

$$1. N_y - N_u = \frac{0}{r^2} - \frac{0}{r^2} = 0 \neq 0$$

$$2. \int_C \mathbf{F} \cdot d\mathbf{r} = \int_C \mathbf{F} \cdot \frac{dr}{dt} dt = \int_0^{2\pi} \frac{\sin^2 \theta \mathbf{i} + \cos^2 \theta \mathbf{j}}{r^2} \cdot \frac{1}{r^2} \mathbf{i} + \frac{1}{r^2} \mathbf{j} d\theta$$

$$= \int_0^{2\pi} \frac{1}{r^4} \cdot d\theta = 2\pi \neq 0$$

3. because it's tangent to the unit circle

$$4. \nabla \theta = \left\langle \frac{1}{1 + \left(\frac{y}{r}\right)^2} \frac{y}{r^2}, \frac{-x}{r^2} \right\rangle$$