ASTR 1040 Recitation: Introduction

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My Info

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A Typical Homework

- Mastering Astronomy
- Short, straightforward problems
- Long, involved problem
- Usually due every Thurs.

A Typical Recitation

- Some kind of mini lecture related to lecture topics
- Answer any questions from class or HW
- Work example problems in preparation for problem sets
- Attendance required?

Dimensional Analysis

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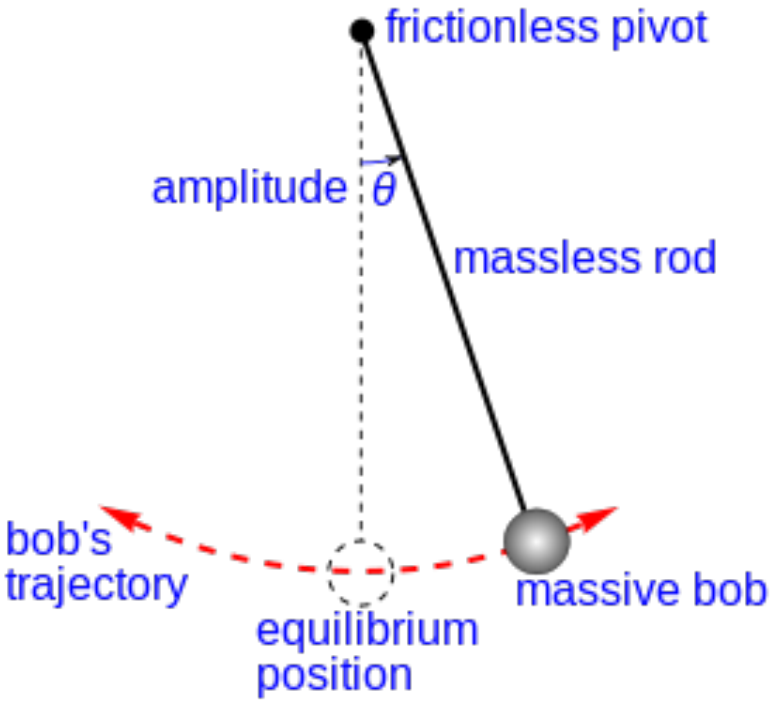
  - What does it mean? $e^{5\,\mathrm{m}}$
  - What does it mean? $\log(3\ \mathrm{N})$
  - What does it mean? $\sin(2\ \mathrm{m/s})$ or $\sin(2\ \mathrm{mph})$

Dimensional Analysis: Case Study 1, Pendulum



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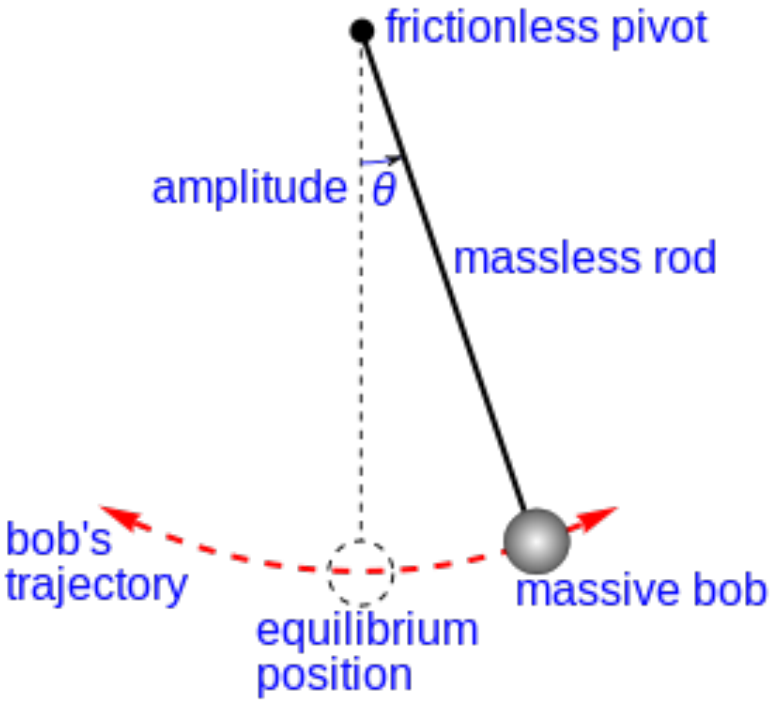

- What are the dimensional quantities?
- What is the frequency of oscillation?

Dimensional Analysis: Case Study 1, Pendulum

$[L]$ = Length $\qquad$ $[M]$ = Mass $\qquad$ $[T]$ = Time

- L is the rod length, units of $[L]$
- m is the mass of the bob, units of $[M]$
- g is gravity, units of $[L]/[T]^2$
- θ is the angle, unitless

