Differential Equation

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1) The order & degree of the differential equation $\left[1+\left(\frac{dy}{dx}\right)^2\right]^{\frac{5}{2}}=\frac{d^3y}{dx^3}$ is -- (i) 2,3 (ii) 3,2 (iii) 3,5 (iv) 5,2

2) The order & degree of the differential equation $\left(\frac{d^3y}{dx^3}\right)^{\frac{2}{3}}=a\left[1+\left(\frac{dy}{dx}\right)^6\right]^{\frac{3}{2}}$ is -- (i) 3,4 (ii) 3,6 (iii) 3,2 (iv) 4,3

3) The order and degree of differential equation $\frac{d^2y}{dx^2}+\left(\frac{dy}{dx}\right)^{\frac{1}{3}}+x^{\frac{1}{4}}=0$ is -- (i) 2,3 (ii) 2,12 (iii) 2,6 (iv) 2,4

4) Find order and degree of differential equation $2\frac{d^2y}{dx^2}+3\sqrt{1-\left(\frac{dy}{dx}\right)^3}-y=0$

5) The order of the differential equation $\left(\frac{d^4y}{dx^4}\right)^3-\frac{d^3y}{dx^3}=\sqrt{1+\frac{dy}{dx}}$ is -- (i) 3 (ii) 4 (iii) 6 (iv) 7

6) The order and degree of differential equation $\sqrt{y+\frac{d^2y}{dx^2}}=x+\left(\frac{dy}{dx}\right)^{\frac{3}{2}}$ is -- (i) 2, 2 (ii) 2, 3 (iii) 2, 4 (iv) 2, 1

7) Order of differential equation $\left(\frac{d^py}{dx^p}\right)^2+\left(\frac{d^qy}{dx^q}\right)^s+y^{\frac{1}{r}}=0$ (where $p>q>r>s$) is -- (i) 2 (ii) s (iii) $2r$ (iv) Not defined

8) Find order & degree of differential equation $\left(\frac{d^py}{dx^p}\right)^2-\left(\frac{d^qy}{dx^q}\right)^{\frac{1}{r}}+\left(\frac{d^sy}{dx^s}\right)^t=0$ where $p>q>r>s>t$

9) Find order & degree of differential equation $\frac{d^4y}{dx^4}+\sin\left(\frac{d^3y}{dx^3}\right)=0$

10) Find order & degree of differential equation $\frac{d^3y}{dx^3}+x\left(\frac{dy}{dx}\right)^4=4\ln\left(\frac{d^4y}{dx^4}\right)$.

11) Find order & degree of differential equation of $\sqrt{\sin x}(dx+dy)=\sqrt{\cos x}(dx-dy)$.

12) The differential equation of the family of lines passing through the origin is -- (i) $x\dfrac{dy}{dx}=y$, (ii) $x+\dfrac{dy}{dx}=0$, (iii) $\dfrac{dy}{dx}=x$, (iv) $x\dfrac{dy}{dx}+y=0$

13) Show that $v=\dfrac{A}{r}+B$ satisfies the differential equation $\dfrac{d^2v}{dr^2}+\dfrac{2}{r}\cdot\dfrac{dv}{dr}=0$

14) Prove that $x=A\cos\sqrt{\mu t}$ is a solution of the differential equation $\dfrac{d^2x}{dt^2}+\mu x=0$

15) Examine that $y=cx+2c^2$ is a general solution of the differential equation $2\left(\dfrac{dy}{dx}\right)^2+x\dfrac{dy}{dx}-y=0.$

16) The differential equation representing the family of curves $y^2=2c\left(x+\sqrt{c}\right)$ where $c>0$ is a parameter. Find the order and degree of this differential equation.

17) Find the differential equation of all curves given by $y=Ae^{2x}+Be^{-\frac{x}{2}}$ where A & B are non-zero parameters.

