You will probably be doing this activity in-class, from directions given by the instructor. If you are doing it on your own, then choose a point in the room that you are in to be the origin. Imagine that your right shoulder is a point in space, relative to that origin. Point your right arm in succession in each of the directions of the basis vectors adapted the various coordinate systems:

- $\{\hat{x}, \hat{y}, \hat{z}\}$ in rectangular coordinates.
- $\left\{\hat{s}, \hat{\phi}, \hat{z}\right\}$ in cylindrical coordinates.
- $\left\{\hat{r}, \hat{\theta}, \hat{\phi}\right\}$ in spherical coordinates.

Solution The basis vectors for a single coordinate:

- point in the direction in which that coordinate is INCREASING;
- are unit vectors (i.e. STRAIGHT arrows of unit length), even when they are associated with a coordinate which is an angle;
- for curvilinear coordinates (NOT rectangular coordinates), they point in different directions at different points in space;
- provide a nice example of a vector field.

The basis vectors for multiple coordinates in a single orthogonal coordinate system:

- are orthogonal (perpendicular) to each other at each single point;
- can be used to expand any vector at a given point.

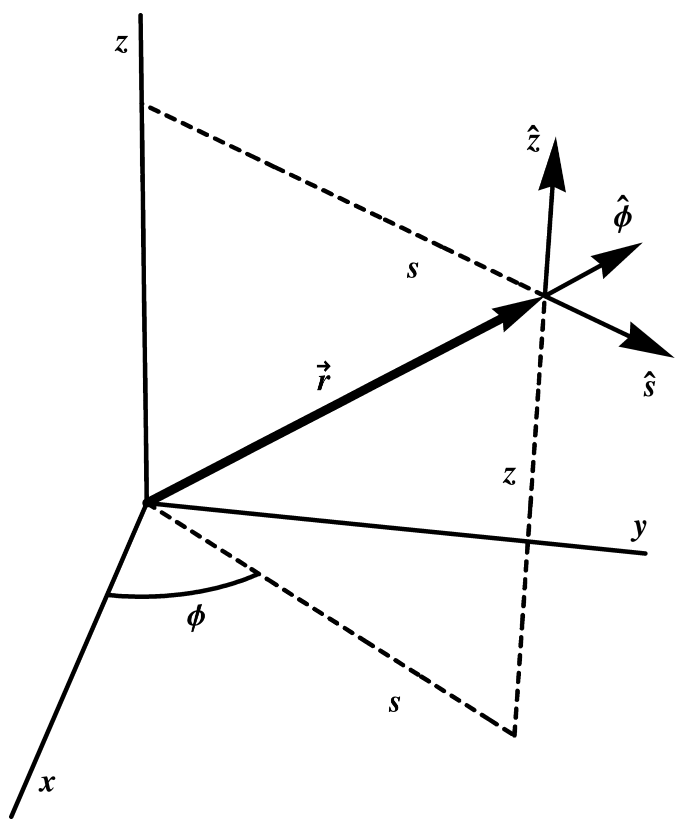

Figure 1: Figure 1: The cylindrical coordinate basis vectors at a single point (s, ϕ, z).

