MATHS

BOOKS - V PUBLICATION

APPLICATION OF DERIVATIVES

Question Bank

1. Find the rate of change of the area of circle with respect to its radius r when $r = 5cm$

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2. The volume of a cube is increasing at a rate of 9 cm^3/s.How fast is in the surface area increasing when the length of an edge is 10 cm?

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3. A stone is dropped into a quiet lake and waves move in circle at a speed of 4 cm per second, At the instant, when the radius of the

circular wave is 10 cm, how fast is the enclosed area increasing?

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4. The length x of a rectangle is decreasing at the rate of 3cm/minute and the width y is increasing at the rate of 2 cm/ minute. When $x = 10cm$ and $y = 6cm$, find the rates of change of (a) the perimeter and (b) the area of the rectangle.

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5. The total cost C (x) in Rupees, associated with the production of x units of an item is given by $C(x) = 0.005x^3 - 0.02x^2 + 30x + 5000$ Find the marginal cost when 3 unit are produced, where by marginal cost we mean the instantaneous rate of change of total cost at any level of output.

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6. The total revenue is Rupees received from the sale of x units of a product is given by $R(x) = 3x^2 + 36x + 5$. Find the marginal revenue, when x = 5, where by marginal revenue we mean the rate of change of total revenue with respect to the number of items sold at an instant.

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7. Find the rate of change of the area of a circle with respect to its radius r when r = 4 cm.

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8. The volume of a cube is increasing at the rate of $8cm^3/S$. How fast is the surface area increasing when the length of an edge is 12cm.

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9. The radius of a circle is increasing uniformly at the rate of $3cm/s$. Find the rate at which the area of the circle is increasing when the radius is $10cm$.

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10. An edge of a variable cube is increasing at the rate of 3 cm / s. How fast is the volume of the cube increasing when the edge is 10 cm long?

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11. A stone is dropped into a quiet lake and waves move in circles at the speed of 5 cm/s. At the instant when the radius of the circular wave is 8 cm, how fast is the enclosed area increasing?

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12. The radius of a circle is increasing at the rate of 0.7 cm/s. What is the rate of increase of

its circumference?

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13. The length of a rectangle is decreasing at the rate of 5 cm/mi and the width is increasing at the rate of 4cm/min.When length is 8 cm and width is 6 cm, find the rate of change of its area.

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14. Suppose that a spherical balloon is inflated and it has volume 'v' and radius 'r' at time 't'. If the balloon is inflated by pumping 900c.c. of gas per second. Find the rate at which the radius of the balloon is increasing when the radious is 15 cm.

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15. A balloon which always remains spherical has a variable radius. Find the rate at which its

volume is increasing with the radius when the latter is $10cm$.

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16. A ladder 5m long is leaning against a wall. The bottom of the ladder is pulled along the ground, away from the wall, at the rate of 2cm/s. How fast is its height on the decreasing when the foot of the ladder is 4m away from the wall.

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17. A particle moves along the curve $6y = x^3 + 2$. Find the points on the curve at which the y coordinate is changing 8 times as fast as the x-coordinate.

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18. The radius of an air bubble is increasing at the rate of $\frac{1}{2}$ cm / s. At what rate is the volume of the bubble increasing when the radius is 1 cm ?

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19. A balloon which always remains spherical has a variable diameter $\frac{3}{2}(2x+1)$. Find the rate of change of its volume with respect to x

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20. Sand is pouring from a pipe at the rate of $12\ cm^3$ / s. The falling sand forms a cone on the ground in such a way that the height of

the cone is always one-sixth of the radius of the base. How fast if the height of the sand cone increasing when the height is 4 cm ?'

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21. The total cost $C(x)$ in Rupees associated with the production of x units of an item is given by

$C(x) = 0.007x^3 - 0.003x^2 + 15x + 4000$

Find the marginal cost when 17 units are produced.