18) Find the differential equation of $y=Ax+\dfrac{B}{x}$ by eliminating two arbitrary constants A & B.

19) Form the differential equation representing family of curves $y=A\cos(x+B)$ where A and B are parameters.

20) Form the differential equation from $y=a\sec x+b\tan x$ where a & b are arbitrary constants.

21) Find the differential equation of all curves satisfying equation $k(y+k)^2=x^3$, where k is a parameter.

22) Find the differential equation of $ax+by+c=0$ by removing three arbitrary constants a, b, c.

23) Find the differential equation of $x^2+y^2=2ax$ where a is a parameter.

24) Show that the differential equation of $\dfrac{x^2}{a^2+\lambda}+\dfrac{y^2}{b^2+\lambda}=1$ (a, b fixed constants & λ arbitrary constant) is $\left(x+y\dfrac{dy}{dx}\right)\left(x\dfrac{dy}{dx}-y\right)=\left(a^2-b^2\right)\dfrac{dy}{dx}$

25) Find general solution of $\dfrac{dy}{dx}+y\,g'(x)=g(x)\cdot g'(x)$

26) If $\frac{dy}{dx} + 2x = e^{3x}$ then find y

27) Find the values of k for which $y = k\sin x$ satisfies the differential equation $\frac{d^2y}{dx^2} + 2y = 2$

28) Solve: $(1 + \cos x)dy = (1 - \cos x)dx$

29) Solve: $\frac{dy}{dx} = e^{x+y} + x^2e^y$ (alt: $\frac{dy}{dx} = e^{x-y} + x^2e^{-y}$)

30) Solve: $\frac{dy}{dx} = e^{4x-3y}$; given $y(0) = 0$

31) Solve: $\frac{dy}{dx} = 1 + e^{2x-y}$; given $y(2) = 2$

32) The general solution of differential equation $\frac{dy}{dx} + x^2 = x^2e^3y$ is -- (i) $1 - e^3y = ce^{x^3}$, (ii) $1 - e^3y = ce^{-x^3}$, (iii) $\left(1 - e^{-3}y\right)^2 = c^2e^{2x^3}$, (iv) None of these.

33) Find the integrating factor of $x\frac{dy}{dx} - y = x\log x$

34) Find the Integrating Factor of $\left(1 + y^2\right)dx = \left(\tan^{-1}y - x\right)dy$

35) The integrating factor of $x(x-1)\frac{dy}{dx} - y = x^2(x-1)^2$ is -- (i) $\frac{x-1}{x}$, (ii) $\frac{x}{x-1}$, (iii) $\frac{1-x}{x}$, (iv) $\frac{x}{1-x}$

36) The Integrating Factor of $(x + y + 1)\frac{dy}{dx} = 1$ is -- (i) e^x, (ii) e^{-x}, (iii) e^y, (iv) e^{-y}

37) The integrating factor of $\frac{dx}{dy} + \frac{x}{y} = \frac{1}{y^2}$ is -- (i) $\log y$, (ii) e^y, (iii) y, (iv) $\frac{1}{y}$

38) Find particular solution of $(x - y)(dx + dy) = dx - dy$ where it is given that $y = -1$ when $x = 0$

39) Solve: $(x + y)(dx - dy) = dx + dy$

40) Solve: $(x\cos x)\frac{dy}{dx} + (x\sin x + \cos x)y = 1$

41) Solve: $\frac{dy}{dx} = \sqrt{4 - y^2}$

42) Solve: $\frac{dy}{dx} = 1 - x + y - xy$

43) Solve: $x\sqrt{1-y^2}dx + y\sqrt{1-x^2}dy = 0$

44) Solve: $\frac{dy}{dx} = \frac{\cos^2 y}{1+x^2}$; given that $y(0) = 0$

45) Solve: $\frac{dy}{dx} = \frac{\cos(\log x)}{\log y}$

46) Solve: $\left(1+x^2\right)\frac{dy}{dx} = x + \tan^{-1} x$

47) Solve: $y - x\frac{dy}{dx} = y^2 + \frac{dy}{dx}$

48) Solve: $y\,dx + \sqrt{1-x^2}\sin^{-1} x\,dy = 0$

49) Solve: $\cos y\,dx + \left(1+e^{-x}\right)\sin y\,dy = 0$; given $y = \frac{\pi}{4}$ when $x = 0$

