This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.

If you have a suggestion to make the keys better, please fill out the short survey here.

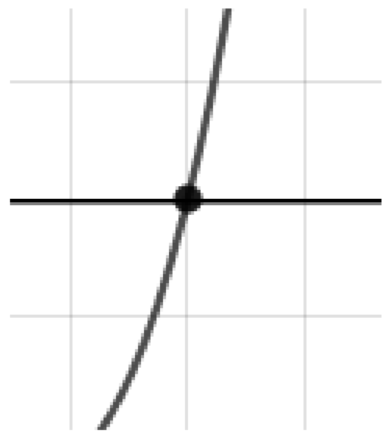
Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.

---

1. Describe the zero behavior of the zero $x = 7$ of the polynomial below.

$$f(x) = 7(x+2)^{12}(x-2)^{8}(x+7)^{12}(x-7)^{9}$$

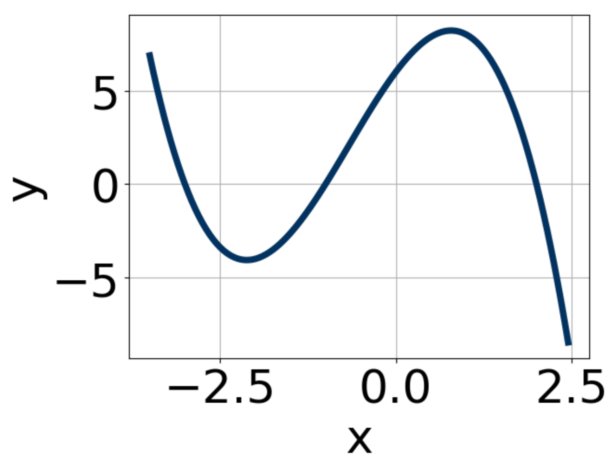
The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

2. Write an equation that *could* represent the graph below.



The solution is $-19(x+1)^5(x-2)^9(x+3)^5$.

Plausible alternative answers include: The factor $(x+1)$ should have an odd power and the leading coefficient should be the opposite sign. The factor -1 should have been an odd power.

The factors -1 and 2 have have been odd power. * This is the correct option. This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

3. Construct the lowest-degree polynomial given the zeros below.

$$-4, \frac{-2}{5}, \text{ and } \frac{-5}{3}$$

The solution is $15x^3 + 91x^2 + 134x + 40$.

Plausible alternative answers include:* $15x^3 + 91x^2 + 134x + 40$, which is the correct option. $15x^3 - 41x^2 - 86x + 40$, which corresponds to multiplying out $(x-4)(5x-2)(3x+5)$. $15x^3 - 91x^2 + 134x - 40$, which corresponds to multiplying out $(x-4)(5x-2)(3x-5)$. $15x^3 + 91x^2 + 134x - 40$, which corresponds to multiplying everything correctly except the constant term. $15x^3 - 29x^2 - 114x - 40$, which corresponds to multiplying out $(x-4)(5x+2)(3x+5)$.

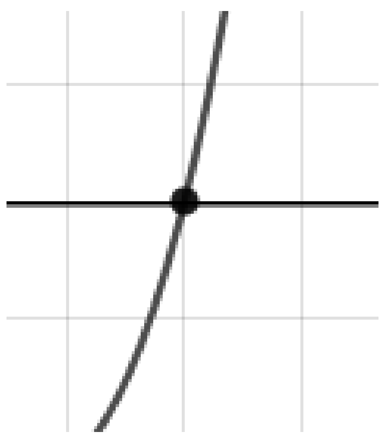
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(x+4)(5x+2)(3x+5)$

---

4. Describe the zero behavior of the zero $x = -3$ of the polynomial below.

$$f(x) = -3(x-2)^7(x+2)^6(x+3)^7(x-3)^4$$

The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

5. Construct the lowest-degree polynomial given the zeros below.

$$\frac{4}{3}, \frac{-7}{2}, \text{ and } \frac{6}{5}$$

The solution is $30x^3 + 29x^2 - 218x + 168$.

