Physics 141.
Mechanics (Honors)

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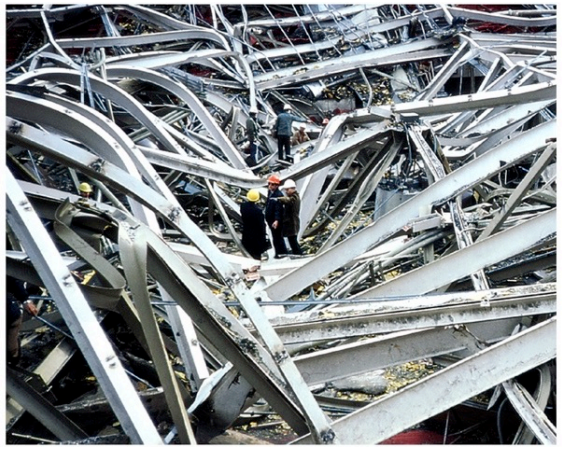
Physics 141.
What are we going to talk about today?

- Goals of the course
- Who am I?
- Who are you?
- Course information:
  - Text books
  - Lectures
  - Recitations
  - Homework
  - Laboratories
  - Exams
  - Diagnostic tests
  - Quizzes
- Units and Measurements
- Measurement Errors and Error Analysis

Physics 141.
Goal of the course.

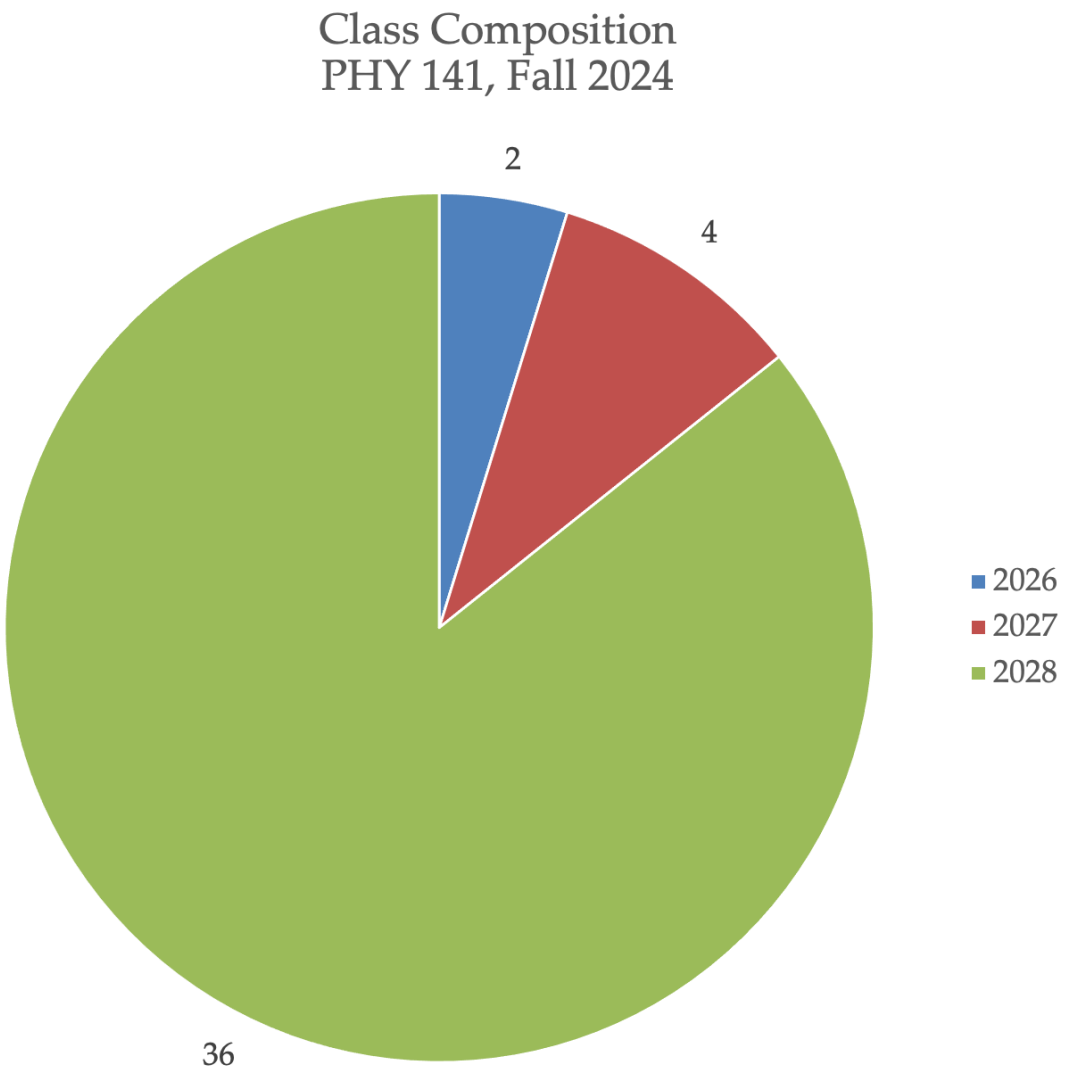
- Physics 141 is a introductory mechanics honors course for science and engineering majors.
- Course topics include motion (linear, rotational, and harmonic), forces, work, energy, conservation laws, and thermodynamics.
- I assume that you have some knowledge of calculus, but techniques will be reviewed when needed.
- I assume you have prior knowledge of physics, based on taking physics in high school.



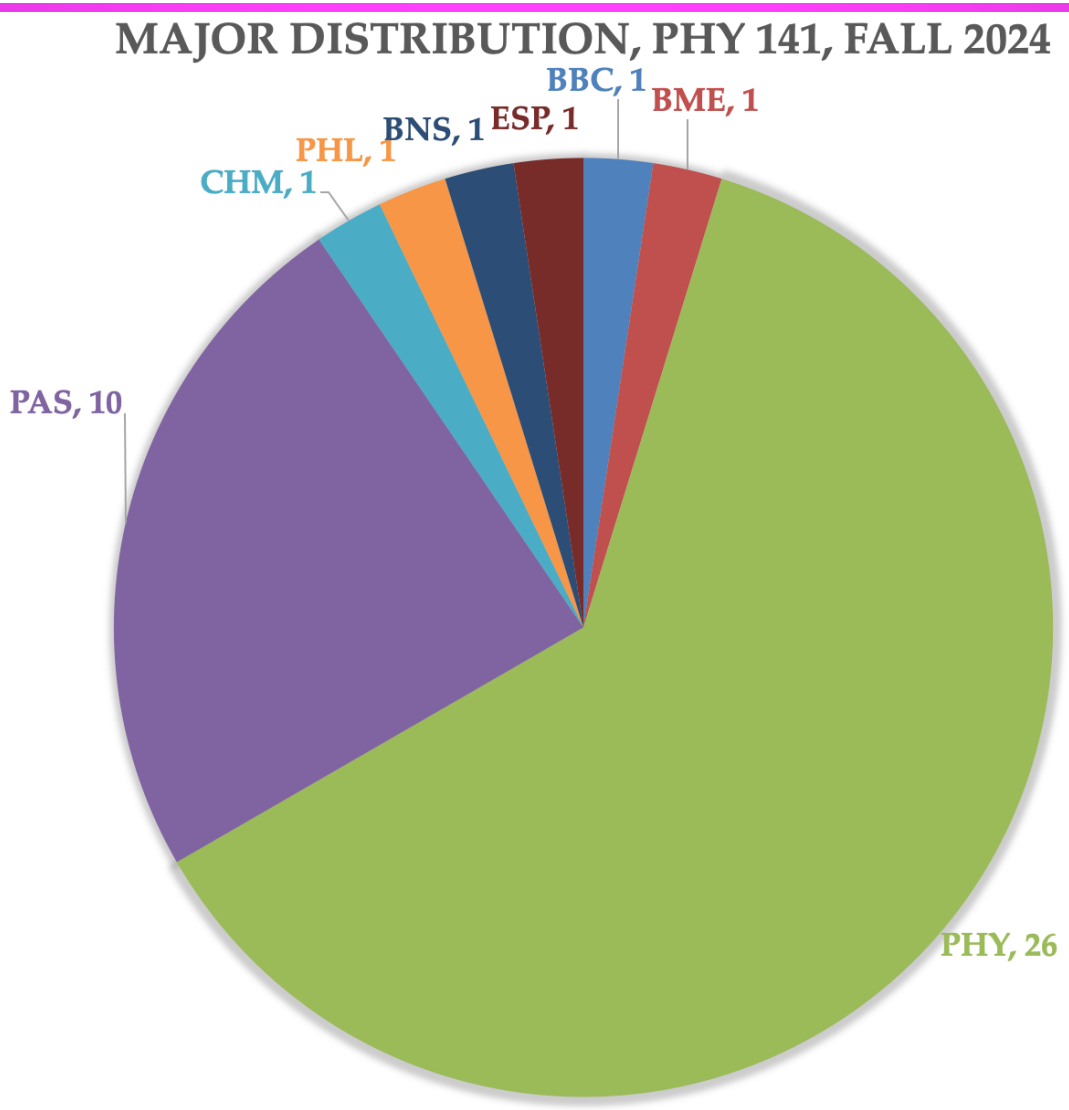
Physics 141.
Who am I?