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22. The total revenue is Rupees received from the sale of x units of a product is given by $R(x) = 13x^2 + 26x + 5$. Find the marginal revenue when x = 7

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23. The rate of change of the area of a circle with respect to its radius r at $r = 6cm$ is a) 10π b)12π c)8π d)11π

A. 10 pi'

B. 12 pi .'

C. 8 pi'

D. 11 pi'

Answer: B

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24. The total revenue in Rupees received from the sale of x units of a product is given by

$R(x) = 3x^2 + 36x + 5.$ The marginal revenue, when $x = 15$ is a)116 b)96 c)90 d)126

A. 116

B. 96

C. 90

D. 126

Answer: D

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25. Show that the function given by $f(x) = 7x - 3$ is strictly increasing on R

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26. Show that the function F given by

$f(x) = x^3 - 3x^2 + 4x, x \in R$

is strictly increasing

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27. Prove that the function given by $f(x) = \cos x$ is

(a) Strictly decreasing in $(0, \pi)$

(b) Strictly increasing in $(\pi, 2\pi)$ and

(c) neither increasing nor decreasing in $(0, 2\pi)$

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28. Find the intervals in which the function f given by $f(x) = x^2 - 4x + 6$ is (a) strictly

increasing (b) Strictly decreasing

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29. Find the intervals in which the function f given by $f(x) = 4x^3 - 6x^2 - 72x + 30$ is (a) strictly increasing (b) strictly decreasing.

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30. Find the interval in which the function $f(x) = \sin x + \cos x, 0 \leq x \leq 2\pi$ is strictly

increasing or strictly decreasing.

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31. Show that the function given by $f(x) = 3x + 17$ is strictly increasing on R.

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32. Show that the function given by $f(x) = e^{2x}$ is strictly increasing on R.

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33. Show that the function given by $f(x) = \sin x$ is

a) strictly increasing in $\left(0, \frac{\pi}{2}\right)$

b) Strictly decreasing in $\left(\frac{\pi}{2}, \pi\right)$

c) Neither increasing nor decreasing in $(0, \pi)$.

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34. Find the intervals in which the function f given $f(x) = 2x^2 - 3x$ is

Strictly Increasing.

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35. Find the intervals in which the function f given by $f(x) = 2x^3 - 3x^2 - 36x + 7$ is Strictly Increasing.

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36. Show that y = log(1+x)-(2x)/(2+x) ,x>-1` is an increasing function of x throughout its

domain.

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37. Find the value of x for which $y = [x(x-2)]^2$ is an increasing function.

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38. Prove that $y = \frac{4\sin\theta}{(2+\cos\theta)} - \theta$ is an increasing function of θ in $\left[0, \frac{\pi}{2}\right]$.

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39. Prove that the logarithmic function is strictly increasing on $(0, \infty)$

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40. Prove that the function f given by $f(x) = x^2 - x + 1$ is neither strictly increasing nor strictly decreasing on $(-1, 1)$

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41. Which of the following functions are strictly decreasing on '(0, pi/2) ?'

A. cos x'

B. cos 2 x'

C. cos 3 x'

D. tan x'

Answer: B

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42. On which of the following intervals is the function f given by $f(x) = x^{100} + \sin x - 1$ strictly decreasing ?

A. (0,1)'.

B. (pi/2, pi)'

C. (0, pi/2)'

D. None of these

Answer: D

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43. Find the least value of a such that the function f given by $f(x) = x^2 + ax + 1$ is strictly increasing on $(1, 2)$

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44. Let I be any interval disjoint from $(-1, 1)$ Prove that the function f given by $f(x) = x + \left(\frac{1}{x}\right)$ is strictly increasing on I.

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45. Prove that the function $f(x) = \log \sin x$ is strictly increasing in $\left(0, \frac{\pi}{2}\right)$ and strictly decreasing in $\left(\frac{\pi}{2}, \pi\right)$

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46. Prove that the function f given by $f(x) = \log \cos x$ is strictly decreasing on $\left(0, \frac{\pi}{2}\right)$ and strictly increasing on $\left(\frac{\pi}{2}, \pi\right)$

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47. Prove that the function given by $f(x) = x^3 - 3x^2 + 3x - 100$ in increasing in R.

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48. The interval in which $y = x^2 e^{-x}$ is increasing is a) (0,2) b) (-2,0) c) ,(2,oo)(-oo,oo)`

A. (-oo, oo)'

B. (-2,0)'

C. (2, oo)'

D. (0,2)'

Answer: D

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49. Find the slope of the tangent to the curve 'y=x^3-x' at 'x=2'.

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50. Find the point at which the tangent to the curve $y = \sqrt{4x - 3} - 1$ has its slope $\frac{2}{3}$

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51. Find the equation of all lines having slope 2 and being tangent to the curve $y + \frac{2}{x - 3} = 0$

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52. Find points on the curve $\frac{x^2}{4}+\frac{y^2}{25}=1$ at which the tangents are parallel

to x-axis

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53. Find the equation of the tangent to the curve $y=\frac{x-7}{(x-2)(x-3)}$ at the point where it cuts the x -axis.

