

**Cylindrical Coordinates** Using the first figure below, determine the **length**  $d\ell$  of each of the three paths shown (the three thick lines). Notice that, along any of these three paths, only one coordinate  $s$ ,  $\phi$ , or  $z$  is changing at a time (i.e. along path 1,  $dz \neq 0$ , but  $d\phi = 0$  and  $ds = 0$ ).

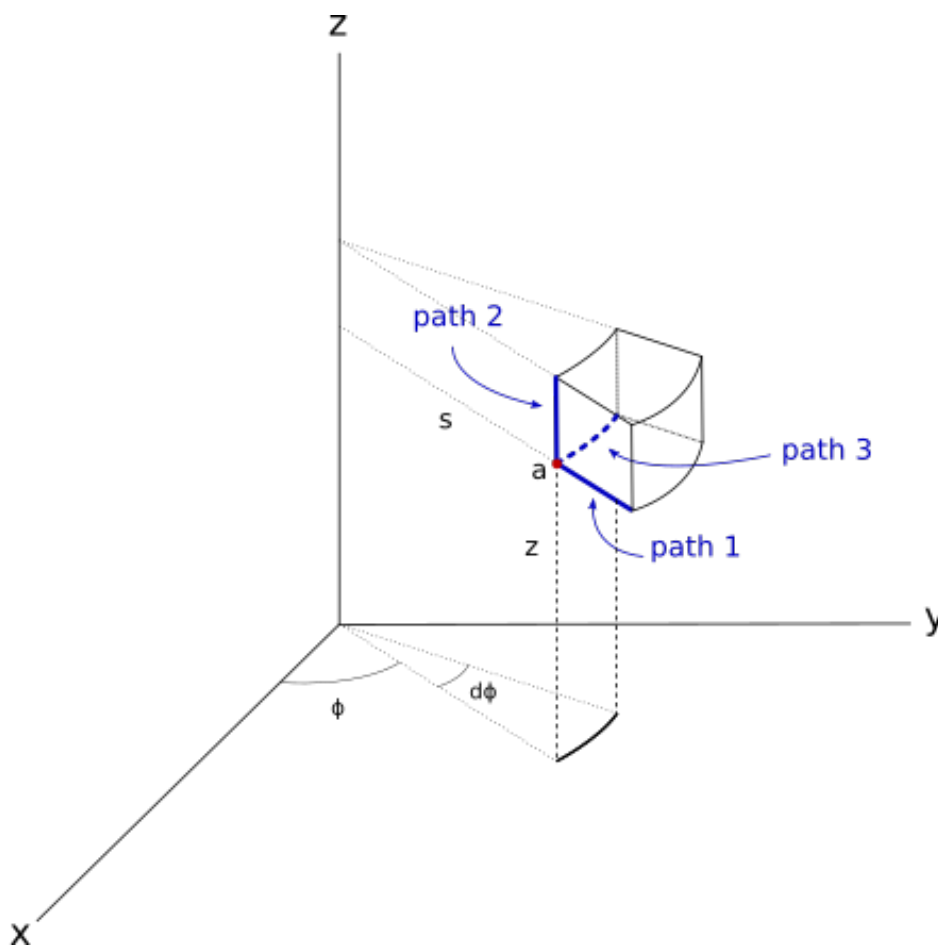
Path 1:  $d\ell =$

Path 2:  $d\ell =$

Path 3:  $d\ell =$

Use your results to determine the volume of the region.

$d\tau =$



**Spherical Coordinates** Using the second figure below, determine the **length**  $d\ell$  of each of the three paths shown (the three thick lines). Notice that, along any of these three paths, only one coordinate  $r$ ,  $\theta$ , or  $\phi$  is changing at a time (i.e. along path 1,  $d\theta \neq 0$ , but  $dr = 0$  and  $d\phi = 0$ ).  
*(Be careful: One path is trickier than the others.)*

Path 1:  $d\ell =$

Path 2:  $d\ell =$

Path 3:  $d\ell =$

Use your results to determine the volume of the region.

$d\tau =$

