09 / 28 / 07

Friday, September 28, 2007
10:01 AM

Scientific Notation

$10,000,000,000 = 1 \times 10^{10}$

$0.0003 = 1 \times 10^{-4}$

Typical Atom Size = 1×10^{-10}

Width of a DNA Strand = 1×10^{-9}
= 1 nanometer

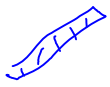
Protein Atom = 1×10^{-8}

Visible Light Wavelength =
$= 1 \times 10^{-7}$

Crystals of Silver Halides = 1×10^{-6}
= 1 Micrometer

Eukryotic (Animal Cells) = 1×10^{-5}

Human Hair = 1×10^{-4}

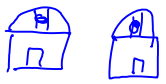


Pupil Diameter = 1×10^{-3}
= Millimeter

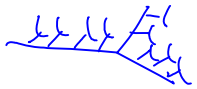
Camera = 1×10^{-2}

Backyard Telescope = 1×10^{-1} 

Hubble Telescope = 1×10^{0} (meter)

Twin Tech Telescopes = 1×10^{1} 

Aricebo Radio Telescope = 1×10^{2} 

VLA = 1×10^{3} 

Santa Barbara = 1×10^{4}

Hawaii = 1×10^{5} (Big Island)

Moon = 1×10^{6} Jupiter = 1×10^{8}

Earth = 1×10^{7} Sun = 1×10^{9}

Distance from Earth to Mars = 1×10^{10}

Sun as a red giant = 1×10^{11}

Size of our Solar System = 1×10^{12}

Heliosphere = 1×10^{13}

Separation Distance (Binary Stars) = 1×10^{14}

Planetary Nebula = 1×10^{15}

Planetary Nebula = 1×10^{15}

Open Cluster = 1×10^{16} = 1 lightyear

Crab Nebula = 1×10^{17} = 10 LY

Globular Cluster = 1×10^{18}

Spiral Galaxy Width = 1×10^{19}

Spiral Galaxy Diameter = 1×10^{20}

Radial Galaxy = 1×10^{21}

Cluster of Galaxies = 1×10^{22}

Supercluster of Galaxies = 1×10^{23}

Hubble Photos

Big Bang Model = 1×10^{24}

Distribution of Universe = 1×10^{25}

Observable Universe = 1×10^{26}

10 / 03 / 07

Wednesday, October 03, 2007
10:06 AM

homework questions online.

http://www.physics.ucsb.edu/~astro1

Small Angle Formula:
Theta (Radians) = D / d
Where D = linear diameter
Where d = distance to object

Alpha (angle) 206,265 x (D / d)
Answer = arc seconds

Metric (logical)	English (crazy)
millimeter, meter, kilo	inch, foot, yard, mile
gram, kilogram	pound, ounce
liter, kiloliter	fluidounce, gallon

Temperatures:
Kelvin Celsius Fahrenheit
Have problems with negative temps
Zero Degrees Calvin = Absolute Zero

Length Conversion:

5 (ly) = 5 (ly) x 1 = 10^16 / 1 (ly) = 5 (10^16)

Speed of Light is 3 x 10^8 m/s

Angle Conversion:

1 (Circle) = 360 (Degrees) = 2pi (Radians)
Pi radians = 180 degrees

1 (degree) = 60' (minutes)
1' minutes = 60'' (arcseconds)
1 degree = 3600 arcseconds

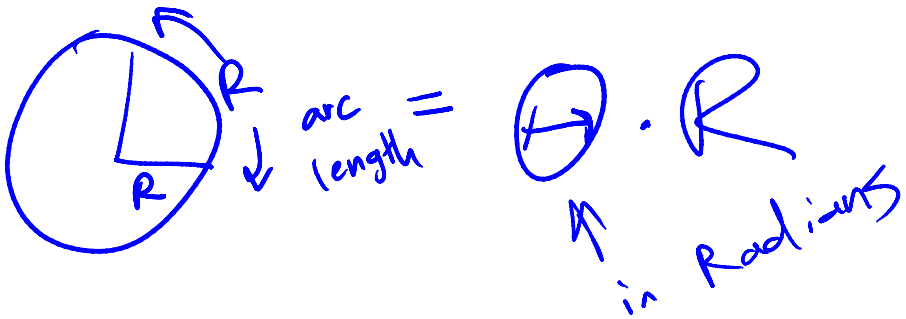
Diameter of the moon:

