Define

$$J(\theta) = -\frac{1}{m} \sum_{i=1}^{m} \left(y^{(i)} \log(h_\theta(x^{(i)})) + (1 - y^{(i)}) \log(1 - h_\theta(x^{(i)})) \right)$$

where $y^{(i)} \in \{0, 1\}$, $x^{(i)} = (x_0^{(i)}, x_1^{(i)}, \ldots, x_n^{(i)})^{\mathrm{T}}$ is a $(n+1)$-dimensional vector with $x_0^{(i)} = 1$, $\theta = (\theta_0, \theta_1, \ldots, \theta_n)^{\mathrm{T}}$ is a $(n+1)$-dimensional vector, $h_\theta(x^{(i)}) = 1/(1 + e^{-\theta^{\mathrm{T}} x^{(i)}})$, and the superscript T indicates the vector transpose. Prove

$$\frac{\partial}{\partial \theta_j} J(\theta) = \frac{1}{m} \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

for $j = 0, 1, \ldots, n$.