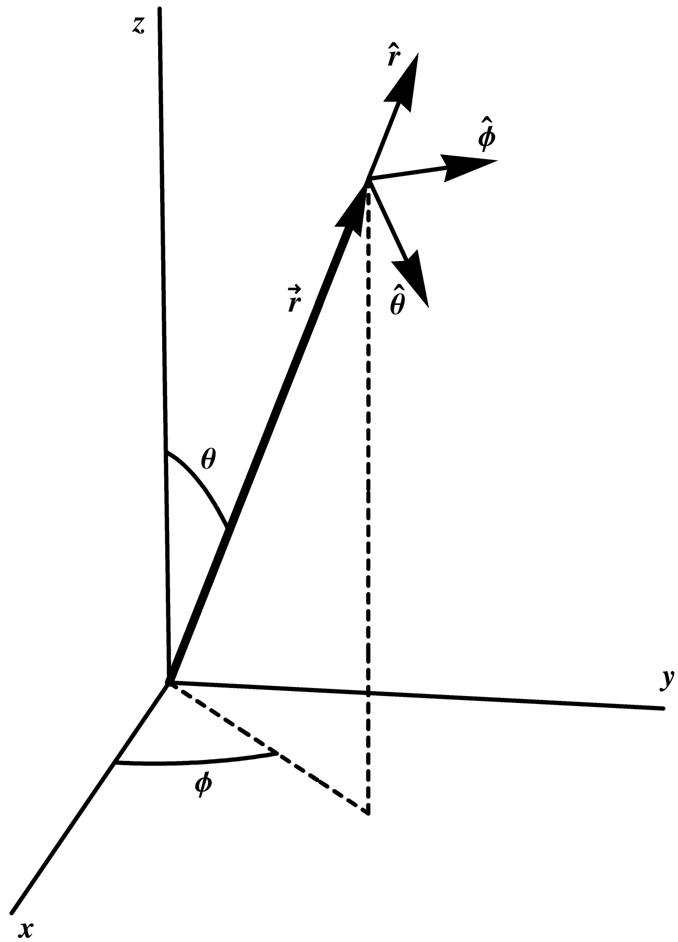

Figure 2: Figure 2: The spherical coordinate basis vectors at a single point (r, θ, ϕ).

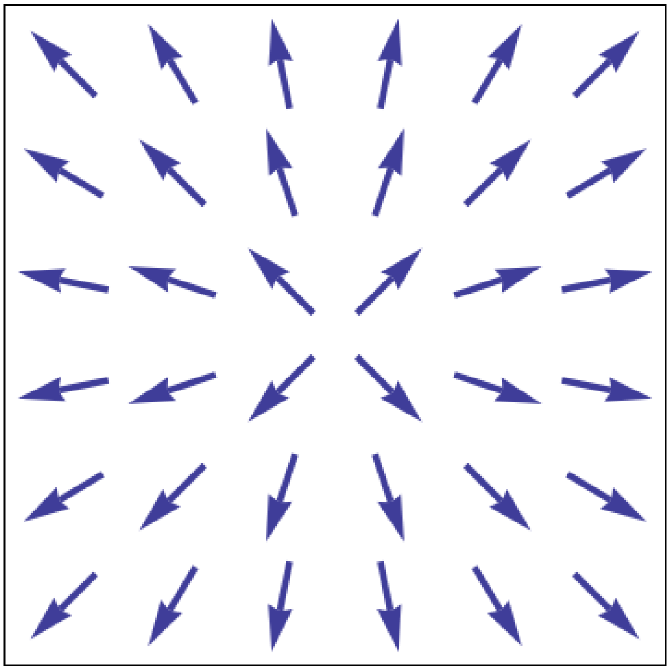

Figure 3: Figure 3: A cross section of the cylindrical coordinate basis vectors $\hat{s}$ in a plane z = constant, as seen from above. Notice that the basis vectors are different from point to point in space.

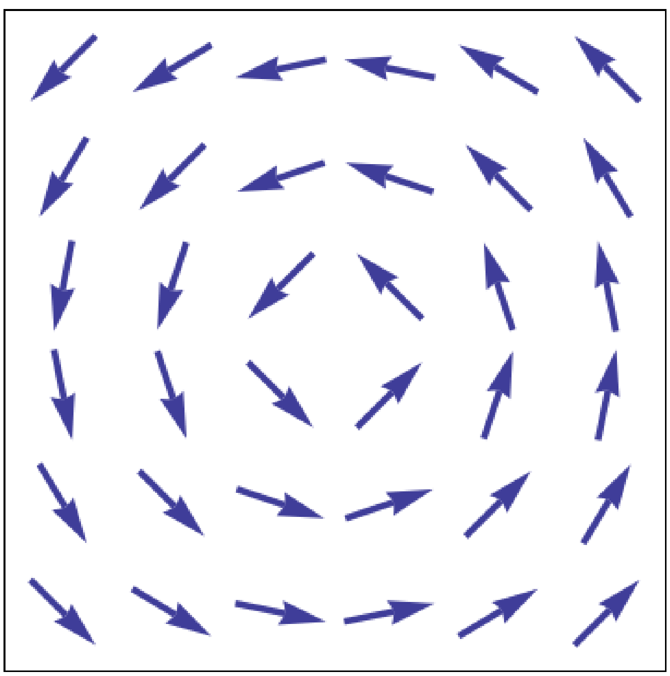

Figure 4: Figure 4: A cross section of the cylindrical coordinate basis vectors $\hat{\phi}$ in a plane z = constant, as seen from above. Notice that the basis vectors are different from point to point in space.