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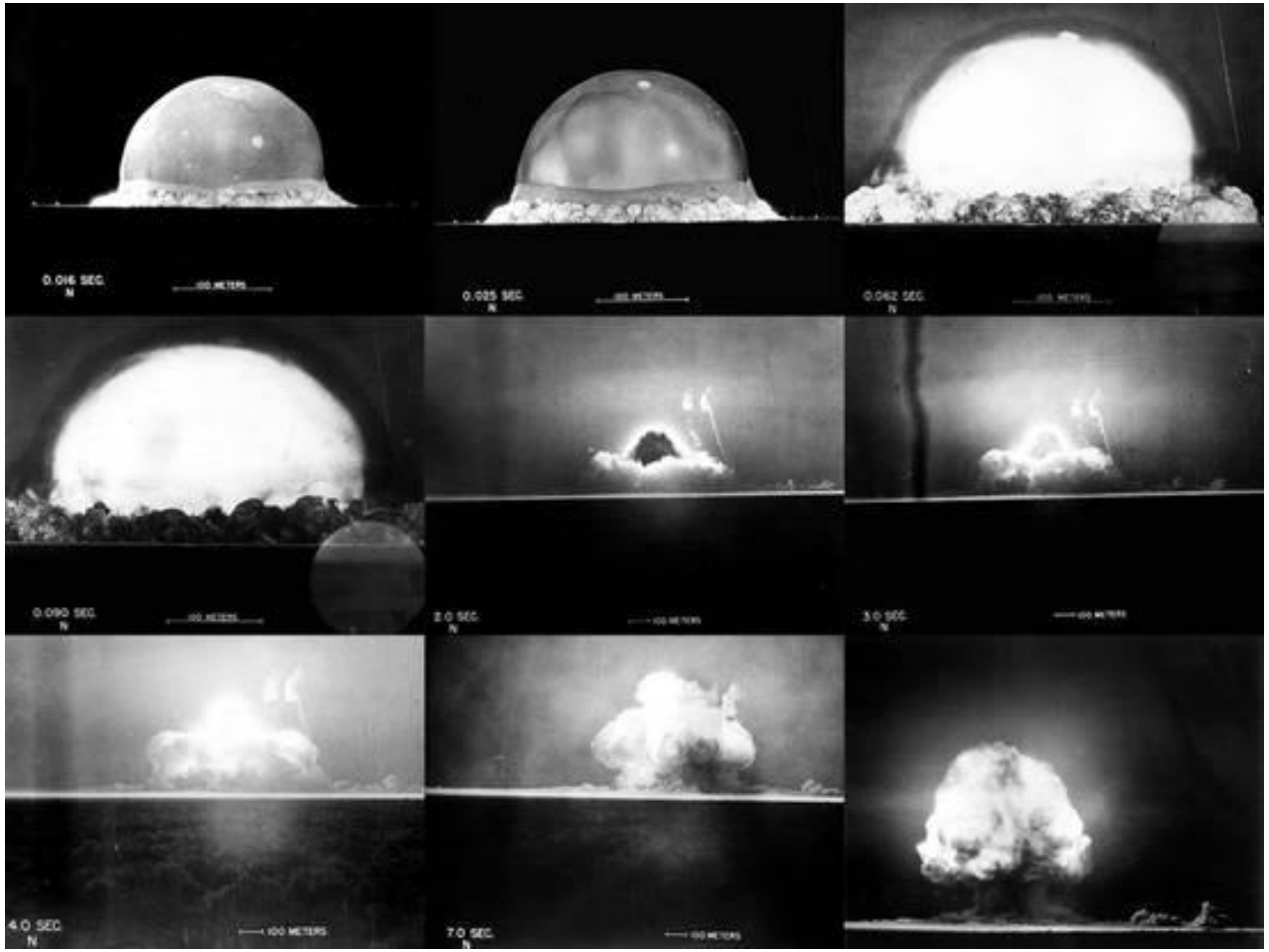
- $f \propto \sqrt{\frac{g}{L}}$

Dimensional Analysis: Case Study 2, Trinity Test

- First detonation of nuclear weapon by US Army in New Mexico, July 1945
- As part of the Manhattan Project, highly classified
- Yield was $\approx$ 22 kilotons TNT, also highly classified

Dimensional Analysis: Case Study 2, Trinity Test



- Life magazine released the pictures $\sim$ 1947
- They had time stamps and size scales
- G. I. Taylor estimates yield with dimensional analysis!

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- Assume energy released in a small space
- Assume a spherical shock wave
- Know r as a function of time, what is the energy?

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Dimensional Analysis: Case Study 2, Trinity Test

- r, the radius of the shock wave has dimensions $[L]$
- t, time has dimensions $[T]$
- ρ, the density of the air has dimensions $[M]/[L]^3$
- E, the energy has dimensions $[M][L]^2/[T]^2$

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- Ultimately want energy, so write $E = C\, r^x\, \rho^y\, t^z$

Dimensional Analysis: Case Study 2, Trinity Test

- $E = C\, r^x\, \rho^y\, t^z$
- Plug in the dimensions for each quantity
- $[M]\,[L]^2\,[T]^{-2} = C\,[L]^x\,[M]^y\,[L]^{-3y}\,[T]^z$

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- Equation for $[M]$: $1 = y$

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- Equation for $[L]$: $2 = x - 3y$

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- Equation for $[M]$: $1 = y$
- Equation for $[L]$: $2 = x - 3y$
- Equation for $[T]$: $-2 = z$

Dimensional Analysis: Case Study 2, Trinity Test

- $E = C\,\rho r^5 t^{-2}$
- Based on the images, at $t = 0.0062$ sec, $r = 80$ m
- Taylor knew (from previous experiments) that $C \approx 1$
- Use density of air, $\rho = 1.2$ kg/m^3

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- $E \approx 1.02 \times 10^{14}$ J ≈ 24.4 kilotons TNT

Lastly...a Pop Quiz

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- A simple questionaire that WILL NOT BE GRADED
- No calculators (you don't need them)
- Place "x" over question number if you do not know
- Circle the question number if you do not remember