**Q.1** Find the point on the curve $f(x) = \cosh(x)$ for which the tangent line is parallel to the line $y = x + 5$

$f'(x) = \sinh(x)$, the tangent is parallel to the line $\Rightarrow m_1 = m_2 \Rightarrow m_1 = 1$

$\sinh(x) = 1 \Rightarrow x = \sinh^{-1}(1) = \ln(1 + \sqrt{2})$

$y = \cosh\left(\ln(1 + \sqrt{2})\right) = \sqrt{2}$ , so the point is $\left(\ln(1 + \sqrt{2}), \sqrt{2}\right)$          **(2-Points)**

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**Q2.** If a snowball melts so that its surface area decreases at a rate of $1\ cm^2 / min$. find the rate at which the diameter decreases when the diameter is $10\ cm$ (NOTE: $Surface\ Area = 4\pi r^2$)

**Let S: the surface area, X: the diameter (2. radius = 2.r)**

$\dfrac{dS}{dt} = -1 cm^2 / min$. $X = 2r \Rightarrow r = \dfrac{X}{2}$   **(1-Point)**

$S = 4\pi r^2 = 4\pi\left(\dfrac{X}{2}\right)^2 = 4\pi\dfrac{X^2}{4} = \pi X^2$

$\dfrac{dS}{dt} = 2\pi X \dfrac{dX}{dt}$   **(1-Point)**

$-1 = 2\pi(10)\dfrac{dX}{dt}$    **(1-Point)**

$\Rightarrow \dfrac{dX}{dt} = \dfrac{-1}{20\pi} cm / min$. **(1-Point)**

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**Q3.** Find the linearization $L(x)$ of the function $f(x) = \sqrt[3]{x}$, $a = -8$, and use it to approximate $\sqrt[3]{-9}$

$f(x) = \sqrt[3]{x} \Rightarrow f(a) = f(-8) = -2$

$f(x) = x^{\frac{1}{3}} \Rightarrow f'(x) = \dfrac{1}{3}x^{-\frac{2}{3}} \Rightarrow f'(a) = f'(-8) = \dfrac{1}{3}(-8)^{-\frac{2}{3}} = \dfrac{1}{3(-8)^{-\frac{2}{3}}} = \dfrac{1}{3\sqrt[3]{(-8)^2}} = \dfrac{1}{12}$ **(1-Point)**

$L(x) = f(a) + f'(a)(x - a) = -2 + \dfrac{1}{12}(x + 8) = -\dfrac{4}{3} + \dfrac{1}{12}x$ **(2-Point)**

$\sqrt[3]{x} \approx L(x)$

$\sqrt[3]{-9} \approx L(-9) = -\dfrac{4}{3} + \dfrac{1}{12}(-9) = -\dfrac{25}{12} = -2.083$ **(1-Point)**