- I am Frank Wolfs!
- I am a professor in the Department of Physics and Astronomy .
- I am an experimental nuclear physicist. I have looked for the quark-gluon plasma (the state of matter that existed a few microseconds after the Big Bang) at Brookhaven National Laboratory on Long Island. Currently, I am looking for dark matter at the Sanford Underground Research Facility (SURF) in South Dakota.
- I consider teaching a very important component of my job, and will do whatever I can to ensure you succeed in this course.

Physics 141.
Who are you?

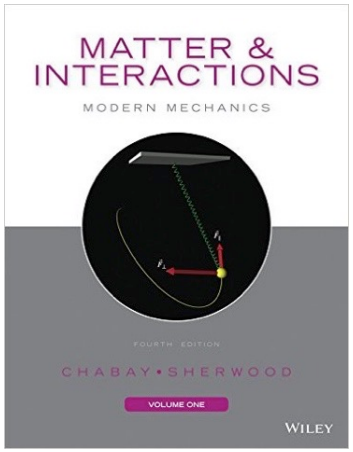


Physics 141.
Who are you?



Physics 141.
Course Information.

- Text Books:
  - **Required**: R. Chabay and B. Sherwood, Matter & Interactions, Volume 1, Modern Mechanics, 4th edition.
  - **Recommended**: P Bevington and D. Robinson, Data Reduction and Error Analysis.



- Poll Everywhere:
  - For quizzes and conceptual tests, we will use the Poll Everywhere tool (using a web browser or text message). **In order to receive credit for your answers, you will need to register to Poll Everywhere with your UR email address**.

or PollEv.com/frankwolfs050

Physics 141.
Course Components.

- Lecture:
  - Focus on the concepts of the material, and its connections to areas outside physics.
  - Not a recital of the text book!
  - The lecture presentation is interspersed with conceptual questions and quizzes, solved with and without help from your neighbors.
- Recitations/Workshops:
  - Small group meetings with a trained teaching assistant.
  - Review course materials and assignments.
  - Consistent attendance of recitations correlates with better grades.

Physics 141.
Course Components.

- Homework assignments:
  - Homework is assigned to practice the material covered in this course and to enhance your analytical problem-solving skills.
  - You will need to struggle with the assignments to do well in this course.
  - You will need to make sure you fully understand the solution to these problems!
  - **Note: late submissions will not be graded.**
- Laboratories:
  - The laboratories give you hands-on experience with making measurements and interpreting data.
  - The laboratories are a required component of the course. **No labs, no grade!**
  - **Note: late submissions will not be graded.**

Physics 141.
Course Components.

- Exams:
  - The exams test you on your basic understanding of the material and your quantitative problem-solving skills.
  - There will be 3 midterm exams and 1 final exam.
  - On each exam you will be provided with a formula sheet that lists all equations that are relevant for the material covered on the exam. There is no need to memorize formulas; you need to focus on understanding how to use them and when to use them.
- Final grades:
  - Calculated in 4 different ways: the highest grade counts.
  - No grading on a curve: grade scale is fixed and known to you!

Physics 141.
Course Components.

- I am here to help you learn this material, but it is up to you to actually master it:
  - If there is something you do not understand you need to ask for help …….. (come and talk, email, ask after class, etc.)
  - It is my job to teach you …… you are paying my salary ……
  - In lecture courses it is difficult to see who needs help. You need to ask for the help you need before you fall behind.

Physics 141.
Course Components.

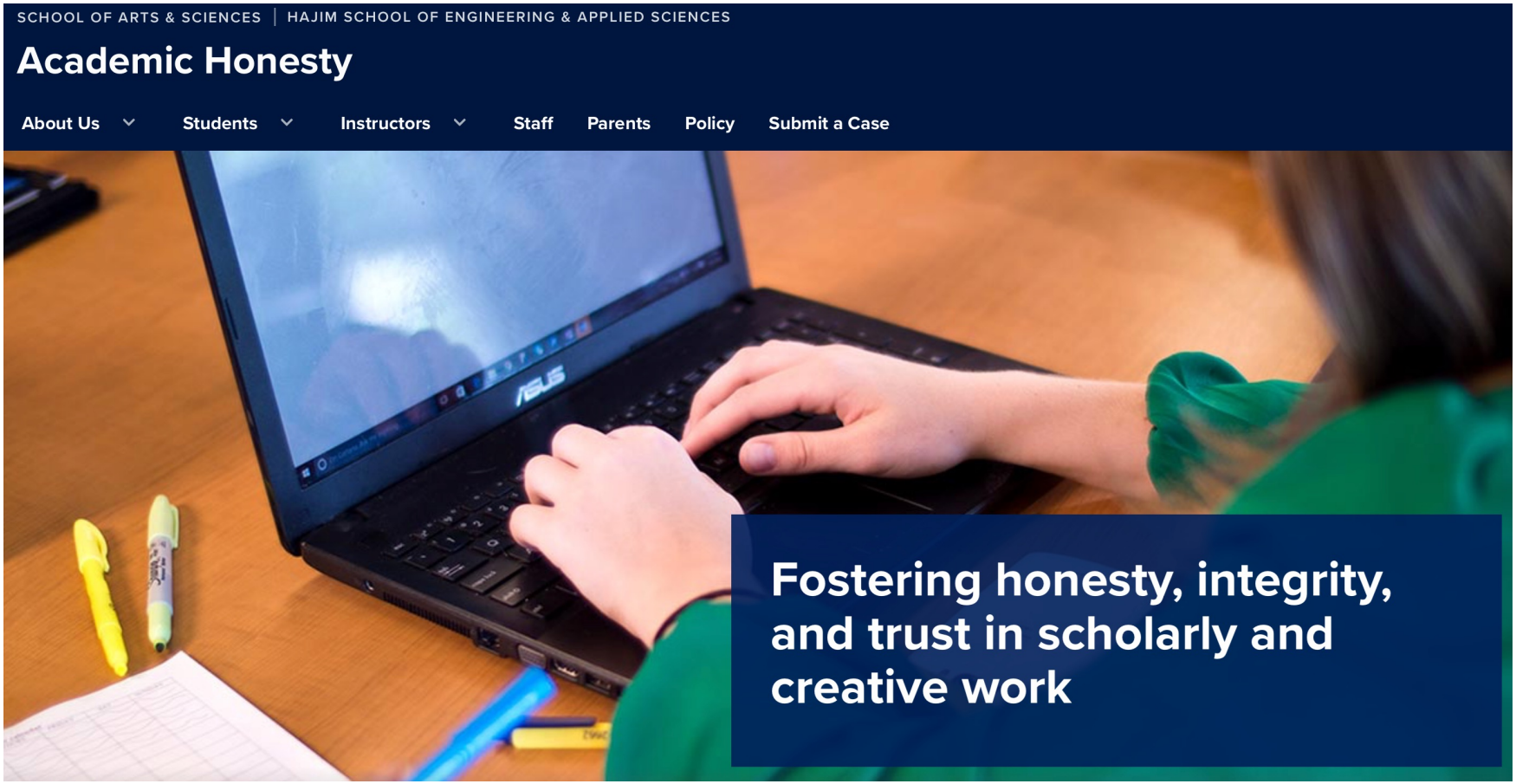
So Very Dutch

Dutch directness

The Dutch are renowned for speaking their minds: from complete strangers reprimanding you for chatting in the train's quiet zone, to a friend not telling you a white lie about your bad haircut. Outsiders often see this as being rude or tactless, but for the Dutch it is actually a virtue of sincerity and honesty. They don't mince their words or beat around the bush, and are often not afraid to discuss hot topics such as religion, politics, immigration or money. In fact, it is even seen as a cultural faux pas to not have an opinion. Some studies trace this directness back to the country's history of Calvinism: Calvinists are concerned with the essence of things and what is really important. The good thing about this 'callous' openness? At least you know exactly where you stand with the Dutch.

