MATHS

JEE MAIN AND ADVANCED

LIMITS AND DERIVATIVES

Illustration

1. Consider the function f(x) = 2x + 3 and we want to find the limit of this function at x = 1.

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2. Consider the function $f(x) = \begin{cases} 2 & x \leq 0 \\ 2 & x > 0 \end{cases}$ Find $\lim_{x \to 2}$

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3. Derivative of $f(x) = x^6$ is (ii) Derivative of $f(x) = \frac{1}{\sqrt{x}}$ is

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4. Derivative of $f(x) = 3^x$ is (ii) Derivative of $f(x) = e^{2x}$ is

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5. Derivative of $f(x) = \log_6 x$ is (ii) Derivative of $f(x) = \left(\frac{1}{\log_x 8}\right)$ is

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6. Derivative of $f(x) = x + e^x$ is

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7. Derivative of $f(x) = x^2$ is

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Example

1. For the function $f(x) = 4x$. Find $\lim_{x \to 2} f(x)$

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2. For the function $f(x) = 2$. Find $\lim_{x \to 1} f(x)$

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3. Find $\lim_{x \to 0} f(x)$, where $f(x) = \begin{cases} x - 1 & x < 0 \\ 0 & x = 0 \\ x = 1 & x > 0 \end{cases}$

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4. Find (i) $\lim_{x \to 5} 6$

(ii) $\lim_{x \to 2} x$

(iii) $\lim_{x \to 3} [x + 2]$

(iv) $\lim_{x \to 2} 4x + 2)$

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5. Evaluate $\lim_{x \to 2} [4x^2 + 3x + 9]$

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6. Evaluate $\lim_{x \to 3} \frac{x^2 - 9}{x + 2}$

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7. Evaluate $\lim_{x \to p} \frac{\sqrt{1 + x} + \sqrt{1 - x}}{1 - x}$

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8. Evaluate $\lim_{x \to 4} \frac{x^2 - 7x + 12}{x^2 - 16}$

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9. Evaluate, $\lim_{x \to 2} \frac{x^3 - 8}{x^2 - 4}$

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10. Evalutate $\lim_{x \to 4} \frac{(x^2 - x - 12)^{18}}{(x^3 - 8x^2 + 16x)^9}$

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11. Evaluate $\frac{X \underset{x \to 1}{-} 1}{2x^{2-7x+5}}$

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12. Evaluate $\lim_{x \to 1} \left(\frac{1}{x^2 + x - 2} - \frac{x}{x^3 - 1} \right)$

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13. Evaluate $\lim_{x \to \sqrt{2}} \frac{x^9 - 3x^8 + x^6 - 9x^4 - 4x^2 - 16x + 84}{x^5 - 3x^4 - 4x + 12}$

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14. Evaluate : $\frac{x^8 - 256}{\substack{X \to 2 \\ x - 2}}$

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15. Evaluate $\lim_{x \to 3} \frac{x^7 - 2187}{x - 81}$

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16. Evaluate $\lim_{x \to a} \frac{(x+3)^{7/5} - (a+3)^{7/5}}{x-a}$

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17. If $\lim_{x \to 3} \frac{x^n - 3^n}{x-3} = 1458$ and $n \in N$, find n.

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18. If $\lim_{x \to a} \frac{x^7 + a^7}{x+a} = 7$, find the value of a.

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19. If $\lim_{x \to 1} \frac{x^3 - 1}{x-1} = \lim_{x \to k} \frac{x^4 - k^4}{x^3 - k^3}$, find the value of k.

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20. Evaluate $\lim_{x \to 0} \frac{\sqrt{x+2} - \sqrt{2}}{x}$

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21. Evaluate $\lim_{x \to 0} \frac{\sin 4x}{6x}$

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22. Evaluate $\lim_{x \to 0} \frac{\sin^2(3x/2x)}{x}$

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23. Evaluate $\lim_{x \to 0} \frac{\sin 3x}{\sin 6x}$

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24. Evaluate $\lim_{x \to 0} \frac{1 - \cos x}{x^2}$

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25. Evaluate $\lim_{x \to 0} \frac{\tan x + 4\tan 2x - 3\tan 3x}{x^2 \tan x}$

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26. Evaluate $\lim_{x \to \frac{\pi}{4}} \frac{1 - \tan x}{x - \frac{\pi}{4}}$

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27. Let f be a real-valued function defined by $f(x) = 3x^2 + 2x + 5$ Find f(1).

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28. Find the derivative of the following functions from the first principle (i) $x^3 + 4x^2$ (ii) $\sqrt{x+1}$

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29. Find the derivative of the following functions from the first principle

(i) $(2x-1)(x+2)$ (ii) $\frac{x-3}{2x+5}$

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30. Find the derivative of the following functions from first principle (i) e^{5x} (ii) $e^{\sqrt{x+1}}$

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31. Find the derivative of the following functions using first principle of derivative.

(i) sin (3x + 2) (ii) $\sin\left(x^2+5\right)$ (iii) x cos x

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32. Find the derivative of the following functions using first principle of derivative.

$\tan(x+1)$

(ii) $\cot\left(x^2+1\right)$

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33. Find the derivative of the following functions

(i) $x^3+\cos x+\sqrt{x}$ (ii) $\left(\sqrt{x}+1\right)^2$ (iii) $\left(x^2+2x-3\right)(x+1)$

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34. Find the derivative of the following functions.

(i) $\left(x^2\tan x\right)$ (ii) $(x+\cos x)\left(\sqrt{x}+1\right)$ (iii) $x^{-3}(e^x+5\sin x)$

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35. Find the derivative of the following functions.

(i) $\left(\frac{x+1}{x+2}\right)$

(ii) $\frac{x^2+1}{\sin x}$

(iii) $\frac{e^x}{1+\cos x}$

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36. Evaluate $\lim_{x \to \infty} \frac{ax^p + bx^{p-3} + c}{a_1 x^q + b_1 x^{q-1} + C_1 X^{q-3} + d_1}$

Where $p > 0$, $q > 0$, a,b,c, a_1, b_1, C_1, d_1 are constants.

