1. Let $f(x)=x^2(x^2+4)(x-3)^3(x-1)$. Which of the following statements about the zeros of f is correct?

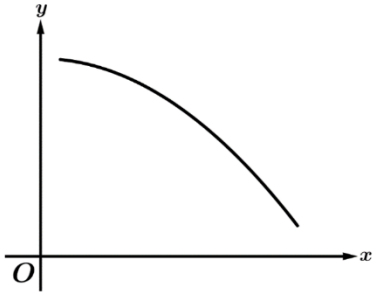
(A) f has 8 distinct real zeros.
(B) f has four distinct real zeros.
(C) f has three distinct real zeros and two non-real zeros.
(D) f has six distinct real zeros and two non-real zeros.

2. Let $g(x)=2x^2+5x-12$. On what intervals is $g(x)\geq 0$?

(A) $\left[-\frac{3}{2},4\right]$ (B) $\left[-4,\frac{3}{2}\right]$ (C) $\left(-\infty,-\frac{3}{2}\right]$ and $[4,\infty)$ (D) $(-\infty,-4]$ and $\left[\frac{3}{2},\infty\right)$

3. The polynomial function h has zeros of $x=3$ (multiplicity of 2), $x=-4$ (multiplicity of 3), $x=2i$ and $x=5-3i$. What is the least possible degree of h?

(A) 4 (B) 6 (C) 7 (D) 9



Graph of *h*

4. The graph of h is shown above. Which of the following statements about h is correct?

(A) The rate of change of h is positive and decreasing.
(B) The rate of change of h is negative and decreasing.
(C) The function h is negative and decreasing.
(D) The function h is negative and the rate of change of h is negative.

5. Let $k(x)=(x^2-9)(x+3)^2(x^2+6x+9)$. Which of the following statements about the zeros and multiplicities of k is correct?

(A) k has zeros at $x=-3$ (multiplicity 5) and $x=3$.

(B) k has zeros at $x=-3$ (multiplicity 4), $x=-9$ and $x=9$.

(C) k has zeros at $x=-3$ (multiplicity 4) and $x=3$ (multiplicity 2).

(D) k has zeros at $x=-3$ and $x=3$ (multiplicity 5).

x	$g(x)$
-7	-13
-5	-12
-3	-8
-1	-3
1	3

6. Selected values of the polynomial function g are shown in the table above. Which of the following statements pairs about g could be true?

(A) g is an odd function and the graph of g is concave down.

(B) g is an odd function and the graph of g is concave up.

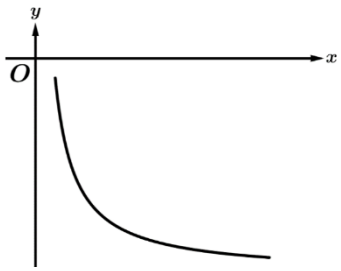
(C) g is an even function and the graph of g is concave down.

(D) g is an even function and the graph of g is concave up.

x	-6	-4	-3	-2	2	b	6
$f(x)$	-4	-5	5	1	a	5	c

7. The table above shows values of the **even** function f at selected values of x. What is the value of $a+b+c$?

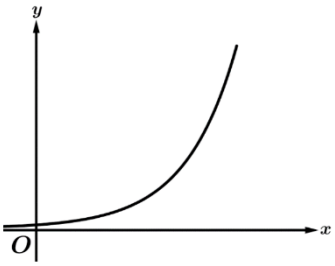
(A) -7 (B) -6 (C) 0 (D) 7



Graph of g

8. The graph of the function g is shown above. Which of the following statements about g is correct?

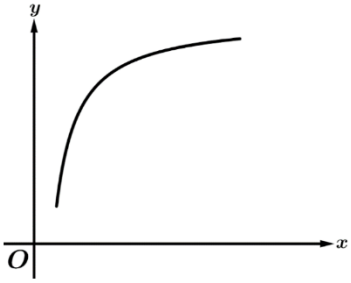
(A) g is increasing at an increasing rate.
(B) g is increasing at a decreasing rate.
(C) g is decreasing at an increasing rate.
(D) g is decreasing at a decreasing rate.



Graph of h

9. The graph of the function h is shown above. Which of the following statements about h is correct?

(A) h is increasing at an increasing rate.
(B) h is increasing at a decreasing rate.
(C) h is decreasing at an increasing rate.
(D) h is decreasing at a decreasing rate.



Graph of k

10. The graph of the function k is shown above. Which of the following statements about k is correct?

(A) k is increasing at an increasing rate.
(B) k is increasing at a decreasing rate.
(C) k is decreasing at an increasing rate.
(D) k is decreasing at a decreasing rate.

11. Let $g(x)=4x^5-2x^4+3x-1$. Which of the following limit statements about the end behavior of g is correct?

(A) $\lim_{x\to-\infty} g(x)=-\infty$ and $\lim_{x\to\infty} g(x)=-\infty$

(B) $\lim_{x\to-\infty} g(x)=-\infty$ and $\lim_{x\to\infty} g(x)=\infty$

(C) $\lim_{x\to-\infty} g(x)=\infty$ and $\lim_{x\to\infty} g(x)=-\infty$

(D) $\lim_{x\to-\infty} g(x)=\infty$ and $\lim_{x\to\infty} g(x)=\infty$

12. Let $h(x)=-2x(x-3)^2(x+4)^3$. Which of the following limit statements about the end behavior of h is correct?

(A) $\lim_{x\to-\infty} h(x)=-\infty$ and $\lim_{x\to\infty} h(x)=-\infty$

(B) $\lim_{x\to-\infty} h(x)=-\infty$ and $\lim_{x\to\infty} h(x)=\infty$

(C) $\lim_{x\to-\infty} h(x)=\infty$ and $\lim_{x\to\infty} h(x)=-\infty$

(D) $\lim_{x\to-\infty} h(x)=\infty$ and $\lim_{x\to\infty} h(x)=\infty$

13. Let the polynomial f be an **odd** function such that $f(-4)=5$ is the location of a local minimum. Which of the following statements *must* be true?

