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____ 44. When you divide to simplify the expression $\dfrac{6x^3+5x^2+2x+7}{2x+3}$, what is the fractional part of the quotient?

A -5

B $-\dfrac{5}{2x+3}$

C $\dfrac{7}{2x+3}$

D $3x^2-2x+4$

____ 45. In the expression $x^3+4x^2+3x+12$, when the first two terms are grouped, and the last two terms are grouped, what is the common binomial factor?

A $x-4$

B x^2+3

C $x+4$

D $x+12$

____ 46. In the expression $40x^2-15x+16x-6$, when the first two terms are grouped, and the last two terms are grouped, what is the common binomial factor?

A $8x-3$

B $5x+2$

C $5x-2$

D $8x+3$

____ 47. The volume of a box is $20x^3+104x^2+96x$. What is a possible expression for the height of the box if the width is $2x$ and the length is $5x+6$?

A $5x+6$

B $2x+8$

C $5x+2$

D $2x-8$

____ 48. Jon has rewritten the expression $10x^3-35x^2+18x-63$ in order to factor it. Describe a reasonable next step for Jon to perform.

A Use the Commutative Property to rewrite the terms in a different order.

B Factor 7 from the second and fourth terms.

C Group the first two terms and factor out the greatest common term of $2x-7$.

D Factor x from each of the four terms.

____ 49. Completely factor $3x^4-15x^3-18x^2$.

A $x^2\left(3x^2+2\right)(1x-9)$

B $3\left(x^2+1\right)\left(x^2-6\right)$

C $3x^2(x+1)(x-6)$

D cannot be factored

____ 50. What is the complete factorization of $10x^3-35x^2-20x$?

A $(2x+1)(x-4)$

B $5x\left(2x^2-7x-4\right)$

C $5x(2x+1)(x-4)$

D $x(2x+1)(5x-20)$

____ 51. Completely factor $4m^4 - 324$.

A $\left(4m^2 + 36\right)\left(m^2 - 9\right)$
C $4(m+3)^2(m+3)(m-3)$
B $4\left(m^2 + 9\right)(m+3)(m-3)$
D cannot be factored

____ 52. Factor $27x^2z + 36xz + 12z$ completely.

A $z(3x+12)^2$
C $3z(3x+2)^2$
B $12z(2x^2 + 3x + 1)$
D $3z(3x+2)(3x-2)$

____ 53. Factor $x^3 + 6x^2 - 25x - 150$.

A $(x-6)(x-5)(x+5)$
C $(x+6)(x^2+25)$
B $(x-6)(x^2+25)$
D $(x+6)(x-5)(x+5)$

____ 54. Factor the expression $54x^6 + 16x^3y^3$.

A $2x^3(3x+2y)(9x^2+6xy+4y^2)$
C $2x^3(27x^3+8y^3)$
B $2x^3(3x+2y)^3$
D $2x^3(3x+2y)(9x^2-6xy+4y^2)$

____ 55. Factor $8x^3 + 125$.

A $(2x-5)\left(4x^2-10x+25\right)$
C $(2x+5)\left(4x^2-10x+25\right)$
B $(2x-5)\left(4x^2+10x+25\right)$
D $(2x+5)\left(4x^2+10x+25\right)$

____ 56. When $x^3 - 125$ is written as a product of a binomial and a trinomial, what is the trinomial factor?

A $x^2 - 5x + 25$
B $x^2 + 5x + 25$
C $x^2 - 10x + 25$
D $x^2 + 10x + 25$

____ 57. Which of the following is equal to $x^6 - 64$?

A $-64x^6$
B $(x^3+8)(x^3-8)$
C $(x^3+8)^2$
D $(x^3-8)^2$

____ 58. A jewelry box has a length that is 2 inches longer than the width and a height that is 1 inch smaller than the width. The volume of the box is 140 cubic inches. What is the width of the jewelry box?

A 2 in.
C 6 in.
B 4 in.
D 5 in.