D (moon) 384,400 (km) =

Radians:

Friday, October 05, 2007
12:59 PM

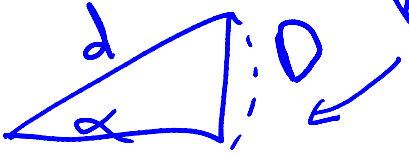
$\theta = 2\pi r$, $r = 1$, θ



Small Angle Formula:

$$D = \frac{d\,\alpha}{206{,}265}$$

α: arc secs



using arc length Doesn't Matter

α: radians

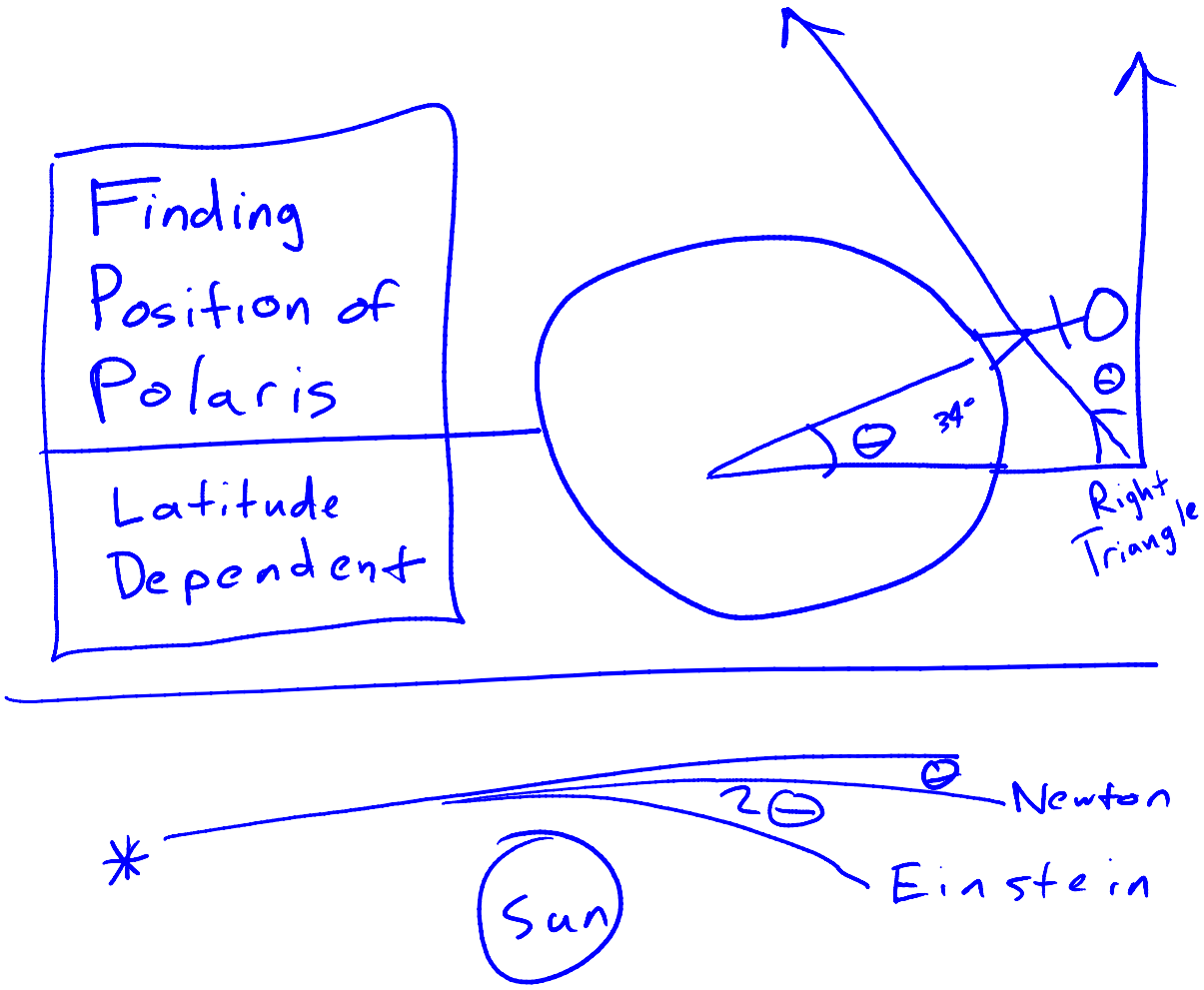
$$D = d\,\theta$$

10 / 05 / 07

Friday, October 05, 2007
10:04 AM

Diurnal Motion

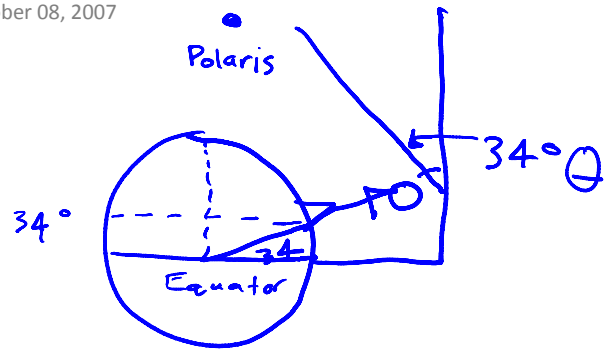
- 1905 = Albert Einstein's theory of spacetime / speed of light is constant
- 1915 = Theory on Sunlight Deflection



Zenith: Straight up from wherever you are from earth, changes based on your position

10 / 08 / 07

Monday, October 08, 2007
10:02 AM



During the summer, the sun is closer to your zenith, making it warmer and the days longer

---

Phases of the Moon

We always see the same face of the moon

Period of Earth's rotation is the same as it's orbit

Earth doesn't block light to moon

Solar Corona: Jets of Hot Gas

Size of moon changes because it is eliptical

Annular Eclipse: Moon further from us

Moon passes through shadow of earth

Light through atmosphere: Blue scattered / Red passes

10 / 10 / 07

Wednesday, October 10, 2007
10:09 AM

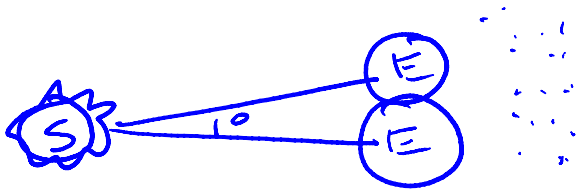
Moon = a inches
Physical Diameter of Moon = 3,500 km

Distance from Earth to Moon = 400,000 km

$$\frac{D_{moon}}{D_{ball}} = \frac{d \text{ Earth to Moon}}{d \text{ ball to globe}}$$

