Physics 1425: General Physics I

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Michael Fowler

Room 307, Physics

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Today's Topics

- Course arrangements, syllabus outline.
- Nature of science: observation and measurement.
- Accuracy, significant figures.
- Units, mass of water, estimation.
- Unit conversions, useful approximations.

Basic Outline

The course has three main parts, each about a month, each followed by a midterm-like exam.

1. Dynamics, Newton's Laws, gravitation.
2. Work, energy and momentum conservation, torque and rotational dynamics.
3. Fluids, simple harmonic motion, heat and thermodynamics.

Part I: Dynamics

1. Preliminaries: measurement, estimation.
2. One-dimensional motion: velocity and acceleration.
3. Projectile motion, vectors.
4. Newton’s Laws of Motion.
5. Vector force diagrams. Friction.
6. Dynamics of circular motion.
7. Gravitation: Kepler’s Laws, Newton’s Law.

Nature of Science

www.mlahanas.de/Greeks/AristotleBiol.htm

Observation: here's Aristotle observing and noting.

Theorizing: finding general laws.

Checking: observe more and do experiments to check the theory!

Aristotle's Law of Motion:

Things move if pushed. Otherwise not. Wrong!

Better Observation: Galileo

- **Invented the telescope,** found the Moon not a perfect sphere, as believed.
- **Studied motion**: imagined a rolling ball without friction: would continue indefinitely, without being pushed!

Measurement and Uncertainty

Galileo, the first real physicist, also experimentally measured acceleration: the rate of increase of speed, of a falling object.

He found the acceleration to be constant, at his level of accuracy.

How do we quantify level of accuracy?

Need explicit statement of expected error:

Example: timing a 100 yard run with a stopwatch,

10.5± 0.1 seconds: Most likely 10.4 to 10.6 secs.

Significant Figures

Number of **reliably known digits**: not counting initial zeroes.

Examples: 62.0 three sig figs

0.0033 two sig figs

It's a measure of claimed accuracy.

Clicker Question!

0.0120 has how many significant figures?

A. 2
B. 3
C. 4
D. 5

0.0120 has three significant figures: the final three, the 120.

Putting that 0 at the end means the writer believes the true value is closer to 0.0120 than it is to 0.0119 or to 0.0121.

Writing 0.012 would just mean closer to 0.012 than to 0.011 or 0.013, so it could be 0.0116 .

Important

The accuracy of output of a calculation cannot exceed the accuracy of **any** of the input!

Calculators don't know this—**you** need to:

1.000/7.0 = 0.14 (correct)

NOT 0.142857142857…

DON'T write down meaningless digits!

(that 7.0 might more precisely be 7.03 or 6.96)

SI Units

Time: unit 1 second: defined as time for a certain excited atom (cesium) to make a specified number of oscillations.

Length: unit 1 meter: defined as distance light travels in a specified fraction of a second.

(The actual number of cesium atom oscillations (about 9 billion) is in the book, as is the precise distance—laser jocks know the speed of light is about one foot per nanosecond, but that's non-SI.)

SI Unit: Mass

- The unit of **mass** is the kilogram, defined as the mass of a chunk of platinum in Paris, shown here.
- From: http://en.wikipedia.org/wiki/File:CGKilogram.jpg
- In2011, a committee will recommend a more fundamental atomic definition.

Useful Fact: the Mass of Water

One liter of water has a mass of one kilogram.

One cubic meter is 1,000 liters.

One cubic meter of water has a mass of 1,000 kg, **one metric ton**, about 2,200 lbs.

Clicker Question: what is your volume in cubic meters, approximately?

A. 0.3
B. 0.2
C. 0.1
D. 0.07
E. 0.05

Powers of Ten

the video

Review Scientific Notation:

$1,234,000 = 1.234 \times 10^{6}$

$0.0000123 = 1.23 \times 10^{-5}$

Review factors of powers of 10 prefixes:

Most common are: (up) kilo, mega, giga, tera, …

(down) milli, micro, nano, pico, …

Each up or down from the next by a factor of 1,000

Converting Units

We'll work in **SI** units: but in the US other units are more common.

Exact conversion factors are in the book and elsewhere

BUT it's useful to memorize *approximate* equivalents for making rough estimates!

Examples ....

Useful Approximations

1 ft ≈ 30 cm

1 meter ≈ 1.1 yards

5 miles ≈ 8 kilometers

50 mph ≈ 80 kph ≈ 22 m/sec

1 kg ≈ 2.2 lbs (technically, kg is mass, lb is weight—so this *isn't* true on the Moon!)

1 gallon ≈ 4 liters

Rough Estimation

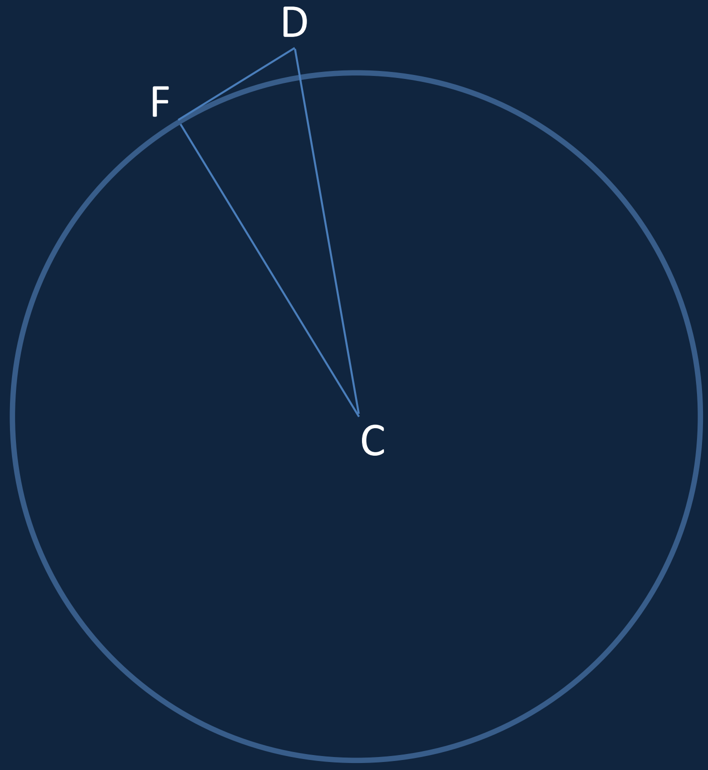
- The new Dubai skyscraper is just over 800 meters high.
- The view from the top extends to about 100 km.

- What is the radius of the Earth?

http://en.wikipedia.org/wiki/File:Dubail21.jpg

D is the top of the Dubai tower, F is the far horizon, C is the center of the Earth. DF is perpendicular to FC.

If the radius of the Earth is R, and the tower has height h, and the furthest visible distance is d, then $R^2 + d^2 = (R + h)^2$.



So $d^2 = 2Rh + h^2$, but h is much smaller than R, so the h^2 is negligible, we can say $d^2 = 2Rh$.

If a replica of the Dubai tower were erected on the Moon, how far away would you be able to see the Moon's surface from the top?

(The Moon's diameter = 0.25 Earth diameters, approximately.)

A. 400 km
B. 200 km
C. 100 km
D. 50 km
E. 25 km