____ 59. How many roots, including repeated roots, does the function $P(x) = -0.5x^3 - 1.5x^2 + 4x - 2$ have?

A 2
C 0
B 1
D 3

____ 60. Which of the following lists all the roots of $x^3 + 3x = 9 + 3x^2$?

A 3 C $3, \pm\sqrt{3}i$

B $3, \pm\sqrt{3}$ D $3, \pm\sqrt{3}, \pm\sqrt{3}i$

____ 61. What are the complex roots of the polynomial $Q(x) = x^2 + 1$?

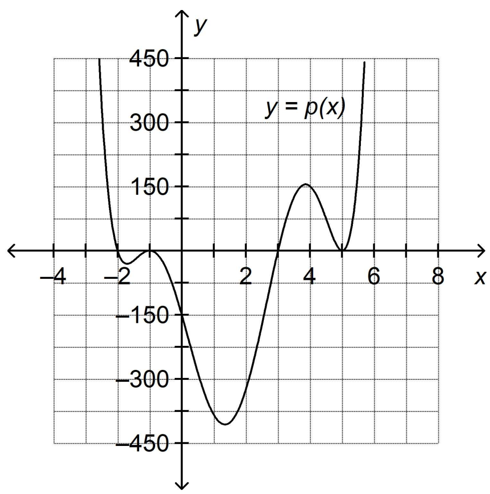
A 1 and -1 C i and $-i$

B *Q(x)* has no complex roots D 0 is the only root

Multiple Response

Identify one or more choices that best complete the statement or answer the question.

____ 1. Which of the following statements are true about the polynomial function $p(x)$? (The zeros of $p(x)$ are integers, and the graph of $p(x)$ does not cross the x-axis at places other than those shown.)



A The degree of $p(x)$ is even.

B The degree of $p(x)$ is 4.

C The leading coefficient of $p(x)$ is negative.

D The degree of $p(x)$ is at least 6.

E The graph of $p(x)$ has a y-intercept of 150.

F $p(x)$ has four distinct zeros.

____ 2. Simplify each of the following expressions to determine which are linear.

A $\left(x^2 + 6x + 9\right) + \left(x^2 - 4x + 4\right)$

B $2\left(2x^2 + x - 10\right) - \left(5x^2 - 3x + 1\right)$

C $4\left(3x^2 + 5x - 4\right) - 6\left(2x^2 + 2x - 1\right)$

D $3\left(x^2 - x + 1\right) + \left(-2x^2 + 4x - 5\right)$

E $4\left(2x^2 - 6x + 7\right) - 8\left(x^2 - 3x + 4\right)$

____ 3. Use the remainder theorem and the factor theorem to determine which of the following binomials are factors of $p(x) = x^3 - 8x^2 + 5x + 14$.

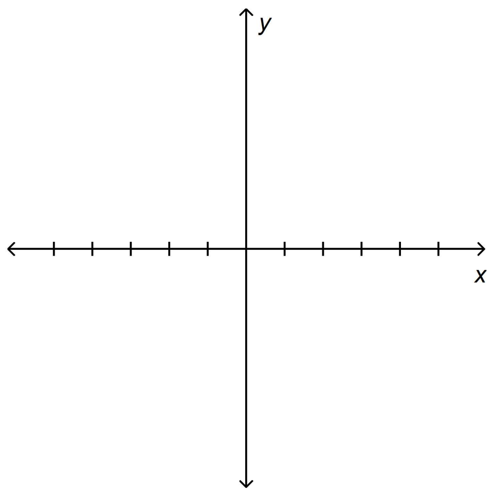
A $x + 1$
B $x + 3$
C $x + 9$
D $x - 2$
E $x - 6$
F $x - 7$

Short Answer

1. Draw a graph of an odd function with exactly two real zeros and a positive leading coefficient.

2. Let $p(x) = x^3 - 2x^2 - 4x + 8$.

a. Identify the zeros of the function. List all zeros as many times as they occur.
b. Sketch a graph of the function.



