Physics 102.002

Professor: Greg Taylor

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Course Goals: Develop your physical intuition

Class Web page: http://www.phys.unm.edu/~gbtaylor/phys102/

Course Text: *Conceptual Physics Fundamentals,* Hewitt

Webassign: YES, you need it.

i-Clickers: YES, you need one. Bring it to every class.

Homework: Reading, Review Questions at the end of each Chapter.

Grading: 10% class participation; 15% homeworks; 75% based on best 3 out of 4 tests. NOTE: there will be NO makeup tests.

Instructions Cont.

Syllabus: handed out, on-line & posted in Upper-West case so be sure to read it.

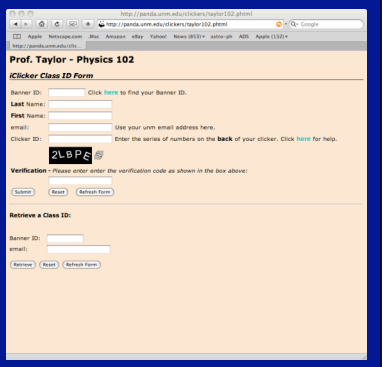
Tests: bring two number 2 pencils. Multiple-Choice.

Office-Hours: Tuesdays 9-11am in PandA 180

Campus Observatory: Fridays 8-10pm

How to Register your Clicker

1. Go to: http://panda.unm.edu/clickers/taylor102.phtml
2. Fill in requested fields:
3. Submit and record your Class ID



How to Register your Clicker cont.

4. Proceed to Clicker web site
5. Enter your BANNER ID for the Student ID
6. Enter your name and clicker number (on the back)
7. Submit and you are done

What is physics?

What is physics?

- The scientific study of matter and energy and how they interact with each other.

- A scientific description of nature which can be used to understand and predict its behavior.

If you include Astronomy (like we do at UNM), then physics is the oldest academic discipline and the most fundamental.

What is science?

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  - What are some patterns or cycles found in nature?

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- Human attempt to describe and understand the relationships that we observe in nature in terms of laws that govern the universe.
  - What are some patterns or cycles found in nature?
    - Seasons
    - Phases of moon
    - Arrow of time
    - Galaxies – spiral, elliptical, irregular
    - Radioactive decay
    - Heat flow: always hot to cold

Measurements

- What is a measurement?

Observations and Measurements

- What is a measurement?
  - An experiment that lets you gain information about some unknown property of an object.
    - Relies on your prior understanding of the experimental conditions.
    - Results in numbers being assigned to quantify "how much" of something the object has.
    - What are some examples of properties that we might want to measure?

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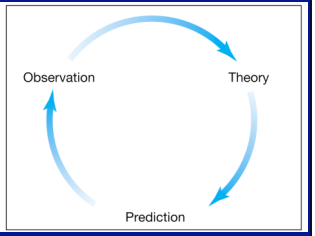
    - What are some examples of properties that we might want to measure?
      - Spatial properties: Size, mass, location, volume, density, etc.
      - Temporal properties: age, duration, lifetime
      - Momenturm, energy, speed, acceleration, etc.

The Scientific Method

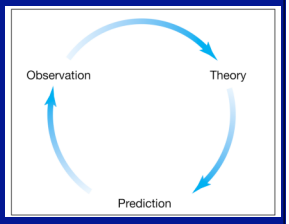
- Combines thinking (theory) and testing (experiment)
- If a prediction does not agree with experiment what must be done?



The Scientific Method

- Combines thinking (theory) and testing (experiment)
- If a prediction does not agree with experiment what do we do?

  Modify or abandon the theory.
- Cyclic process with no end
- Other factors
  - Trial and error
  - Intuition
  - Accidental discovery



Foundations

The Metric System
(used by scientists and foreigners)

Mass

1 kilogram (kg) = 1000 grams (g)

28 g = 1 ounce

If your mass is 220 lbs, it's also 100 kg.

We tend to use mass and weight interchangeably, but weight depends on gravity.