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37. Evaluate $\lim_{x \to \infty} \sqrt{x}\left(\sqrt{x-2007} - \sqrt{x}\right)$

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38. (i) $\underset{x \to \infty}{Lt} e^x \sin\left(Ke^{-x}\right)$

(ii) $\lim_{x \to \infty} \left(\frac{\sin \frac{3}{4^x}}{\frac{\tan(4)}{3^x}} \right)$

(iii) $\lim_{x \to \infty} \left(1 - a^4\right)^{-x} \tan\left(b\left(1 - a^4\right)^x\right), -1 < a < 1, a \neq 0$ and $b \in R$

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39. (i) $\lim_{x \to 0} \frac{a^x - 1}{\log_a(1 + x)}, a > 0$ (ii) $\underline{\lim} (x \to 0) \frac{In(X + a) - Ina}{e^{2x} - 1}$

(ii) $\lim_{x \to \frac{\pi}{4}} \frac{In(\tan x)}{1 - \cot x}$

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40. Find $\frac{dy}{dx}$ when

(i) $Y = \frac{x}{\log_a X}$

(ii) Y = cos x cos 2x cos 4x cos 8x

(iii)

$y = x^3 + \tan x - e^x + x \log_e x + (\sin x)a^x + \cos \sec x - 2007, a > 0$

(iv) $y = (1+x)(1+x^2)(1+x^4)(1+x^8)\ldots\ldots(1+x^{2n})$

(v) If y = f(x), where $f\left(x+\frac{1}{x}\right) = x^4 + x^{-4}$

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41. Evaluate the following limits

(i) $\lim_{x \to \frac{\pi}{2}} \tan^2 x\left[\sqrt{2\sin^2 x + 3\sin x + 4} - \sqrt{\sin^2 x + 6\sin x + 2}\right]$

(ii) $\lim_{\theta \to 0} \frac{\sqrt{1+\sin 3\theta} - 1}{\ln(1+\tan 2\theta)}$

(iii) $\lim_{x \to 0} \frac{\sqrt{1+x} - \sqrt[3]{1+x}}{x}$

(iv) $\lim_{\phi \to 0} \frac{8}{\phi^8}\left(1 - \frac{\cos(\phi^2)}{2} - \frac{\cos(\phi^2)}{4} + \frac{\cos(\phi^2)}{2} \cdot \frac{\cos(\phi^2)}{4}\right)$

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Try Yourself

1. Calculate $\lim_{x \to 2}$, where $f(x) = \begin{cases} 3 & \text{if} \quad x \le 2 \\ 4 & \text{if} \quad x > 2 \end{cases}$

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2. Calculate $\lim_{x \to 0} f(x)$, where $f(x) = \frac{1}{x^2}$ for $x > 0$

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3. Find $\lim_{x \to 1} f(x)$, where $f(x) = \begin{cases} x+1 & x \neq 1 \\ 0 & x = 1 \end{cases}$

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4. Find $\lim_{X \to 0} f(x)$ where $f(x) = \begin{cases} x & x \neq 0 \\ 5 & x = 0 \end{cases}$

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5. Evalute

(i) $\lim_{x \to 1} \left[\frac{x}{2}\right]$ (ii) $\lim_{x \to 2} \left[x^2 - 5\right]$

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6. Evalute $\lim_{x \to 3} [9x - 14]$

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7. Evaluate $\lim_{x \to 1} [3x^4 + 4]$

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8. Evaluate $\lim_{x \to 3} [4x^3 + 3x^2 + 2x + 6]$

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9. Evaluate $\lim_{x \to 0} \left[\frac{3x^2 + 4x + 5}{x^2 - 2x + 3}\right]$

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10. Evaluate $\lim_{x \to 2} \left[\frac{x^2 - 4}{2x + 2}\right]$

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11. Evaluate $\lim_{x \to 1} \frac{1+(x-1)^2}{1+x^2}$

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12. Evaluate $\lim_{x \to a} \frac{\sqrt{x}+\sqrt{a}}{x+a}$

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13. Evaluate $underst(x \to 2)(\lim)\frac{x^2+2x-8}{x^2-4}$

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14. Evaluate $\lim_{x \to 3} \frac{x^2-10x+21}{x^2-9}$

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15. Evaluate $\lim_{x \to 1} \frac{x^3 - 1}{x - 1}$

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16. Evaluate $\lim_{x \to 2} \frac{x^3 - 3x^2 + 4}{x^4 - 8x^2 + 16}$

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17. Evaluate $\lim_{x \to 3} \frac{x - 3}{4x^2 - 15x + 9}$

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18. Evaluate $\lim_{x \to 1/4} \frac{4x - 1}{2\sqrt{x} - 1}$

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19. Evaluate $\lim_{x \to 2} \left[\frac{1}{x - 2} - \frac{2(2x - 3)}{x^3 - 3x^2 + 2x} \right]$

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20. Evaluate $\lim_{x \to 2} (x^2 - 4)\left[\frac{1}{x+2} + \frac{1}{x-2}\right]$

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21. Evaluate $\lim_{x \to \sqrt{3}} \frac{3x^8 + x^7 - 11x^6 - 2x^5 9x^4 - x^3 + 35x^2 + 6x + 30}{x^5 - 2x^4 + 4x^2 - 9x + 6}$

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22. Evaluate $\lim_{x \to 3} \frac{x^3 - 7x^2 + 15x - 9}{x^4 - 5x^3 + 27x - 27}$

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23. Evaluate $\lim_{x \to 4} \frac{x^5 - 1024}{x - 5}$

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24. Evaluate $\lim_{x \to 16} \frac{x^{3/2} - 64}{x - 16}$

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25. Evaluate $\lim_{x \to 0} \frac{1 - x^n - 1}{x}$

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26. Evaluate $\lim_{x \to a} \frac{(x+4)^{5/4} - (a+4)^{5/4}}{x - a}$

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27. If $\lim_{x \to 3} \frac{X^n - 3^n}{x - 3} = 405$ and $n \in N$ Find n

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28. If $\lim_{x \to 2} \frac{X^n - 2^n}{x - 2} = 448$ and $n \in N$, find n

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29. If $\lim_{x \to a} \frac{x^5 + a^5}{x + a} = 405$, Find the value of a.

