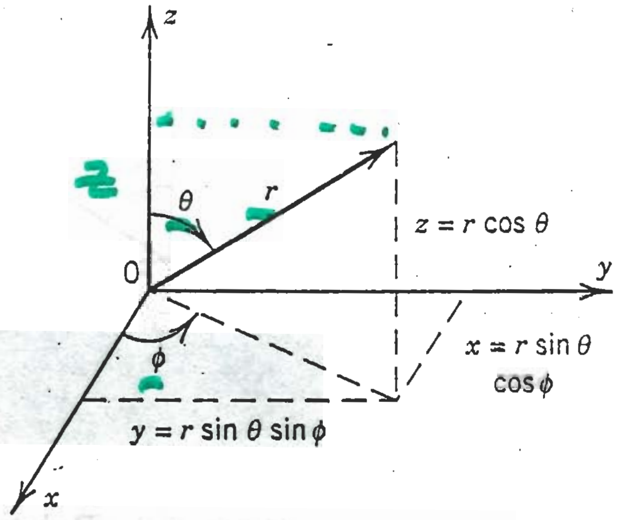

Figure 9.8 Relationship between Cartesian coordinates (x, y, z) and spherical coordinates (r, θ, ϕ). The differential volume in this coordinate system is $d\tau = r^2 \sin\theta \, dr \, d\theta \, d\phi$.

Table 9.2 First Several Spherical Harmonics

Y_ℓ^m

s	$Y_0^0 = \dfrac{1}{(4\pi)^{1/2}}$	$Y_2^0 = \left(\dfrac{5}{16\pi}\right)^{1/2}(3\cos^2\theta - 1)$ d_{z^2}
P_z	$Y_1^0 = \left(\dfrac{3}{4\pi}\right)^{1/2}\cos\theta$	$Y_2^1 = \left(\dfrac{15}{8\pi}\right)^{1/2}\sin\theta\cos\theta\, e^{i\phi}$
$P_{x,y}$	$Y_1^1 = \left(\dfrac{3}{8\pi}\right)^{1/2}\sin\theta\, e^{i\phi}$	$Y_2^{-1} = \left(\dfrac{15}{8\pi}\right)^{1/2}\sin\theta\cos\theta\, e^{-i\phi}$
$P_{x,y}$	$Y_1^{-1} = \left(\dfrac{3}{8\pi}\right)^{1/2}\sin\theta\, e^{-i\phi}$	$Y_2^2 = \left(\dfrac{15}{32\pi}\right)^{1/2}\sin^2\theta\, e^{2i\phi}$
		$Y_2^{-2} = \left(\dfrac{15}{32\pi}\right)^{1/2}\sin^2\theta\, e^{-2i\phi}$

$P_x \propto \sin\theta\cos\phi$

$P_y \propto \sin\theta\sin\phi$

similarly for d orbitals