From KLM Holland Herald

Academic Honesty
https://www.rochester.edu/college/honesty/



You will need to submit the academic honesty contract by 9/1.

Some examples of what is acceptable in Phy 141?

- Working together on homework assignments.
- Working together on the analysis of your lab experiments.
- Helping each other understanding difficult concepts of the course.
- Asking questions.
- Asking for help when you need help.

Some examples of what is NOT acceptable in Phy 141?

- Copying the homework solutions of another student and submitting it as your own.
- Copying the lab report of another student and submitting it as your own.
- Using the lab data collected by a different group.
- Cheating on exams.
- Bringing cell phones to exams.
- If in doubt, ask!

The Physics 141 Home Page

http://teacher.pas.rochester.edu/PHY141/Phy141HomePage.shtml

Physics 141, Fall 2024. Department of Physics and Astronomy | University of Rochester

Course Information | Lectures | Exams | Homework | Laboratories | Other Links | Practice Exams

Physics 141 Homepage. Fall 2024.

Professor Frank L. H. Wolfs

First course of a three-course honors sequence, recommended for prospective departmental concentrators and other science or engineering students with interest in physics and mathematics. Topics studied are similar to those in Physics 121, but are covered in greater depth. The course also puts an emphasis on "modern mechanics" and starts with the theory of relativity instead of Newtonian mechanics. The topics that are covered include the four fundamental interactions, the atomic nature of matter, conservation laws, energy quantization, multi-particle systems, angular momentum, entropy, the kinetic theory of gases, and the efficiency of engines. It is assumed that the students enrolled in this course have taken at least one physics course in high school.

This course meets every Tuesday and Thursday between 9.40 am and 10.55 am in Hoyt Auditorium. See you there!

Last updated on Thursday, June 6, 2024 7:53

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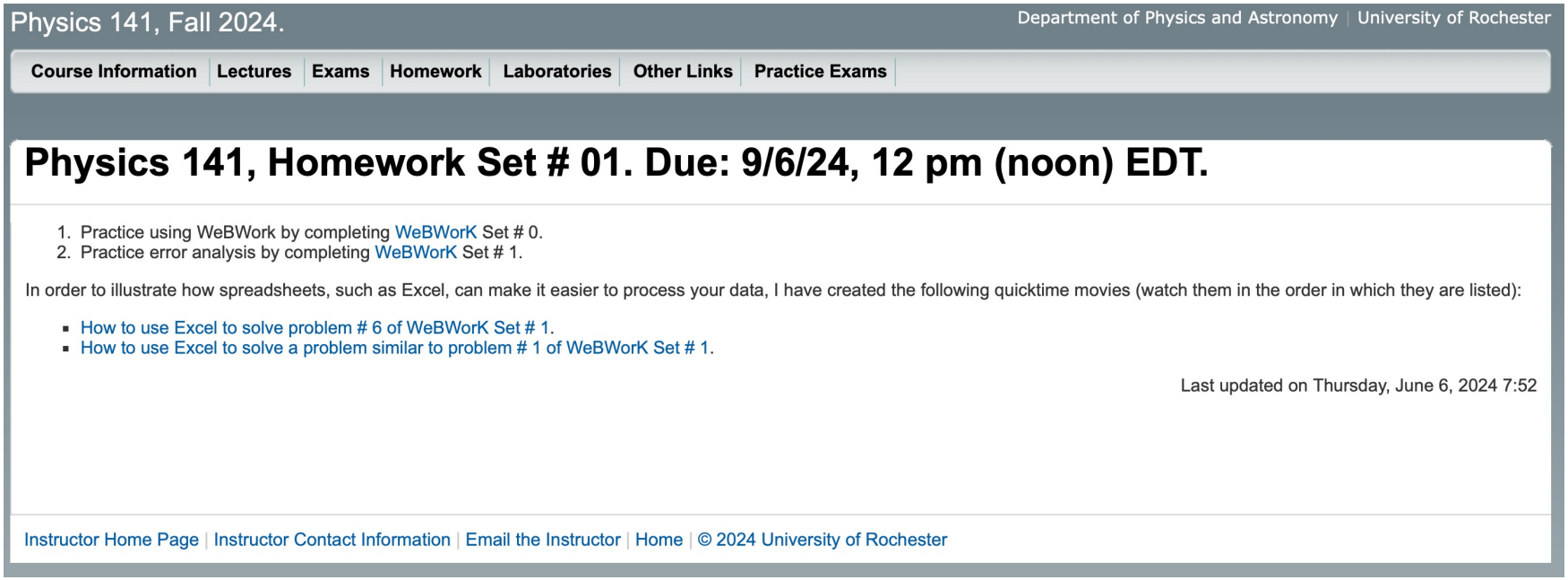
Physics 141 Homework.
More details during Lecture 02.



Physics 141, Fall 2024.

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Course Information | Lectures | Exams | Homework | Laboratories | Other Links | Practice Exams

Physics 141, Homework Set # 01. Due: 9/6/24, 12 pm (noon) EDT.

1. Practice using WeBWork by completing WeBWorK Set # 0.
2. Practice error analysis by completing WeBWorK Set # 1.

In order to illustrate how spreadsheets, such as Excel, can make it easier to process your data, I have created the following quicktime movies (watch them in the order in which they are listed):

- How to use Excel to solve problem # 6 of WeBWorK Set # 1.
- How to use Excel to solve a problem similar to problem # 1 of WeBWorK Set # 1.

Last updated on Thursday, June 6, 2024 7:52

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AND NOW ….

SOMETHING COMPLETELY DIFFERENT: UNITS!

Making measurements.
Using units.

- Theories in physics are developed on the basis of experimental observations, or are tested by comparing predictions with the results of experiments.
- Being able to carry out experiments and understand their limitations is a critical part of physics or any experimental science.
- In every experiment you make errors; understanding what to do with these errors is required if you want to compare experiments and theories.

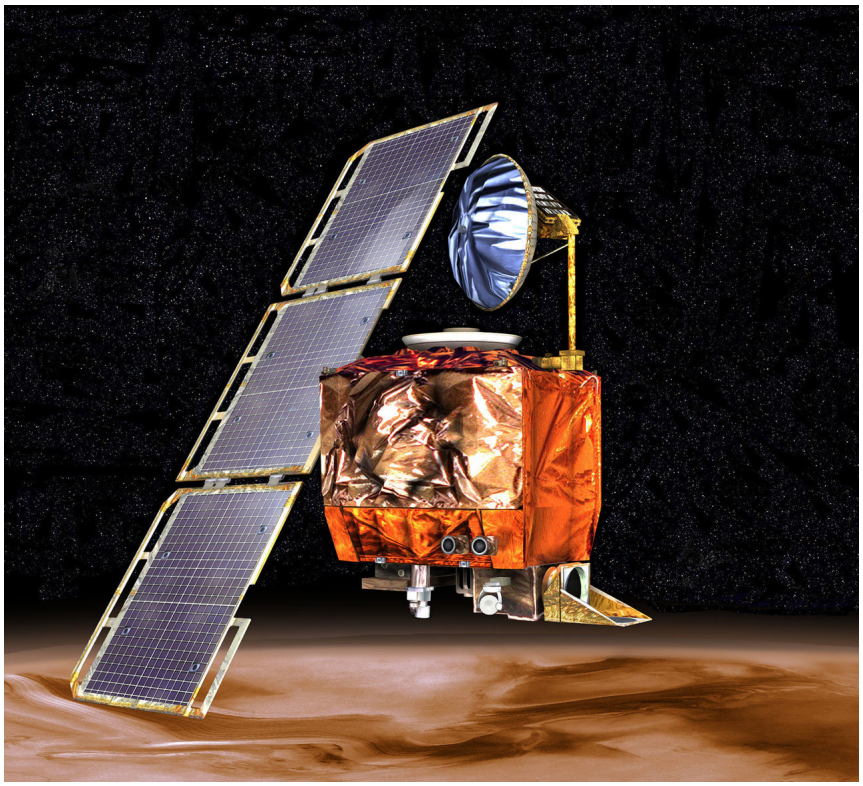
Making measurements. Using units.

- In order to report the results of experiments, we need to agree on a system of units to be used.
- Only if all equipment is calibrated with respect to the same standard can we compare the results of different experiments.
- Although different units can be used to report different measurements, we need to know what units are used and how to do unit conversions.
- Using the wrong units can lead to expensive mistakes.

http://science.ksc.nasa.gov/mars/msp98/images.html

The Mars Climate Orbiter.

