

Nondimensionalization !

my world

example 1:

$$g = 10 \text{ m/s}^2$$

$$h = 2000 \text{ m} \quad t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{4000}{10}} = 20 \text{ sec}$$

Real world

$$g = 1 \text{ m}^*/\text{s}^{*2} \quad h = 1 \text{ m}^* \rightarrow t = \sqrt{\frac{2h}{g}} = 1 \text{ s}^*$$

but How many seconds is 1 s^*

$$g = \frac{1 \text{ m}^*}{\text{s}^{*2}} = 10 \text{ m/s}^2 \Rightarrow \text{s}^{*2} = 400 \text{ s}^2$$

$$1 \text{ m}^* = 2000 \text{ m} \rightarrow \text{s}^* = 20 \text{ s}$$

As you can see the time of ball fall is $t = 1 \text{ s}^* = 20 \text{ s}$ which is the same as real world

example 2:

$$\ddot{\theta} = -\frac{g}{L} \sin \theta \quad \theta \ll 1 \rightarrow \ddot{\theta} = -\frac{g}{L} \theta$$

Real world

$$g = 10 \text{ m/s}^2 \quad L = 0.1 \text{ m}$$

$$\rightarrow \ddot{\theta} = -\frac{g}{L} \theta = 100 \theta \rightarrow \theta = \sin(10t)$$

$$\theta(t=1) = \sin(10)$$

$$g = 1 \text{ m}^*/\text{s}^{*2} \quad L = 1 \text{ m}^* \quad \text{my world!}$$

$$\rightarrow \ddot{\theta} = -\frac{g}{L} \theta = -\theta \rightarrow \theta = \sin(t)$$

Now we want to calculate θ at $t = 1 \text{ s}$. But so $t = ? \text{ s}^*$

$$g = \frac{1 \text{ m}^*}{\text{s}^{*2}} = 10 \text{ m/s}^2 \Rightarrow \text{s}^* = 0.1 \text{ s}$$

$$L = 1 \text{ m}^* = 0.1 \text{ m}$$

$$\rightarrow t = 1 \text{ s} = 10 \text{ s}^*$$

$$\Rightarrow \theta(t=1 \text{ s}) = \theta(t=10 \text{ s}^*) = \sin(10)$$