5.32 The hole concentration in p-type GaAs is given by $p(x) = 10^{16}(1 + x/L)^2$ cm^{-3} for $-L \le x \le 0$ where $L = 12$ μm. The hole diffusion coefficient is $D_p = 10$ cm^2/s. Calculate the hole diffusion current density at (*a*) $x = 0$, (*b*) $x = -6$ μm, and (*c*) $x = -12$ μm.

Per (5.34), $J_{px|dif} = -eD_p \dfrac{dp}{dx}$. Using the given $p(x)$, we get

$$J_{px|dif} = -1.602176634\times10^{-19}(10)\frac{d}{dx}\left[10^{16}\left(1+\frac{x}{L}\right)^2\right]$$

$$= -1.602176634\times10^{-19}(10)10^{16}\left(1+\frac{x}{L}\right)2\left(\frac{1}{L}\right)$$

$$= \frac{-0.0320435327}{12\times10^{-6}(100\,\text{cm}/1\text{m})}\left(1+\frac{x}{L}\right)$$

$$= -26.702944\left(1+\frac{x}{L}\right)\ (\text{A/cm}^2)$$

a) At $x = 0$, $J_{px|dif} = -26.702944(1 + 0)$ $\Rightarrow$ **$J_{px|dif} = -26.703$ A/cm^2.**

b) At $x = -6$ µm, $J_{px|dif} = -26.702944(1 + -6/12)$ $\Rightarrow$ **$J_{px|dif} = -13.351$ A/cm^2.**

c) At $x = -12$ µm, $J_{px|dif} = -26.702944(1 + -12/12)$ $\Rightarrow$ **$J_{px|dif} = 0$ A/cm^2.**