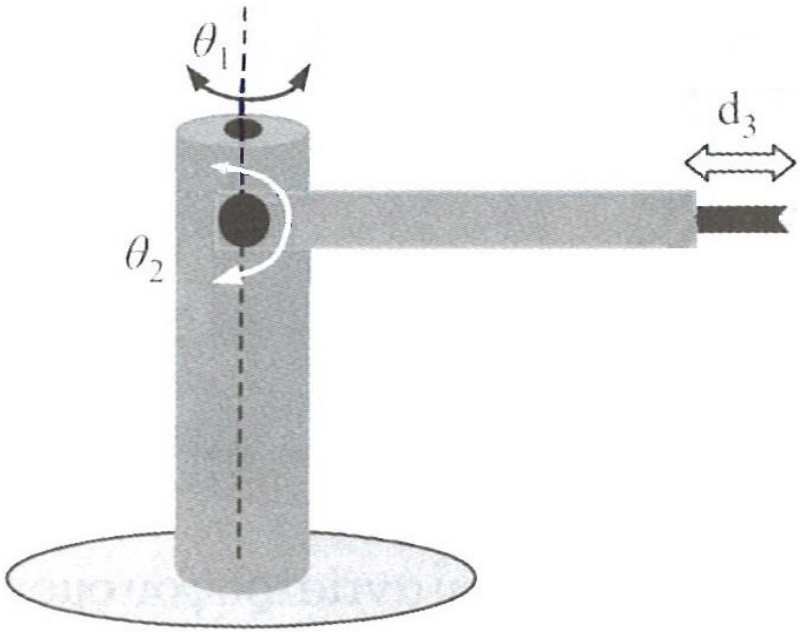
Forward Kinematics – DH exercise:

The manipulator shown in the figure has two revolute and one prismatic joint, with variables θ_1, θ_2 and d_3 correspondingly, which are also shown in the figure.



Given only the parameters shown in the figure:

a. Find the DH parameters of the manipulator and the homogeneous transformations that connect each link to the previous one (hint: place the world frame at the centre of joint θ_2).

b. What is the value of θ_2 when the manipulator is at the position shown in the figure?

c. What is the position of the manipulator for $\theta_1 = \theta_2 = 0$?

d. Find the orientation R and position of the tip $[p_x \quad p_y \quad p_z]^T$ of the manipulator w.r.t. the world frame.

e. Prove that $p_x^2 + p_y^2 + p_z^2 = {d_3}^2$ (as the spherical geometry of the manipulator dictates).