- The orbiter burned up in the atmosphere of Mars on September 23, 1999.
- The cause of the burn up was due to different units used by different groups and lack of unit conversion:
  - The navigation team used the metric units: kg, m, s.
  - The company that built the orbiter used English units: pound, feet, second.
  - Someone did not convert the units.



https://science.nasa.gov/mission/mars-climate-orbiter/

Making measurements. Which mile? Which inch?

- If you use inches, which inches?
  - Swedish inches?
  - Dutch inches?
  - US inches?
- If you use miles, which miles?
  - Statute mile?
  - Nautical mile?
  - Scots mile?
  - Irish mile?
- Notes:
  - 1 nautical mile is 1/60th of a degree of latitude.
  - 1 nautical mile is 1,852 m.
  - 1 statute mile is 1,609 m.

Several carpenter's rulers were found aboard *Vasa*. The top three rulers employ the Swedish foot, with 12 inches, while the last one is based on the Dutch 11-inch foot. Measurement differences might have resulted in one side of the ship weighing much more than the other.

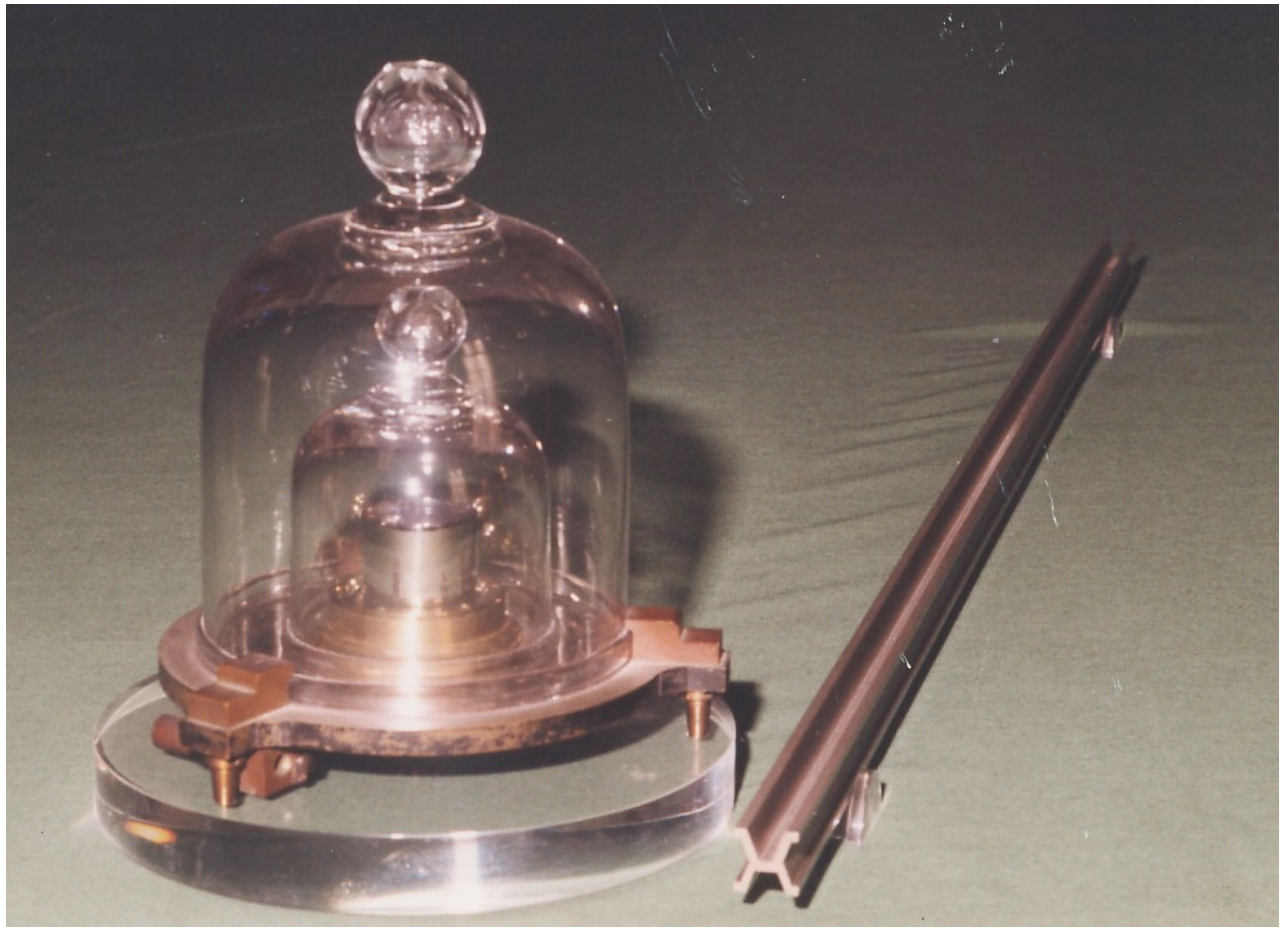
Discovering a new unit while walking Hadrian's Wall: the roman mile: 1.48 km.

Two turrets were built per roman mile.

Making measurements.
Using units.

- In this course we will use the SI System of units:
  - Length: meter (m)
  - Time: second (s)
  - Mass: kilogram (kg)
- The SI units are related to the units you use in your daily life:
  - Length: 1” = 2.54 cm = 0.0254 m
  - Conversion factors can be found in the front cover of the book.

The old base SI units.



The old standard of the kg and the old standard of the m.

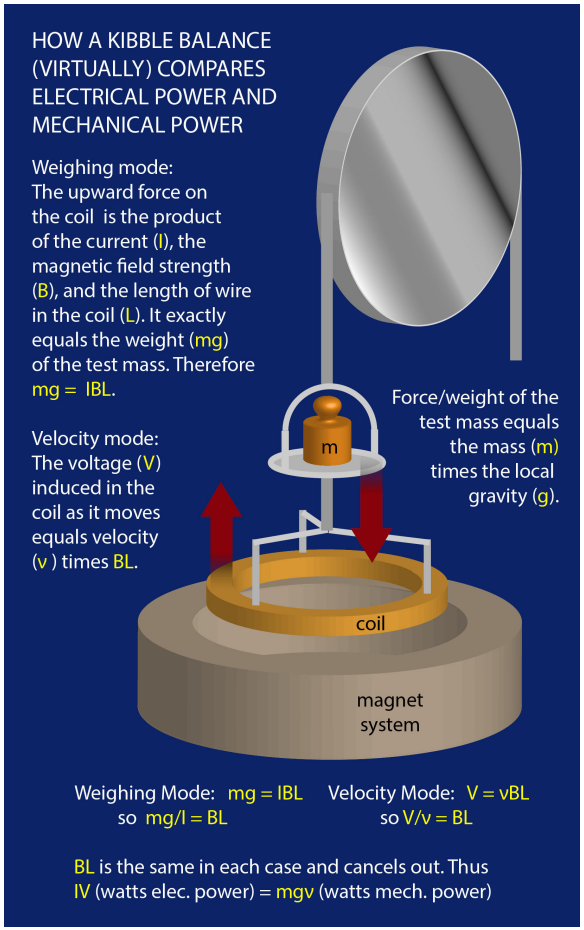
The base units.
The unit of length: changes over time!