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30. If $\lim_{x \to 0} \frac{x^9 + a^9}{x + a} = 9$, find the value of a

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31. If $\lim_{x \to 2} \frac{x - 2}{\sqrt[3]{x} - \sqrt[3]{2}} = \lim_{x \to k} \frac{x^2 - k^2}{x - k}$ find the value of K

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32. If $\lim_{x \to a} \frac{x\sqrt{x} - a\sqrt{a}}{x - 1} = \lim_{x \to 3} \frac{x^3 - 27}{x - 3}$, find the value of a.

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33. Evaluate $\lim_{x \to 2} \frac{\sqrt{3-x}-1}{2-x}$

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34. Evaluate $\lim_{x \to 3} \frac{\sqrt{x+3}-\sqrt{6}}{x^2-9}$

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35. Evaluate $\lim_{x \to 0} \frac{\tan 5x}{2x}$

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36. Evaluate $\lim_{x \to 0} \frac{\sin ax}{x}$

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37. Evaluate $\lim_{x \to 0} \frac{\sin^2 4x}{x^2}$

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38. Evaluate $\lim_{x \to 0} \frac{\sin \frac{5x}{4}}{x^2}$

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39. Evaluate $\lim_{x \to 0} \frac{\sin^2 ax}{\sin^2 bx}$

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40. Evaluate $\lim_{x \to 0} \frac{\sin 5x}{\sin 7x}$

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41. Evaluate $\lim_{x \to 0} \frac{1 - \cos 2x}{x}$

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42. Evaluate $\lim_{x \to 0} \frac{1 - \cos ax}{1 - \cos bx}$

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43. Evaluate $\lim_{x \to 0} \frac{\tan x - \sin x}{x^3}$

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44. Evaluate $\lim_{x \to 0} \frac{x^3 \cot x}{1 - \cos x}$

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45. Evaluate $\lim_{x \to \frac{\pi}{4}} \frac{\sin x - \cos x}{x - \frac{\pi}{4}}$

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46. Evaluate $\lim_{x \to \frac{\pi}{4}} \frac{\cos x - \sin x}{\cos 2x}$

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47. Find the derivative of $f(x) = x^3 + 1$ at x = - 1

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48. Find the derivative of $f(x) = 2x^3 + 3x^2 + 5x + 9$ at x = 2

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49. Find the derivative of $\sqrt{3x + 5}$ using first principle of derivative

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50. Find the derivative of $x^2 + 5x + 3$ using first principle of derivative.

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51. Find the derivative of $(3x-2)(x+1)$ using first principle of derivative.

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52. Find the derivative of $\frac{2x+3}{4x+1}$ using first principle of derivatives

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53. Find the derivative of e^{7x-2} using first principle of derivative

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54. Find the derivative of e^{x^2-5x} using first principle of derivative

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55. Find the derivative of sin(4x - 1) using first principle of derivative

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56. Find the derivative of $\cos\left(x^2+3\right)$ using first principle of derivatives.

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57. Find the derivative of $\tan\left(\sqrt{x}\right)$ w.r.t. x., using first principle

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58. Find the derivative of cot (3x + 5) using first principle of derivatives

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59. Findt the derivative of $f(x)=x^3+\frac{1}{\sqrt{x}}+5$

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60. Find the derivative of $f(x) = \tan x + \sin x + x^5$

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61. Find the derivative of $f(x) = x \sin x$ from the first principle.

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62. Find the derivative of f(x) = (x + 1) (cos x)

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63. Find the derivative of $f(x) = \dfrac{2x + 1}{x + 3}$

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64. Find the derivative of $\frac{e^x}{1+x^2}$

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Section A

1. $\lim_{x \to 0} \left(x^4 + x^2 - 2x + 1\right)$ is eqal to

A. 0

B. 1

C. 2

D. -1

Answer: B

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2. If the function $f(x) = \begin{cases} 3 & x < 0 \\ 12 & x > 0 \end{cases}$ then $\lim_{x \to 0} f(x) =$

A. 0

B. 3

C. 12

D. Does not exist

Answer: D

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3. $\lim_{x \to 3} (3x + 5)$ is equal to

A. 8

B. 12

C. 14

D. 16

Answer: C

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4. $\lim_{x \to 2} \frac{x^2 - 4}{x + 3}$ is equal to

A. 0

B. 1

C. $\frac{1}{5}$

D. $\frac{8}{5}$

Answer: A

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5. If $F(x) = \begin{cases} -x^2 + 1 & x < 0 \\ 0 & x = 0 \\ x^2 + 1 & x > = 0 \end{cases}$, .then $\lim_{x \to 0} f(x)$ is

A. 0

B. 1

C. 2

D. -1

Answer: B

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6. $\lim_{x \to 0} \frac{\sqrt{1+3x}+\sqrt{1-3x}}{1+3x}$ is equal to

A. 2

B. 1

C. 0

D. -1

Answer: A

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7. $\lim_{x \to 1} \frac{x^2 + x - 2}{x^2 - 1}$ is equal to

A. 0

B. -1

C. 2

D. $\frac{3}{2}$

Answer: D

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8. $\lim_{x \to 3} \frac{x^2 - 27}{x^2 - 9}$ is equal to

A. $\frac{3}{2}$

B. $\frac{9}{2}$

C. 0

D. 3

Answer: B

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9. $\lim_{x \to 1/2} \frac{8x^3 - 1}{16x^4 - 1}$ is equal to

A. $\frac{1}{2}$

B. $\frac{3}{2}$

C. $\frac{3}{4}$

D. $\frac{1}{4}$

Answer: C

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10. $\lim_{x \to 2} \frac{x^7 - 128}{x - 2}$ is equal to

A. 448

B. 128

C. 64

D. 0

Answer: A

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11. $\lim_{x \to 0} \frac{\sin 3x}{x}$ is equal to

A. 1

B. 3

C. 2

D. 0

Answer: B

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12. $\lim_{x-0} \frac{1-\cos 4x}{x^2}$ is equal to

A. 0

B. 2

C. 4

D. 8

Answer: D

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13. $\lim_{x \to 0} \frac{(1+x)^5 - 1}{(1+x)^3 - 1}$ is equal to

A. 6

B. $\frac{9}{4}$

C. $\frac{5}{3}$

D. $\frac{3}{5}$

Answer: C

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14. $\lim_{x \to 0} \frac{K \sin x}{lx + mx \cos x}$ is equal to

