```
α = 1.33
```

```
1.33
```

refractive index of water.

```
Clear[α]
```

```
θ := ArcSin[Sin[ϕ] / α]
```

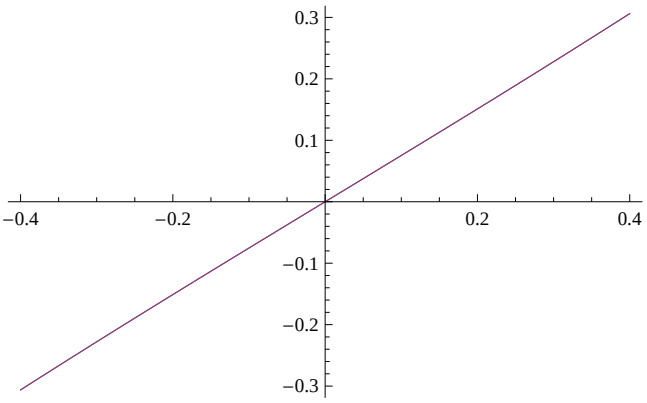
snell' s law solved for refracted angle.

```
Tan[θ]
```

$$\frac{0.75188\ \text{Sin}[\phi]}{\sqrt{1 - 0.565323\ \text{Sin}[\phi]^2}}$$

the tangent of the refracted angle.

```
Plot[{Sin[ϕ] / Sqrt[α^2 - Sin[ϕ]^2], Tan[θ]}, {ϕ, -0.4, 0.4}]
```



one tangent vs the other.
close enough to linear.

```
23.4 π / 180 // N
```

```
0.408407
```

Sun' s vertical motion in radians

```
Sin[ϕ] / Sqrt[α^2 - Sin[ϕ]^2] /. {ϕ → (23.4 π / 180)}
```

```
0.312882
```

size of the inner circle compared to the full base plate.