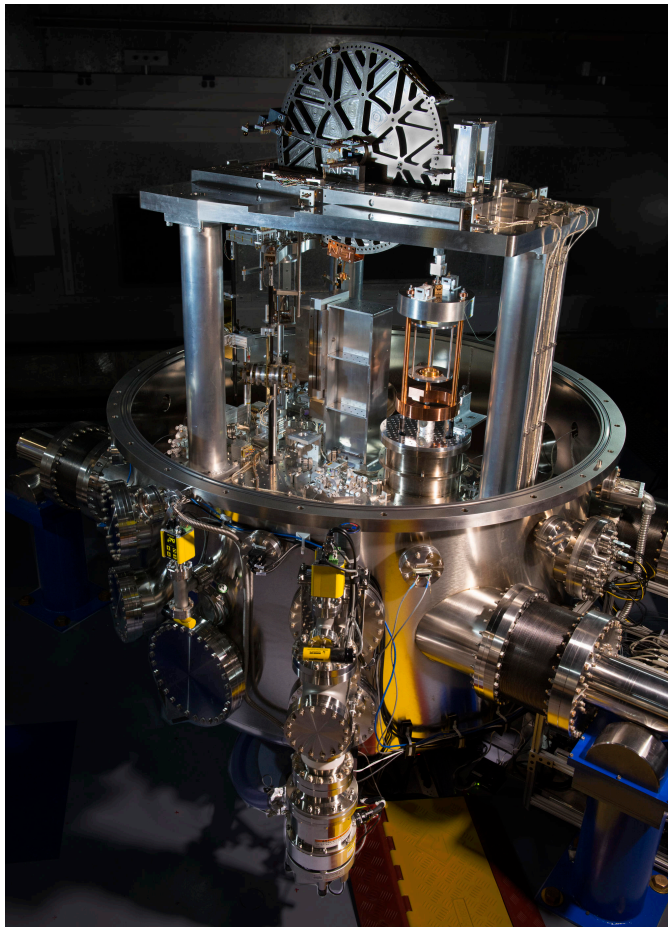
- One ten-millionth of the meridian line from the north pole to the equator that passes though Paris.
- Distance between 2 fine lines engraved near the ends of a Platinum-Iridium bar kept at the International Bureau of Weights and Measures in Paris.
- 1,650,763.73 Wavelengths of a particular orange-red light emitted by Krypton-86 in a gas discharge tube.
- Path length traveled by light in vacuum during a time interval of 1/299,792,458 of a second.

The base units.
Their current definitions.

- TIME - UNIT: SECOND (s)
  - One second is the time occupied by 919,263,170 vibrations of the light (of a specified wavelength) emitted by a Cesium-133 atom.
- LENGTH - UNIT: METER (m)
  - Path length traveled by light in vacuum during a time interval of 1/299,792,458 of a second.
- MASS - UNIT: KILOGRAM (kg)
  - Defined by taking the fixed numerical value of the Planck constant h to be $6.62607015 \times 10^{-34}$ when expressed in the unit J·s, which is equal to $kg \cdot m^2 \cdot s^{-1}$, where the meter and the second are defined in terms of c and $\Delta\nu_{Cs}$.

Calibrating the new mass scale.





https://www.nist.gov/si-redefinition/kilogram-kibble-balance

AND NOW ….

SOMETHING COMPLETELY DIFFERENT: ERROR ANALYSIS!

Error Analysis.
Some (but certainly not all) important facts.

- Why should we care?
- Types of errors.
- The Gaussian distribution - not all results can be described in terms of such distribution, but most of them can.
- Estimate the parameters of the Gaussian distribution (the mean and the width).
- Error propagation.
- The weighted mean.

- Note: Some of the following slides are based on the slides for a lab lecture, prepared by Prof. Manly of the Department of Physics and Astronomy.

Error Analysis.
Is statistics relevant to you personally?

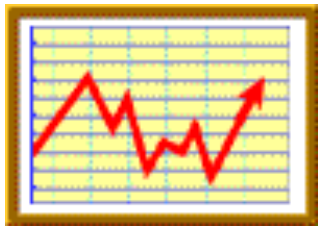
	Month 1	Month 2	
Bush	42%	41%	
Dukakis	40%	43%	
Undecided	18%	16%	±4%

Headline: Dukakis surges past Bush in polls!

Error Analysis.
Is statistics relevant to you personally?

Global Warming

Analytical medical diagnostics



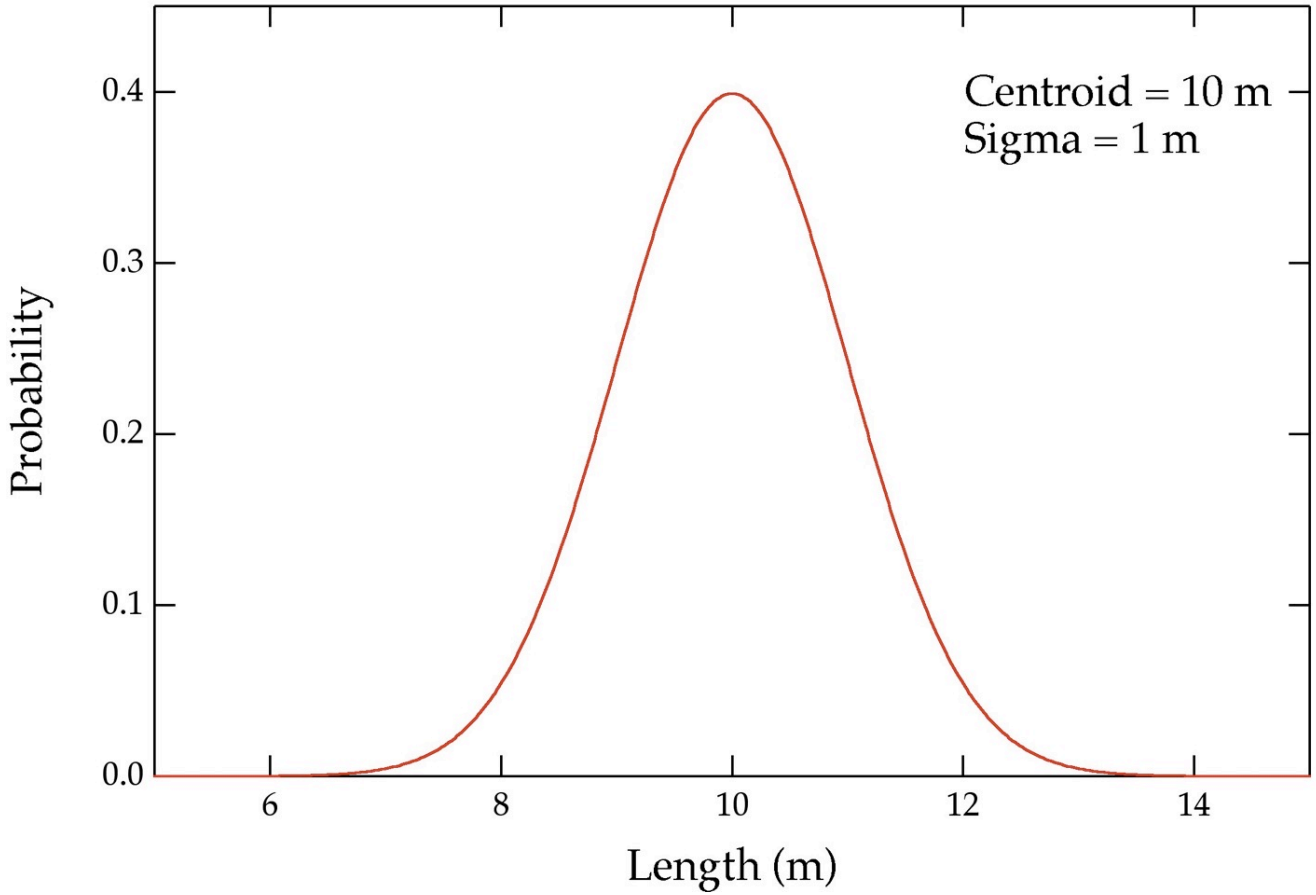
Effect of EM radiation

Error Analysis.
Type of Errors.

- Statistical errors:
  - Results from a random fluctuation in the process of measurement. Often quantifiable in terms of "number of measurements or trials". Tends to make measurements less precise.

- Systematic errors:
  - Results from a bias in the observation due to observing conditions or apparatus or technique or analysis. Tend to make measurements less accurate.