A. $\frac{k}{l+m}$

B. $\frac{l+m}{k}$

C. 0

D. $\frac{k}{l}$

Answer: A

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15. $\lim_{x \to 0} \frac{\sqrt{1+x+x^2} - \sqrt{x+1}}{2X^2}$ is equal to

A. $\frac{1}{6}$

B. $\frac{1}{4}$

C. $\frac{3}{2}$

D. $\frac{9}{2}$

Answer: B

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16. $\lim_{x \to 0} \frac{\sin^2 x/4}{x}$ is equal to

A. 0

B. 1

C. 2

D. -1

Answer: A

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17. $\lim_{x \to 0} \frac{2\sin x - \sin 2x}{x^3}$ ie equal to

A. 2

B. 1

C. 2

D. -1

Answer: B

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18. $\frac{\sqrt{a+x} - \sqrt{a}}{x\sqrt{a^2+ax}}$ $x \to 0$ is equal to

A. $2\sqrt{a}$

B. $\sqrt{a}$

C. $\frac{1}{2\sqrt{a}}$

D. $\frac{1}{2a^{3/2}}$

Answer: D

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19. $\lim_{x \to 3} \frac{x^3 - x^2 + 15x - 9}{x^4 - 5x^3 + 27x - 27}$ is equal to

A. $\frac{2}{9}$

B. $\frac{9}{2}$

C. 1

D. 0

Answer: A

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20. If $f(x) = x^4 + 2x^3$, them $\lim_{x \to 2} \frac{f(x) - f(2)}{x - 2}$ is equal to

A. 48

B. 56

C. 64

D. 98

Answer: B

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21. $\underset{x \to \sqrt{2}}{It} \frac{x^2 - 2}{x^2 + \sqrt{2}x - 4}$ is equal to

A. $\frac{3}{2}$

B. $\frac{1}{2}$

C. $\frac{2}{3}$

D. 2

Answer: C

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22. $\lim_{x \to 27} \left(x^{1/3} + 3\right)\left(X^{1/3} - 3\right)\frac{)}{x - 27}$ is equal to

A. $\frac{3}{2}$

B. $\frac{2}{9}$

C. $\frac{2}{3}$

D. 2

Answer: B

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23. $\lim_{x \to 2} \frac{x^3 + x^2 + 4x + 12}{x^3 - 3x + 2}$ is equal to

A. 8

B. $\frac{3}{4}$

C. $\frac{3}{5}$

D. 4

Answer: A

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24. $\lim_{x \to 4} \frac{x^2 - 16}{\sqrt{x} - 2}$ is equal to

A. 8

B. 64

C. 16

D. 32

Answer: D

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25. $\lim_{x \to 2} \frac{x - 2}{\sqrt{x} - \sqrt{2}}$ is equal to

A. $\sqrt{2}$

B. $2\sqrt{2}$

C. $\frac{1}{\sqrt{2}}$

D. 2

Answer: B

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26. $\lim_{x \to 0} \frac{x}{\tan x}$ is equal to

A. 1

B. 2

C. 3

D. 4

Answer: A

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27. The derivative of $f(x) = x^2$ at $x = 1$ is

A. 1

B. 2

C. 3

D. 4

Answer: B

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28. The derivative of $f(x) = x^2 + 2x$ at $x = 2$ is

A. 10

B. 12

C. 14

D. 16

Answer: C

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29. The derivative of $f(x) = \sin 2x$ is

A. cos 2X

B. 2 cos 2X

C. tan 2X

D. $\frac{\cos 2x}{2}$

Answer: B

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30. The derivative of $f(x) = \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2$ is

A. $\sqrt{x} + \frac{1}{\sqrt{x}}$

B. $2\left(\frac{\sqrt{x}+1}{\sqrt{x}}\right)$

C. $1-\frac{1}{x^2}$

D. $1+\frac{1}{x^2}$

Answer: C

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31. If $Y=\frac{1+\tan x}{1-\tan x}$, then $\frac{dy}{dx}$ is

A. $\frac{2\sec^2 x}{(1-\tan x)^2}$

B. $\frac{2\sec^2 x}{1+\tan x}$

C. $\frac{\sin^2 x}{1+\tan x}$

D. $\frac{\sec^2 x}{1+\tan x}$

Answer: A

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32. The derivative of $f(x) = x^{-3}(3 + 7.\ x)$ is

A. $\dfrac{9}{x^4 - \frac{14}{x^3}}$

B. $-\dfrac{9}{x^4} - 14x^3$

C. $\dfrac{9}{x^4} + \dfrac{14}{x^2}$

D. $-\dfrac{9}{x^4} - \dfrac{14}{x^3}$

Answer: D

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33. The derivative of $f(x) = \dfrac{3x + 2\sin x}{x + 5\cos x}$ is

A. $\dfrac{\cos x(2x + 15) + 10 + \sin x(15x - 2)}{(x + 5\cos x)^2}$

B. $\dfrac{(\cos x + 10)(\sin x - 15)}{(x + 5\cos x)^2}$

C. $\dfrac{\cos x(2x + 16) + 15 + \sin x}{(x5\cos x)^2}$

D. $\dfrac{(2x + 15)(15 + \sin x)}{(x + 5\cos x)^2}$

Answer: A

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34. The derivative of $f(x) = \left(x + \frac{1}{x}\right)^3$

A. $3x^2 + \frac{3}{x^4} - 3$

B. $3x^2 - \frac{3}{x^4} + 3 - \frac{3}{x^2}$

C. $3x^2 + \frac{3}{x^4} - 3 + \frac{3}{x^2}$

D. $3x^2 + \frac{3}{x^4} 3 + \frac{3}{x^2}$

Answer: B

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35. Compute the derivative of $f(x) = \sin^2 x$.