Distance

1 meter (m) = 100 centimeters (cm)
= 39.4 inches
(slightly longer than a yard - your professor is 1.8 m in height)

1 cm = 0.39 inches

Volume

1 cubic centimeter or 1 cm^3 = 0.06 cubic inches
(about the size of a sugar cube)

Density

Density = $\frac{\text{Mass}}{\text{Volume}}$ (g / cm^3)

Densities of Common Substances

Balsa Wood	0.13 g / cm^3
Oak	0.7
Gasoline	0.7
Plastic	~1.0
Water	1.0
Average Rock	2.4
Iron	7.9
Lead	11.3
Gold	19.3

See DEMO

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Temperature

The Celsius Scale:

T(°C) = 5/9 [T(°F) - 32 °F]

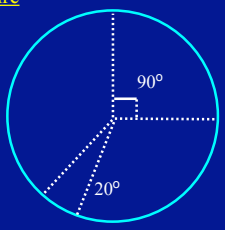
so 32 °F = 0 °C
212 °F = 100 °C
68 °F = 20 °C

The Kelvin Scale:

T(K) = T(°C) + 273 °C

"Absolute zero" 0 K = -273 °C

Angular Measure



360°, or 360 degrees, in a circle.

1° = 60' or arcminutes
1' = 60" or arcseconds
1" = 1000 mas or milli-arcseconds

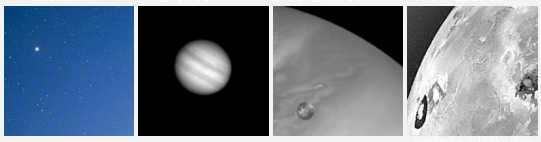
THE QUEST FOR RESOLUTION

Resolution = Observing wavelength / Telescope diameter

Angular Resolution	Optical (5000A) Diameter	Instrument	Radio (4cm) Diameter	Instrument
1′	2mm	Eye	140m	GBT+
1″	10cm	Amateur Telescope	8km	VLA-B
0.″05	2m	HST	160km	MERLIN
0.″001	100m	Interferometer	8200km	VLBI

Jupiter and Io as seen from Earth

1 arcmin 1 arcsec 0.05 arcsec 0.001 arcsec



Scientific Notation

(A shorthand way of writing very large and small numbers, which occur often in astronomy and physics).

We use powers, or exponents, of 10:

100	= 10^2 (= 10 x 10)
1000	= 10^3 (= 10 x 10 x 10)
1,000,000	= 10^6
10	= 10^1
1	= 10^0
0.1	= 10^{-1}
0.0001	= 10^{-4}
0.007	= 7 x 10^{-3}

Add the exponents

4000 x 0.002 = (4 x 10^3) x (2 x 10^{-3})
= 8 x 10^0 = 8

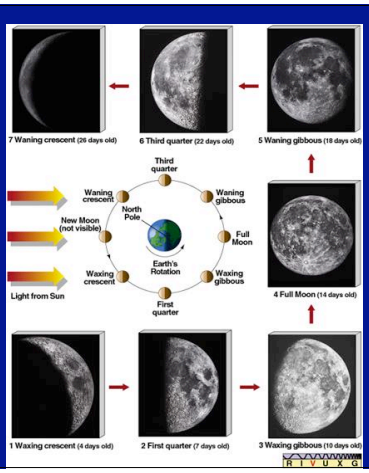
The Motion of the Moon

The Moon has a cycle of "phases", which lasts about 29 days.

Half of the Moon's surface is lit by the Sun.

During this cycle, we see different fractions of the sunlit side.

Which way is the Sun here?



Clicker Question:

One arcsecond is equal to:

A: 1/3600 degrees

B: 1/60 degrees

C: 60 arcminutes

D: 60 degrees

Clicker Question:

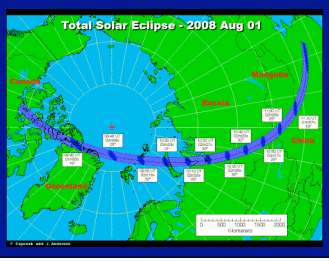
Have you ever seen a solar eclipse?

A: Total eclipse of the sun.