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54. Find the equation of the tangent to the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = 2$ at (1,1).

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55. Find the equation of tangent to the curve given by $x = a\sin^3 t, y = b\cos^3 t$ at a point where $t = \frac{\pi}{2}$.

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56. Find the slope of the tangent to the curve

$y = 3x^4 - 4x \quad \text{at} \quad x = 4$

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57. Find the slope of the tangent to the curve.

$y = \dfrac{x-1}{x-2}, x \neq 2$

at $x = 10$

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58. Find the slope of the tangent to curve $y = x^3 - x + 1$ at the point whose x-coordinate is 2.

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59. Find the slope of the tangent to the curve $y = x^3 - 3x + 2$ at the point whose x-coordinate is 3.

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60. Find the slope of the normal to the curve

$$x = a\cos^3\theta, y = a\sin^3\theta \quad \text{at} \quad \theta = \frac{\pi}{4}$$

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61. Find the slope of the normal to the curve

$$x = 1 - a\sin\theta, y = b\cos^2\theta \text{ at } \theta = \frac{\pi}{2}$$

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62. Find points at which the tangent to the curve $y = x^3 - 3x^2 - 9x + 7$ is parallel to the x-axis.

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63. Find a point on the curve $y = (x - 2)^2$ at which the tangent is parallel to the chord joining the points (2,0) and (4,4).

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64. Find the point on the curve $y = x^3 - 11x + 5$ at which the tangent is $y = x - 11$

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65. Find the equation of all lines having slope -1 that are tangent to the curve $y = \frac{1}{x-1}, x \neq 1$

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66. Find the equation of all lines having slope 2 which are tangents to the curve $y = \frac{1}{x-3}, x \neq 3.$

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67. Find the equation of all lines having slope zero which are tangent to the curve $y = \frac{1}{x^2 - 2x + 3}$

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68. Find the points on the curve $\frac{x^2}{9} + \frac{y^2}{16} = 1$ at which tangents are parallel to x-axis

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69. Find the equation of the tangent line to the curve $y = x^2 - 2x + 7$ which is

a) parallel to the line $2x - y + 9 = 0$

b) perpendicular to the line $5y - 15x = 13$

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70. Show that the tangents to the curve $y = 7x^3 + 11$ at the points where x = 2 and $x = -2$ are parallel.

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71. Find the points on the curve $y = x^3$ at which the slope of the tangent is equal to the y co-ordinate of the point.

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72. For the curve $y = 4x^3 - 2x^5$, find all the points at which the tangent passes through the origin.

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73. Find the points on the curve $x^2 + y^2 - 2x - 3 = 0$ at which the tangent are parallel to x-axis.

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74. Find the equation of the normal at the point (am^2, am^3) for the curve $ay^2 = x^3$.

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75. Find the equation, of the normal to the curve $y = x^3 + 2x + 6$

which are parallel to the line $x + 14y + 4 = 0$

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76. Find the equations of the tangent and normal to the parabola $y^2 = 4ax$ at the point $(at^2, 2at)$

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77. Prove that the curve $x = y^2$ and $xy = k$ cut at right angles, if $8k^2 = 1$.

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78. Find the equations of the tangent and normal to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ at the point (x_0, y_0)

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79. Find the equation of the tangent to the curve $y = \sqrt{3x - 2}$ which is parallel to the line $4x - 2y + 5 = 0$.

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80. The slope of the normal to the curve $y = 2x^2 + 3\sin x$ at $x = 0$ is a)3 b)$\frac{1}{3}$ c)-3 d)$-\frac{1}{3}$

A. 3

B. '1/3'

C. -3'

D. -1/3'

Answer: D

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81. The line $y = x + 1$ is a tangent to the curve $y^2 = 4x$ at the point a)$(1, 2)$ b)$(2, 1)$ c) $(1, -2)$ d) $(-1, 2)$

A. (1,2)'

B. (2,1)'

C. (1,-2)'

D. '(-1,2)'

Answer: A

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82. Use differentiation to approximate $\sqrt{36.6}$.

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83. Use differential to approximate $25^{\frac{1}{3}}$

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84. Find the approximate value of $f(3.02)$ where $f(x) = 3x^2 + 5x + 3$.

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85. Find the approximate change in the volume V of a cube of side x meters caused by increasing the side by $2\ \%$

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86. If the radius of a sphere is measured as 9 cm with an error of 0.03 cm,then find the approximate error in calculating its volume.