A. $\cos^2 x$

B. 2 sin x

C. sin 2 X

D. cos 2 x

Answer: C

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36. The derivative of $f(x) = (x - 4)^2$ is

A. 2(x - 2)

B. $x^2 - 4$

C. x - 4

D. 2(x - 4)

Answer: D

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37. Ther derivative of f(x) = sec(X) tan(x) is

A. $\sec^3 x \tan x$

B. $\sec\left(2\sec^2 x - 1\right)$

C. $\sec x\left(\tan^2 x - 1\right)$

D. sec x

Answer: B

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38. The derivative of $f(x) = \dfrac{2\sqrt{x} - 1}{x}$ is

A. $\dfrac{1}{x} + \dfrac{1}{x^{3/2}}$

B. $\dfrac{1}{x^{3/2}} + \dfrac{1}{x^2}$

C. $\dfrac{1}{x^3} - \dfrac{1}{x^2}$

D. $\dfrac{1}{x} - \dfrac{1}{x^{3/2}}$

Answer: B

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39. The derivative of f(X) = x cos x + tan x is

A. x sin x + cos x - x^2

B. x sin x + cos x + $\sec^2 x$

C. $-x$ sin x + cos x + sec x

D. $-x$ sin x + cos x + $\sec^2 x$

Answer: D

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40. The derivative of $f(x) = e^{2x}$ is

A. $2e^{2x}$

B. e^{2x}

C. $\frac{e^{2x}}{2}$

D. $-e^{2x}$

Answer: A

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41. The derivative of $f(x) = 2x^2 - 3x + 7$ at x = - 1 is

A. 7

B. -7

C. 6

D. 12

Answer: B

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42. The derivative of $f(x) = \frac{x^4}{e^x}$ is

A. $\frac{x^2(4+x)}{e^{2x}}$

B. $\frac{x^2(4-x)}{e^{2x}}$

C. $\frac{x^3(4-x)}{e^x}$

D. $\frac{x^3(4+x)}{e^x}$

Answer: C

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43. $\lim_{x \to 0} \frac{x \tan 3x}{\sin^2 x}$ is

A. 0

B. 1

C. 2

D. 3

Answer: D

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44. The derivative of $f(x) = \frac{x+2}{2x+1}$ is

A. $\frac{3}{(2x+1)}$

B. $-\frac{3}{(2x+1)^2}$

C. $\frac{3}{(2x+1)^2}$

D. $-\frac{3}{(2x+1)}$

Answer: B

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45. If $Y = \left(\frac{2-3\cos x}{\sin x}\right)$, then $\frac{dy}{dx}$ at $x = \frac{\pi}{4}$ is

A. $2\left(3-\sqrt{2}\right.$

B. $2 - 3\sqrt{2}$

C. $3\sqrt{2} + 1$

D. $6 - \sqrt{2}$

Answer: A

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46. The derivative of $f(x) = x^4 e^x$ is

A. $4x^3 e^x$

B. $x^4 e^x$

C. $x^3 e^x (x + 4)$

D. $x^2 e^x (x + 4)$

Answer: C

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47. The derivative of $f(x) = \frac{8^x}{\sin x}$

A. $\frac{8^x \log 8}{\sin^2 x}$

B. $\frac{8^x \cos x}{\sin^2 x}$

C. $\frac{8^x \log 8 - \cos x}{\sin^2 x}$

D. $\frac{8^x (\log 8. \sin x - \cos x)}{\sin^2 x}$

Answer: D

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48. The derivative of f(x) = x log x is

A. $\frac{x}{\log x}$

B. 1

C. 1 + log x

D. 1 - log x

Answer: C

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49. If $y = x^4 + 2x^2 + 3x + 1$, then $\frac{dy}{dx}$ at x = 1 is

A. 10

B. 11

C. 12

D. 7

Answer: B

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50. If for $f(x) = kx^2 + 5x + 3$, $f'(2) = 6$, then k is equal to

A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. $\frac{1}{3}$

D. 1

Answer: B

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Section B

1. Let $\lim_{x \to 0} \frac{\sin 2X}{x} = a$ and $\lim_{x \to 0} \frac{3x}{\tan x} = b$, then a + b equals

A. 5

B. 6

C. 0

D. 4

Answer: A

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2. Let $\lim_{x \to 0} \frac{\sin 2X}{\tan\left(\frac{x}{2}\right)} = L,$ and $\lim_{x \to 0} \frac{e^{2x} - 1}{x} = L_2$ then the value of $L_1 L_2$ is

A. 4

B. 8

C. 6

D. 2

Answer: B

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3. $\lim_{x \to 0} \frac{\log(1 + 2x)}{x} + \lim_{x \to 0} \frac{x^4 - 2^4}{x - 2}$ equals

A. 30

B. 32

C. 35

D. 34

Answer: D

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4. $\lim_{x \to \infty} \left(\sqrt{x+1} - \sqrt{x}\right)$ equals

A. ∞

B. 0

C. -1

D. 1

Answer: B

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5. The value of $\lim_{x \to 0} \left(\frac{1}{x} - \cot x \right)$ equals

A. 1

B. -1

C. 2

D. 0

Answer: D

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6. $\lim_{x \to \infty} \left(\frac{x^4 \sin\left(\frac{1}{x}\right) + x^2}{1 + |x|^3} \right)$ equals

A. -1

B. 1

C. 0

D. 2

Answer: A

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7. $\lim_{x \to 0} \frac{x \tan 2X - X \tan x}{(1 - \cos 2X)^2}$ equals

A. 1

B. $\frac{1}{2}$

C. $-\frac{1}{3}$

D. $\frac{1}{4}$

Answer: B

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8. The value of $\lim_{x \to 1} \frac{x^5 - 3x + 2}{x - 1}$ equals

A. 1

B. $\frac{1}{2}$

C. -2

D. 0

Answer: B

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9. The value of $\lim_{x \to 0} \frac{\tan x - \sin s}{x^3}$ equals

A. 1

B. $\frac{1}{2}$

C. $\frac{-1}{2}$

D. -1

Answer: B

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10. $\lim_{x \to 0} \frac{2^x - 1}{\sqrt{1+x} - 1} =$

A. 2

B. $\log_e 2$

C. $\log_e 2)$

D. $2 \log_e 2$

Answer: D

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11. The value of $\lim_{x \to 0} \frac{\log(5+x) - \log(5-x)}{x}$ equals

A. $\frac{1}{5}$

B. $\frac{2}{5}$

C. 0

D. Does not exist

Answer: B

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12. $m, n \in I^+$, then $\lim_{x \to 0} \frac{\sin x^n}{(\sin x)^m}$ equals