10 / 12 / 07

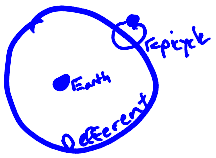
Friday, October 12, 2007
10:07 AM

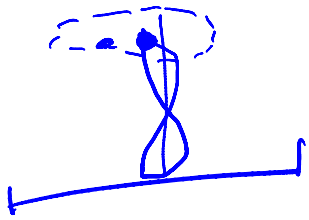


- The motion of the planets
- Ancient Greeks had the belief that the earth is the center of the universe
    - Ptolemy: Earth centric view of universe
    - Nicolaus Copernicus: proposed the sun is the center of the universe (heliocentric)
    - Tycho Brahe, Johannes Kepler, Galileo Galilei: solidified heliocentric model / using mathematics
    - Isaac Newton: Father of modern physical science: first comprehensive physical theory (gravity)
    - Albert Einstein: space-time/ general relativity / proved during a total solar eclipse
- Retrograde Motion: the differing paths that the planets follow around the earth.
- Sidereal day: the duration of time it takes the earth to make one full revolution in relation to the background starts
    - 24 hours is only the time it takes for the sun to make a full revolution which is slightly different than a sidereal day.
    - Occurs because over the course of a day, the earth has moved about 1 degree along its path around the sun.
- Ancient greeks believe the stars moved opposite the sun and moon to account for retrograde motion
- Acquems razor: physical problems must have the simplest explanation
- Copernicus: problem with his theory was that the planets do not travel in perfectly circular orbits.