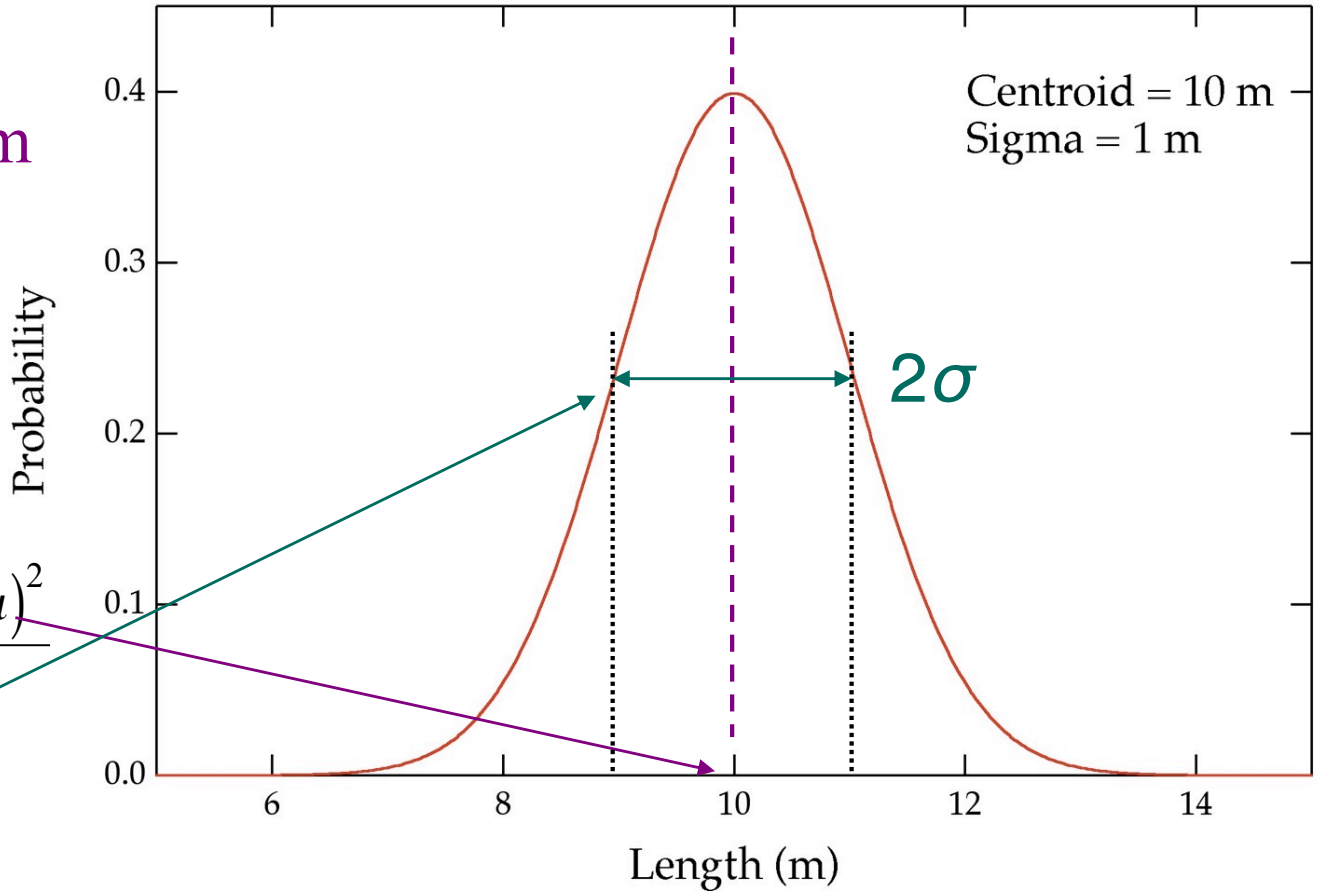
The Gaussian distribution: the most common error distribution.



The Gaussian Distribution: its mean and its standard deviation.

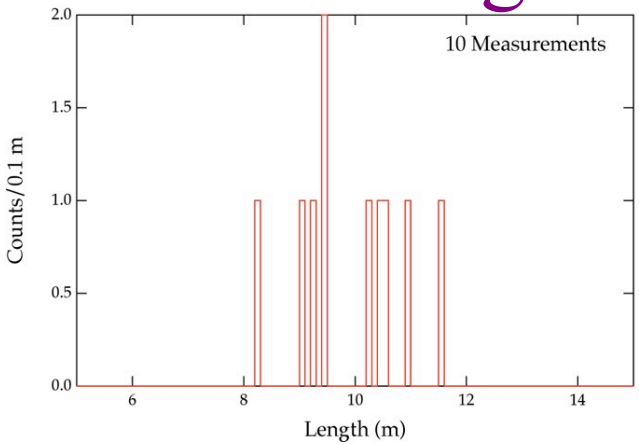
1σ is roughly the half-width at half-maximum of the distribution.

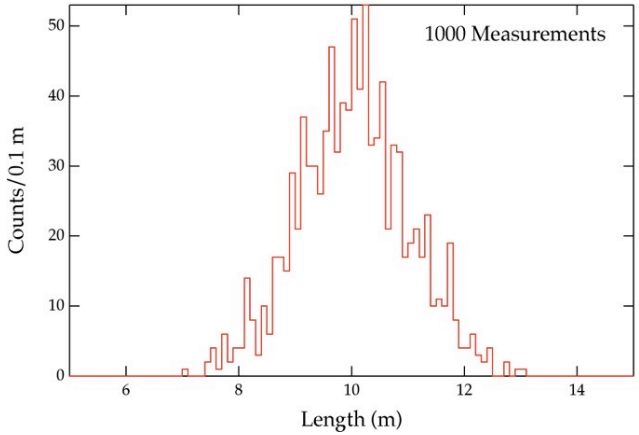
$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

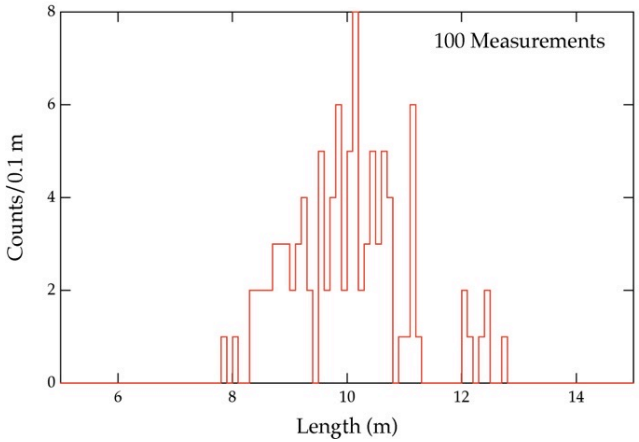


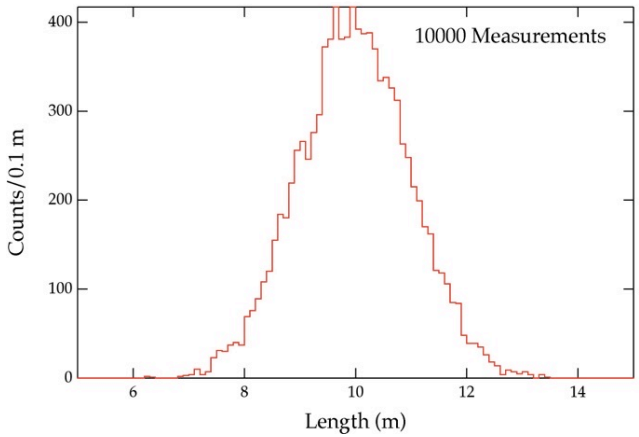
Making measurements: increasing the number of measurements increases the accuracy.

Length = 10 m, σ = 1 m.

