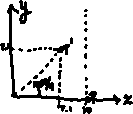
## 3.1.) Degrees of Freedom

1.) **2 DOF**

2.) **3 DOF**

3.) **5 DOF**

## 3.2.) Rotation Matrices



## 3.3.) Inverting Homogeneous Transformations

## 3.4.) Homogeneous Transformations

3.1.)

3.2.)

3.3.)

3.4.)

4.1.)

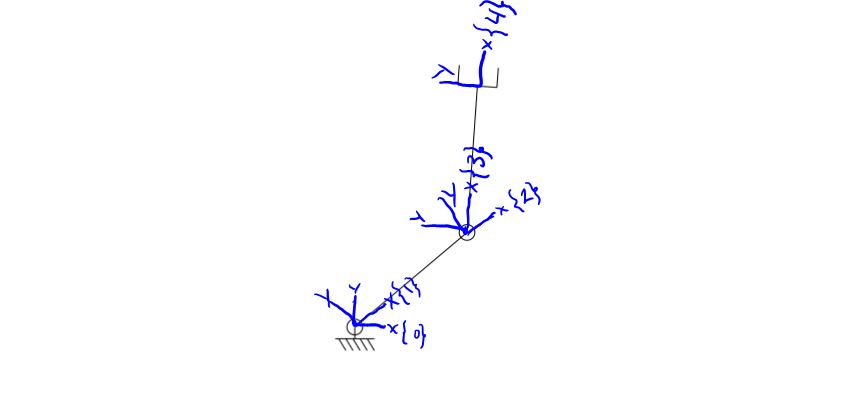
4.2.)

4.3.)

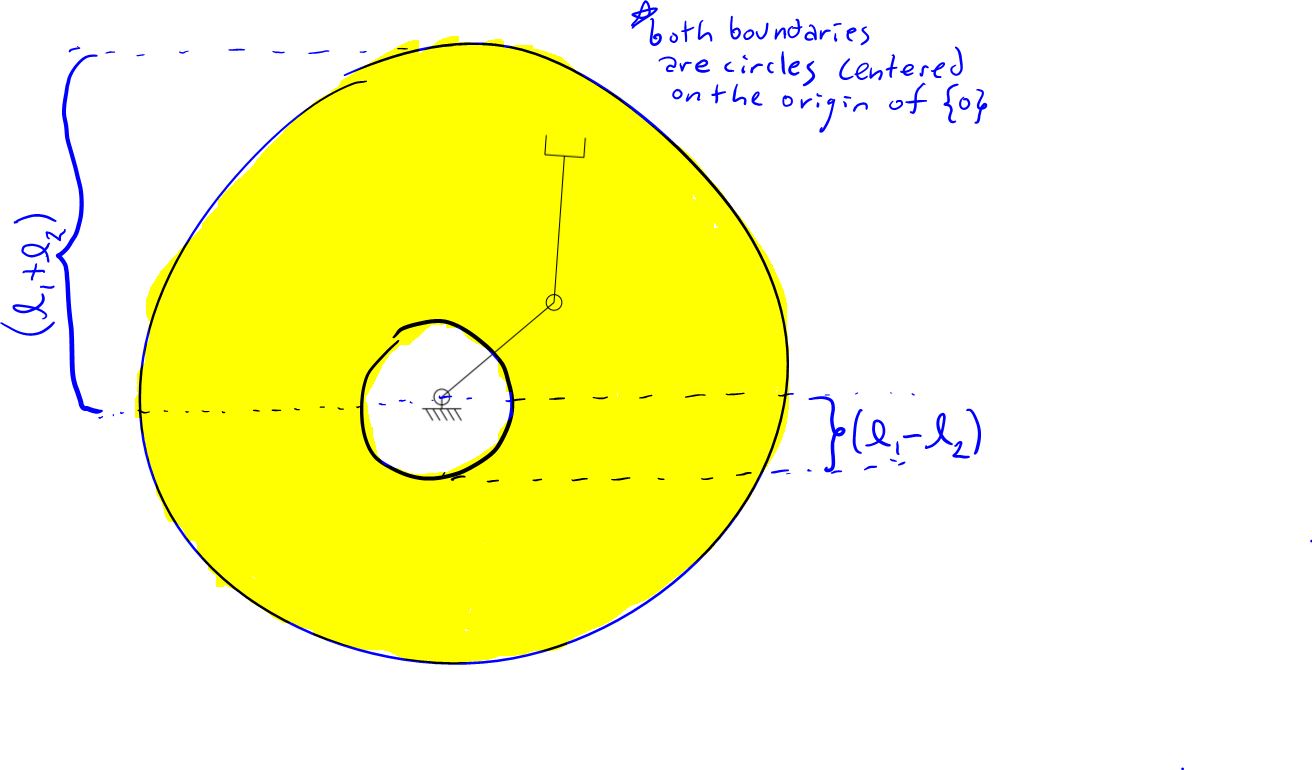
4.4.)