A. 1, if $n < m$

B. 0, if n = m

C. $\frac{n}{m}$

D. 0, if $n > m$

Answer: D

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13. The value of $\lim_{x \to \frac{\pi}{4}} \frac{\sin x - \cos x}{\left(x - \frac{\pi}{4}\right)}$ equals

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. 2

D. $\frac{1}{2}$

Answer: A

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14. The value of $\lim_{x \to 0} \frac{\sin(\pi \cos^2 x)}{x^2}$ equals

A. $-\pi$

B. π

C. $\frac{\pi}{2}$

D. 2π

Answer: B

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15. The value of $\lim_{n \to \infty} \frac{2n^2 - 3n + 1}{5n^2 + 4n + 2}$ equals

A. $\frac{1}{2}$

B. $\frac{2}{3}$

C. $\frac{2}{5}$

D. 1

Answer: C

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16. The value of $\lim_{\theta \to \frac{\pi}{2}} (\sec\theta - \tan\theta)$ equals

A. 0

B. 1

C. 2

D. ∞

Answer: A

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17. The value of $\lim_{x \to \infty} \left(\sqrt{x^2 + x + 1} - \sqrt{x^2 - x + 1}\right)$ equals

A. 0

B. 1

C. -1

D. ∞

Answer: B

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18. The value of $\lim_{x \to 0} \left(\frac{1}{x^2} - \cot x\right)$ equals

A. 1

B. 0

C. ∞

D. Does not exist

Answer: C

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19. The value of $\lim_{h \to 0} \left\{ \frac{1}{h(8+h)^{1/3}} - \frac{1}{2h} \right\}$ equals

A. $\frac{1}{12}$

B. $\frac{-4}{3}$

C. $\frac{-16}{3}$

D. $\frac{-1}{48}$

Answer: D

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20. The value of $\lim_{x \to \infty} \left\{ \sqrt{x + \sqrt{x + \sqrt{x}}} - \sqrt{x} \right\}$ equals

A. 0

B. $\frac{1}{2}$

C. 2

D. log 2

Answer: B

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21. $\lim_{x \to 2} \left(\frac{[x]^3}{3} - \left[\frac{x}{3} \right]^{-3} \right)$ is where [x] represents the integral part of x

A. 0

B. $\frac{64}{27}$

C. $\frac{8}{3}$

D. $\frac{3}{8}$

Answer: C

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22. $\underset{x \to 2}{Lt}\{[x-2]+[2-x]-x\} =$ where [.] represents greater intergral function

A. 0

B. 3

C. -3

D. -2

Answer: C

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23. If {x} denotes the fractional part of x, then $\lim_{x \to 0} \frac{\{x\}}{\tan\{x\}}$ is equal to

A. 1

B. 0

C. -1

D. Limit does not exist

Answer: D

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24. The least integer n for which $\lim_{x \to 0} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$ is a finite non-zero number is

A. 4

B. 3

C. 2

D. 1

Answer: B

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25. Let α and β be the distinct roots of $ax^2 + bx + c = 0$ then $\underset{x \to \alpha}{Lt} \frac{1 - \cos(ax^2 + bx + c)}{(x - \alpha)^2}$ equal to

A. $\frac{1}{2}(\alpha - \beta)^2$

B. $-\frac{a^2}{2}(\alpha - \beta)^2$

C. 0

D. $\frac{a^2}{2}(\alpha - \beta)^2$

Answer: D

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26. $\underset{x \to 0}{Lt} \frac{\sqrt{1 - \cos 2x}}{\sqrt{2}x} =$

A. 1

B. -1

C. Zero

D. Does not exist

Answer: D

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27. The value of $\lim_{x \to 0} \frac{\sin\alpha X - \sin\beta x}{e^{\alpha x} - e^{\beta x}}$ equals

A. 0

B. 1

C. -1

D. $\alpha - \beta$

Answer: B

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28. The value of $\lim_{x+\frac{\pi}{2}} \frac{\left\{1-\frac{\tan(x)}{2}\right\}\{1-\sin x\}}{\left\{1+\frac{\tan(X)}{2}\right\}(\pi-2x)^3}$ equals

A. 0

B. $\frac{1}{32}$

C. ∞

D. $\frac{1}{8}$

Answer: B

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29. The value of $\lim_{x\to\infty} \frac{(4^x-1)^3}{\sin\frac{x}{4}\log\left(1+\frac{x^2}{3}\right)}$ equals

A. $3(\log 4)^3$

B. $4(\log 4)^3$

C. $12(\log 4)^3$

D. $15(\log 4)^3$

Answer: C

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30. If $0 < \alpha < \beta$ then $\lim_{n \to \infty} (\beta^n + \alpha^n)^{\frac{1}{n}}$ is equal to

A. α

B. β

C. $\alpha\beta$

D. e

Answer: B

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31. $\lim_{x \to 0} \frac{\sin(nx)((a-n)nx - \tan x)}{x^2} = 0$ when n is a non-zero positive integer,then a equal to _____

A. $\frac{n+1}{2}$

B. $n^2 + 1$

C. $\frac{1}{n+1}$

D. $n + \frac{1}{n}$

Answer: D

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32. $\lim_{x+5^+} \frac{x^2 - gx + 20}{x - [x]}$ is equal to

A. 0

B. 1

C. 2

D. Not define

Answer: B

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33. $\lim_{x \to 0} \frac{\sin 2X}{2 - \sqrt{4 - x}}$ is

A. 2

B. 4

C. 8

D. 0

Answer: C

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34. $\lim_{x \to 0} \frac{1 - \cos x}{x\sqrt{x^2}}$

A. $\frac{1}{2}$

B. $-\frac{1}{2}$

C. 0

D. Does not exist

Answer: D

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Section C

1. Let $f(x) = \frac{(x-1)}{(2x^2 - 7x + 5)}$ then

A. $\lim_{x \to 1} f(x) = -\frac{1}{3}$

B. $\lim_{x \to 0} f(x) = -\frac{1}{5}$

C. $\lim_{x \to \infty} f(x) = 0$

D. $\lim_{x + \frac{5}{2}} f(x)$ does not exist

Answer: A::B::C::D

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2. Let f(x) = [x] and [] represents the greatest integer function, then