50) Solve: $e^x \tan y\,dx + (1-e^x)\sec^2 y\,dy = 0$

51) Solve: $(e^x+1)y\,dy - \left(y^2+1\right)e^x dx = 0$; given $y(0) = 0$

52) Solve: $\left(1+e^{2x}\right)dy + e^x\left(1+y^2\right)dx = 0$; given $y(0) = 1$

53) Solve: $y\,dx - x\,dy = xy\,dx$, when $x = 1, y = 1$

54) Solve: $x\,dy - y\,dx = \left(x^2+y^2\right)dx$

55) Solve: $xdx + ydy + \frac{xdy - ydx}{x^2+y^2} = 0$ given $y = 1$ when $x = 1$

56) Solve: $x^2(x\,dx + y\,dy) + 2y(x\,dy - y\,dx) = 0$

57) The general solution of differential equation $ydx + xdy = xy(dy - dx)$ is -- (i) $\ln(cxy) = x - y$, (ii) $\ln(xy) = cxy$, (iii) $\ln(cxy) = y - x$, (iv) None of these.

58) The general solution of differential equation $y^2(x\,dy + y\,dx) + (x\,dy - y\,dx) = 0$ is -- (i) $xy = \frac{x}{y} + c$, (ii) $x + y = xy + c$, (iii) $\log|x+y| = cx$, (iv) $\log\left|\frac{x}{y}\right| = \frac{x}{y} + c$

59) General solution of $x^2(x\,dy + y\,dx) + (x\,dy - y\,dx) = 0$ is -- (i) $xy + \dfrac{y}{x} = c$, (ii) $xy - \dfrac{y}{x} = c$, (iii) $xy + \dfrac{x}{y} = c$, (iv) $\dfrac{x}{y} - xy = c$

60) Solve: $xdy - ydx = 2\sqrt{y^2 - x^2}dx$

61) Solve: $xdy - ydx = \sqrt{x^2 + y^2}dx$

62) Solve: $\left(x - \sqrt{xy}\right)dy = y\,dx$

63) Solve: $\left(x^2 + y^2\right)dx - 2xy\,dy = 0$ given $y = 0$ when $x = 1$

64) Solve: $x^2(y-1)dx + y^2(x-1)dy = 0$

65) Solve: $\left(x^2y^2 + xy\right)ydx + \left(x^2y^2 - 1\right)xdy = 0$

66) Solve: $\left(4x^2y - 6\right)dx + x^3dy = 0$

67) Solve: $\left(3xy + y^2\right)dx + \left(x^2 + xy\right)dy = 0$

68) Solve: $\left(xy^2 + x\right)dx + \left(x^2y + y\right)dy = 0$ when $x = 0, y = 1$

69) Solve: $\left(x^2 - yx^2\right)dy + \left(y^2 + x^2y^2\right)dx = 0$

70) Solve: $\left(x^2 + xy\right)dy = \left(x^2 + y^2\right)dx$

71) Solve: $ydx + \left(x^2 - xy\right)dy = 0$

72) Solve: $x(x-y)dy + y^2dx = 0$

73) Solve: $\dfrac{dy}{dx} + \dfrac{y(x+y)}{x^2} = 0$

74) Solve: $\dfrac{dy}{dx} = \dfrac{3x + 2y}{2x - 3y}$ given $y(1) = 0$

75) Solve: $\dfrac{dy}{dx} = \dfrac{y(2y - x)}{x(2y + x)}$ given $y = 1$ when $x = 1$