## 3.5.) Workspace and Frames

1-5.)



6.)



## 3.6.) Forward Kinematics of an RR Arm

1.)

2.)

3.)

4.)

5.)

6.)

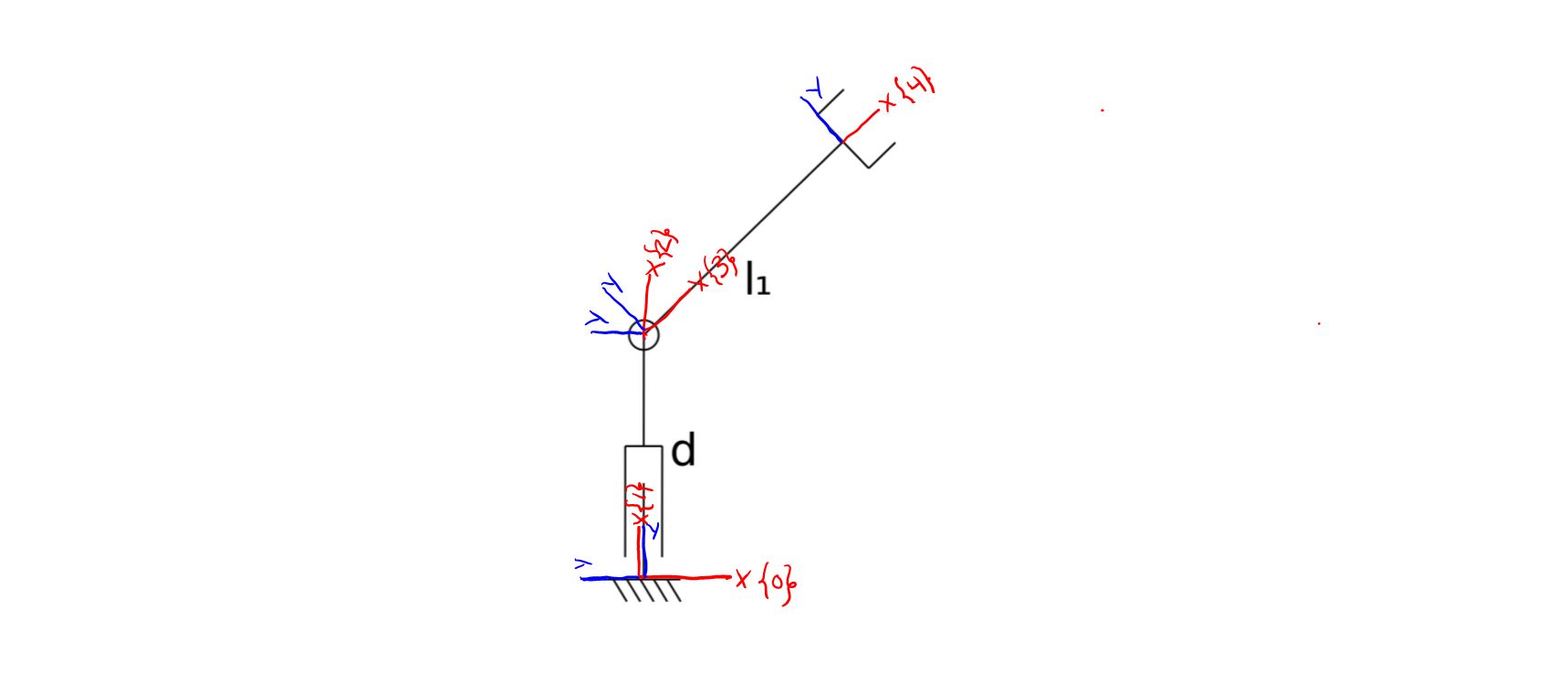
6.1.)

