# 1 | **Tiling the Pringlehouse**

As a review, our pringles shaped house has the following parametres:

$$\begin{cases} x(t) = 30cos(t) \\ y(t) = 20sin(t) \end{cases} \tag{1}$$

and the roof is defined by:

$$r(x,y) = \frac{1}{400}\left(\sqrt{3}x - y\right)^2 - \frac{1}{400}\left(\sqrt{3}y - x\right)^2 + 10 \tag{2}$$

We will first convert the above function into rectangular bounds to take the area of.

$$x = 30cos(t) \tag{3}$$

$$\Rightarrow \frac{x}{30} = cos(t) \tag{4}$$

$$\Rightarrow t = arccos\left(\frac{x}{30}\right) \tag{5}$$

Supplying this back to the original expression for y:

$$y = 20sin\left(arccos\left(\frac{x}{30}\right)\right) \tag{6}$$

$$= 20\sqrt{1 - \left(\frac{x}{30}\right)^2} \tag{7}$$

Therefore, the actual integral:

$$\int_{-30}^{30} \int_{-20\sqrt{1-\left(\frac{x}{30}\right)^2}}^{20\sqrt{1-\left(\frac{x}{30}\right)^2}} 1dy\ dx \tag{8}$$

We will endeavor now to use technology.

```
var("x y")
f(x,y) = 1
f.integrate(y, -20*sqrt(1-(x/30)^2), 20*sqrt(1-(x/30)^2)).integrate(x, -30,30)
```

It appears that the area of the floor is $600\pi$.

We can do this something for the function of the roof. We will first figure correction factor $dA$, then take the integral as prescribed.

$$dA = \sqrt{1 + \left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2} \tag{9}$$

At this point, we realize that the actual function will turn to be much too complicated to integrate by hand at this moment; therefore, we will create the expression digitally.

```
r(x,y) = (1/400)*(sqrt(3)*x-y)^2 - (1/400)*(sqrt(3)*y+x)^2 + 10
da = sqrt(1+r.diff(x)^2+r.diff(y)^2)
monte_carlo_integral(da.integrate(y, -20*sqrt(1-(x/30)^2), 20*sqrt(1-(x/30)^2)), [-30], [30], 10000000)
```

Looks like the result is converting to about $2002.2$ for this shape.

## 2 | Three Dimensional Region!

Slowly adding up the arguments to this figure reveals its general shape:

```
f(x) = 1-x^2
plot(y, -10, 10)
```