Plausible alternative answers include:$30x^3 + 109x^2 - 34x - 168$, which corresponds to multiplying out $(3x+4)(2x+7)(5x-6)$. $30x^3 + 29x^2 - 218x - 168$, which corresponds to multiplying everything correctly except the constant term. $30x^3 - 101x^2 - 62x + 168$, which corresponds to multiplying out $(3x+4)(2x-7)(5x-6)$. * $30x^3 + 29x^2 - 218x + 168$, which is the correct option. $30x^3 - 29x^2 - 218x - 168$, which corresponds to multiplying out $(3x+4)(2x-7)(5x+6)$.

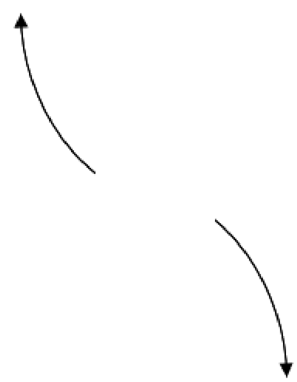
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(3x-4)(2x+7)(5x-6)$

---

6. Describe the end behavior of the polynomial below.

$$f(x) = -3(x-2)^3(x+2)^4(x+8)^5(x-8)^5$$

The solution is the graph below.



General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

7. Construct the lowest-degree polynomial given the zeros below.

$$5-3i \text{ and } -1$$

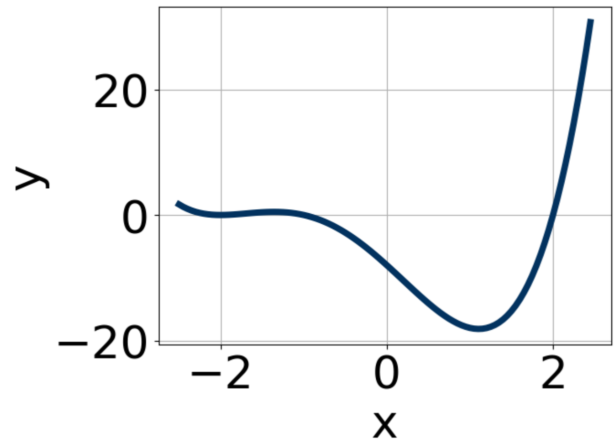
The solution is $x^3 - 9x^2 + 24x + 34$.

> **Plausible alternative answers include:**$x^3 + x^2 + 4x + 3$, which corresponds to multiplying out $(x+3)(x+1)$. $x^3+9x^2+24x-34$, which corresponds to multiplying out $(x-(5-3i))(x-(5+3i))(x-1)$. x^3+x^2-4x-5, which corresponds to multiplying out $(x-5)(x+1)$. * $x^3-9x^2+24x+34$, which is the correct option. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(5-3i))(x-(5+3i))(x-(-1))$.

---

8. Write an equation that *could* represent the graph below.



The solution is $20(x+2)^6(x+1)^{11}(x-2)^7$.

> **Plausible alternative answers include:** The factor -2 should have an even power and the factor -1 should have an odd power. * This is the correct option. This corresponds to the leading coefficient being the opposite value than it should be. The factor $(x-2)$ should have an odd power and the leading coefficient should be the opposite sign. The factor $(x+1)$ should have an odd power.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

9. Construct the lowest-degree polynomial given the zeros below.

$$-5+3i \text{ and } -2$$

The solution is $x^3+12x^2+54x+68$.

> **Plausible alternative answers include:** x^3+x^2-x-6, which corresponds to multiplying out $(x-3)(x+2)$. * $x^3+12x^2+54x+68$, which is the correct option. $x^3+x^2+7x+10$, which corresponds to multiplying out $(x+5)(x+2)$. $x^3-12x^2+54x-68$, which corresponds to multiplying out $(x-(-5+3i))(x-(-5-3i))(x-2)$. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

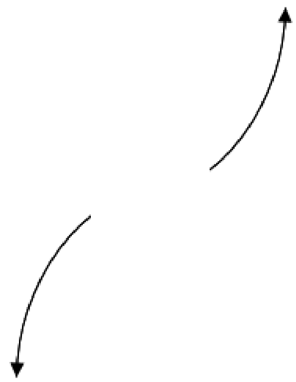
General Comment: Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(-5+3i))(x-(-5-3i))(x-(-2))$.

