Physics 3344 **Professor Scalise**
Fall 2006 **Assignment #3**

Due: 7 September 2006

1. Show that $\dot{\hat{e}}_\theta = -\hat{e}_r\dot{\theta}$.
2. Find the radial and tangential components of the jerk (time derivative of the acceleration) in two dimensions.
3. If $\vec{X}$ is an unknown vector satisfying the following relations involving the known vectors $\vec{A}$ and $\vec{B}$ and the known scalar ϕ

   $$\vec{A} \times \vec{X} = \vec{B} \qquad\qquad \vec{A} \cdot \vec{X} = \phi$$

   express $\vec{X}$ in terms of $\vec{A}$, $\vec{B}$, and ϕ.
4. Derive the scale factors h_r, h_θ, and h_ϕ for spherical polar coordinates from the equations relating $\{r, \theta, \phi\}$ to $\{x, y, z\}$.
5. Evaluate the following. (You may find it convenient to work in spherical polar coordinates, although Cartesian will give the same answers.) Simplify as much as possible.
   (a) $\vec{\nabla}\, r$ where $r = |\vec{r}|$ (gradient of the magnitude of the displacement vector)
   (b) $\vec{\nabla} \cdot \vec{r}$ (divergence of the displacement vector)
   (c) $\vec{\nabla} \times \vec{r}$ (curl of the displacement vector)
   (d) $\vec{\nabla}[\ln(r)]$ (gradient of the natural logarithm of the magnitude of the displacement vector)
   (e) $\nabla^2[\ln(r)]$ (laplacian of the natural logarithm of the magnitude of the displacement vector)