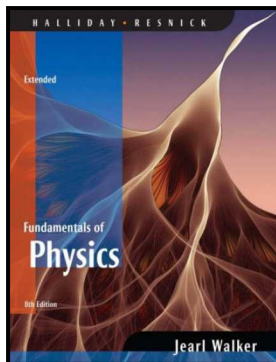


Workshop Physics

1017 - 312

University Physics II



Week 1 : Day 2

Outline

- ❑ **Activity – Pendulum Velocities**
 - Verifying the relation of v and ω
 - *Calculating uncertainties*
- ❑ ***The Mechanical Universe***
 - *Movie – “Moving in Circles”*

Activity - Pendulum Velocities

□ Simple Pendulum

- Determine period for various lengths, L
 - Use a fixed angle – less than 20°
 - Time several periods to find average

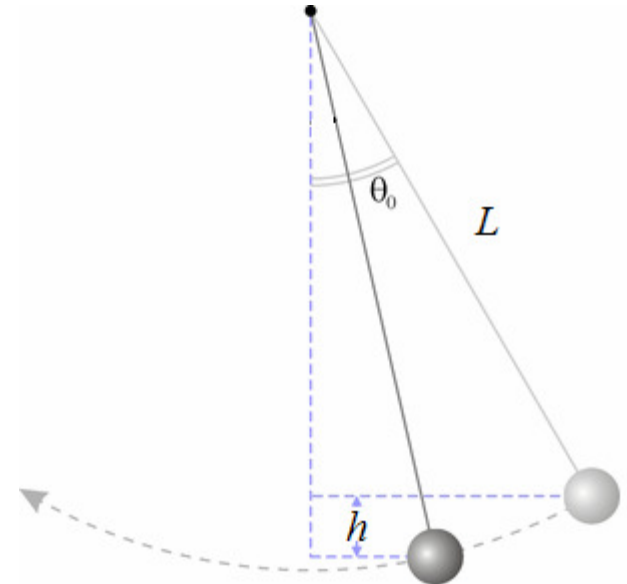
- Determine angular velocity at bottom
 - Use average angular velocity

$$\omega_{ave} \equiv \frac{\Delta\theta}{\Delta t} = \frac{4\theta_0}{T}, \quad \omega_{max} = \sqrt{2}\omega_{ave}$$

- Determine the linear velocity, v at the bottom
 - Use conservation of energy

$$\Delta K + \Delta U = 0 \Rightarrow v_{max} = \sqrt{2gh}$$

- Determine the ratio of the maximum linear and angular velocity, v_{max} / ω_{max}
 - Calculate for each length and compare to L



Data Table and Analysis

- ❑ Organize your data in a table similar to the following:

Trial #	L (m)	T (s)	θ (rad)	h (m)	ω_{\max} (rad/s)	v_{\max} (m/s)	v_{\max} / ω_{\max} (m)
1							
2							
3							
4							
5							

- ❑ Determine the percent error and uncertainty for each trial
 - Does the ratio predict the length within the experimental uncertainty ?

Calculating Uncertainties

- **The uncertainty in a measured value may be calculated in two ways:**
 - If a measurement is taken once use ½ of the smallest increment on the device.
 - *i.e., on a standard meter stick use*

$$\pm \frac{1}{2} \text{ mm} = 0.5 \text{ mm} = 0.05 \text{ cm} = 0.005 \text{ m}$$

- When a measurement is made more than once use the *standard deviation* as a measure of the uncertainty
 - *In general use the following:*

$$\sigma_z \equiv \sqrt{\Delta z^2} = \sqrt{\left(\frac{1}{N} \sum_{i=1}^N z_i - \bar{z} \right)^2}, \quad \bar{z} \equiv \frac{1}{N} \sum_{i=1}^N z_i$$

Propagating Errors

- ❑ Measurement errors compound in a derived quantity such as, $z = x^m y^n$
- ❑ To determine the uncertainty in such a derived quantity use the following:

$$\frac{\Delta z}{z} = |m| \frac{\Delta x}{x} + |n| \frac{\Delta y}{y} + \dots$$

Movie – “Moving in Circles”

□ The Mechanical Universe

- Produced in 1985 at CalTech
- History and Mathematics of Classical Mechanics

□ Moving in Circles

- A look at the Platonic theory of uniform circular motion.
- Video on Demand (VOD) available at:
 - <http://www.learner.org/resources/series42.html?pop=yes&pid=556>