---

10. Describe the end behavior of the polynomial below.

$$f(x) = 5(x+8)^5(x-8)^{10}(x+3)^5(x-3)^5$$

The solution is the graph below.



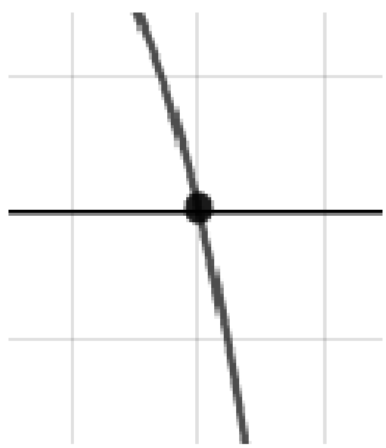
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

11. Describe the zero behavior of the zero $x = -2$ of the polynomial below.

$$f(x) = 6(x-5)^7(x+5)^4(x+2)^9(x-2)^6$$

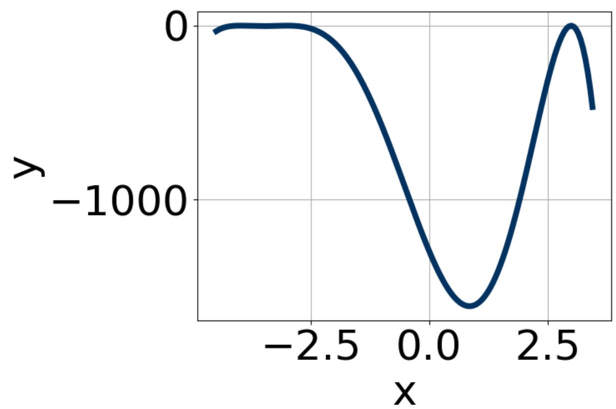
The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

12. Write an equation that *could* represent the graph below.



The solution is $-19(x+3)^4(x+4)^{10}(x-3)^8$.

> **Plausible alternative answers include:*** This is the correct option. The factor $(x-3)$ should have an even power and the leading coefficient should be the opposite sign. This corresponds to the leading coefficient being the opposite value than it should be. The factors $(x+4)$ and $(x-3)$ should both have even powers. The factor $(x-3)$ should have an even power.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

13. Construct the lowest-degree polynomial given the zeros below.

$$\frac{-4}{3}, \frac{-5}{3}, \text{ and } -7$$

The solution is $9x^3 + 90x^2 + 209x + 140$.

> **Plausible alternative answers include:**$9x^3 + 66x^2 + x - 140$, which corresponds to multiplying out $(3x-4)(3x+5)(x+7)$. $9x^3 - 90x^2 + 209x - 140$, which corresponds to multiplying out $(3x-4)(3x-5)(x-7)$. * $9x^3+90x^2+209x+140$, which is the correct option. $9x^3+36x^2-169x+140$, which corresponds to multiplying out $(3x-4)(3x-5)(x+7)$. $9x^3 + 90x^2 + 209x - 140$, which corresponds to multiplying everything correctly except the constant term.

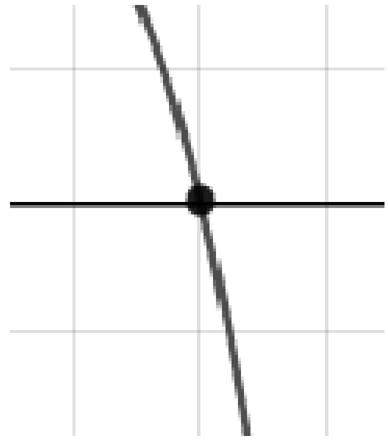
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(3x + 4)(3x+5)(x+7)$

---

14. Describe the zero behavior of the zero $x = -8$ of the polynomial below.

$$f(x) = -6(x+2)^{11}(x-2)^7(x+8)^3(x-8)^2$$

The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

15. Construct the lowest-degree polynomial given the zeros below.

$$\frac{1}{2}, \frac{3}{4}, \text{ and } 4$$

The solution is $8x^3 - 42x^2 + 43x - 12$.

