

# Experiment 08: Physical Pendulum



**8.01t**  
**Nov 10, 2004**

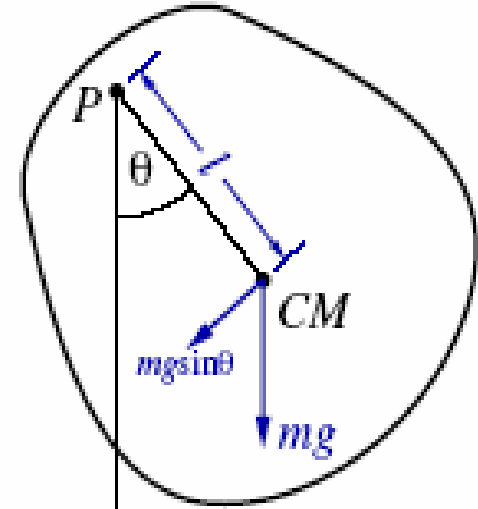
# Goals

- Investigate the oscillation of a real (physical) pendulum and compare to an ideal (point mass) pendulum.
- Angular frequency calculation:

$$\vec{\tau} = I\vec{\alpha} \qquad -lmg \sin \theta = I \frac{d^2 \theta}{dt^2}$$

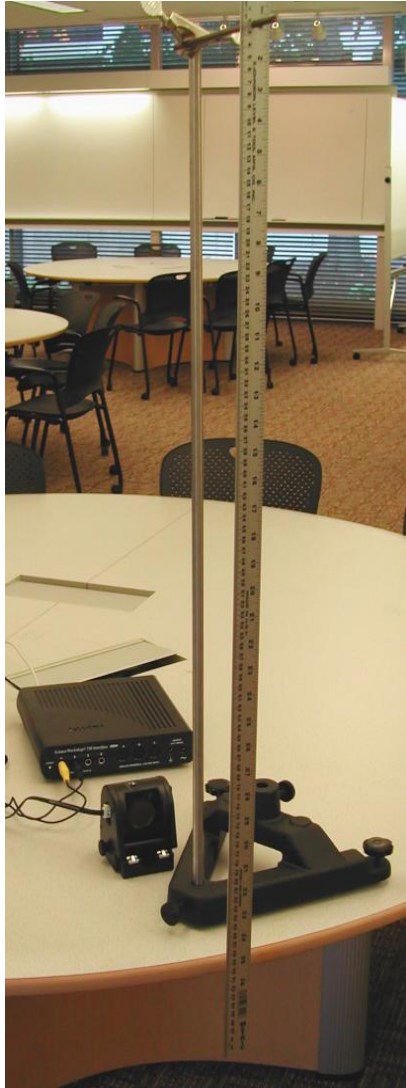
$$\frac{d^2 \theta}{dt^2} + \frac{lmg}{I} \sin \theta = 0$$

With  $\sin \theta \simeq \theta$  :  $\omega = \sqrt{\frac{lmg}{I}} \qquad \frac{d^2 \theta}{dt^2} + \frac{lmg}{I} \theta = 0$



- Practice calculating moments of inertia, using them, and solving the  $\tau = I \alpha$  equation of motion.

