a) \[ F = \overline{P} \theta, \quad \phi = \tan^{-1} \frac{\omega}{r-1} \]

\[ \text{side view:} \quad R = \overline{P}, \quad \text{top view} \]

\( \phi \) is the angle \( P' \overline{P} \)
\( (P' \) is the projection of \( P \) to the \( xy \)-plane). Intuitively, \( \tan^{-1}(\infty) = \frac{\pi}{2}, \quad \tan^{-1}(-\infty) = -\frac{\pi}{2} \)
\( \phi \) and \( \overline{P} \) are defined except on the unit circle in the \( xy \)-plane (center at \( 0 \))
- i.e., the locus where \( z = 0 \), \( r-1 = 0 \),
- and the \( z \)-axis \( (r=0) \), since \( \nabla \phi \) has \( r \) in the denominator:
\[ \frac{\partial \phi}{\partial x} = \frac{1}{r}, \quad \frac{\partial \phi}{\partial y} = \frac{i}{r} \]

b) \[ C_1 = \text{unit circle in } xy \text{-plane positively oriented} \]
\[ C = \text{circle } \]
\[ \text{as } P \text{ moves around } C \text{ in direction shown, } \Delta \phi = 2\pi = \oint C \nabla \phi \cdot d\ell \]

If it goes around \( C_1 \) in this direction \( n \) times, \( \oint C \nabla \phi \cdot d\ell = 2n\pi \).
Sense is true for any closed, smooth \( C \).