

Physics 102.002

Professor: Greg Taylor

Phys 102.002

Professor: Greg Taylor

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.html>
2. Fill in requested fields:
3. Submit and record your Class ID

The screenshot shows a web browser window with the URL <http://panda.unm.edu/clickers/taylor102.html>. The page title is "Prof. Taylor - Physics 102 Clicker Class ID Form". It contains a registration form with fields for Banner ID, Last Name, First Name, email, and Clicker ID. There is a "Click here to find your Banner ID" link. A CAPTCHA image shows the letters "ZLBPS". Below the CAPTCHA is a "Verification" section with a "Submit" button. At the bottom, there is a "Retrieve a Class ID" section with fields for Banner ID and email, and "Retrieve" and "Refresh Form" buttons.

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

The screenshot shows the "iClicker Web Registration" page. It has a header with the "iClicker" logo. The main content area says "Have questions about clicker registration? Contact us at support@iClicker.com or 866-209-0688. Thank you for using iClicker! Please complete the form below. Your professor will then be able to give you credit for using your iClicker in class." There are input fields for First Name, Last Name, Student ID, and Clicker ID. A CAPTCHA image shows the number "580692". Below the CAPTCHA is a "Submit" button. At the bottom, there is a note: "To enable your clicker ID, see the back of your clicker and enter the series of numbers on the bottom of your clicker."

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?

What is science?

- 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?

What is science?

- 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

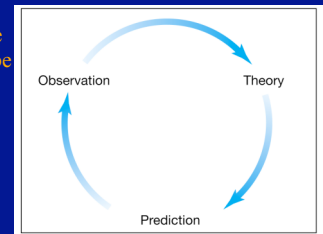
- What is a measurement?
 - An experiment that lets you gain information about some unknown property of an object.
 - Relies on your prior understanding of the experimental conditions.
 - Results in numbers being assigned to quantify “how much” of something the object has.
 - What are some examples of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

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?
 - Spatial properties: Size, mass, location, volume, density, etc.
 - Temporal properties: age, duration, lifetime
 - Momentum, energy, speed, acceleration, etc.

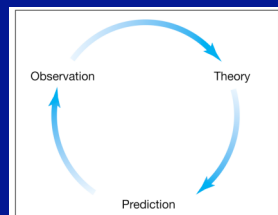
The Scientific Method

- 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 cm³ = 0.06 cubic inches
(about the size of a sugar cube)

Density

Density = $\frac{\text{Mass}}{\text{Volume}}$ (g / cm³)

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

Density

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

Densities of Common Substances

Balsa Wood	0.13 g / cm ³
Oak	0.7
Gasoline	0.7
Plastic	0.9
Water	1.0
Average Rock	2.4
Iron	7.9
Lead	11.3
Gold	19.3

Temperature

The Celsius Scale:

$$T(^{\circ}\text{C}) = 5/9 [T(^{\circ}\text{F}) - 32^{\circ}\text{F}]$$

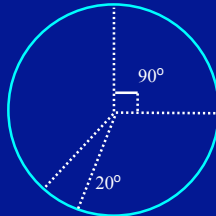
$$\begin{aligned} \text{so } 32^{\circ}\text{F} &= 0^{\circ}\text{C} \\ 212^{\circ}\text{F} &= 100^{\circ}\text{C} \\ 68^{\circ}\text{F} &= 20^{\circ}\text{C} \end{aligned}$$

The Kelvin Scale:

$$T(\text{K}) = T(^{\circ}\text{C}) + 273^{\circ}\text{C}$$

$$\text{"Absolute zero"} \quad 0 \text{ K} = -273^{\circ}\text{C}$$

Angular Measure



360°, or 360 degrees, in a circle.

$$1^{\circ} = 60' \text{ or arcminutes}$$

$$1' = 60'' \text{ or arcseconds}$$

$$1'' = 1000 \text{ mas or milli-arcseconds}$$

THE QUEST FOR RESOLUTION

Resolution = Observing wavelength / Telescope diameter				
Angular Resolution	Optical (5000Å)		Radio (4cm)	
	Diameter	Instrument	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

Atmosphere gives 1" limit without corrections which are easiest in radio



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

$$\begin{aligned} 4000 \times 0.002 &= (4 \times 10^3) \times (2 \times 10^{-3}) \\ &= 8 \times 10^0 = 8 \end{aligned}$$

← Add the exponents

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?





One arcsecond is equal to:

- ## Clicker Question:

A: Total eclipse of the sun.
B: Partial solar eclipse.
C: None

Total Solar Eclipse - 2008 Aug 01

This map shows the path of the total solar eclipse across the Arctic region. The path is marked by a thick purple line, with the central line indicating the path of totality. Key locations and times are labeled along the path:

