$$\nabla \phi(r,\theta,t) \quad \text{at } d \ll \frac{c}{\omega} = \frac{\lambda}{2\pi} \ll r$$

$$\phi(r,\theta,t) = \frac{p_0}{4\pi\varepsilon_0}\frac{\cos\theta}{r}\frac{\omega}{c}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)$$

$$\nabla\phi(r,\theta,t) = \underbrace{\frac{\partial\phi(r,\theta,t)}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial\phi(r,\theta,t)}{\partial\theta}\hat{\theta}}_{\text{see EQ 2 polar grad of a scalar}} \qquad \text{(gradient is a VECTOR!)}$$

$$= \frac{\partial}{\partial r}\left(\frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\frac{\cos\theta}{r}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)\right)\hat{r} + \frac{1}{r}\frac{\partial}{\partial\theta}\left(\frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\frac{\cos\theta}{r}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)\right)\hat{\theta}$$

$$= \frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\cos\theta\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\right)\sin\left(\omega\left(t+\frac{r}{c}\right)\right) + \frac{1}{r}\frac{\partial}{\partial r}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)\right]\hat{r} +$$

$$+ \left[\frac{1}{r} * \left(\frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\frac{1}{r}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)\frac{\partial}{\partial\theta}\cos\theta\right]\hat{\theta}$$

$$= \frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\cos\theta\left[-\frac{1}{r^2}\sin\left(\omega\left(t+\frac{r}{c}\right)\right) + \frac{1}{r}\frac{\partial\sin\left(\omega\left(t+\frac{r}{c}\right)\right)}{\partial\left(\omega\left(t+\frac{r}{c}\right)\right)} * \frac{\partial\left(\omega\left(t+\frac{r}{c}\right)\right)}{\partial r}\right]\hat{r} +$$

$$+ \left[\frac{1}{r^2}\frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\sin\left(\omega\left(t+\frac{r}{c}\right)\right) * (-\sin\theta)\right]\hat{\theta}$$

$$= \frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\left[-\cos\theta\frac{1}{r^2}\sin\left(\omega\left(t+\frac{r}{c}\right)\right) + \cos\theta\frac{1}{r}\cos\left(\omega\left(t+\frac{r}{c}\right)\right) * \left(+\frac{\omega}{c}\right)\right]\hat{r} +$$

$$+ \left[-\frac{p_0}{4\pi\varepsilon_0}\frac{\omega}{c}\frac{1}{r^2}\sin\left(\omega\left(t+\frac{r}{c}\right)\right)\sin\theta\right]\hat{\theta}$$

$$\nabla\phi \simeq \frac{p_0}{4\pi\varepsilon_0}\frac{\omega^2}{c^2}\frac{\cos\theta}{r}\cos\left(\omega\left(t+\frac{r}{c}\right)\right)\hat{r}$$