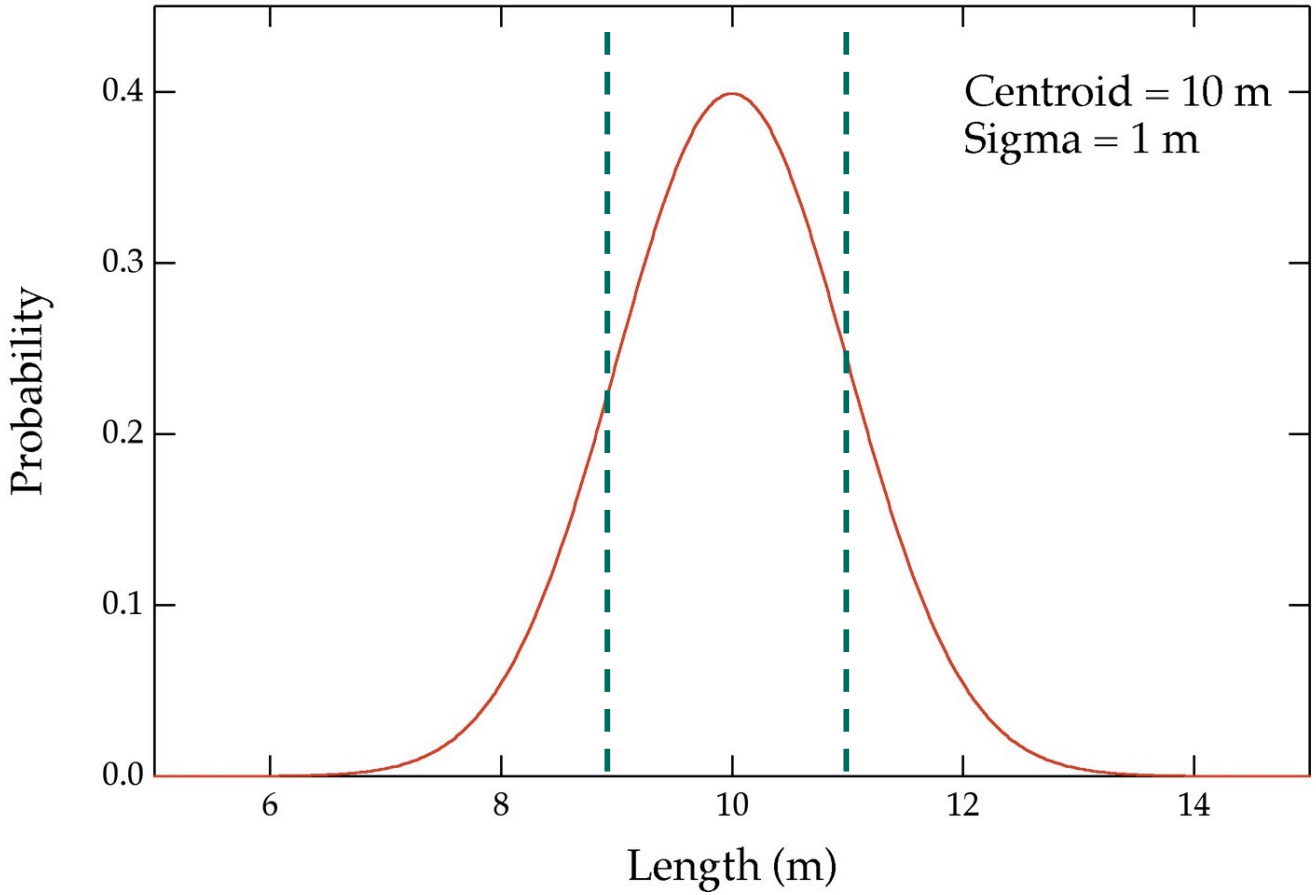




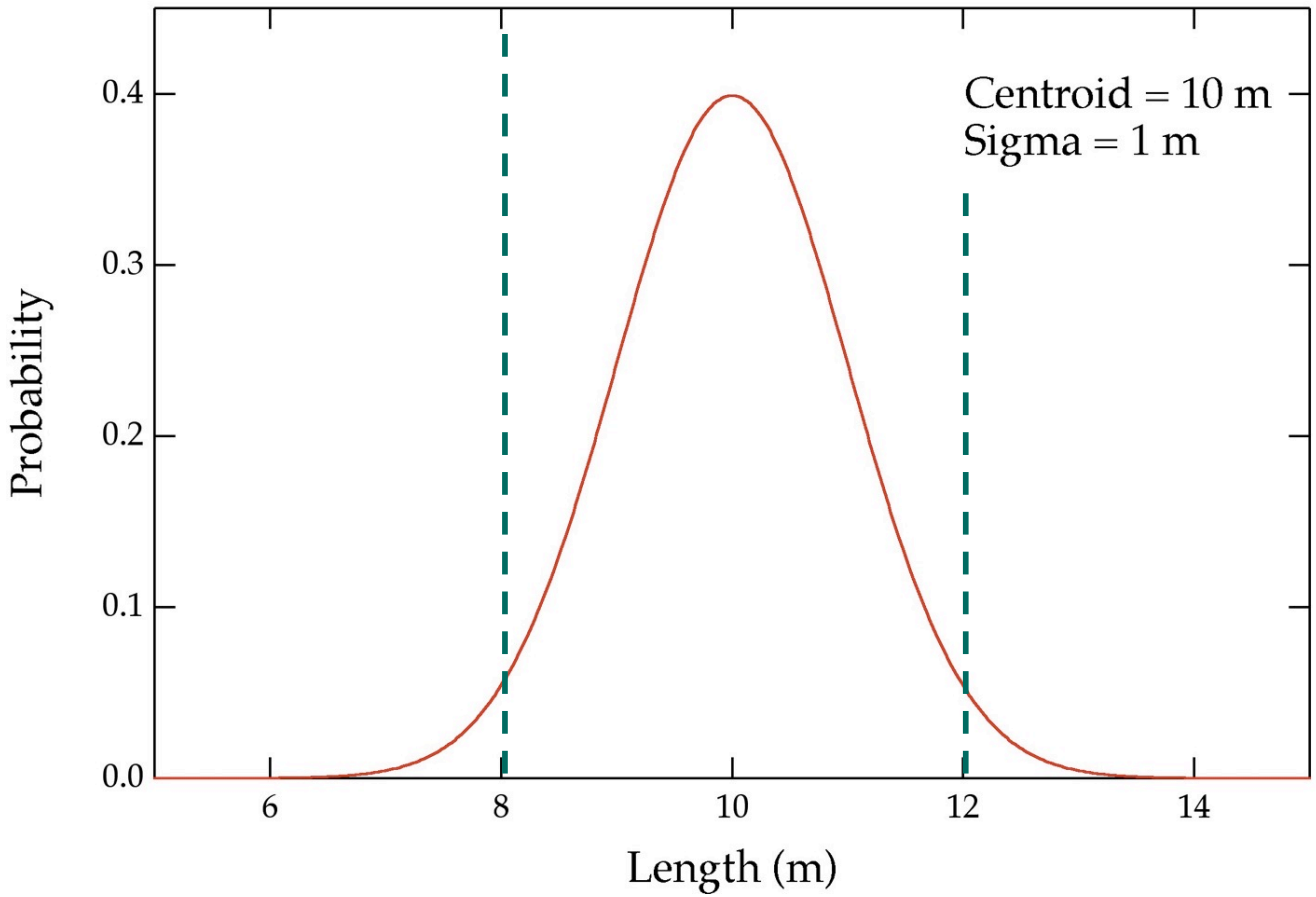




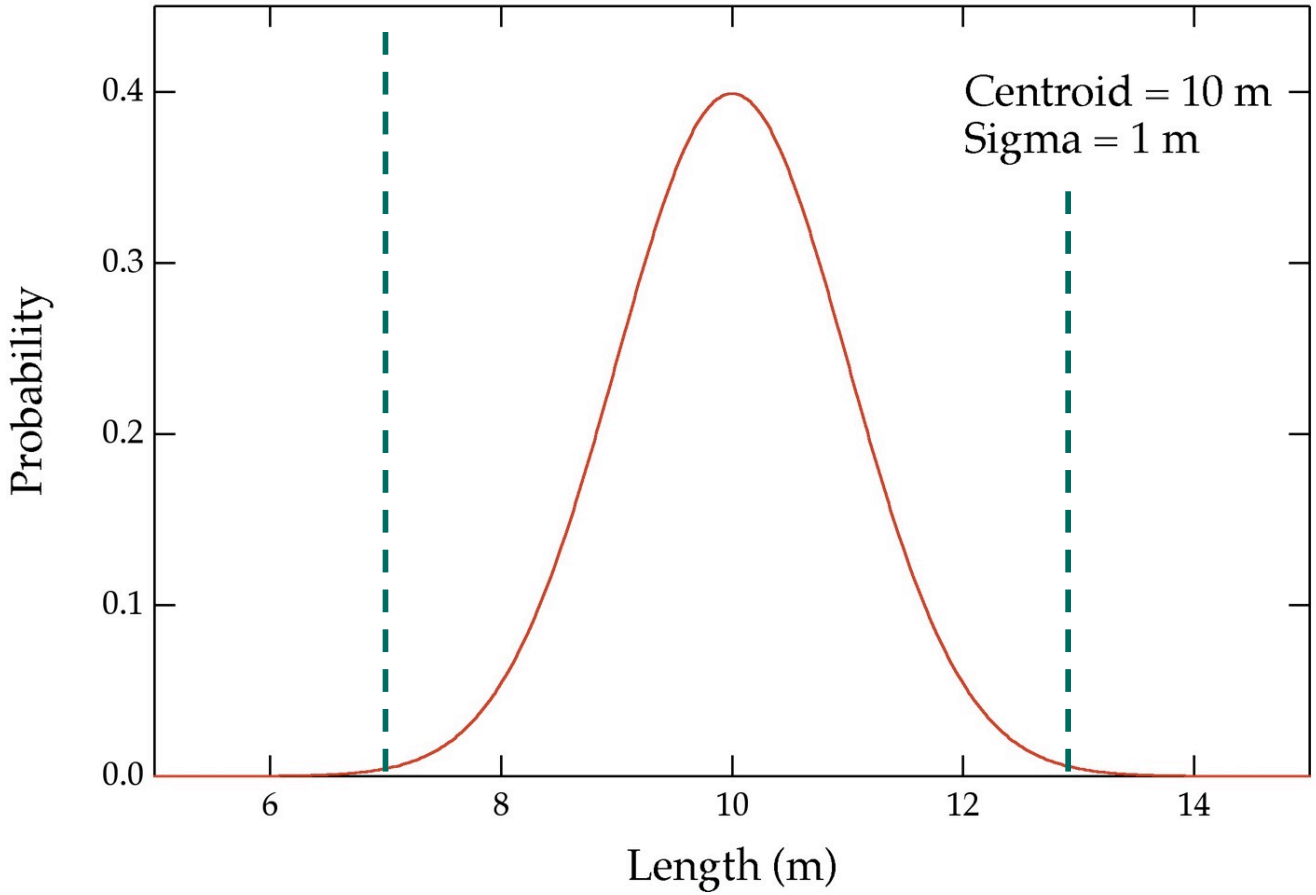
Probability of a single measurement falling within $\pm 1\sigma$ of the mean is 0.683.