- Greenland:** Nuuk (07:08), Qaanaaq (07:10), Upernivik (07:12), Umanak (07:14), Umanak (07:16), Umanak (07:18), Umanak (07:20), Umanak (07:22), Umanak (07:24), Umanak (07:26), Umanak (07:28), Umanak (07:30), Umanak (07:32), Umanak (07:34), Umanak (07:36), Umanak (07:38), Umanak (07:40), Umanak (07:42), Umanak (07:44), Umanak (07:46), Umanak (07:48), Umanak (07:50), Umanak (07:52), Umanak (07:54), Umanak (07:56), Umanak (07:58), Umanak (08:00).
- Canada:** Inuvik (08:02), Tuktoyaktuk (08:04), Tuktoyaktuk (08:06), Tuktoyaktuk (08:08), Tuktoyaktuk (08:10), Tuktoyaktuk (08:12), Tuktoyaktuk (08:14), Tuktoyaktuk (08:16), Tuktoyaktuk (08:18), Tuktoyaktuk (08:20), Tuktoyaktuk (08:22), Tuktoyaktuk (08:24), Tuktoyaktuk (08:26), Tuktoyaktuk (08:28), Tuktoyaktuk (08:30), Tuktoyaktuk (08:32), Tuktoyaktuk (08:34), Tuktoyaktuk (08:36), Tuktoyaktuk (08:38), Tuktoyaktuk (08:40), Tuktoyaktuk (08:42), Tuktoyaktuk (08:44), Tuktoyaktuk (08:46), Tuktoyaktuk (08:48), Tuktoyaktuk (08:50), Tuktoyaktuk (08:52), Tuktoyaktuk (08:54), Tuktoyaktuk (08:56), Tuktoyaktuk (08:58), Tuktoyaktuk (09:00).
- Russia:** Umanak (09:02), Umanak (09:04), Umanak (09:06), Umanak (09:08), Umanak (09:10), Umanak (09:12), Umanak (09:14), Umanak (09:16), Umanak (09:18), Umanak (09:20), Umanak (09:22), Umanak (09:24), Umanak (09:26), Umanak (09:28), Umanak (09:30), Umanak (09:32), Umanak (09:34), Umanak (09:36), Umanak (09:38), Umanak (09:40), Umanak (09:42), Umanak (09:44), Umanak (09:46), Umanak (09:48), Umanak (09:50), Umanak (09:52), Umanak (09:54), Umanak (09:56), Umanak (09:58), Umanak (10:00).
- Alaska:** Umanak (10:02), Umanak (10:04), Umanak (10:06), Umanak (10:08), Umanak (10:10), Umanak (10:12), Umanak (10:14), Umanak (10:16), Umanak (10:18), Umanak (10:20), Umanak (10:22), Umanak (10:24), Umanak (10:26), Umanak (10:28), Umanak (10:30), Umanak (10:32), Umanak (10:34), Umanak (10:36), Umanak (10:38), Umanak (10:40), Umanak (10:42), Umanak (10:44), Umanak (10:46), Umanak (10:48), Umanak (10:50), Umanak (10:52), Umanak (10:54), Umanak (10:56), Umanak (10:58), Umanak (11:00).
- Chukotka:** Umanak (11:02), Umanak (11:04), Umanak (11:06), Umanak (11:08), Umanak (11:10), Umanak (11:12), Umanak (11:14), Umanak (11:16), Umanak (11:18), Umanak (11:20), Umanak (11:22), Umanak (11:24), Umanak (11:26), Umanak (11:28), Umanak (11:30), Umanak (11:32), Umanak (11:34), Umanak (11:36), Umanak (11:38), Umanak (11:40), Umanak (11:42), Umanak (11:44), Umanak (11:46), Umanak (11:48), Umanak (11:50), Umanak (11:52), Umanak (11:54), Umanak (11:56), Umanak (11:58), Umanak (12:00).

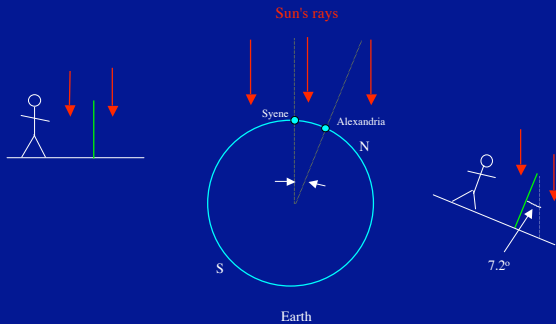
The map also shows the path of the partial eclipse, indicated by a thinner purple line. The path of totality is shown as a thick purple line. The map includes latitude and longitude lines, and a scale bar indicating distances in kilometers and miles.

DEMO - Phases of the Moon

The diagram illustrates the Moon's orbit around Earth. A dashed green circle represents the Moon's orbit. Earth is shown as a yellow sphere in the center. The Moon is shown as a smaller grey sphere. Light rays from the Sun are shown as parallel lines. The diagram shows the Moon during a solar eclipse (between Earth and Sun) and during a lunar eclipse (Earth between Sun and Moon). Labels include: "Moon's orbit", "Moon during solar eclipse", "Earth", "Earth's shadow is 2.5 times wider than moon", "Moon's shadow", "Vegeter 1 moon diameter", "Moon during lunar eclipse", "Light rays from upper edge of sun", "Light rays from lower edge of sun".

- 5

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,

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

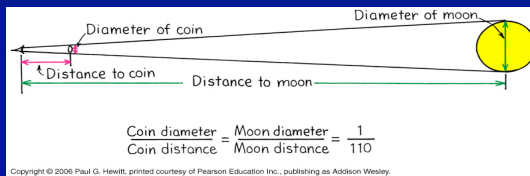
=> circumference is 250,000 stadia, or 40,000 km.

So radius is:

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

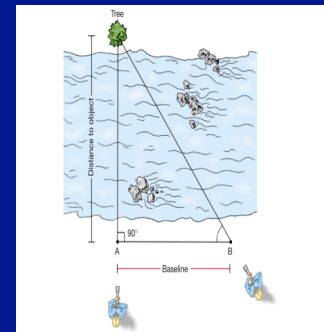
(very close to modern value, 6378 km!)

Determining the Distance to the Moon



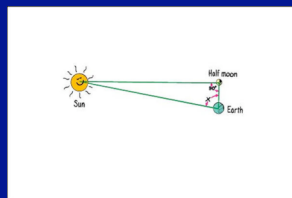
Triangulation - Using Geometry to Measure Distances

- 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 1/2 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.