> **Plausible alternative answers include:**$8x^3 - 34x^2 + 5x + 12$, which corresponds to multiplying out $(2x+1)(4x-3)(x-4)$. $8x^3 - 22x^2 - 37x - 12$, which corresponds to multiplying out $(2x+1)(4x+3)(x-4)$. * $8x^3 - 42x^2 + 43x - 12$, which is the correct option. $8x^3 - 42x^2 + 43x + 12$, which corresponds to multiplying everything correctly except the constant term. $8x^3 + 42x^2 + 43x + 12$, which corresponds to multiplying out $(2x+1)(4x+3)(x+4)$.

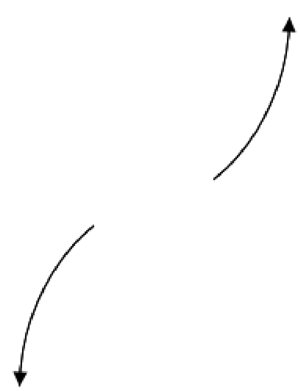
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(2x-1)(4x-3)(x-4)$

---

16. Describe the end behavior of the polynomial below.

$$f(x) = 2(x+7)^4(x-7)^9(x-4)^2(x+4)^2$$

The solution is the graph below.



General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

17. Construct the lowest-degree polynomial given the zeros below.

$$-2 + 2i \text{ and } -2$$

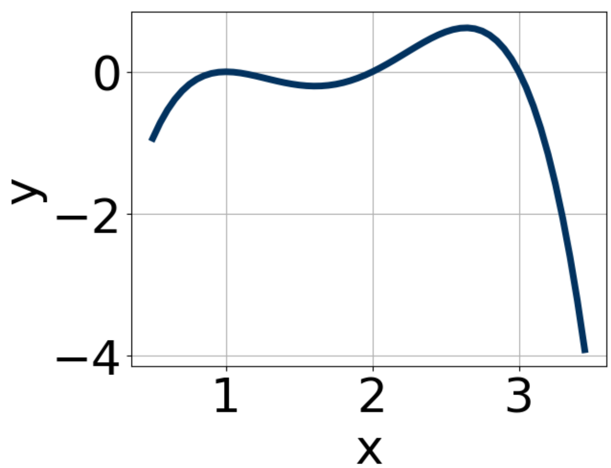
The solution is $x^3 + 6x^2 + 16x + 16$.

Plausible alternative answers include:* $x^3 + 6x^2 + 16x + 16$, which is the correct option. $x^3 - 6x^2 + 16x - 16$, which corresponds to multiplying out $(x - (-2 + 2i))(x - (-2 - 2i))(x - 2)$. $x^3 + x^2 + 0x - 4$, which corresponds to multiplying out $(x - 2)(x + 2)$. $x^3 + x^2 + 4x + 4$, which corresponds to multiplying out $(x+2)(x+2)$. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-2 + 2i))(x - (-2 - 2i))(x - (-2))$.

---

18. Write an equation that *could* represent the graph below.



The solution is $-8(x - 1)^8(x - 3)^7(x - 2)^5$.

Plausible alternative answers include:* This is the correct option. This corresponds to the leading coefficient being the opposite value than it should be. The factor 1 should have an even power and the factor 3 should have an odd power. The factor $(x - 3)$ should have an odd power. The factor $(x - 2)$ should have an odd power and the leading coefficient should be the opposite sign.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

19. Construct the lowest-degree polynomial given the zeros below.

$$-2 + 2i \text{ and } 3$$

The solution is $x^3 + x^2 - 4x - 24$.

Plausible alternative answers include:$x^3 + x^2 - x - 6$, which corresponds to multiplying out $(x + 2)(x - 3)$. $x^3 + x^2 - 5x + 6$, which corresponds to multiplying out $(x - 2)(x - 3)$. *

$x^3+x^2-4x-24$, which is the correct option. $x^3-1x^2-4x+24$, which corresponds to multiplying out $(x-(-2+2i))(x-(-2-2i))(x+3)$. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

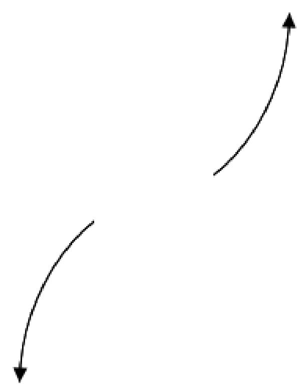
General Comment: Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(-2+2i))(x-(-2-2i))(x-(3))$.