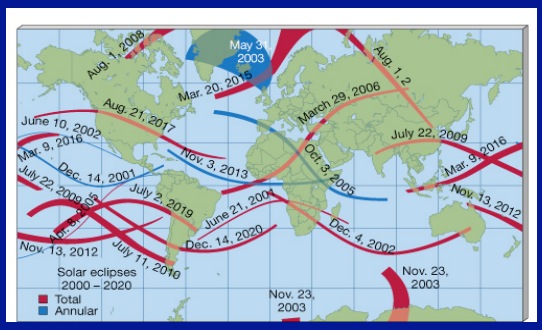
B: Partial solar eclipse.

C: None

Note: Total solar eclipse on August 1, 2008



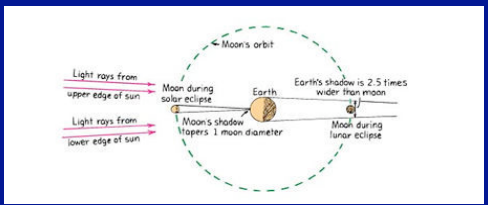
Recent and upcoming total and annular solar eclipses



The Motion of the Moon

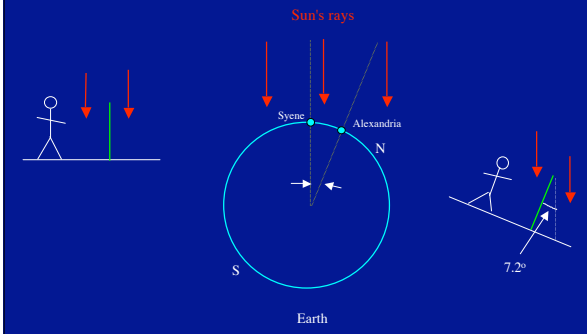
DEMO - Phases of the Moon

Inferring the Size of the Moon



- Moon's shadow during solar eclipse <= 270 km.
  - Very small => tapers by one moon diameter
  - Earth's shadow is 2.5 times wider than the moon
    - must taper by same amount during lunar eclipse => Earth is 3.5 times wider than the moon

Eratosthenes Determines the Size of the Earth in about 200 B.C.



He knows the distance between the two cities is 5000 "stadia".

From geometry then,

$$\frac{7.2^\circ}{360^\circ} = \frac{5000 \text{ stadia}}{\text{Earth's circumference}}$$

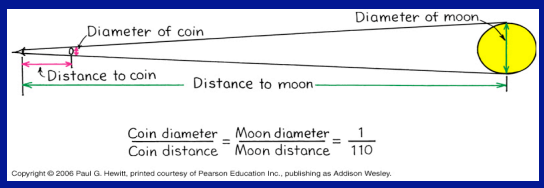
=> circumference is 250,000 stadia, or 40,000 km.

So radius is:

$$\frac{40{,}000 \text{ km}}{2\pi} = 6366 \text{ km}$$

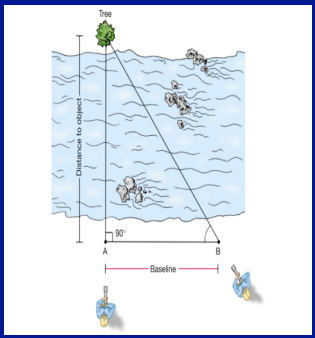
(very close to modern value, 6378 km!)

Determining the Distance to the Moon



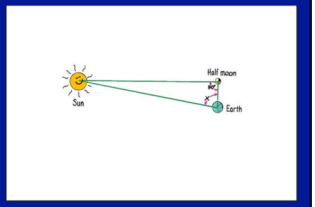
Triangulation - Using Geometry to Measure Distances

- Know:
  - Angle at A
  - Angle at B
  - Length of Baseline
- Calculate:
  - Distance to object



The Earth-Sun Distance

- At any time exactly half of the moon's surface is lit by the sun.
- During a quarter moon we only see ½ of this half.
- Knowing Earth-Moon distance and measuring angle `X' we can find Earth-Sun distance.
  - Wait for a quarter moon and use triangulation



Clicker Question:

Have you seen a lunar eclipse?

A: Total eclipse of the moon.

B: Partial lunar eclipse.

C: None

Why don't we get eclipses every month?

A: The moon has lots of holes in it.

B: The moon moves too far away to block the sunlight.

C: The orbit of the moon is tilted.

D: We do get them every month but don't notice.