76) Solve: $x^2y\,dx - \left(x^3 + y^3\right)dy = 0$

77) Solve: $\left(1+3e^{\frac{y}{x}}\right)dy+3e^{\frac{y}{x}}\left(1-\frac{y}{x}\right)dx=0$

78) Solve: $\left(1+e^{\frac{x}{y}}\right)dx+e^{\frac{x}{y}}\left(1-\frac{x}{y}\right)dy=0$

79) Solve: $x\frac{dy}{dx}=y+x\tan\frac{y}{x}$ given $y=\frac{\pi}{2}$ when $x=1$

80) Solve: $\left(x+y\cos\frac{y}{x}\right)dx=x\cos\frac{y}{x}dy$

81) Solve: $x\cos\left(\frac{y}{x}\right)(ydx+xdy)=y\sin\left(\frac{y}{x}\right)(xdy-ydx)$

82) Solve: $\left(y\sin\frac{y}{x}-x\cos\frac{y}{x}\right)x\,dy=\left(x\cos\frac{y}{x}+y\sin\frac{y}{x}\right)y\,dx$

83) Solve: $\frac{dy}{dx}=\frac{y}{x}\left\{\log\left(\frac{y}{x}\right)+1\right\}$

84) Solve: $\frac{dy}{dx}-\frac{y}{x}+\csc\frac{y}{x}=0$ given $y=0$ when $x=1$

85) Solve: $\frac{dy}{dx}=\frac{2x-y+2}{2y-4x+1}$

86) Solve: $\frac{dy}{dx}=(x+y)^2$ given $y=1$ when $x=0$

87) Solve: $(x+y)^2\frac{dy}{dx}=a^2$

88) Solve: $\sin^{-1}\left(\frac{dy}{dx}\right)=x+y$

89) Solve: $\cos^{-1}\left(\frac{dy}{dx}\right)=x+y$

90) Solve: $\tan^{-1}\left(\frac{dy}{dx}\right)=x+y$

91) Solve: $\frac{dy}{dx}=\sin(x+y)+\cos(x+y)$

92) Solve: $\log(x+y)^{x+y}\left(1+\frac{dy}{dx}\right)=1$

93) Solve: $x\dfrac{dy}{dx} = y + \sqrt{x^2 + y^2}$

94) Solve: $e^{\frac{dy}{dx}} = x + 1$ given $y(0) = 3$

95) Solve: $\log\left(\dfrac{dy}{dx}\right) = 3x - 5y$; given that $y = 0$ when $x = 0$

96) Solve: $\log\left(\dfrac{dy}{dx}\right) = 4x - 2y - 2$ given $y(1) = 1$

97) Solve: $\dfrac{dy}{dx} - y = e^x$; given $y(0) = 1$

98) Solve: $\dfrac{dy}{dx} + \dfrac{2}{x}y = x^3$

99) Solve: $x\dfrac{dy}{dx} - y = x^2$

100) Solve: $x\dfrac{dy}{dx} - y = \log x$; given $y(1) = 0$

101) Solve: $\left(1 - x^2\right)\dfrac{dy}{dx} - xy = 1$

102) Solve: $\left(1 - x^2\right)\dfrac{dy}{dx} - xy = x$; given $y = 2$ when $x = 0$

103) Solve: $(x + 3)\dfrac{dy}{dx} - 3y = (x + 3)^2$

104) Solve: $x \log x\dfrac{dy}{dx} + y = \dfrac{2}{x}\log x$ where $x > 1$

105) Solve: $\left(1 + x^2\right)\dfrac{dy}{dx} + 2xy = \sqrt{x^2 + 4}$

106) Solve: $\left(1 + x^2\right)\dfrac{dy}{dx} - 2xy = \left(x^2 + 1\right)\left(x^2 + 2\right)$