---

20. Describe the end behavior of the polynomial below.

$$f(x) = 5(x+9)^4(x-9)^7(x-7)^4(x+7)^4$$

The solution is the graph below.



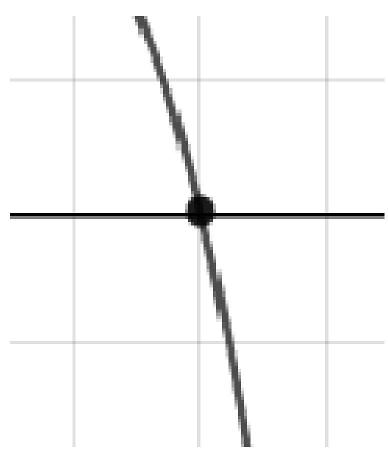
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

21. Describe the zero behavior of the zero $x=-9$ of the polynomial below.

$$f(x) = -2(x-4)^9(x+4)^7(x+9)^3(x-9)^2$$

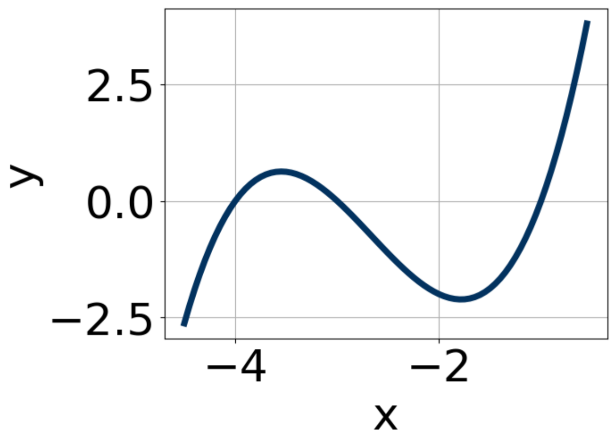
The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

22. Write an equation that *could* represent the graph below.



The solution is $3(x+4)^7(x+3)^5(x+1)^5$.

> **Plausible alternative answers include:** The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign. The factors -4 and -3 have have been odd power. * This is the correct option. The factor -4 should have been an odd power. This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

23. Construct the lowest-degree polynomial given the zeros below.

$$1, \frac{7}{4}, \text{ and } \frac{5}{3}$$

The solution is $12x^3 - 53x^2 + 76x - 35$.

> **Plausible alternative answers include:** $12x^3+53x^2+76x+35$, which corresponds to multiplying out $(x+1)(4x+7)(3x+5)$. $12x^3+13x^2-34x-35$, which corresponds to multiplying out $(x+1)(4x+7)(3x-5)$. * $12x^3-53x^2+76x-35$, which is the correct option. $12x^3-53x^2+76x+35$, which corresponds to multiplying everything correctly except the constant term. $12x^3-29x^2-6x+35$, which corresponds to multiplying out $(x+1)(4x-7)(3x-5)$.

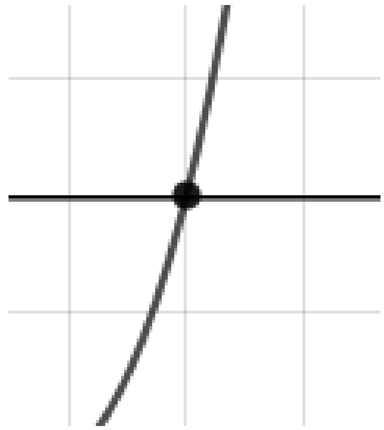
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(x-1)(4x-7)(3x-5)$

---

24. Describe the zero behavior of the zero $x=9$ of the polynomial below.

$$f(x) = 2(x-7)^6(x+7)^4(x+9)^8(x-9)^7$$

The solution is the graph below.



General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

25. Construct the lowest-degree polynomial given the zeros below.

$$7, \frac{-7}{3}, \text{ and } 4$$

The solution is $3x^3 - 26x^2 + 7x + 196$.