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87. Find the approximate value of $f(2.01)$, where $f(x) = 4x^2 + 5x + 2$

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88. Find the approximate value of $f(5.001)$ where $f(x) = x^3 - 7x^2 + 15$.

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89. Find the approximate change in the volume V of a cube of side x meters caused by increasing the side by 1%.

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90. Find the approximate change in the surface area of a cube of side x meters caused by decreasing the side by 1%.

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91. If the radious of a sphere is measured as 7m with an error of 0.02m then find the approximate error in calculating its volume.

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92. If the radius of a sphere is measured as $9m$ with an error of $0.03m$, then find the approximate error in calculating its surface area.

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93. Find the approximate value of $f(3.02)$ where $f(x) = 3x^2 + 5x + 3$.

A. 47.66

B. 57.66

C. 67.66

D. 77.66

Answer: D

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94. Find the approximate change in volume of a cube of side x meters caused by an increase in the side by 3%.

A. 0.06 x^3 m^3'

B. 0.6 x^3 m^3'

C. 0.09 x^3 m^3'

D. 0.9 x^3 m^3'

Answer: C

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95. Find all points of local maxima and local minima of the function f given by $f(x) = x^3 - 3x + 3$

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96. Find all the point of local maxima and local minima of the function f given by $f(x) = 2x^3 - 6x^2 + 6x + 5$

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97. Find local minimum value of the function f given by $f(x) = 3 + |x|, x \in R$

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98. Find local maximum and local minimum value of the function f given, by $f(x) = 3x^4 + 4x^3 - 12x^2 + 12$

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99. Find all the point of local maxima and local minima of the function f given by $f(x) = 2x^3 - 6x^2 + 6x + 5$

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100. Find two positive numbers whose sum is 15 and the sum of whose squares is minimum.

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101. If length of three sides of a trapezium other than base are equal to 10cm. Then find the area of the trapezium when it is maximum.

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102. Prove that the radius of the right circular cylinder of greatest curved surface area which can be inscribed in a given cone is half of that of the cone.

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103. Find the absolute maximum value and minimum value of the function.

$f(x) = 2x^3 - 15x^2 + 36x + 1, x \in [1, 5]$

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104. Find the absolute maximum value and minimum value of the function.

$f(x) = 12x^{\frac{4}{3}} - 6x^{\frac{1}{3}}, x \in [-1, 1]$

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105. Find the maximum profit that a company can make, if the profit function is given by $p(x) = 41 - 24x - 18x^2$

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106. Find both the maximum value and the minimum value of $3x^4 - 8x^3 + 12x^2 - 48x + 25$ on the interval $[0, 3]$

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107. At what points in the interval $[0, 2\pi]$, does the function $\sin 2x$ attain its maximum value?

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108. What is the maximum value of the function $\sin x + \cos x$?

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109. Find the maximum value of $2x^3 - 24x + 107$ in the interval $[1, 3]$. Find the maximum value of the same function in $[-3, -1]$

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110. It is given that at x = 1, the function $x^4 - 62x^2 + ax + 9$ attains its maximum value, on the interval [0,2]. Find the value of a ?

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111. Find the maximum and minimum values of $x + \sin 2x$ on $[0, 2\pi]$

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112. Find two numbers whose sum is 24 and whose product as large as possible.

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113. Find two positive numbers x and y such that $x + y = 60$ and xy^3 is maximum.

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114. Find two numbers x and y such that their sum is 35 and the product x^2y^5 is a maximum.

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115. Find two positive numbers whose sum is 16 and the sum of whose Cubes is minimum.

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116. An rectangle sheet of tin with adjascent sides 45 cm and 24 cm is to be made into a box without top, by cutting off equal squares of side x from the corners the folding up the flaps.

For what value of x, the volume of the box will be maximum.

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117. Show that all rectangles with a given perimeter, the square has the maximum area.

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118. Of all the cylinders with given surface area, show that the volume is maximum when height is equal to the diameter of the base .

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119. Of all the closed cylindrical cans (right circular) of a given volume of 100 cubic. cm. find the dimensions of the can which has the minimum surface area.

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120. A wire of length 28 m is cut into two pieces. One of the Pieces is be made into a square and the other in to a circle. What should be the length of the two pieces so that

combined area of the square and the circle is minimum using differentiation?

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121. Show that the right circular cone of least curved surface and given volume has an altitude equal to $\sqrt{2}$ times the radius of the base.