Probability of a single measurement falling within $\pm 2\sigma$ of the mean is 0.954.



Probability of a single measurement falling within $\pm 3\sigma$ of the mean is 0.997.



Do you agree?

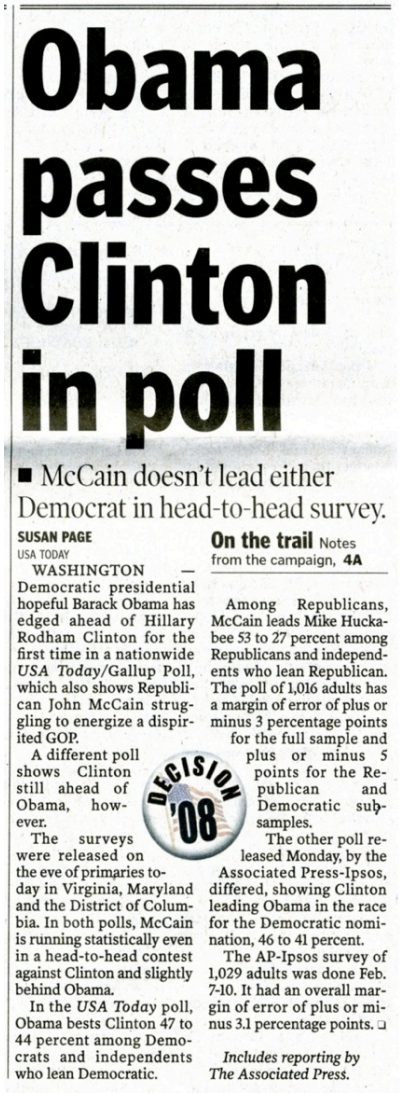
	Month 1	Month 2	
Bush	42%	41%	
Dukakis	40%	43%	
Undecided	18%	16%	±4%

Headline: Dukakis surges past Bush in polls!

Do you agree?

- The sampling error is ±5%.
- Do you agree with the conclusion of the article?

In the *USA Today* poll, Obama bests Clinton 47 to 44 percent among Democrats and independents who lean Democratic.



Obama passes Clinton in poll

■ McCain doesn't lead either Democrat in head-to-head survey.

SUSAN PAGE
USA TODAY

WASHINGTON — Democratic presidential hopeful Barack Obama has edged ahead of Hillary Rodham Clinton for the first time in a nationwide *USA Today*/Gallup Poll, which also shows Republican John McCain struggling to energize a dispirited GOP.

A different poll shows Clinton still ahead of Obama, however.

The surveys were released on the eve of primaries today in Virginia, Maryland and the District of Columbia. In both polls, McCain is running statistically even in a head-to-head contest against Clinton and slightly behind Obama.

In the *USA Today* poll, Obama bests Clinton 47 to 44 percent among Democrats and independents who lean Democratic.

On the trail Notes from the campaign, **4A**

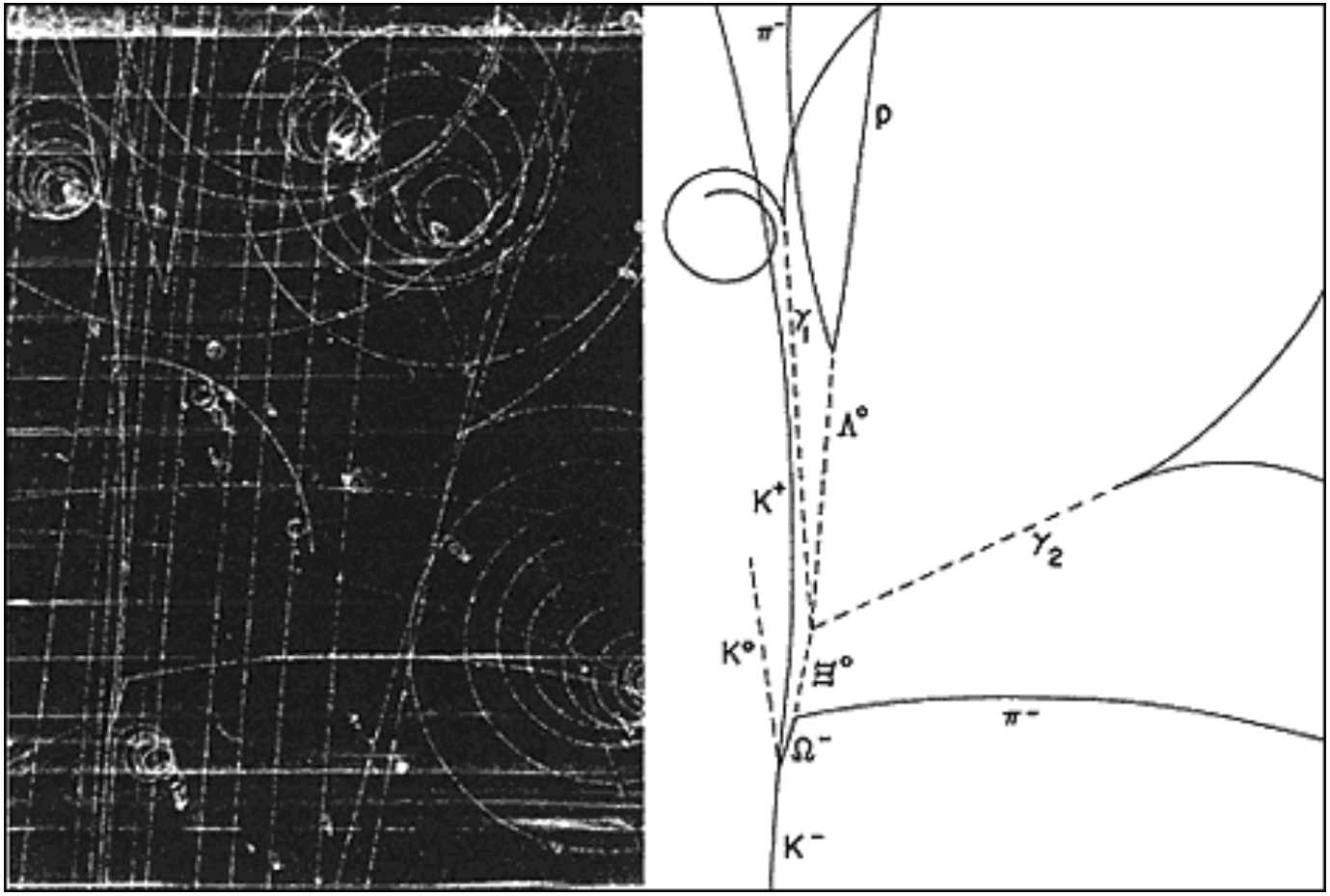
Among Republicans, McCain leads Mike Huckabee 53 to 27 percent among Republicans and independents who lean Republican. The poll of 1,016 adults has a margin of error of plus or minus 3 percentage points for the full sample and plus or minus 5 points for the Republican and Democratic subsamples.

The other poll released Monday, by the Associated Press-Ipsos, differed, showing Clinton leading Obama in the race for the Democratic nomination, 46 to 41 percent.

The AP-Ipsos survey of 1,029 adults was done Feb. 7-10. It had an overall margin of error of plus or minus 3.1 percentage points. ❑

Includes reporting by The Associated Press.

Done for today.
Next class: more about errors.



Credit: Brookhaven National Laboratory, NY, USA
http://www.bnl.gov/bnlweb/history/Omega-minus.asp