107) Solve: $\left(1 + x^2\right)\dfrac{dy}{dx} + 2xy = \cot x$

108) Solve: $\left(x^2 - 1\right)\dfrac{dy}{dx} + 2xy = \dfrac{2}{x^2 - 1}$

109) Solve: $\left(1-x^2\right)\dfrac{dy}{dx}-2xy=x-x^3$

110) Solve: $\left(x-y^2\right)dx+2xy\,dy=0$

111) Solve: $(x+1)\dfrac{dy}{dx}-y=e^{3x}(x+1)^2$

112) Solve: $\dfrac{dy}{dx}+\dfrac{y}{\log_e x}=\dfrac{2}{x}$

113) Solve: $\dfrac{dy}{dx}+\dfrac{y}{x\log_e x}=\dfrac{2}{x}$

114) Solve: $\cos^2 x\dfrac{dy}{dx}+y=\tan x$; where $0\le x\le\dfrac{\pi}{2}$

115) Solve: $\dfrac{dy}{dx}+y\sec x=\tan x$; where $0\le x\le\dfrac{\pi}{2}$

116) Solve: $\sin x\dfrac{dy}{dx}+3y=\cos x$

117) Solve: $\dfrac{dy}{dx}+y\cot x=2\cos x$

118) Solve: $\dfrac{dy}{dx}-3y\cot x=\sin 2x$, given $y=2$ when $x=\dfrac{\pi}{2}$

119) Solve: $\dfrac{dy}{dx}+y\cot x=2x+x^2\cot x$; where $y(0)=0$

120) Solve: $\dfrac{dy}{dx}=-\dfrac{x+y\cos x}{1+\sin x}$

121) Solve: $\left(1+x^2\right)\dfrac{dy}{dx}+y=e^{\tan^{-1}x}$

122) Solve: $\dfrac{dy}{dx}=\dfrac{x\sqrt{x^2-1}+y}{\sqrt{x^2-1}}$; given $y=1$ when $x=1$

123) Solve: $(1+x)\dfrac{dy}{dx}-\tan y=(1+x)^2e^x\sec y$

124) Solve: $x\cos x\dfrac{dy}{dx}+y(x\sin x+\cos x)=1$

125) Solve. $xy\dfrac{dy}{dx} - y^2 = (x+y)^2 e^{-\frac{y}{x}}$

126) Solve: $\left(xe^{\frac{y}{x}} + y\right)dx = xdy$; given $y(1) = 1$

127) Solve: $ye^y dx = \left(y^3 + 2xe^y\right)dy$ when $x = 2, y = 1$

128) Solve: $(e^x + 1)y\,dy - \left(y^2 + 1\right)e^x dx = 0$, given $y = 0$ when $x = 0$

129) Solve: $x\dfrac{dy}{dx} = y \cdot (\log y - \log x + 1)$

130) Solve: $\dfrac{dy}{dx} - y\tan x + y^2 \sec x = 0$

131) Solve: $dx + xdy = e^{-y}\sec^2 y\,dy$

132) Solve: $\left(1 + y^2\right)(1 + \log x)dx + x\,dy = 0$; given $y = 1$ when $x = 1$

133) Solve: $\left(\tan^{-1} y - x\right)dy = \left(1 + y^2\right)dx$ given $y(0) = 0$

134) Solve: $\left(1 + x^2\right)\dfrac{dy}{dx} + y = \tan^{-1} x$

135) Solve: $1 + y^2 + \left(x - e^{-\tan^{-1} y}\right)\dfrac{dy}{dx} = 0$

136) Solve: $\left(xy^2 - e^{\frac{1}{x^3}}\right)dx - x^2 y dy = 0$ when $y = 0, x = 1$

137) Solve: $y - x\dfrac{dy}{dx} = 2\left(1 + x^2\dfrac{dy}{dx}\right)$ given $y = 1$ when $x = 1$