> **Plausible alternative answers include:**$3x^3 + 26x^2 + 7x - 196$, which corresponds to multiplying out $(x+7)(3x-7)(x+4)$. $3x^3 - 26x^2 + 7x - 196$, which corresponds to multiplying everything correctly except the constant term. $3x^3 + 16x^2 - 63x - 196$, which corresponds to multiplying out $(x+7)(3x+7)(x-4)$. $3x^3 + 2x^2 - 105x + 196$, which corresponds to multiplying out $(x+7)(3x-7)(x-4)$. * $3x^3 - 26x^2 + 7x + 196$, which is the correct option.

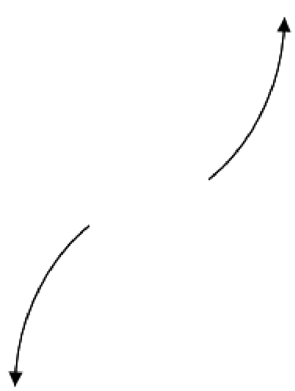
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(x-7)(3x+7)(x-4)$

---

26. Describe the end behavior of the polynomial below.

$$f(x) = 7(x+6)^3(x-6)^6(x-3)^3(x+3)^3$$

The solution is the graph below.



General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

27. Construct the lowest-degree polynomial given the zeros below.

$$2 - 2i \text{ and } 2$$

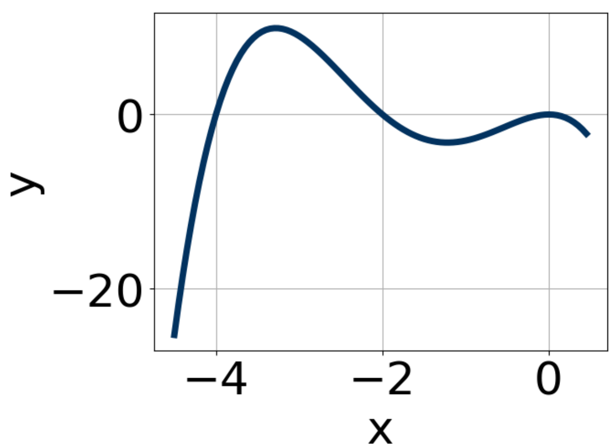
The solution is $x^3 - 6x^2 + 16x - 16$.

Plausible alternative answers include:$x^3 + x^2 - 4x + 4$, which corresponds to multiplying out $(x-2)(x-2)$. $x^3+6x^2+16x+16$, which corresponds to multiplying out $(x-(2-2i))(x-(2+2i))(x+2)$. x^3+x^2+0x-4, which corresponds to multiplying out $(x+2)(x-2)$. * $x^3-6x^2+16x-16$, which is the correct option. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (2 - 2i))(x - (2 + 2i))(x - (2))$.

---

28. Write an equation that *could* represent the graph below.



The solution is $-2x^8(x + 2)^7(x + 4)^9$.

Plausible alternative answers include: This corresponds to the leading coefficient being the opposite value than it should be. The factor 0 should have an even power and the factor -2 should have an odd power. * This is the correct option. The factor $(x + 2)$ should have an odd power. The factor $(x + 4)$ should have an odd power and the leading coefficient should be the opposite sign.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

29. Construct the lowest-degree polynomial given the zeros below.

$$-2 - 4i \text{ and } 3$$

The solution is $x^3 + x^2 + 8x - 60$.

Plausible alternative answers include:* $x^3 + x^2 + 8x - 60$, which is the correct option. $x^3 + x^2 - x - 6$, which corresponds to multiplying out $(x + 2)(x - 3)$. $x^3 + x^2 + x - 12$, which corresponds to multiplying out $(x+4)(x-3)$. $x^3-1x^2+8x+60$, which corresponds to multiplying out $(x-(-2-4i))(x-(-2+4i))(x+3)$. This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

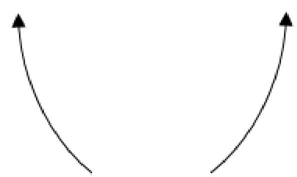
General Comment: Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(-2-4i))(x-(-2+4i))(x-(3))$.

---

30. Describe the end behavior of the polynomial below.

$$f(x) = 7(x+5)^4(x-5)^5(x+9)^2(x-9)^3$$

The solution is the graph below.



General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.