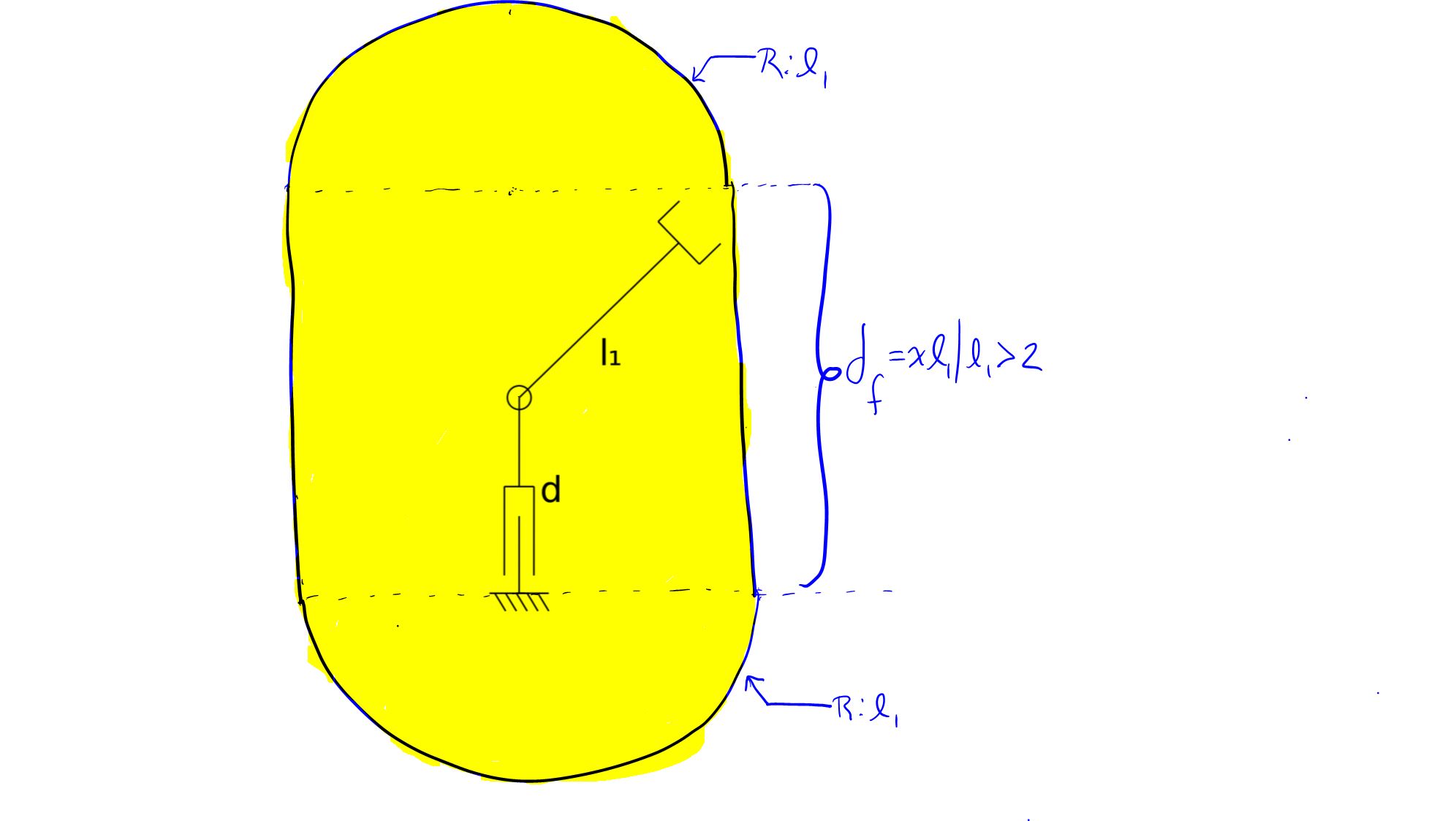
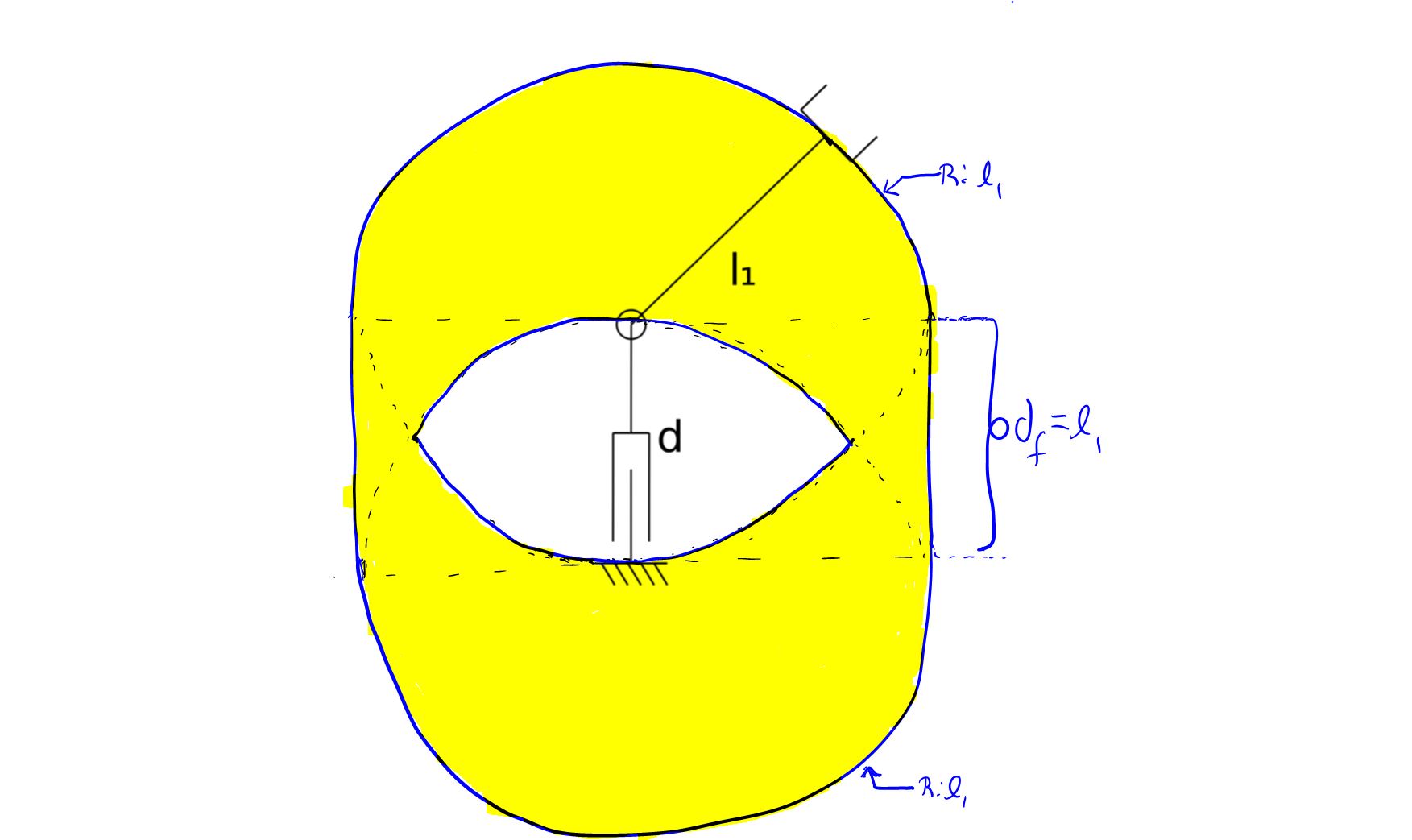
6.2.)

6.3.)

6.4.)

## 3.7.) Workspace and Frames of a PR Arm





(here, x is depicted infinitesimally larger than 2).

## 3.8.) Forward Kinematics of a PR Arm

1.)

2.)

3.)

4.)

5.)

6.)

6.1.)

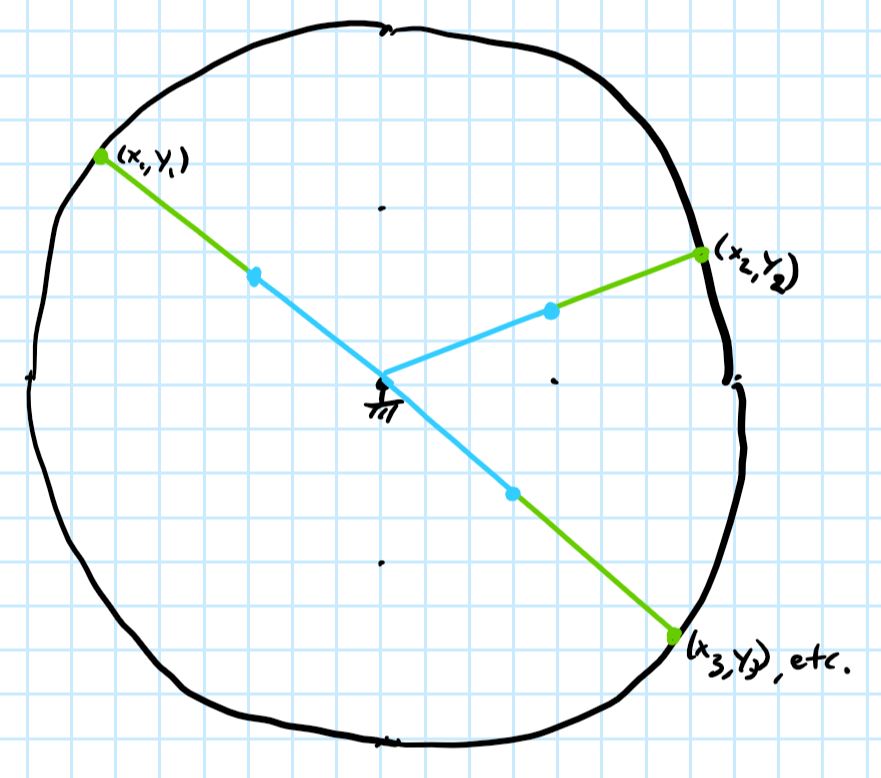
6.2.)

6.3.)

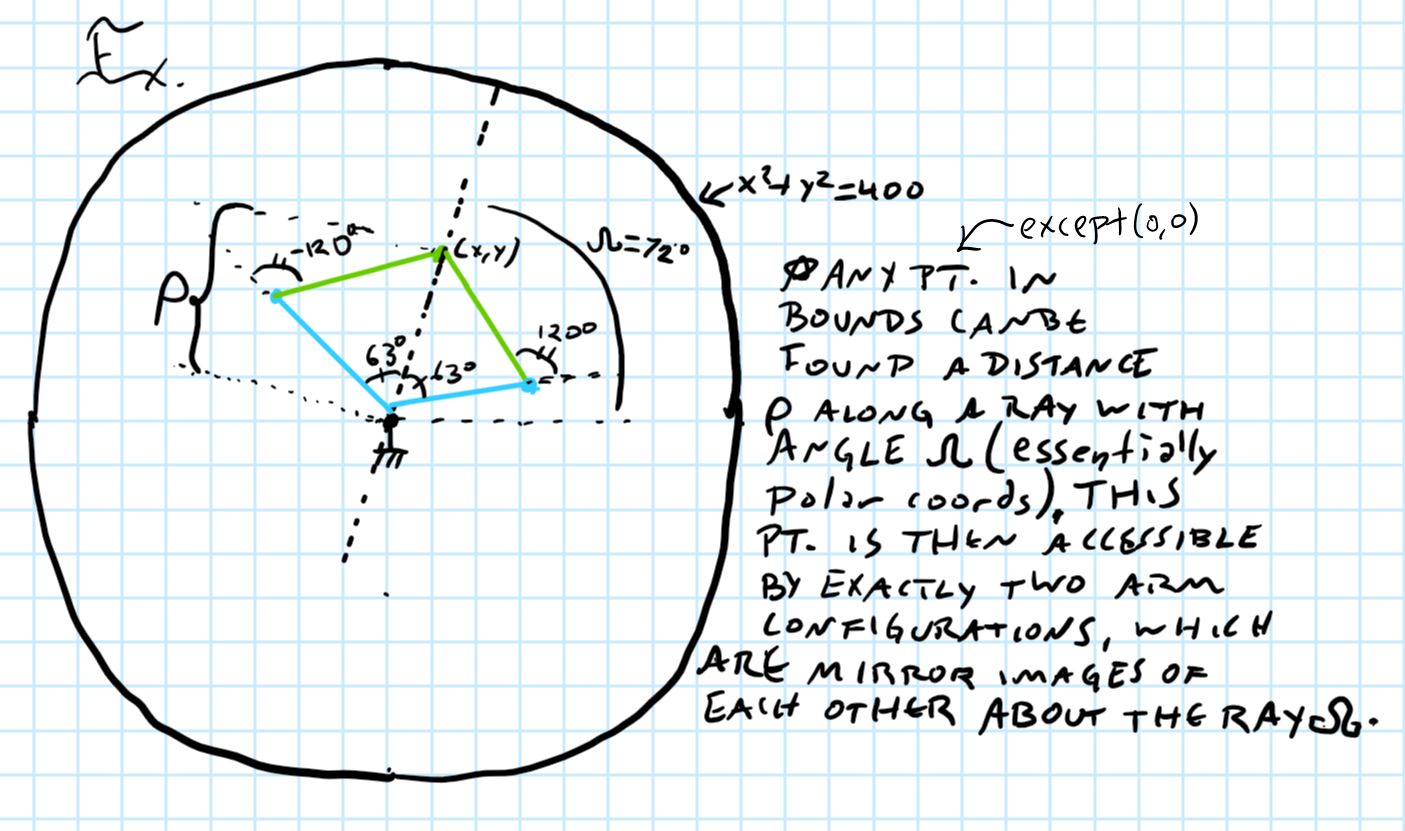
6.4.)

## 3.9.) Singularities

1.) Any point on the circle (the boundary where ).



2.) Any point in the region (any points besides (0,0) within, but not on, the outer the boundary).



3.) , where and can occupy any value.