138) Solve: $y - x\dfrac{dy}{dx} = a\left(y^2 + \dfrac{dy}{dx}\right)$

139) Solve: $(x + \tan y)dy = \sin 2y\,dx$

140) Solve: $\dfrac{x + y\frac{dy}{dx}}{x\frac{dy}{dx} - y} = \sqrt{\dfrac{1 - x^2 - y^2}{x^2 + y^2}}$

141) Solve: $\left(x + 2y^3\right)\dfrac{dy}{dx} = y$

142) Solve: $\left(2x - 10y^3\right)\dfrac{dy}{dx} + y = 0$

143) Solve: $\left(x + 2y^2\right)\dfrac{dy}{dx} = y$, where $y > 0$

144) Solve: $y^2 + \left(x - \dfrac{1}{y}\right)\dfrac{dy}{dx} = 0$

145) Solve: $(x + y + 1)\dfrac{dy}{dx} = 1$; given that $y(0) = 0$

146) Solve: $\dfrac{dy}{dx} = \dfrac{y^2 + y + 1}{x^2 + x + 1}$

147) Solve: $\left(1 + y + x^2 y\right)dx + \left(x + x^3\right)dy = 0$

148) Solve: $\sqrt{1 + x^2 + y^2 + x^2 y^2} + xy\dfrac{dy}{dx} = 0$

149) Solve: $\dfrac{dy}{dx} = \dfrac{1}{x\cot y + \sec y}$

150) Solve: $\dfrac{dy}{dx} = \dfrac{1}{x\cos y + \sin 2y}$

151) Solve: $(xy\cos xy + \sin xy)dx + x^2\cos xy\, dy = 0$

152) Solve: $\dfrac{dy}{dx} + \dfrac{y}{x}\log y = \dfrac{y}{x^2}(\log y)^2$

153) Solve: $x\left(\dfrac{dy}{dx} + y\right) = 1 - y$

154) If the differential equation of all straight lines, whose distance from origin is10 unit, is $\left(y - x\dfrac{dy}{dx}\right)^2 = A\left\{1 + \left(\dfrac{dy}{dx}\right)^2\right\}$, then find value of A.

155) Find the differential equation of all ellipses, who center is at origin.

156) Find the differential equation of all circles touching x-axis at origin.

157) Show that the differential equation of all circles touching y-axis at origin is $2xy\dfrac{dy}{dx} = y^2 - x^2$

158) Find the differential equation of all circles, lying at first co-ordinate and touch both axes.

159) Find the differential equation of all circles whose centres are on x-axis and radius variable.

160) The slope of a curve at a point (x, y) is $\frac{3y+2x+4}{4x+6y+5}$ and the curve passing through the point $(0, -1)$. Find the equation of the curve.

161) The slope of a curve at point (x, y) is $\frac{x^2+y^2}{2xy}$ and the curve passing through the point $(1, 0)$. Find the equation of curve.

162) Show that the equation of the curve, passing through the point $(1, 0)$ and satisfying the differential equation $\left(1+y^2\right)dx + xydy = 0$ is $x^2 - y^2 = 1$

163) A particle is moving with velocity u through a straight line and its acceleration is equal to its displacement. At an instant, if displacement be x and velocity be v, then prove that $v^2 = u^2 + x^2$

164) Find the differential equation of all parabolas, whose axes are along y-axis and vertices are at origin.

165) A point is moving through a parabolic curve $y^2 = 4x$. At which point abscissa increases at twice the rate the ordinate increases?

166) A point moves through a curve $6y = x^3 + 2$. At which point ordinate increases at 8 times the rate of abscissa increases?

167) If the rate of change of area of a circle is equal to rate of change of its diameter, then radius of the circle is -- (i) $\frac{2}{\pi}$, (ii) $\frac{1}{\pi}$, (iii) $\frac{\pi}{2}$, (iv) π

168) If the area of a circle increases uniformly with respect to time, then show that the rate of increment of its circumference is inversely proportional to its radius.

