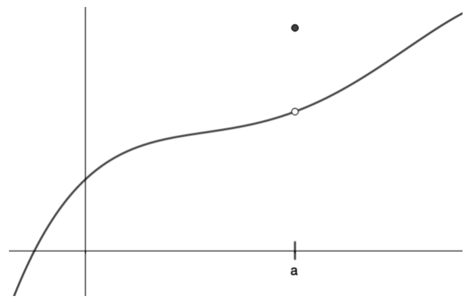


1. The graph of a function *f* is shown above. Which of the following statements about *f* is false?

a. *f* is continuous at $x = a$.
b. *f* has a relative maximum at $x = a$.
c. $x = a$ is in the domain of *f*.
d. $\lim_{x \to a^+} f(x) = \lim_{x \to a^-} f(x)$.
e. $\lim_{x \to a} f(x)$ exists.

2. For $x \geq 0$, the horizontal line $y = 2$ is an asymptote for the graph of the function *f*. Which of the following statements must be true?

a. $f(0) = 2$
b. $f(x) \neq 2$ for all $x \geq 0$
c. $f(2)$ is undefined.
d. $\lim_{x \to 2} f(x) = \infty$
e. $\lim_{x \to \infty} f(x) = 2$

3. Let f be a function that is continuous on the closed interval $[2,4]$ with $f(2)=10$ and $f(4)=20$. Which of the following is guaranteed by the Intermediate Value Theorem?

a. $f(x)=13$ has at least one solution in the open interval $(2,4)$.
b. $f(3)=15$.
c. f attains a maximum on the open interval $(2,4)$.
d. $f'(x)=5$ has at least one solution in the open interval $(2,4)$.
e. $f'(x)>0$ for all x in the open interval $(2,4)$.

---

4. If $\lim_{x\to 3} f(x)=7$, which of the following must be true?
I. f is continuous at $x=3$.
II. f is differentiable at $x=3$.
III. $f(3)=7$.

a. None.
b. II only.
c. III only.
d. I and III only.
e. I, II, and III

5. If $\lim_{x \to a} f(x) = L$, where L is a real number, which of the following must be true?

a. $f'(a)$ exists.
b. $f(x)$ is continuous at $x = a$.
c. $f(x)$ is defined at $x = a$.
d. $f(a) = L$
e. none of the above.

---

6. At $x = 3$, the function given by $f(x) = \begin{cases} x^2, & x < 3 \\ 6x - 9, & x \geq 3 \end{cases}$ is

a. undefined.
b. continuous but not differentiable.
c. differentiable but not continuous.
d. neither continuous nor differentiable.
e. both continuous and differentiable.

7. Which of the following are continuous at $x = 1$?

I. $\ln(x)$

II. e^x

III. $\ln(e^x - 1)$

a. I only
b. II only
c. I and II only
d. II and III only
e. I, II, and III

---

8. If the function *f* is continuous for all real numbers and if $f(x) = \frac{x^2 - 4}{x + 2}$ when $x \neq -2$, then $f(-2) =$

a. -4
b. -2
c. -1
d. 0
e. 2

9. If *f* is a continuous function on $\left[a,b\right]$, which of the following is necessarily true?

a. f' exists on $\left(a,b\right)$.
b. If $f\left(x_0\right)$ is a maximum of *f*, then $f'\left(x_0\right)=0$.
c. $\lim_{x\to x_0} f\left(x\right)=f\left(\lim_{x\to x_0} x\right)$ for $x_0\in\left(a,b\right)$.
d. $f'\left(x\right)=0$ for some $x\in\left[a,b\right]$.
e. The graph of f' is a straight line.

$$f\left(x\right)=\begin{cases}\dfrac{x^2-4}{x-2} & \text{if } x\neq 2\\ 1 & \text{if } x=2\end{cases}$$

10. Let *f* be the function defined above. Which of the following statements about *f* are true?
I. *f* has a limit at $x=2$.
II. *f* is continuous at $x=2$.
III. *f* is differentiable at $x=2$.

a. I only.
b. II only.
c. III only.
d. I and II only.
e. I, II, and III.

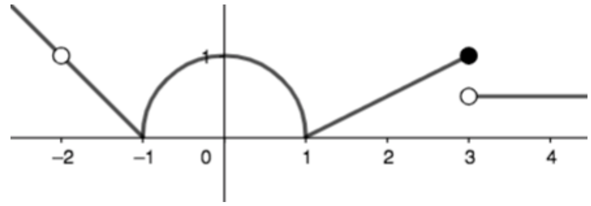
11. What is the domain of the function f given by $f(x)=\dfrac{\sqrt{x^2-4}}{x-3}$?

a. $\{x : x \neq 3\}$
b. $\{x : |x| \leq 2\}$
c. $\{x : |x| \geq 2\}$
d. $\{x : |x| \geq 2 \text{ and } x \neq 3\}$
e. $\{x : x \geq 2 \text{ and } x \neq 3\}$

---

12. What is $\lim\limits_{x\to\infty}\dfrac{x^2-4}{2+x-4x^2}$?

a. -2
b. $-\dfrac{1}{4}$
c. $\dfrac{1}{2}$
d. 1
e. The limit does not exist.



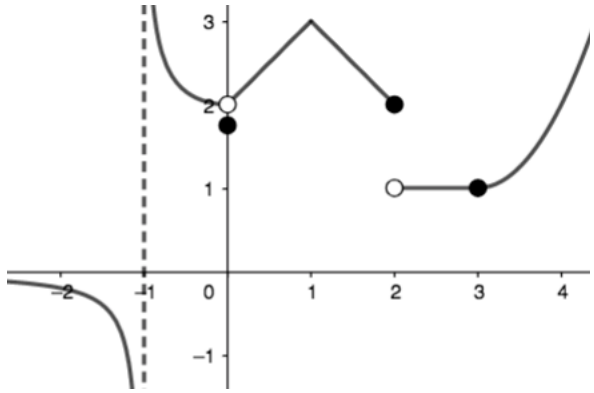
13. The graph of a function f is shown above. For which of the following values of c does $\lim_{x \to c} f(x) = 1$?

a. 0 only
b. 0 and 3 only
c. -2 and 0 only
d. -2 and 3 only
e. -2, 0, and 3

---

14. The graph of which of the following equations has $y = 1$ as an asymptote?

a. $y = \ln(x)$
b. $y = \sin(x)$
c. $y = \dfrac{x}{x+1}$
d. $y = \dfrac{x^2}{x+1}$
e. $y = e^{-x}$



15. The graph of a function f is shown above. If $\lim_{x \to b} f(x)$ exists and f is not continuous at b, then $b =$

a. -1
b. 0
c. 1
d. 2
e. 3

---

16. A polynomial $p(x)$ has a relative maximum at $(-2,4)$, a relative minimum at $(1,1)$, a relative maximum at $(5,7)$, and no other critical points. How many zeros does $p(x)$ have?

a. One
b. Two
c. Three
d. Four
e. Five

17. If a function f is continuous for all x and if f has a relative maximum at $(-1,4)$ and a relative minimum at $(3,-2)$, which of the following statements must be true?

a. The graph of f has a point of inflection somewhere between $x=-1$ and $x=3$.
b. $f'(-1)=0$
c. The graph of f has a horizontal asymptote.
d. The graph of f has a horizontal tangent at $x=3$.
e. The graph of f intersects both axes.

---

18. Let f be a continuous function on the closed interval $[-3,6]$. If $f(-3)=-1$ and $f(6)=3$, then the Intermediate Value Theorem guarantees that

a. $f(0)=0$
b. $f'(c)=\frac{4}{9}$ for at least one c between -3 and 6.
c. $-1\le f(x)\le 3$ for all x between -3 and 6.
d. $f(c)=1$ for at least one c between -3 and 6.
e. $f(c)=0$ for at least one c between -1 and 3.

x	0	1	2
$f(x)$	1	k	2

19. The function f is continuous on the closed interval $[0,2]$ and has values that are given in the table above. The equation $f(x)=\frac{1}{2}$ must have at least two solutions in the interval $[0,2]$ if $k=$

a. 0
b. $\frac{1}{2}$
c. 1
d. 2
e. 3

---

20. Let f be a function that is differentiable on the open interval $(1,10)$. If $f(2)=-5$, $f(5)=5$, and $f(9)=-5$, which of the following must be true?

I. f has at least 2 zeros.
II. The graph of f has at least one horizontal tangent.
III. For some c, $2<c<5$, $f(c)=3$.

a. None
b. I only
c. I and II only
d. I and III only
e. I, II, and III

21. Let g be a continuous function on the closed interval $\left[0,1\right]$. Let $g\left(0\right)=1$ and $g\left(1\right)=0$. Which of the following is NOT necessarily true?

a. There exists a number h in $\left[0,1\right]$ such that $g\left(h\right)\geq g\left(x\right)$ for all x in $\left[0,1\right]$.
b. For all a and b in $\left[0,1\right]$, if $a=b$, then $g\left(a\right)=g\left(b\right)$.
c. There exists a number h in $\left[0,1\right]$ such that $g\left(h\right)=\frac{1}{2}$.
d. There exists a number h in $\left[0,1\right]$ such that $g\left(h\right)=\frac{3}{2}$.
e. For all h in the open interval $\left(0,1\right)$, $\lim_{x\to h} g\left(x\right)=g\left(h\right)$.

