Problem 2.53) a) The linear velocity of the spherical surface is $\boldsymbol{V}(\rho = R, \theta, \phi) = (R \sin\theta)\omega\, \hat{\boldsymbol{\phi}}$. Therefore, the surface current density is $\boldsymbol{J}_s(R, \theta, \phi, t) = \sigma_s \boldsymbol{V}(R, \theta, \phi) = (R\omega\sigma_s \sin\theta)\hat{\boldsymbol{\phi}}$. The units of $\boldsymbol{J}_s$ are the units of R [m] times the units of ω [sec^{-1}] times the units of σ_s [coulomb/m^2], namely, [ampere/m].

b) In spherical coordinates, the divergence of the vector field $\boldsymbol{J}_s$ whose only component is along the ϕ-axis, is given by $\boldsymbol{\nabla} \cdot \boldsymbol{J}_s = \frac{1}{R \sin\theta} \frac{\partial J_{s\phi}}{\partial \phi} = 0$. Since the surface-charge-density σ_s has no time-dependence, its derivative with respect to time is zero, that is, $\frac{\partial \sigma_s}{\partial t} = 0$. Clearly, $\boldsymbol{\nabla} \cdot \boldsymbol{J}_s + \frac{\partial \sigma_s}{\partial t} = 0$.