

# 1 Find Area/Volume from the Vector Differential

Start with  $d\vec{r}$  in rectangular, cylindrical, and spherical coordinates. Use these expressions to write the scalar area elements  $dA$  (for different coordinate equals constant surfaces) and the volume element  $d\tau$ . It might help you to think of the following surfaces: The various sides of a rectangular box, a finite cylinder with a top and a bottom, a half cylinder, and a hemisphere with both a curved and a flat side, and a cone.

(a) Rectangular:

$$dA = \quad (1)$$

$$d\tau = \quad (2)$$

(b) Cylindrical:

$$dA = \quad (3)$$

$$d\tau = \quad (4)$$

(c) Spherical:

$$dA = \quad (5)$$

$$d\tau = \quad (6)$$