A. $\lim_{x \to 1+} f(x) = 1$

B. $\lim_{x \to 2008-} f(x) = 2007$

C. $\lim_{x \to k} f(x) = 2008, K \in (2008, 2009)$

D. $\lim_{x \to 2008-} x - [x] = 1$

Answer: A::B::C::D

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3. Let $f(x) = \frac{[x] - [\sin x]}{1 - \sin[\cos x]}$ and $g(x) = \frac{1}{f(x)}$ and [] represents the greatest integer function, then

A. $\lim_{x \to 0} f(x)$ exist

B. $\frac{1}{\underset{x \to 0}{g(x)}}$ exists

C. $\lim_{x \to 0} g(x)$ does not exists

D. $\lim_{x \to 0} f(x) = 0$

Answer: A::B::C::D

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4. If y = tan x tan 2x tan 3x, then $\frac{dy}{dx}$ equals

A.

$$3\sec^2 3x \tan x \tan 2x + 2\sec^2 2x \tan 3x \tan x + \sec^2 x \tan 2x \tan 3x$$

B. $2y(\cos ec2x + 2\cos ec4x + 3\cos ec6x)$

C. $3\sec^2 3x - 2\sec^2 2x - \sec^2 x$

D. $\sec^2 x + 2\sec^2 2x + 3\sec^2 3x$

Answer: A, B, C

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5. Which of the following statements (s) is/are true?

A. $\lim_{x \to a} \frac{a^x - x^a}{x^x - a^a} = -1$ then a is 1

B. $\lim_{n \to \infty} \log_{n-1} n. \log_n (n+1) n. \log_{(n+1)} (n+2)$.....

$\log_{(n^5 - 1)} n^5 = 5$

C. $\lim_{x \to n} \log_{\frac{x^2+1}{x+1}} \left(\sqrt{x^2+1} - x\right) = 1$

D. $\lim_{\substack{x \to 0 \\ y \to 0}} \frac{x^2}{y} = 0$, when (x,y) $\to$ (0,0) along the curve $y^2 = x^3$

Answer: A::B::C::D

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6. $(\lim)_{x \underset{\infty}{\to}} x^2 \sin\left((\log)_e \sqrt{\frac{\cos \pi}{x}}\right)$ a. 0 b. $\frac{\pi^2}{2}$ c. $\frac{\pi^2}{4}$ d. $\frac{\pi^2}{8}$

A. $\frac{\pi^2}{4}$

B. $-\frac{\pi^2}{4}$

C. $\frac{\pi^2}{8}$

D. $-\frac{\pi^2}{8}$

Answer: B

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Section D

1. We have

$$f(x)\lim_{n\to\infty}\frac{\cos(x)}{2}\frac{\cos(x)}{2^2}\frac{\cos(x)}{2^3}\frac{\cos(x)}{2^4}\ldots\ldots\ldots\frac{\cos(x)}{2^n}=\frac{\sin x}{2^n\sin\frac{x}{2^n}}$$

using the identity

$\lim_{n\to\infty}\lim_{x\to 0}$ f(x) equals

A. 0

B. 1

C. 2

D. $\frac{1}{2}$

Answer: B

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2. We have

$$f(x) \lim_{n \to \infty} \frac{\cos(x)}{2} \frac{\cos(x)}{2^2} \frac{\cos(x)}{2^3} \frac{\cos(x)}{2^4} \ldots\ldots \ldots \frac{\cos(x)}{2^n} = \frac{\sin x}{2^n \sin \frac{x}{2^n}}$$

using the identity

$$\lim_{n \to \infty} \sum_{k=1}^{n} \tan\left(\frac{x}{2^k}\right)$$ equals

A. $\frac{1}{x - \tan x}$

B. $\frac{1}{x} - \cot x$

C. $x + \cot x$

D. $x + \tan x$

Answer: B

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3. We have

$$f(x)\lim_{n\to\infty}\frac{\cos(x)}{2}\frac{\cos(x)}{2^2}\frac{\cos(x)}{2^3}\frac{\cos(x)}{2^4}\ldots\ldots$$

$$\ldots\frac{\cos(x)}{2^n}=\frac{\sin x}{2^n\sin\frac{x}{2^n}}$$

using the identity

$$\lim_{n\to\infty}\sum_{k=1}^{n}\frac{1}{2^{2k}}\sec^2\left(\frac{x}{2^k}\right)$$ equals

A. $\cos ec^2x-\frac{1}{x^2}$

B. $\cos ec^2x+\frac{1}{x^2}$

C. $\cos ec^2x-x^2$

D. $\cos ec^2x+x^2$

Answer: A

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4. Let $\lim_{x \to 0}$ f(x) be a finite number, where

$$f(x) = \frac{\sin x + ae^x + be^{-x} + c\ln(1+x)}{x^3}$$ a,b,e in R`

A. $-\frac{1}{3}$

B. 0

C. $\frac{1}{2}$

D. 1

Answer: A

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5. Let $\lim_{x \to 0}$ f(x) be a finite number, where

$$f(x) = \frac{\sin x + ae^x + be^{-x} + c\ln(1+x)}{x^3}$$ a,b,e in R`

A. $-\frac{1}{3}$

B. $\frac{1}{2}$

C. 0`1

D.

Answer: A

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6. Let $\lim_{x \to 0}$ f(x) be a finite number, where

$$f(x) = \frac{\sin x + ae^{x} + be^{-x} + c\ln(1+x)}{x^3}$$ a,b,e in R`

A. $-\frac{1}{3}$

B. $\frac{1}{2}$

C. 0

D. 2

Answer: A

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Section E

1. Statement-1 : $\lim_{x \to 0} \frac{\sqrt{1 - \cos 2x}}{x}$ at (x = 0). Right and limit $\neq$ hand limit

A. Statement - 1 isTurue, Statement-2 is True, Statement-2 is a correct explanation for statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is Not a correct explanation for statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement -1 is False, Statement-2 is True

Answer: A

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2. Statement-1 : $\lim_{x \to 0} \frac{\sqrt{1 - \cos 2x}}{x}$ does not exist

Statement-2 : for $\frac{\sqrt{1 - \cos 2x}}{x}$ at (x = 0) right hand limi $\neq$ Left hand limit

A. Statement - 1 isTurue, Statement-2 is True, Statement-2 is a correct explanation for statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is Not a correct explanation for statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement -1 is False, Statement-2 is True

Answer: D

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3. Statement-1 : $\lim_{x \to 0-} \frac{\sin[x]}{[x]} = \sin[x] \neq 0$, Where [x] is the integral part of x.

