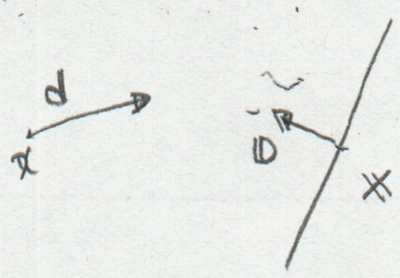
Ray tracing

Plane Surface



- cross point

$x + ld$ is on the surface:

$$\{x + ld - X\} \cdot D = 0$$

$$l = \frac{X \cdot D - x \cdot D}{d \cdot D}$$

$$x' = x + ld$$

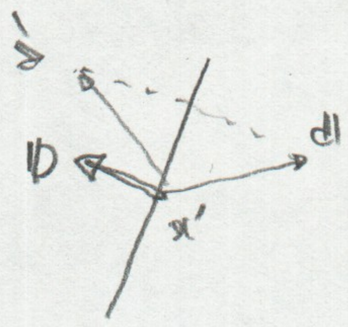
- Reflection:

d' is reflected direction

$$\begin{cases} d' = d + l'D \\ (d' + d) \cdot D = 0 \end{cases}$$

$$l' = -\frac{2d \cdot D}{|D^2|}$$

$$d' = d + lD$$



Spherical Surface

$$x' - x = ld$$

$$|X_c - x'| = R$$

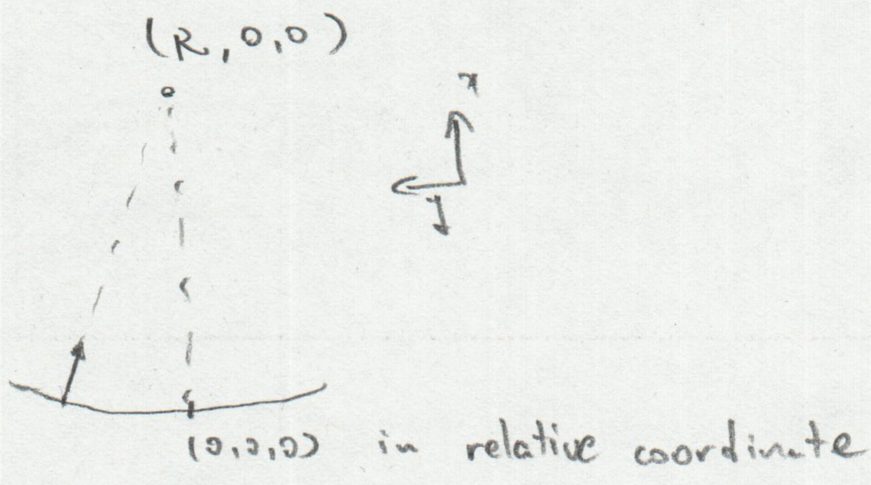
$$X_c = x + R \cdot \frac{D}{|D|}$$

$$\left| \left(X + R\frac{D}{|D|} - x \right) - ld \right|^2 = R^2$$

$$l = \frac{1}{|d|^2} \left\{ d \cdot (X_c - x) \pm \sqrt{\{d \cdot (X - x)\}^2 - \{|X_c - x|^2 - R^2\}|d|^2} \right\}$$

$$x' = x' + ld$$

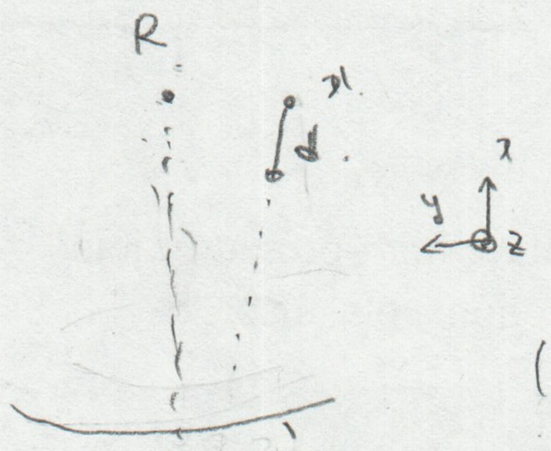
normal direction at x'



Ray tracing

Cylindrical Surface

in relative surface.



$$x' = x + l\,d$$

$$(x'-R)^2 + y'^2 = R^2$$

$$(x + l d_x - R)^2 + (y + l d_y)^2 = R^2$$

$$\underbrace{(d_x^2+d_y^2)}_{a} l^2 + 2\underbrace{\{(x-R)d_x + y d_y\}}_{b} l + \underbrace{x^2 + y^2 - 2Rx}_{c} = 0$$

$$l = \frac{1}{a}\{-b \pm \sqrt{B^2 - a\cdot c}\}$$

$$x' = x + l\,d.$$