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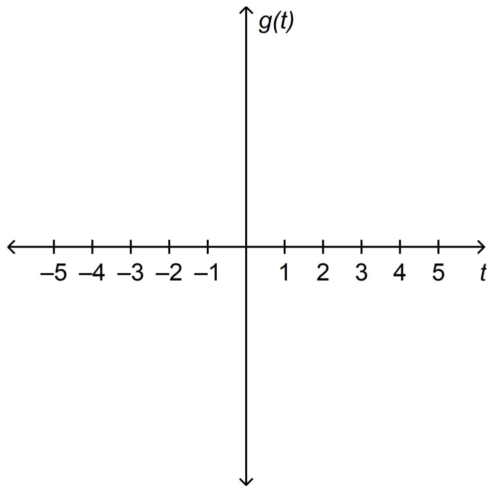
3. Let $g(t) = (t+2)\left(t^2 - 5t + 4\right)$.

   a. Identify the zeros of the function. Show your work.
   b. Sketch a graph of the function.



4. Find the difference $(7a^3 + 5a) - (4a^3 + 4a)$.

5. Multiply $(b-4)(b^2 + 3b - 2)$.

6. Multiply $(5x + 3y)^2$.

7. Find the product.
   $\left(x^2 - 2\right)\left(2x^2 + 5x - 3\right)$.

8. A triangle has a base of $6a^2c$ and a height of $2a^3 - 3ac + 1$. Write and simplify an expression for the area of the triangle. Show your work.

9. Use the remainder theorem and the factor theorem to show that $x - 5$ is a factor of $p(x) = x^3 - 7x^2 + 2x + 40$. Then factor $p(x) = x^3 - 7x^2 + 2x + 40$ completely.

10. Use the remainder theorem to determine the remainder when $p(x) = x^4 - 4x^3 - 11x^2 + 66x - 72$ is divided by $x - 4$. Then use polynomial long division to verify the remainder.

11. Divide.
    $\left(x^3 + x^2 - 20x + 24\right) \div (x - 3)$

12. Simplify.
$$\frac{2x^2 - 4x}{x - 2}$$

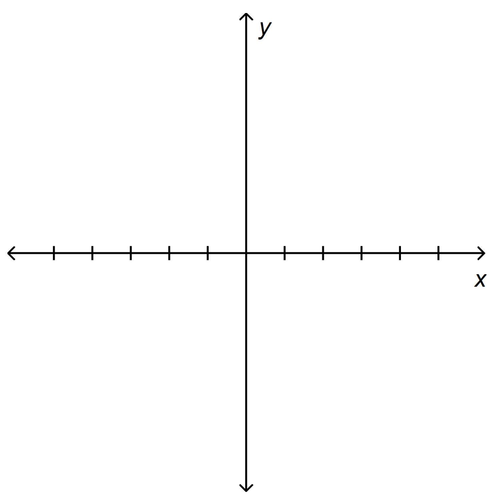
13. Divide.
$(15x^2 + 10x - 5) \div 5x$

14. Divide.
$(12x^2 - 23x - 24) \div (4x + 3)$

15. Factor $15a^3 + 20a^2 - 6a - 8$ by grouping.

16. Let $p(x) = x^3 - 2x^2 - 4x + 8$.

   a. Identify the zeros of the function. List all zeros as many times as they occur.
   b. Sketch a graph of the function.



17. $x^3 - x^2 + x - 1 = 0$ is a polynomial equation.

Part A**:** Explain how you know, without factoring, the number of roots and the minimum number of real roots.

Part B**:** Factor the polynomial to support your answer to ***Part A***. Explain which factor(s), if any, indicate(s) that there are complex roots.

18. $f(x) = x^4 - 16$ is a polynomial function.

Part A: How many zeros does *f* have? What are the possible combinations of real and complex zeros?

Part B: Find the zero(s) of $f(x) = x^4 - 16$. Explain how you found your answer(s).

Part C: Let $g(x) = x^4 + 16$. How many real and complex zeros does *g* have? Explain.

Essay

1. Is $x - 5$ a factor of $3x^3 - 17x^2 + 11x - 5$? How do you know?

2. Is $x + 3$ a factor of $2x^3 + 4x^2 + x - 4$? How do you know?