Statement-2 : $\lim_{x \to 0+} \frac{\sin[x]}{[x]} \neq 0$, where [x] the integral part of x.

A. Statement - 1 isTurue, Statement-2 is True, Statement-2 is a correct explanation for statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is Not a correct explanation for statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement -1 is False, Statement-2 is True

Answer: B

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4. Statement-1 : $\lim_{x \to 0} \frac{1 - \cos x}{x(2^x - 1)} = \frac{1}{2} \log_2 e.$

Statement : $\lim_{x \to 0} \frac{\sin x}{x} = 1, \lim_{x \to 0} \frac{a^x - 1}{x} = \log a, a > 0$

A. Statement - 1 isTurue, Statement-2 is True, Statement-2 is a correct explanation for statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is Not a correct explanation for statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement -1 is False, Statement-2 is True

Answer: A

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Section F

1.

Column-I	Column-II
$A.\ \lim_{x \to 0} \frac{\cos x - \cos 3x}{x(\sin x - \sin 3x)}$	$p.\ 3$
$B.\ \lim_{x \to 0} \frac{\sin 4x}{\tan 2x}$	$q.\ -2$
$C.\ \lim_{x \to \infty} \frac{x^4 + 2x^3 + 3}{2x^4 - x + 2}$	$r.\ \frac{1}{2}$
$D.\ \lim_{x \to 2} \frac{\sqrt{3x^2 + 3x - 9} - \sqrt{3x + 3}}{x - 2}$	$s.\ 2$

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2.

Column-I	Column-II
$A.\ f(x) = \frac{1}{\sqrt{x-2}}$	$p.\ \lim_{x \to 0} f(x) = 1$
$B.\ f(x) = \frac{3x - \sin x}{x + \sin x}$	$q.\ \lim_{x \to 0} f(x) = 0$
$C.\ f(x) = x\sin\frac{\pi}{x} f(0) = 0$	$r.\ \lim_{x \to \infty} f(x) = 0$
$f(x) = \frac{\tan^{-1}(1)}{x}$	$s.\ \lim_{x \to 0}$ does not exist

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3.

(Column-I, Column-II), $\left(A.\ \lim_{x \to 0}\left[\frac{\sin[x]}{[x]}\right], p.0\right), \left(B.\ \lim_{x \to 0}\right)\left[\frac{\tan[x]}{[x]}\right],$

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Section G

1. If $y = f(x)$ and $y^4 - 4y + x = 0$. If $f(-8) = 2$, then the value of $|28f'(-8)|$ is

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2. If $f(x) = f(1-x)$ and f(x) is differentiable are every real value of x then the value of $f'\left(\frac{1}{2}\right) + f'\left(\frac{1}{4}\right) + f'\left(\frac{3}{4}\right)$ is _____

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3. The value of $\lim_{x \to 0} \frac{e^{\sin^3 x} - \cos\left((\sin x)^3\right)}{x^3}$ is ____

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4. If $\lim_{x \to 0} \frac{1}{x^2}\left(e^{2mx} = e^x - x\right) = \frac{3}{2}$ then the value of m is _____

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5. If $\lim_{x \to 0} \left[\frac{m\sin x}{x}\right] = 8$ then the value of m is ([.] in the greatest integer function).

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Section H

1. STATEMENT-1 : $\lim_{x \to \infty} \frac{\log[x]}{[x]} = 0$. STATEMENT-2 : $\lim_{x \to 0} \frac{\sqrt{\sec^2 - 1}}{x}$ does not exist. STATEMENT-3: $\lim_{x \to 2} (x-1)^{\frac{1}{x-2}} = 1$

A. TTT

B. TTF

C. FTF

D. FFF

Answer: B

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2. $\lim_{x \to 0} \frac{A\sin x + B\log(1+x^2) + C(1-\cos x)}{x^2} = 2$ then

Statement-1 : A = 1

Statement-2 : 2B + C = 4

Statement-3 A + B + C = 0

A. TTT

B. TTF

C. FTF

D. FFF

Answer: C

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Section I

1. If $\lim_{x \to 0} \frac{\sin 2X + a\sin x}{x^3} = b$ (finite), then $(ab)^2$ equals.....

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2. Let

$$y = 1 + \frac{a_1}{x - a_1} + \frac{a_2 x}{(x - a_1)(x - a_2)} + \frac{a_3 x^2}{(x - a_1)(x - a_2)(x - a_3)} + \cdots \frac{}{(x}$$

Find $\frac{dy}{dx}$

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3. If $y = \frac{1}{1 + x^{a-b} + x^{c-b}} + \frac{1}{1 + x^{b-c} + x^{a-c}} + \frac{1}{1 + x^{b-a} + x^{c-a}}$ then find $\frac{dy}{dx}$ at $e^{a^{b^c}}$

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4. Evaluate $\lim_{x \to 0} \left[\frac{2008 \sin x}{x}\right] + \left[\frac{2009 \tan x}{x}\right]$ where [x] denotes the greatest integer $\leq x$.

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5. Evaluate $\lim_{x \to 0} \frac{k^{[x]} - 1 - |x| InK}{x^2}, k > 0$

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6. If Y = kx, then show that $\frac{dy}{dx} = \frac{y}{x}$

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Section J

1. If $\lim_{x \to 0} \frac{x^3}{\sqrt{a+x}(bx - \sin x)} = 1, a \in R^+$, then the value of a + b + 1975 is .....

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2. Evaluate, $Lt_{n \to \infty} \left(\frac{1 + \sqrt[n]{4}}{2} \right)^n$

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3. If $\lim_{x \to 1} \left(1 + ax + bx^2\right)^{\frac{c}{x-1}} = e^3$, then the value of a + b + bc + 2009 is.....

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