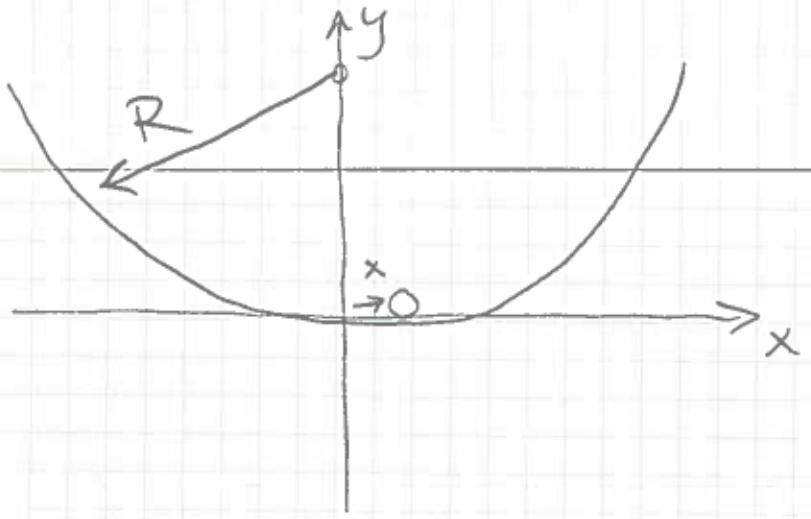
3)



A bowl of hemispherical shape, with radius

$R = 0.14\,m$

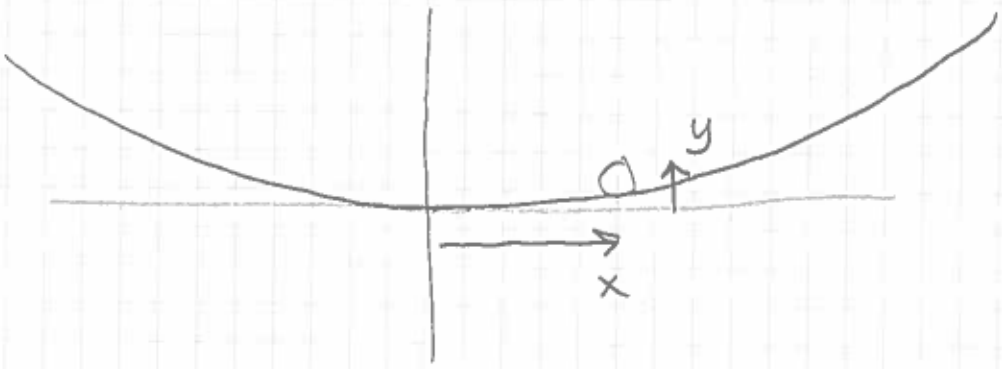
sits on table.

A marble displaced by small distance

$x \ll R$

oscillates around bottom.

What is period of oscillation?



When displaced by x, the marble has height y above bottom.

$$GPE = mgy$$

but $x^2 + y^2 = R^2$ for circle at origin

$$\rightarrow \quad y^2 = R^2 - x^2$$

This circle is not centered at origin, but at $(0,R)$. So →

$$y = R - [R^2 - x^2]^{1/2} \quad \text{for circle at } y = R$$

$$= R - \left[R^2\left(1 - \frac{x^2}{R^2}\right)\right]^{1/2}$$

$$= R - R\left(1 - \frac{x^2}{R^2}\right)^{1/2}$$

Use binomial theorem

$$y \cong R\left(\frac{1}{2}\frac{x^2}{R^2}\right)$$