(A) $f(4)=-5$ is the location of a local minimum.

(B) $f(4)=-5$ is the location of a local maximum.

(C) $f(4)=5$ is the location of a local minimum.

(D) $f(4)=5$ is the location of a local maximum.

$$h(x)=\begin{cases} 3x^2+1, & \text{if } x<4 \\ 4x-9, & \text{if } x\geq 4 \end{cases}$$

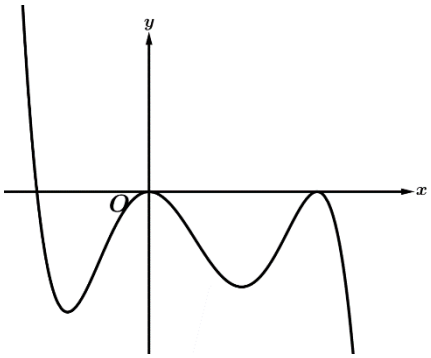
14. Let h be the piecewise defined function shown above. What is the average rate of change of h over the interval $0\leq x\leq 5$?

(A) 2 (B) 4 (C) 6 (D) 15

$$h(x)=\begin{cases} 3x^2+1, & \text{if } x<4 \\ 4x-9, & \text{if } x\geq 4 \end{cases}$$

15. Let h be the piecewise defined function shown above. What is the average rate of change of h over the interval $4\leq x\leq 6$?

(A) –17 (B) 4 (C) 8 (D) 30



Graph of *f*

16. The graph of the polynomial function f is shown above. Which of the following could be the expression for f?

(A) $-x(x+2)(x-3)^2$

(B) $-x(x+2)(x-3)$

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

(D) $x^2(x+2)(x-3)^2$

17. Let $g(x)=-2x(x+4)^3(x-7)^4$. What are all the intervals where $g(x)<0$?

(A) $(-4,0)$ only

(B) $(-4,0)$ and $(7,\infty)$

(C) $(-\infty,-4)$ and $(0,\infty)$

(D) $(-\infty,-4)$, $(0,7)$, and $(7,\infty)$

Directions: A graphing calculator is needed for problems 18 – 21.

18. Let $f(x) = -1.352x^5 + 3.051x^4 - 1.964x^2 + 6.542$, where $-1 \le x \le 2$. Which of the following statements about f is correct on the closed interval $-1 \le x \le 2$?

(A) f has two relative minima and two relative maxima.
(B) f has three relative minima and three relative maxima.
(C) f has one relative minimum and one relative maximum.
(D) f has two relative minima and four relative maxima.

19. Let $g(x) = 3.526x^4 - 5.152x^3 + 0.789x^2 - 2.665x - 4.152$, where $-1 \le x \le 2$. Which of the following statements about g is correct?

(A) g has a local minimum at $x = 1.143$.
(B) g has a local minimum at $x = -7.842$.
(C) g has a local maximum at $x = 1.143$.
(D) g has a local maximum at $x = -7.842$.

20. For the function g in problem 19, what is the complete interval where g is decreasing over the closed interval $-1 \le x \le 2$?

(A) $(1.143, 2)$
(B) $(-1,\ 1.143)$
(C) $(-0.653,\ 1.143)$
(D) $(-0.653,\ 1.782)$

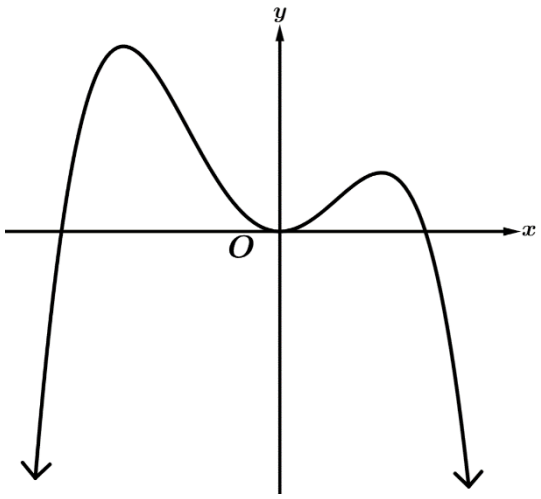
21. Let $h(x) = 2.351x^3 - 7.662x^2 + 2.117x + 1.302$, where $-1 \le x \le 3$. Find all zeros of h.

Directions: Complete each of the following problems. Be sure to show all necessary work to earn credit.

22. Factor the following expressions completely.

a) $\left(x^2-9\right)\left(x^2-3x-18\right)$ b) $3x^2-2x-8$ c) $4x^3-10x^2-24x$

23. Let $k\left(x\right)=2x^4+9x^3-5x^2$. Find all intervals where $k\left(x\right)\geq 0$.



Graph of *h*

24. The graph of the polynomial function h is shown above. Write two limit statements to describe the end behavior of the function h.

Left Limit Statement:

Right Limit Statement: