1. If $f(x)=(2x+1)^4$, then the 4th derivative of $f(x)$ at $x=0$ is

(A) 0 (B) 24 (C) 48 (D) 240 (E) 384

---

2. If $y=\dfrac{3}{4+x^2}$, then $\dfrac{dy}{dx}=$

(A) $\dfrac{-6x}{(4+x^2)^2}$ (B) $\dfrac{3x}{(4+x^2)^2}$ (C) $\dfrac{6x}{(4+x^2)^2}$ (D) $\dfrac{-3}{(4+x^2)^2}$ (E) $\dfrac{3}{2x}$

---

3. $\lim\limits_{n\to\infty}\dfrac{4n^2}{n^2+10{,}000n}$ is

(A) 0 (B) $\dfrac{1}{2{,}500}$ (C) 1 (D) 4 (E) nonexistent

4. If $f(x)=x$, then $f'(5)=$

(A) 0 (B) $\dfrac{1}{5}$ (C) 1 (D) 5 (E) $\dfrac{25}{2}$

---

5. The slope of the line tangent to the graph of $y=\ln\left(\dfrac{x}{2}\right)$ at $x=4$ is

(A) $\dfrac{1}{8}$ (B) $\dfrac{1}{4}$ (C) $\dfrac{1}{2}$ (D) 1 (E) 4

---

6. If $y=10^{(x^2-1)}$, then $\dfrac{dy}{dx}=$

(A) $(\ln 10)10^{(x^2-1)}$ (B) $(2x)10^{(x^2-1)}$ (C) $(x^2-1)10^{(x^2-2)}$

(D) $2x(\ln 10)10^{(x^2-1)}$ (E) $x^2(\ln 10)10^{(x^2-1)}$

---

7. The position of a particle moving along a straight line at any time t is given by $s(t)=t^2+4t+4$. What is the acceleration of the particle when $t=4$?

(A) 0 (B) 2 (C) 4 (D) 8 (E) 12

---

8. If $x^2 + xy + y^3 = 0$, then, in terms of x and y, $\frac{dy}{dx} =$

(A) $-\frac{2x+y}{x+3y^2}$ (B) $-\frac{x+3y^2}{2x+y}$ (C) $\frac{-2x}{1+3y^2}$ (D) $\frac{-2x}{x+3y^2}$ (E) $-\frac{2x+y}{x+3y^2-1}$

---

9. The domain of the function defined by $f(x) = \ln\left(x^2 - 4\right)$ is the set of all real numbers x such that

(A) $|x| < 2$ (B) $|x| \le 2$ (C) $|x| > 2$ (D) $|x| \ge 2$ (E) x is a real number

---

10. The function defined by $f(x) = x^3 - 3x^2$ for all real numbers x has a relative maximum at $x =$

(A) -2 (B) 0 (C) 1 (D) 2 (E) 4

---

11. If $y = \cos^2 x - \sin^2 x$, then $y' =$

(A) -1 (B) 0 (C) $-2\sin(2x)$ (D) $-2(\cos x + \sin x)$ (E) $2(\cos x - \sin x)$

---

12. If $y = \arctan(\cos x)$, then $\frac{dy}{dx} =$

(A) $\frac{-\sin x}{1+\cos^2 x}$ (B) $-\left(\operatorname{arcsec}(\cos x)\right)^2 \sin x$ (C) $\left(\operatorname{arcsec}(\cos x)\right)^2$

(D) $\frac{1}{(\arccos x)^2 + 1}$ (E) $\frac{1}{1+\cos^2 x}$

---

13. If $f(x) = e^x$, which of the following is equal to $f'(e)$?

(A) $\lim_{h\to 0} \frac{e^{x+h}}{h}$ (B) $\lim_{h\to 0} \frac{e^{x+h} - e^e}{h}$ (C) $\lim_{h\to 0} \frac{e^{e+h} - e}{h}$

(D) $\lim_{h\to 0} \frac{e^{x+h} - 1}{h}$ (E) $\lim_{h\to 0} \frac{e^{e+h} - e^e}{h}$

---

14. $\frac{d}{dx}\left(\frac{1}{x^3} - \frac{1}{x} + x^2\right)$ at $x = -1$ is

(A) -6 (B) -4 (C) 0 (D) 2 (E) 6

---

15. If the position of a particle on the x-axis at time t is $-5t^2$, then the average velocity of the particle for $0 \le t \le 3$ is

(A) -45 (B) -30 (C) -15 (D) -10 (E) -5

---

16. Which of the following functions are continuous for all real numbers x ?

I. $y = x^{\frac{2}{3}}$

II. $y = e^x$

III. $y = \tan x$

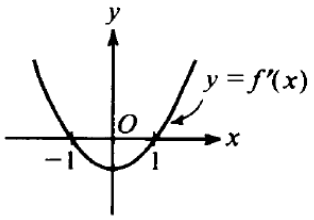
(A) None (B) I only (C) II only (D) I and II (E) I and III

---

17. The volume of a cone of radius r and height h is given by $V = \frac{1}{3}\pi r^2 h$. If the radius and the height both increase at a constant rate of $\frac{1}{2}$ centimeter per second, at what rate, in cubic centimeters per second, is the volume increasing when the height is 9 centimeters and the radius is 6 centimeters?

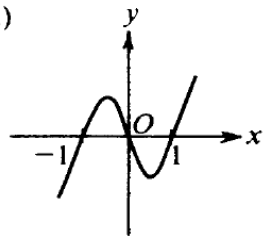
(A) $\frac{1}{2}\pi$ (B) 10π (C) 24π (D) 54π (E) 108π

18.

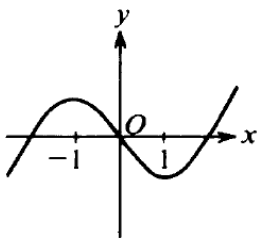


The graph of the derivative of f is shown in the figure above. Which of the following could be the graph of f?

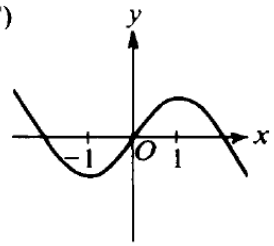
(A)



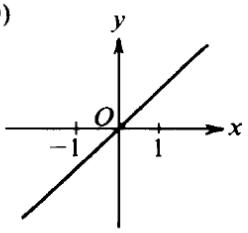
(B)



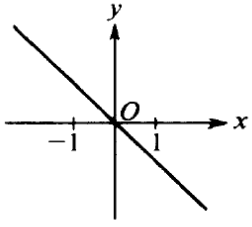
(C)



(D)



(E)



19. Let f and g have continuous first and second derivatives everywhere. If $f(x) \le g(x)$ for all real x, which of the following must be true?

I. $f'(x) \le g'(x)$ for all real x
II. $f''(x) \le g''(x)$ for all real x
III. $\int_0^1 f(x)\,dx \le \int_0^1 g(x)\,dx$

(A) None (B) I only (C) III only (D) I and II only (E) I, II, and III

---

20. If $f(x) = \dfrac{\ln x}{x}$, for all $x > 0$, which of the following is true?

(A) f is increasing for all x greater than 0.
(B) f is increasing for all x greater than 1.
(C) f is decreasing for all x between 0 and 1.
(D) f is decreasing for all x between 1 and e.
(E) f is decreasing for all x greater than e.

---

21. If $\lim\limits_{x \to a} f(x) = L$, 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

---

22. An equation of the line tangent to $y = x^3 + 3x^2 + 2$ at its point of inflection is

(A) $y = -6x - 6$ (B) $y = -3x + 1$ (C) $y = 2x + 10$

(D) $y = 3x - 1$ (E) $y = 4x + 1$

---

23. If $y = x^2 e^x$, then $\dfrac{dy}{dx} =$

(A) $2xe^x$ (B) $x\left(x + 2e^x\right)$ (C) $xe^x\left(x + 2\right)$

(D) $2x + e^x$ (E) $2x + e$

---

24. A particle with velocity at any time t given by $v(t) = e^t$ moves in a straight line. How far does the particle move from $t = 0$ to $t = 2$?

(A) $e^2 - 1$ (B) $e - 1$ (C) $2e$ (D) e^2 (E) $\frac{e^3}{3}$

---

25. The graph of $y = \frac{-5}{x-2}$ is concave downward for all values of x such that

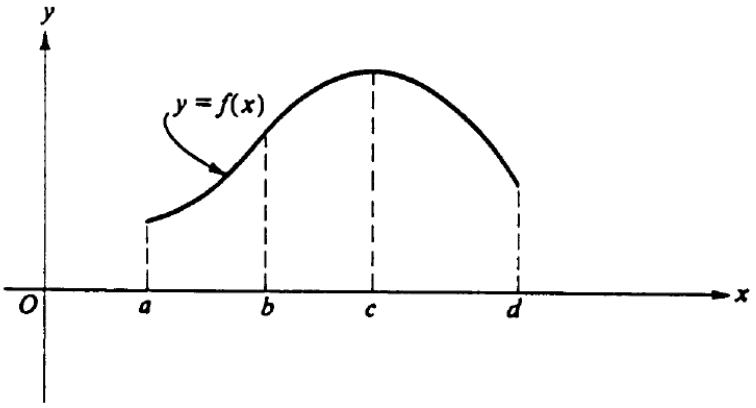
(A) $x < 0$ (B) $x < 2$ (C) $x < 5$ (D) $x > 0$ (E) $x > 2$

---

26. If $y = \frac{\ln x}{x}$, then $\frac{dy}{dx} =$

(A) $\frac{1}{x}$ (B) $\frac{1}{x^2}$ (C) $\frac{\ln x - 1}{x^2}$ (D) $\frac{1 - \ln x}{x^2}$ (E) $\frac{1 + \ln x}{x^2}$

27.



The graph of $y = f(x)$ is shown in the figure above. On which of the following intervals are $\frac{dy}{dx} > 0$ and $\frac{d^2y}{dx^2} < 0$?

I. $a < x < b$
II. $b < x < c$
III. $c < x < d$

(A) I only (B) II only (C) III only (D) I and II (E) II and III

28. If $x + 2xy - y^2 = 2$, then at the point $(1,1)$, $\frac{dy}{dx}$ is

(A) $\frac{3}{2}$ (B) $\frac{1}{2}$ (C) 0 (D) $-\frac{3}{2}$ (E) nonexistent

---

29. An equation of the line tangent to the graph of $f(x) = x(1-2x)^3$ at the point $(1,-1)$ is

(A) $y = -7x + 6$ (B) $y = -6x + 5$ (C) $y = -2x + 1$

(D) $y = 2x - 3$ (E) $y = 7x - 8$

---

30. If $f(x) = \sin x$, then $f'\left(\frac{\pi}{3}\right) =$

(A) $-\frac{1}{2}$ (B) $\frac{1}{2}$ (C) $\frac{\sqrt{2}}{2}$ (D) $\frac{\sqrt{3}}{2}$ (E) $\sqrt{3}$

---

31. If $f(x) = \sqrt{2x}$, then $f'(2) =$

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{\sqrt{2}}{2}$ (D) 1 (E) $\sqrt{2}$

---

32. A particle moves along the x-axis so that at any time $t \geq 0$ its position is given by $x(t) = t^3 - 3t^2 - 9t + 1$. For what values of t is the particle at rest?

(A) No values (B) 1 only (C) 3 only (D) 5 only (E) 1 and 3

---

33. If $y = 2\cos\left(\frac{x}{2}\right)$, then $\frac{d^2y}{dx^2} =$

(A) $-8\cos\left(\frac{x}{2}\right)$ (B) $-2\cos\left(\frac{x}{2}\right)$ (C) $-\sin\left(\frac{x}{2}\right)$ (D) $-\cos\left(\frac{x}{2}\right)$ (E) $-\frac{1}{2}\cos\left(\frac{x}{2}\right)$

---

34. Let f be a polynomial function with degree greater than 2. If $a \neq b$ and $f(a) = f(b) = 1$, which of the following must be true for at least one value of x between a and b?

I. $f(x) = 0$
II. $f'(x) = 0$
III. $f''(x) = 0$

(A) None (B) I only (C) II only (D) I and II only (E) I, II, and III

35. If $f'(x) = \cos x$ and $g'(x) = 1$ for all x, and if $f(0) = g(0) = 0$, then $\lim_{x \to 0} \frac{f(x)}{g(x)}$ is

(A) $\frac{\pi}{2}$ (B) 1 (C) 0 (D) -1 (E) nonexistent

---

36. $\frac{d}{dx}\left(x^{\ln x}\right) =$

(A) $x^{\ln x}$ (B) $(\ln x)^x$ (C) $\frac{2}{x}(\ln x)\left(x^{\ln x}\right)$ (D) $(\ln x)\left(x^{\ln x - 1}\right)$ (E) $2(\ln x)\left(x^{\ln x}\right)$

---

37. 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.

---

38. The $\lim_{h \to 0} \frac{\tan 3(x+h) - \tan 3x}{h}$ is

(A) 0 (B) $3\sec^2(3x)$ (C) $\sec^2(3x)$ (D) $3\cot(3x)$ (E) nonexistent

---

39. The absolute maximum value of $f(x) = x^3 - 3x^2 + 12$ on the closed interval $[-2, 4]$ occurs at $x =$

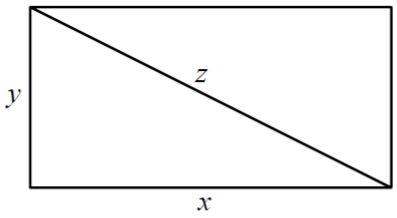
(A) 4 (B) 2 (C) 1 (D) 0 (E) -2

---

40. If $f(x) = e^x \sin x$, then the number of zeros of f on the closed interval $[0, 2\pi]$ is

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

41.



The sides of the rectangle above increase in such a way that $\frac{dz}{dt}=1$ and $\frac{dx}{dt}=3\frac{dy}{dt}$. At the instant when $x=4$ and $y=3$, what is the value of $\frac{dx}{dt}$?

(A) $\frac{1}{3}$ (B) 1 (C) 2 (D) $\sqrt{5}$ (E) 5

---

42. 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

---

43. The volume of a cylindrical tin can with a top and a bottom is to be 16π cubic inches. If a minimum amount of tin is to be used to construct the can, what must be the height, in inches, of the can?

(A) $2\sqrt[3]{2}$ (B) $2\sqrt{2}$ (C) $2\sqrt[3]{4}$ (D) 4 (E) 8

44. If $f(x)=x^{\frac{3}{2}}$, then $f'(4)=$

(A) –6 (B) –3 (C) 3 (D) 6 (E) 8

---

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

(A) –5 (B) –2 (C) 1 (D) 3 (E) nonexistent

46. If $x^3+3xy+2y^3=17$, then in terms of x and y, $\frac{dy}{dx}=$

(A) $-\frac{x^2+y}{x+2y^2}$

(B) $-\frac{x^2+y}{x+y^2}$

(C) $-\frac{x^2+y}{x+2y}$

(D) $-\frac{x^2+y}{2y^2}$

(E) $\frac{-x^2}{1+2y^2}$

---

47. 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

---

48. An equation of the line tangent to the graph of $y=\frac{2x+3}{3x-2}$ at the point $(1,5)$ is

(A) $13x-y=8$ (B) $13x+y=18$ (C) $x-13y=64$

(D) $x+13y=66$ (E) $-2x+3y=13$

49. If $y=\tan x-\cot x$, then $\frac{dy}{dx}=$

(A) $\sec x\csc x$ (B) $\sec x-\csc x$ (C) $\sec x+\csc x$ (D) $\sec^2 x-\csc^2 x$ (E) $\sec^2 x+\csc^2 x$

---

50. If $f(x)=(x-1)^2\sin x$, then $f'(0)=$

(A) -2 (B) -1 (C) 0 (D) 1 (E) 2

---

51. For what value of x does the function $f(x)=(x-2)(x-3)^2$ have a relative maximum?

(A) -3 (B) $-\frac{7}{3}$ (C) $-\frac{5}{2}$ (D) $\frac{7}{3}$ (E) $\frac{5}{2}$

---

52. The slope of the line normal to the graph of $y = 2\ln(\sec x)$ at $x = \frac{\pi}{4}$ is

(A) -2

(B) $-\frac{1}{2}$

(C) $\frac{1}{2}$

(D) 2

(E) nonexistent

---

53. If $f(x) = \sin\left(\frac{x}{2}\right)$, then there exists a number c in the interval $\frac{\pi}{2} < x < \frac{3\pi}{2}$ that satisfies the conclusion of the Mean Value Theorem. Which of the following could be c ?

(A) $\frac{2\pi}{3}$ (B) $\frac{3\pi}{4}$ (C) $\frac{5\pi}{6}$ (D) π (E) $\frac{3\pi}{2}$

---

54. Let f be the function defined by $f(x) = \begin{cases} x^3 & \text{for } x \le 0, \\ x & \text{for } x > 0. \end{cases}$ Which of the following statements about f is true?

(A) f is an odd function.

(B) f is discontinuous at $x = 0$.

(C) f has a relative maximum.

(D) $f'(0) = 0$

(E) $f'(x) > 0$ for $x \neq 0$

---

55. At what value of x does the graph of $y = \frac{1}{x^2} - \frac{1}{x^3}$ have a point of inflection?

(A) 0 (B) 1 (C) 2 (D) 3 (E) At no value of x

---

56. How many critical points does the function $f(x) = (x+2)^5(x-3)^4$ have?

(A) One (B) Two (C) Three (D) Five (E) Nine

57. If $f(x) = (x^2 - 2x - 1)^{\frac{2}{3}}$, then $f'(0)$ is

(A) $\frac{4}{3}$ (B) 0 (C) $-\frac{2}{3}$ (D) $-\frac{4}{3}$ (E) -2

---

58. $\frac{d}{dx}\left(2^x\right) =$

(A) 2^{x-1} (B) $(2^{x-1})x$ (C) $(2^x)\ln 2$ (D) $(2^{x-1})\ln 2$ (E) $\frac{2x}{\ln 2}$

---

59. A particle moves along a line so that at time t, where $0 \le t \le \pi$, its position is given by $s(t) = -4\cos t - \frac{t^2}{2} + 10$. What is the velocity of the particle when its acceleration is zero?

(A) -5.19 (B) 0.74 (C) 1.32 (D) 2.55 (E) 8.13

---

60. The function f given by $f(x) = x^3 + 12x - 24$ is

(A) increasing for $x < -2$, decreasing for $-2 < x < 2$, increasing for $x > 2$
(B) decreasing for $x < 0$, increasing for $x > 0$
(C) increasing for all x
(D) decreasing for all x
(E) decreasing for $x < -2$, increasing for $-2 < x < 2$, decreasing for $x > 2$

---

61. $\lim_{\theta \to 0} \frac{1 - \cos\theta}{2\sin^2\theta}$ is

(A) 0 (B) $\frac{1}{8}$ (C) $\frac{1}{4}$ (D) 1 (E) nonexistent

62. If $f(x) = e^{3\ln(x^2)}$, then $f'(x) =$

(A) $e^{3\ln(x^2)}$ (B) $\frac{3}{x^2}e^{3\ln(x^2)}$ (C) $6(\ln x)e^{3\ln(x^2)}$ (D) $5x^4$ (E) $6x^5$

---

63. The top of a 25-foot ladder is sliding down a vertical wall at a constant rate of 3 feet per minute. When the top of the ladder is 7 feet from the ground, what is the rate of change of the distance between the bottom of the ladder and the wall?

(A) $-\frac{7}{8}$ feet per minute

(B) $-\frac{7}{24}$ feet per minute

(C) $\frac{7}{24}$ feet per minute

(D) $\frac{7}{8}$ feet per minute

(E) $\frac{21}{25}$ feet per minute

64. 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

65. If f is a differentiable function, then $f'(a)$ is given by which of the following?

I. $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$

II. $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$

III. $\lim_{x\to a}\frac{f(x+h)-f(x)}{h}$

(A) I only (B) II only (C) I and II only (D) I and III only (E) I, II, and III

66. If the second derivative of f is given by $f''(x) = 2x - \cos x$, which of the following could be $f(x)$?

(A) $\frac{x^3}{3} + \cos x - x + 1$

(B) $\frac{x^3}{3} - \cos x - x + 1$

(C) $x^3 + \cos x - x + 1$

(D) $x^2 - \sin x + 1$

(E) $x^2 + \sin x + 1$

67. The radius of a circle is increasing at a nonzero rate, and at a certain instant, the rate of increase in the area of the circle is numerically equal to the rate of increase in its circumference. At this instant, the radius of the circle is

(A) $\frac{1}{\pi}$ (B) $\frac{1}{2}$ (C) $\frac{2}{\pi}$ (D) 1 (E) 2

68. What is the minimum value of $f(x) = x \ln x$?

(A) $-e$ (B) -1 (C) $-\frac{1}{e}$ (D) 0 (E) $f(x)$ has no minimum value.

69. If $f(x) = x\sqrt{2x-3}$, then $f'(x) =$

(A) $\frac{3x-3}{\sqrt{2x-3}}$

(B) $\frac{x}{\sqrt{2x-3}}$

(C) $\frac{1}{\sqrt{2x-3}}$

(D) $\frac{-x+3}{\sqrt{2x-3}}$

(E) $\frac{5x-6}{2\sqrt{2x-3}}$

70. If $f(x) = -x^3 + x + \frac{1}{x}$, then $f'(-1) =$

(A) 3 (B) 1 (C) –1 (D) –3 (E) –5

---

71. The graph of $y = 3x^4 - 16x^3 + 24x^2 + 48$ is concave down for

(A) $x < 0$

(B) $x > 0$

(C) $x < -2$ or $x > -\frac{2}{3}$

(D) $x < \frac{2}{3}$ or $x > 2$

(E) $\frac{2}{3} < x < 2$

---

72. $\frac{d}{dx}\cos^2(x^3) =$

(A) $6x^2 \sin(x^3)\cos(x^3)$

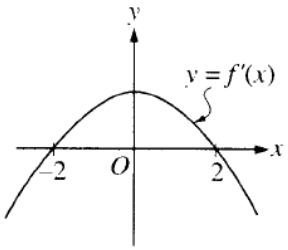
(B) $6x^2 \cos(x^3)$

(C) $\sin^2(x^3)$

(D) $-6x^2 \sin(x^3)\cos(x^3)$

(E) $-2\sin(x^3)\cos(x^3)$

73.



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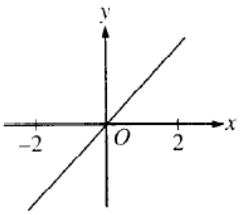
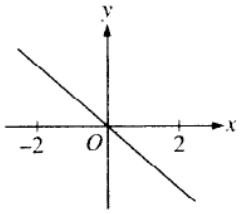
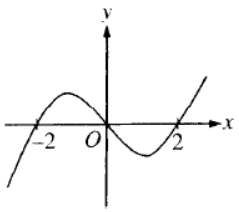
(A)



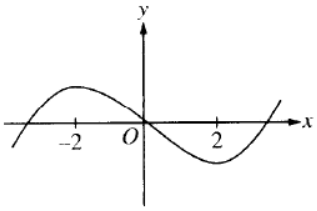
(B)



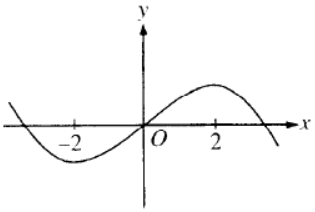
(C)



(D)



(E)



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74. At what point on the graph of $y=\frac{1}{2}x^2$ is the tangent line parallel to the line $2x-4y=3$?

(A) $\left(\frac{1}{2},-\frac{1}{2}\right)$ (B) $\left(\frac{1}{2},\frac{1}{8}\right)$ (C) $\left(1,-\frac{1}{4}\right)$ (D) $\left(1,\frac{1}{2}\right)$ (E) $(2,2)$

75. Let f be a function defined for all real numbers x. If $f'(x)=\frac{|4-x^2|}{x-2}$, then f is decreasing on the interval

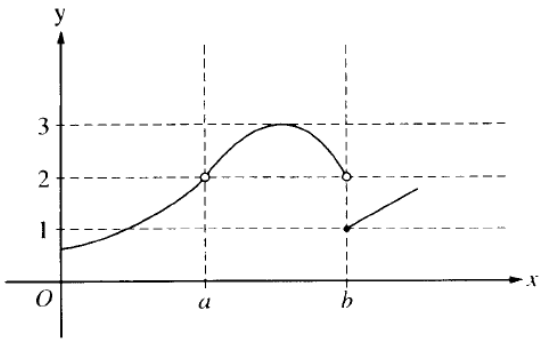
(A) $(-\infty,2)$ (B) $(-\infty,\infty)$ (C) $(-2,4)$ (D) $(-2,\infty)$ (E) $(2,\infty)$

---

76. Let f be a differentiable function such that $f(3)=2$ and $f'(3)=5$. If the tangent line to the graph of f at $x=3$ is used to find an approximation to a zero of f, that approximation is

(A) 0.4 (B) 0.5 (C) 2.6 (D) 3.4 (E) 5.5

77.



The graph of the function f is shown in the figure above. Which of the following statements about f is true?

(A) $\lim_{x\to a} f(x) = \lim_{x\to b} f(x)$

(B) $\lim_{x\to a} f(x) = 2$

(C) $\lim_{x\to b} f(x) = 2$

(D) $\lim_{x\to b} f(x) = 1$

(E) $\lim_{x\to a} f(x)$ does not exist.

---

78. If $x^2 + y^2 = 25$, what is the value of $\frac{d^2y}{dx^2}$ at the point $(4,3)$?

(A) $-\frac{25}{27}$ (B) $-\frac{7}{27}$ (C) $\frac{7}{27}$ (D) $\frac{3}{4}$ (E) $\frac{25}{27}$

---

79. If $f(x) = \ln\left|x^2 - 1\right|$, then $f'(x) =$

(A) $\left|\frac{2x}{x^2-1}\right|$

(B) $\frac{2x}{\left|x^2-1\right|}$

(C) $\frac{2|x|}{x^2-1}$

(D) $\frac{2x}{x^2-1}$

(E) $\frac{1}{x^2-1}$

80. $\lim_{x\to 1}\frac{x}{\ln x}$ is

(A) 0 (B) $\frac{1}{e}$ (C) 1 (D) e (E) nonexistent

81. What are all values of x for which the function f defined by $f(x)=(x^2-3)e^{-x}$ is increasing?

(A) There are no such values of x.

(B) $x<-1$ and $x>3$

(C) $-3<x<1$

(D) $-1<x<3$

(E) All values of x

82. What is the x-coordinate of the point of inflection on the graph of $y=\frac{1}{3}x^3+5x^2+24$?

(A) 5 (B) 0 (C) $-\frac{10}{3}$ (D) -5 (E) -10

83. If f is continuous for $a\le x\le b$ and differentiable for $a<x<b$, which of the following could be false?

(A) $f'(c)=\frac{f(b)-f(a)}{b-a}$ for some c such that $a<c<b$.

(B) $f'(c)=0$ for some c such that $a<c<b$.

(C) f has a minimum value on $a\le x\le b$.

(D) f has a maximum value on $a\le x\le b$.

(E) $\int_a^b f(x)dx$ exists.

84. If $x^2+xy=10$, then when $x=2$, $\frac{dy}{dx}=$

(A) $-\frac{7}{2}$ (B) -2 (C) $\frac{2}{7}$ (D) $\frac{3}{2}$ (E) $\frac{7}{2}$

85. Let f and g be differentiable functions with the following properties:

(i) $g(x) > 0$ for all x
(ii) $f(0) = 1$

86. What is the instantaneous rate of change at $x = 2$ of the function f given by $f(x) = \dfrac{x^2 - 2}{x - 1}$?

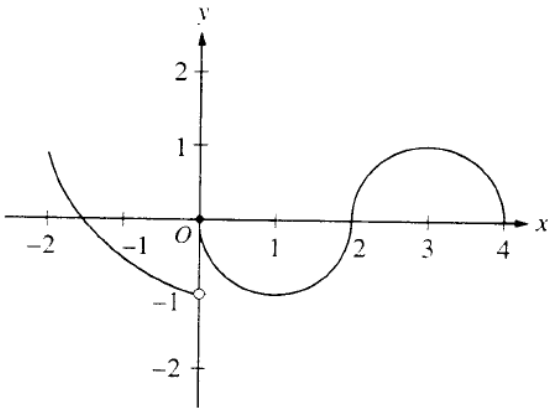
(A) -2 (B) $\dfrac{1}{6}$ (C) $\dfrac{1}{2}$ (D) 2 (E) 6

---

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

(A) $\ln 2$ (B) $\ln 8$ (C) $\ln 16$ (D) 4 (E) nonexistent

88.



The graph of the function f shown in the figure above has a vertical tangent at the point $(2,0)$ and horizontal tangents at the points $(1,-1)$ and $(3,1)$. For what values of x, $-2 < x < 4$, is f not differentiable?

(A) 0 only (B) 0 and 2 only (C) 1 and 3 only (D) 0, 1, and 3 only (E) 0, 1, 2, and 3

---

89. A particle moves along the x-axis so that its position at time t is given by $x(t) = t^2 - 6t + 5$. For what value of t is the velocity of the particle zero?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

---

90. If $f(x)=\sin\left(e^{-x}\right)$, then $f'(x)=$

(A) $-\cos(e^{-x})$

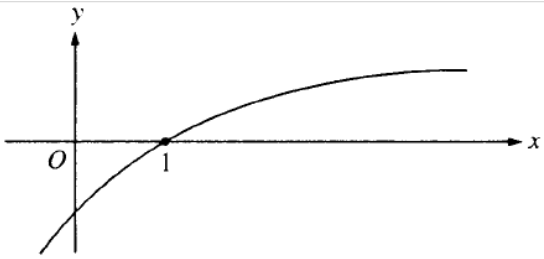
(B) $\cos(e^{-x})+e^{-x}$

(C) $\cos(e^{-x})-e^{-x}$

(D) $e^{-x}\cos(e^{-x})$

(E) $-e^{-x}\cos(e^{-x})$

91.



The graph of a twice-differentiable function f is shown in the figure above. Which of the following is true?

(A) $f(1)<f'(1)<f''(1)$

(B) $f(1)<f''(1)<f'(1)$

(C) $f'(1)<f(1)<f''(1)$

(D) $f''(1)<f(1)<f'(1)$

(E) $f''(1)<f'(1)<f(1)$

---

92. An equation of the line tangent to the graph of $y=x+\cos x$ at the point $(0,1)$ is

(A) $y=2x+1$ (B) $y=x+1$ (C) $y=x$ (D) $y=x-1$ (E) $y=0$

---

93. If $f''(x)=x(x+1)(x-2)^2$, then the graph of f has inflection points when $x=$

(A) -1 only (B) 2 only (C) -1 and 0 only (D) -1 and 2 only (E) -1, 0, and 2 only

---

94. The function f is given by $f(x) = x^4 + x^2 - 2$. On which of the following intervals is f increasing?

(A) $\left(-\frac{1}{\sqrt{2}}, \infty\right)$

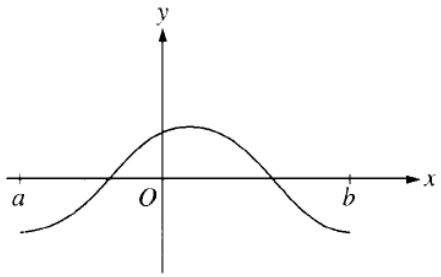
(B) $\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$

(C) $(0, \infty)$

(D) $(-\infty, 0)$

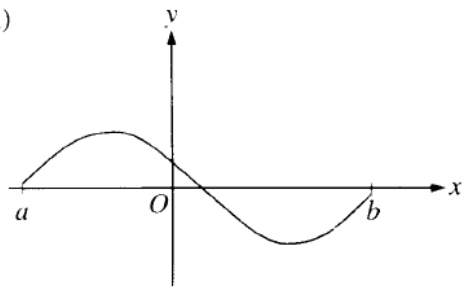
(E) $\left(-\infty, -\frac{1}{\sqrt{2}}\right)$

95.

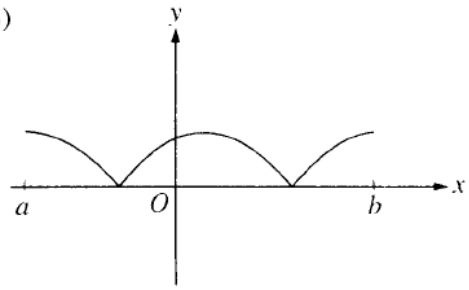


The graph of f is shown in the figure above. Which of the following could be the graph of the derivative of f?

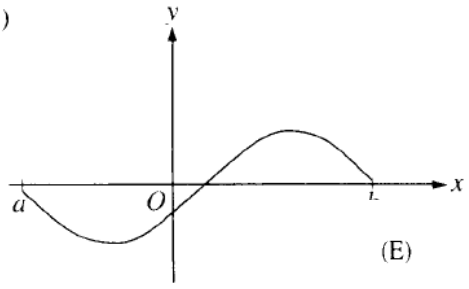
(A)



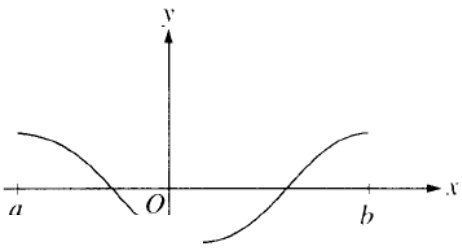
(B)



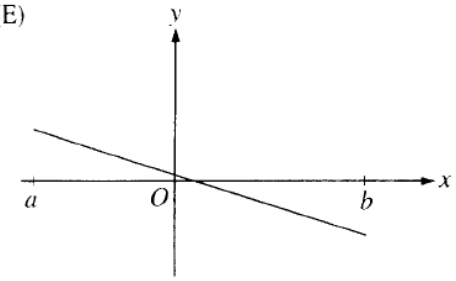
(C)



(D)



(E)



96. The maximum acceleration attained on the interval $0 \le t \le 3$ by the particle whose velocity is given by $v(t) = t^3 - 3t^2 + 12t + 4$ is

(A) 9 (B) 12 (C) 14 (D) 21 (E) 40

97. If $f(x) = \tan(2x)$, then $f'\left(\frac{\pi}{6}\right) =$

(A) $\sqrt{3}$ (B) $2\sqrt{3}$ (C) 4 (D) $4\sqrt{3}$ (E) 8

98. $\lim_{x\to\infty} \frac{(2x-1)(3-x)}{(x-1)(x+3)}$ is

A -3 B -2 C 2 D 3 E nonexistent

---

99. If $f(x) = (x-1)(x^2+2)^3$, then f'(x) =

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

D $(x^2+2)^2(7x^2-6x+2)$ E $-3(x-1)(x^2+2)^2$

---

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

A $-\frac{1}{2}$ B 0 C 1 D $\frac{5}{3}$ E nonexistent

---

101. $f(x) = \begin{cases} \frac{x^2-4}{x-2} & \text{if } x \neq 2 \\ 1 & \text{if } x = 2 \end{cases}$

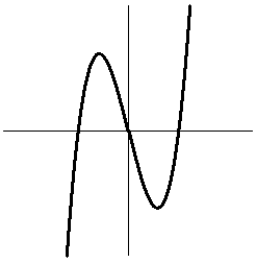
Let f be the function defined above. Which of the following statements about f are true?

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

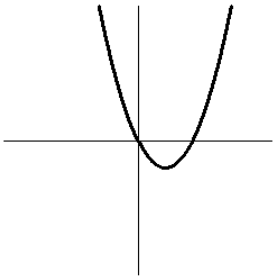
102. If f(x) = cos (3x), then $f'(\frac{\pi}{9}) =$

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

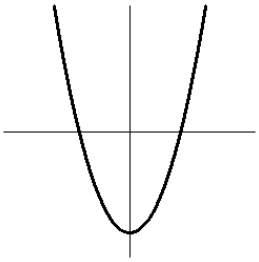


103. The graph of a function f is shown above. Which of the following could be the graph of f' ?

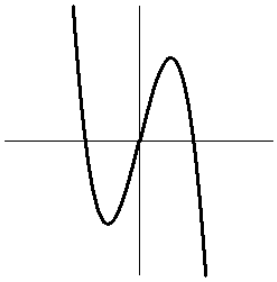
A



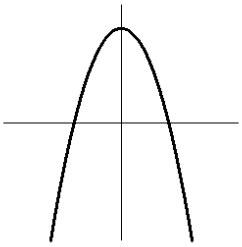
B



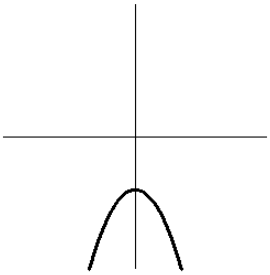
C



D



E



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104. If $f(x) = e^{(2/x)}$, then f'(x) =

A $2e^{(2/x)}\ln x$ B $e^{(2/x)}$ C $e^{(-2/x^2)}$ D $\frac{-2}{x^2}e^{(2/x)}$ E $-2x^2e^{(2/x)}$

---

105. If $f(x) = x^2 + 2x$, then $\frac{d}{dx}(f(\ln x)) =$

A $\frac{2\ln x + 2}{x}$ B 2xlnx + 2x C 2lnx + 2 D $2\ln x + \frac{2}{x}$ E $\frac{2x+2}{x}$

106.

x	0	1	2	3
f''(x)	5	0	-7	4

The polynomial function f has selected values of its second derivative f'' given in the table above.

Which of the following statements must be true?

A f is increasing on the interval (0,2)
B f is decreasing on the interval (0,2)
C f has a local maximum at x = 1
D The graph of f has a point of inflection at x = 1.
E The graph of f changes concavity in the interval (0,2)

---

107. If sin(xy) = x, then $\frac{dy}{dx}$ =

A $\frac{1}{\cos(xy)}$ B $\frac{1}{x\cos(xy)}$ C $\frac{1-\cos(xy)}{\cos(xy)}$

D $\frac{1-y\cos(xy)}{x\cos(xy)}$ E $\frac{y(1-\cos(xy))}{x}$

---

108. In the xy-plane, the line x + y = k, where k is a constant, is tangent to the graph of $y = x^2 + 3x + 1$. What is the value of k?

A -3 B -2 C -1 D 0 E 1

---

109. What are all the horizontal asymptotes of the graph of $y = \frac{5+2^x}{1-2^x}$ in the xy-plane?

A y = -1 only B y = 0 only C y = 5 only

D y = -1 and y = 0 E y = -1 and y = 5

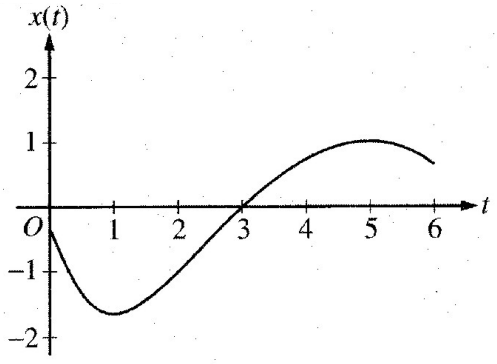
---

110. Let f be a function with a second derivative given by $f''(x) = x^2(x-3)(x-6)$. What are the x-coordinates of the points of inflection of the graph of f?

A 0 only B 3 only C 0 and 6 only D 3 and 6 only

E 0, 3, and 6

111.



A particle moves along a straight line. The graph of the particle's position x(t) at time t is shown for 0 < t < 6. The graph has horizontal tangents at t = 1 and t = 5 and a point of inflection at t = 2. For what values of t is the velocity of the particle increasing?

A 0 < t < 2 B 1 < t < 5 C 2 < t < 6 D 3 < t < 5 only

E 1 < t < 2 and 5 < t < 6

---

112. The function f is twice differentiable with f(2) = 1, f '(2) = 4, and f "(2) = 3. What is the value of the approximation of f(1.9) using the line tangent to the graph of f at x = 2?

A 0.4 B 0.6 C 0.7 D 1.3 E 1.4

$$f(x)=\begin{cases} cx+d \ \ for\ x\le 2 \\ x^2-cx \ \ for x>2 \end{cases}$$

113. Let f be the function defined, where c and d are constants. If f is differentiable at x = 2, what is the value of c + d?

A -4 B -2 C 0 D 2 E 4

---

114. What is the slope of the line tangent to the curve y = arctan (4x) at the point at which x = $\frac{1}{4}$?

A 2 B $\frac{1}{2}$ C 0 D $-\frac{1}{2}$ E -2