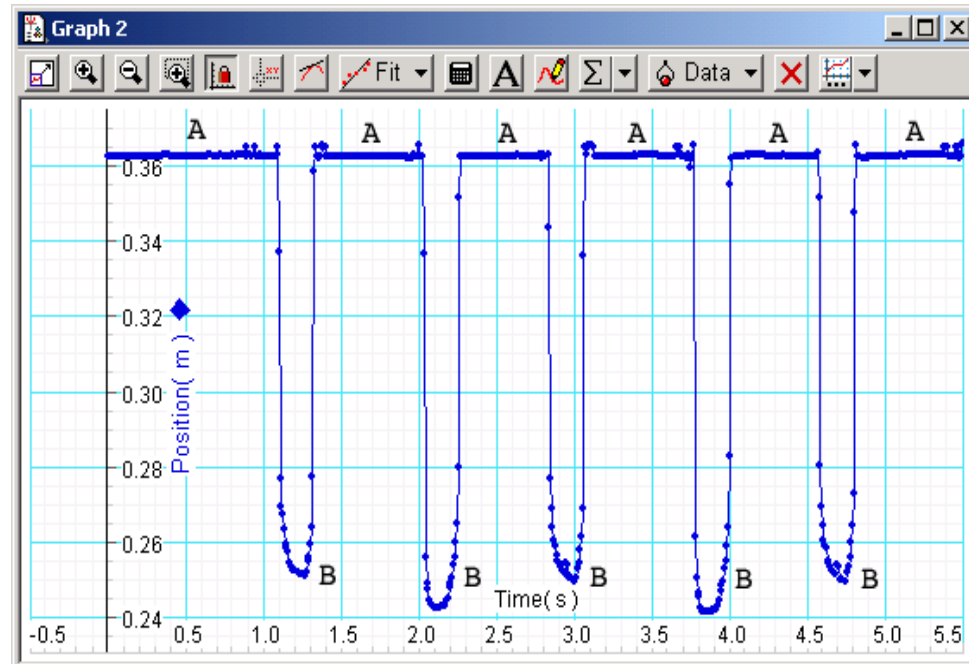
# Equipment setup



- ❑ Suspend 1m ruler so it can swing over edge of table.
- ❑ Measure the period of oscillation with the DataStudio motion sensor.
- ❑ Set motion sensor on narrow beam, aim it to just miss support rod and hit ruler about 25 cm away.
- ❑ Place a chair about 40-50 cm from motion sensor to intercept ultrasound beam when ruler swings out of beam.

# Understanding the graphs

Position vs. time data from the motion sensor.



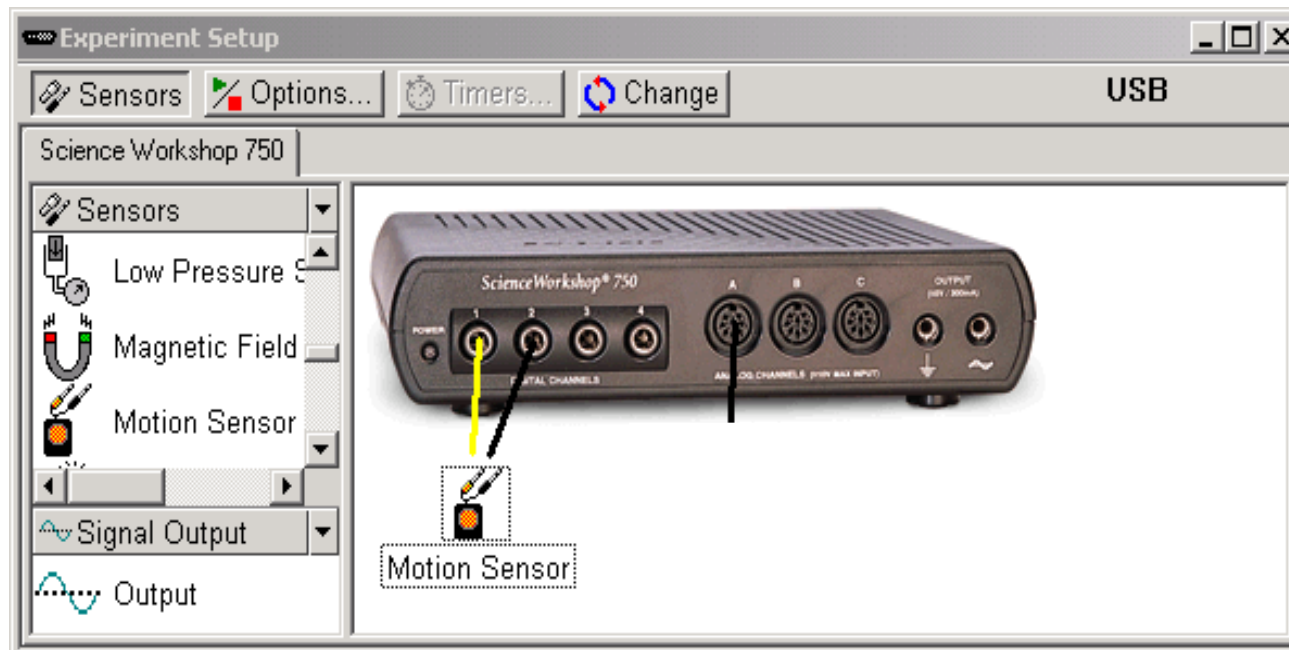
What is happening:

1. Along the top plateaus marked by A?
2. At the downward peaks marked by B?

How do you use this graph to find the period of oscillation of the pendulum?

# Starting DataStudio

- ❑ Create a new experiment.
- ❑ Plug motion sensor into the 750 and
- ❑ drag their icons to inputs in the Setup window.



- ❑ Double-click the Motion Sensor icon, set trigger rate to 120.
- ❑ Plot position vs. time.

# Ruler pendulum

Click  Options...

Delayed Start = None.      Automatic Stop = 10 sec.

Pull ruler aside and release it to swing at the same time you start DataStudio.

Measure periods filling in the table below.

Displacement	$\theta_0$	Period
0.10 m	0.10	
0.25 m	0.25	
0.50 m	0.52	

# Modified ruler pendulum

Clip a 50g brass weight to the ruler at positions in table in order to change the moment of inertia. (Clip is 8.6 g.)  
Measure the period of oscillation filling in the table below:

Displacement	Weight	Position	Period
0.20 m	58.6 g	0.25 m	
0.20 m	58.6 g	0.50 m	
0.20 m	58.6 g	0.90 m	