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122. The point on the curve $x^2 = 2y$ which is nearest to the point (0,5) is --

A. '(2 sqrt2, 4)'

B. (2 sqrt2, 0)'

C. (0,0)'

D. (2,2)'

Answer: A

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123. Choose the correct answer. For all real values of x , the minimum value of $\frac{1-x+x^2}{1+x+x^2}$ is a)0 b)1 c)3 d)1/3

A. 0

B. 1

C. 3

D. 1/3)

Answer: D

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124. The maximum value of $[x(x-1)+1]^{1/3} 0 \leq x \leq 1$ is a) $\left(\frac{1}{2}\right)^{\frac{1}{3}}$ b)1/2 c) 1 d)0

A. (-13)^13'

B. (1/3)

C. 1

D. 0

Answer: C

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125. A man of 2 m height walks at a uniform speed of 6km/h away from a lamp post of 6m height. The rate at which the length of his shadow increases is

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126. Find intervals in which the function given by

$f(x) = \frac{3}{10}x^4 - \left(\frac{4}{5}\right)x^3 - 3x^2 + \frac{36}{5}x + 11$

is (a) strictly increasing (b) strictly decreasing

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127. The functions f(x) $= \tan^{-1}(\sin x + \cos x), x > 0$ is always an increasing functions on the interval :

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128. A circular disc of radius 3 cm is being heated. Due to expansion, its radius increases at the rate of 0.05 cm / s. Find the rate at which its area is increasing when radius is 3.2 cm.

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129. An open topped box is to be constructed by removing equal squares from each corner of a 3 metre by 8 metre rectangular sheet of

aluminium and folding up the sides. Find the volume of the largest such box.

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130. Manufacturer can sell, x items at a price of rupees $\left(5-\left(\frac{x}{100}\right)\right)$ each. The cost price of x items is Rs. $\left(\frac{x}{5}+500\right)$. Find the number of items he should sell to earn maximum profit:

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131. Show that the function given by $f(x) = \frac{\log x}{x}$ has maximum at $x = e$.

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132. Find the equation of the tangent and normal at the point (1,2) on the parabola $y^2 = 4x$.

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133. Find the intervals in which the function f given by $f(x) = x^3 + \frac{1}{x^3}, x \neq 0$ is

(i) increasing

(ii) decreasing

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134. Find the points at which the function f given by

$f(x) = (x-2)^4(x+1)^3$ has

i) local maxima

ii) local minimà

iii) point of inflexion

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135. Find the absolute maximum and minimum values of the function f given by $f(x) = \cos^2 x + \sin x, x \in [0, \pi]$

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136. A cylindrical tank of radius '10 m' is being filled. with wheat at the rate of 314 .cubic inetre per hour. Then the depth of the wheat is increăsing at the rate of

A. 1mh

B. 0.1mh

C. 1.1mh

D. 0.5mh

Answer: A

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137. The slope of the normal to the curve $x = t^2 + 3t - 8$ and $y = 2t^2 - 2t - 5$ at the point $(2, -1)$ is a) $\frac{6}{7}$ b) $-\frac{6}{7}$ c) $\frac{7}{6}$ d) $-\frac{7}{6}$

A. (22)/7

B. 6/7

C. 7/6

D. $\frac{-6}{7}$

Answer: B

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138. The line $y = mx + 1$ is a tangent to the curve $y^2 = 4x$ Find the value of m.

A. 1

B. 2

C. 3

D. 1/2

Answer: A

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139. The normal at the point $(1, 1)$ on the curve $2y + x^2 = 3$ is a)$x + y = 0$ b) $x - y = 0$ c)$x + y + 1 = 0$ d)$x - y = 1$

A. x+y=0'

B. x-y=0'

C. x+y+1=0'

D. x-y=1'

Answer: B

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140. The normal to the curve $x^2 = 4y$ passing $(1, 2)$ is

A. x+y=3'

B. x-y=3'

C. x+y=1'

D. x-y=1'

Answer: A

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141. The points on the curve $9y^2 = x^3$, where the normal to the curve makes equal intercept. with : the axes are

A. (4, +- 8/3)'

B. (4,-8/3)'

C. (4, 3/8)'

D. (+- 4, 3/8)'

Answer: A

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142. Find the equation to the tangent and normal at $(2, -2)$ to the curve $y^2 = \frac{x^3}{4-x}$

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143. Find the equations of the tangent and normal to the parabola $y^2 = 4ax$ at the point $(at^2, 2at)$

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144. Find both maximum and minimum value of $3x^4 - 8x^3 + 12x^2 - 48x + 1$ on the interval $[1, 4]$

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