169) If the circumference of a circle increases uniformly, then show that the rate of increment of its area is proportional to its radius.

170) A circular ink drop increases at a rate of 2 square cm per second. Find the rate of change of its radius at time $2\frac{6}{11}$ sec.

171) If the rate of increment of radius of a circle is $\frac{1}{\pi}$, then find the rate of change of its area when radius is 2 unit.

172) A particle starts from the origin with a velocity 5 cm/s and moves in a straight line, its acceleration at time t seconds being $\left(3t^2 - 5t\right)$ cm/s^2. Find velocity of the particle and its distance from the origin at the end of 4 seconds.

173) If population growth rate is $5\ \%$, in how many years, it becomes double?

174) A radio-active element satisfies the equation $\frac{dv}{dt} = -kv$ for its natural decay, where v is the volume of the element at time t and k is positive constant. If 40% of the substance disappear in 25 years, find the time it takes to disappear 60% of the substance.

175) At any instant, the rate of disintegration of Uranium is proportional to its mass. If the amount of Uranium at time t_1 and t_2 is m_1 and m_2 respectively, then show that half life of uranium is $\frac{(t_2 - t_1)\log 2}{\log m_1 - \log m_2}$

176) Let the rate of growth of a colony of bacteria be proportional to the square* root of the number of bacteria present at any time. When an experiment started, it was estimated that there were about 16 times of bacteria after 5 hours, then when it is 49 times? (*alt: cube)

177) Let the rate of growth of population in a city be proportional to number of citizen at any time. When an experiment started, it was estimated that there were about double of population after 30 years, then when it is three times? Given $\log_e 3 = 1.6 \log_e 2$

178) Let r be the radius of any sphere. If s & v be the area of outer surface and volume of this sphere respectively, then show that $2\frac{dv}{dt} = r\frac{ds}{dt}$

179) Spherical raindrops are evaporated. The rate of decrement of volume of raindrop is proportional to its surface area. Prove that the radius of spherical raindrop changes uniformly.

180) The volume of a spherical balloon increases at a rate of 10 cc per second. Find the rate of change of its outer surface when its radius is 16 cm.

181) The rate of increment of surface area of a spherical bubble is $2\ cm^2/s$. Find the rate of increment of its volume when radius of the bubble is 6 cm.

182) The rate of change of radius of a sphere is $\frac{1}{2\pi}$ with respect to time. Find the rate of change of area of its outer surface when radius is 5 cm.

183) A balloon which always remains spherical on inflation, is being inflated by pumping in 40 c.c. per minute. Find the rate of change of surface area when radius is 8 c.m. Find also the increase in radius in the next $\frac{1}{2}$ minute.

184) A spherical snowball melts at a rate proportional to its volume at that time. If half the ice melts in 30 minutes, then prove that the volume of the remaining ice is $\frac{1}{8}$ part of original volume after 90 minutes of start of melting ice.

185) The rate of change of volume of a cube is constant. Prove that the rate of change of total surface area of this cube is inversely proportional to its side.

186) The volume of a cube changes in such a way that it remains a cube after that change. Show for for a cube (whose volume is 1 cube unit), rate of change of volume = $\frac{3}{2} \times$ (rate of change of anyone surface area)

187) If γ be the increase in volume per degree centigrade of a cube of unit volume and β be the increase in area per degree centigrade of each surface of the cube, then show that $2\gamma = 3\beta$

188) A right-circular conical water tank, with its vertex down and semi-vertical angle being $\frac{\pi}{6}$, loses water out of a circular hole at its bottom at a rate of $\pi\ cm^3 / \sec$. Find the rate of change of radius of water level when it is 3 cm deep.

189) A right-circular inverted conical water tank has height 18 inch and diameter of base 10 inch. Water is poured in this tank at a rate of 4 cubic inches per minute. Find the rate of increment of surface (alt, rate of increment of height) of water when depth of water is 12 inch?