---

22. $\lim_{x\to 0}\frac{5x^4+8x^2}{3x^4-16x^2}$ is

a. $-\frac{1}{2}$
b. 0
c. 1
d. $\frac{5}{3}$
e. nonexistent

23. $\lim\limits_{x\to\infty}\frac{(2x-1)(3-x)}{(x-1)(x+3)}$ is

a. -3
b. -2
c. 2
d. 3
e. nonexistent

---

24. $\lim\limits_{x\to\infty}\frac{x^3-2x^2+3x-4}{4x^3-3x^2+2x-1}$ is

a. 4
b. 1
c. $\frac{1}{4}$
d. 0
e. -1

25. $\lim_{n\to\infty} \frac{3n^3 - 5n}{n^3 - 2n^2 + 1}$ is

a. -5
b. -2
c. 1
d. 3
e. nonexistent

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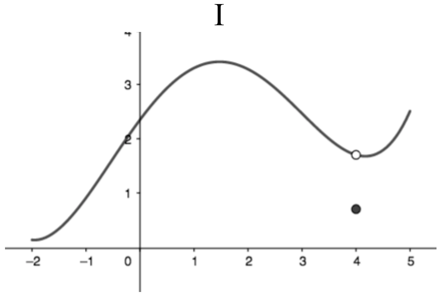
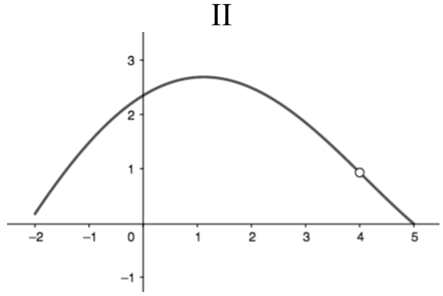
26. For which of the following does $\lim_{x\to 4} f(x)$ exist?

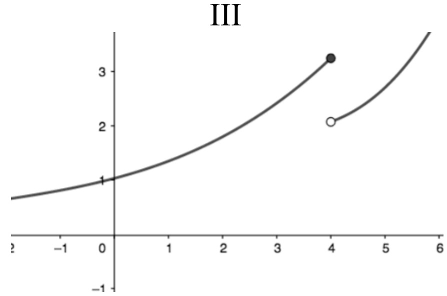
I



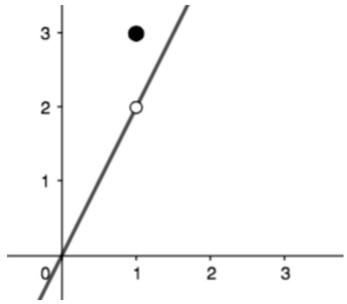
II



III



a. I only
b. II only
c. III only
d. I and II only
e. I and III only



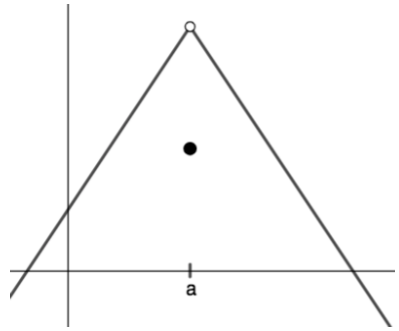
27. The graph of the function f is shown in the figure above. The value of $\lim_{x\to 1}\left(\sin\left(f\left(x\right)\right)\right)$ is

a. 0.909
b. 0.841
c. 0.141
d. –0.416
e. nonexistent

---

28. If $f\left(x\right)=\begin{cases} \ln\left(x\right) & \text{for } 0<x\le 2 \\ x^2\ln\left(2\right) & \text{for } 2<x\le 4 \end{cases}$, then $\lim_{x\to 2} f\left(x\right)$ is

a. $\ln\left(2\right)$
b. $\ln\left(8\right)$
c. $\ln\left(16\right)$
d. 4
e. nonexistent



29. The graph of the function *f* is shown above. Which of the following statements must be false?

a. $f(a)$ exists

b. $f(x)$ is defined for $0 < x < a$.

c. *f* is not continuous at $x = a$.

d. $\lim_{x \to a} f(x)$ exists.

e. $\lim_{x \to a} f'(x)$ exists.

---

30. If $a \neq 0$, then $\lim_{x \to a} \frac{x^2 - a^2}{x^4 - a^4}$ is

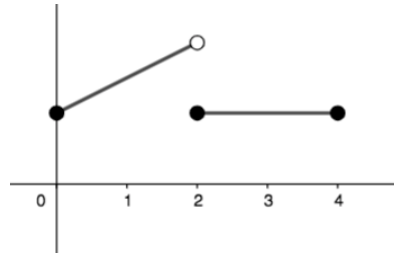
a. $\frac{1}{a^2}$

b. $\frac{1}{2a^2}$

c. $\frac{1}{6a^2}$

d. 0

e. nonexistent



31. The figure above shows the graph of a function *f* with domain $0 \le x \le 4$. Which of the following statements are true?

I. $\lim_{x \to 2^-} f(x)$ exists.

II. $\lim_{x \to 2^+} f(x)$ exists.

III. $\lim_{x \to 2} f(x)$ exists.

a. I only
b. II only
c. I and II only
d. I and III only
e. I, I, and III

$$f(x) = \begin{cases} \dfrac{(2x+1)(x-2)}{(x-2)} & \text{for } x \neq 2 \\ k & \text{for } x = 2 \end{cases}$$

32. Let *f* be the function defined above. For what value of *k* is *f* continuous at $x = 2$?

a. 0
b. 1
c. 2
d. 3
e. 5

33. If the graph of $y = \frac{ax+b}{x+c}$ has a horizontal asymptote $y = 2$ and a vertical asymptote $x = -3$, then $a + c =$

a. -5
b. -1
c. 0
d. 1
e. 5