Lecture 1.3
The Simple Pendulum

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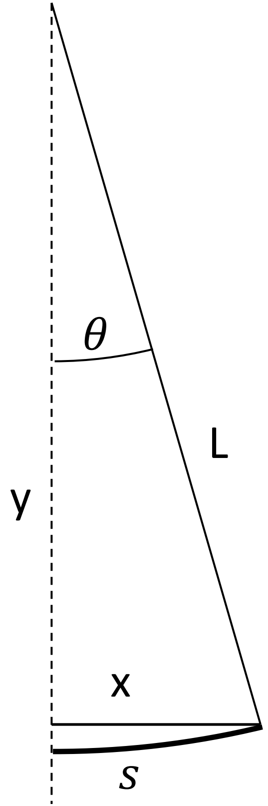
The Small Angle Approximation



(Arc length)
$s = L\theta$

We will use this a lot in this course:

$$\sin\theta = \frac{x}{L}$$

$$\sin\theta \approx \frac{s}{L}$$

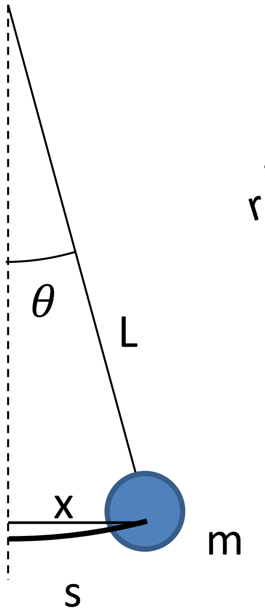
$$\boxed{\sin\theta \approx \theta}$$

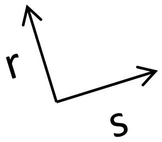
Also:

$$\boxed{\tan\theta \approx \theta}$$

Valid approximation
(errors <1%)
for about
$|\theta| < 15°$ to $20°$

Simple Pendulum
(Small Angle Solution)

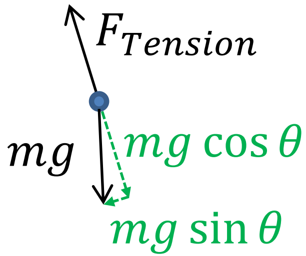




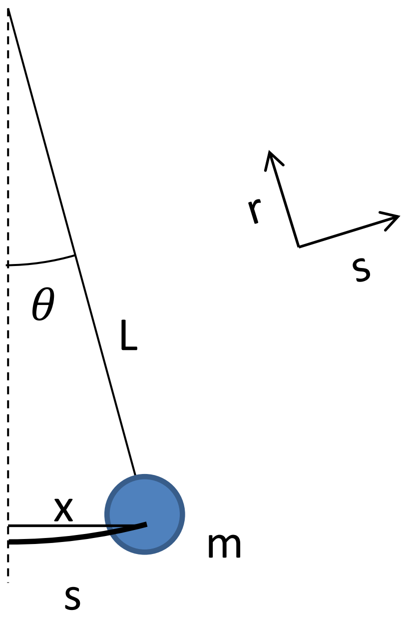
Write weight in (r, s) coordinates:

$$F_{m,r} = -mg\cos\theta$$

$$F_{m,s} = -mg\sin\theta$$



Simple Pendulum
(Small Angle Solution)



- Net force in s direction:

$$F_s = -mg\sin(\theta)$$
$$F_s = -mg(x/L)$$
$$F_s \approx -mg(s/L)$$

Compare to
$F = -kx$
with
$\omega^2 = k/m$

- Resulting motion: SHM with

$$\omega^2 = g/L$$