

$$a) \left[ \int_{\partial S} f d\vec{T} \right]_i = \int_{\partial S} f d\vec{T} \cdot \vec{e}_i = \int_S \vec{\nabla} \times (f d\vec{T} \cdot \vec{e}_i) = \int_S \epsilon_{jik} \partial_j (f d\vec{s} \cdot \vec{e}_i) \vec{e}_k =$$

$$= \int_S \epsilon_{jik} \partial_j (f \vec{n} \cdot \vec{e}_i) \vec{e}_k d\vec{s} = \int_S \epsilon_{jik} \partial_j (f \vec{e}_k) (\vec{n} \cdot \vec{e}_i) d\vec{s} = - \int_S \epsilon_{jik} [\vec{\nabla} f]_j [\vec{n}]_k d\vec{s} = \left[ - \int_S \vec{\nabla} f \times \vec{n} d\vec{s} \right]_i$$

$$b) \int_{\partial V} \vec{\nabla} r^2 \cdot \vec{n} d\vec{s} = \int_V \vec{\nabla}^2 r^2 dV = V \frac{\partial^2}{\partial x_i^2} r_i^2 = 2 V \partial_i r_i = 6 V$$