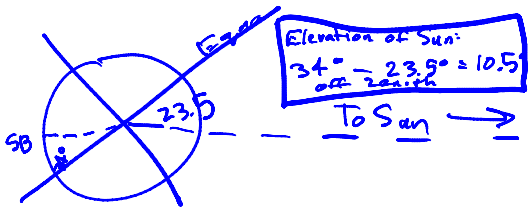
10 / 15 / 07

Monday, October 15, 2007
9:58 AM





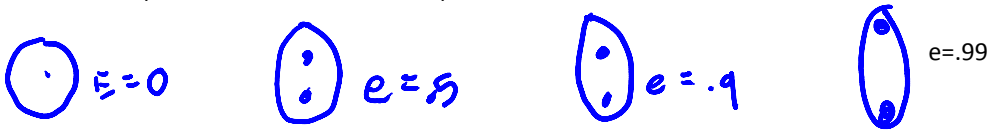
Summer Solstice: latitude - 23.5
Winter Solstice: latitude + 23.5
Answers will be difference from horizon
Subtract totals from 90 for elevation of horizon



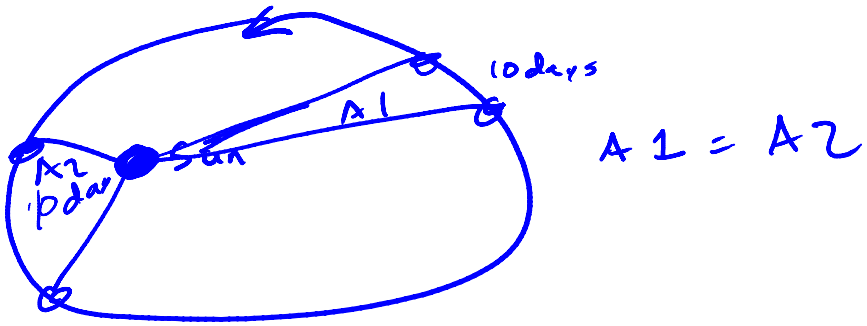
Ptolomy: Geocentric
Nicolaus Copernicus: heliocentric to explain retrograde motion
Tycho Brahe: precise data down to arcminute (worked with Kepler) (party animal)
Johannes Kepler: Use of elliptical paths to explain brahe's data (worked with brahe)
Galileo Galilei: First irrefutable evidence that sun is the center
Isaac Newton:

KEPLER: 3 laws of planetary motion. He did not know anything about gravity, but relied solely on empirical data.

1) The orbit of a planet around the sun is ellipse with the sun at one focus



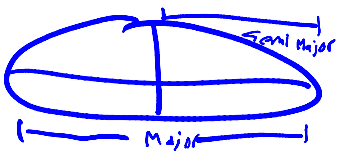
2) A line joining a planet and the Sun weeps out equal areas in equal intervals of time.



3) The square of a planet's orbital period is equal to the cube of its semimajor axis

P^2 = a^3 -> period must be expressed in years and the semimajor axis must be expressed in AU's

The somnium (1630)
Student goes on the moon



10 / 17 / 07

Wednesday, October 17, 2007
10:06 AM

For Midterm:
- Sheet will be online and given to us online
- Get pink scantron
- Bring calculator

Motion and Gravity

Isaac Newton (1643 - 1727)
- Made sense of observations at the time
- Created calculus to describe his observations

Albert Einstein (1879 - 1955)
- Corrected problems with newtons laws of motion to include what happens as you approach the speed of light
- 1915 - generalized his theory of relativity to include relativity (like when near black hole)

Newton's three laws of motion

First Law:
Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by a force

Second Law:
An object will accelerate if acted upon by a force according to the equation (force = mass x acceleration)
- Acceleration is a change in velocity over a given time
- There are only 4 known forces in nature
  - Gravitational (keeps you in your seat)
  - Electromagnetic force (keeps you from falling through your seat)
  - Strong Nuclear (nuclear energy)
  - Weak Force (radioactivity)
- Acceleration is either a change in speed or change in DIRECTION

Third Law:
For every action, there is an equal but opposite reaction.

Gravity: Newton's law of gravity:

Newton's law of gravity states that any two objects will attract each other according to the equation: Force of gravity = G [(mM)/(r^2)]

G is a universal constant of nature: G = 6.7 x 10^-11

Weird Al Yankovic - messed up on the gravitational law in the release
- Inversely proportional to the square of the distances between them - PANCREAS

G - the value of g was first measured by Henry Cavendish in 1798. Cavendish was actually interseted in measuring the average density of Earth, not G itself.

10 / 17 / 07

Wednesday, October 17, 2007
10:30 AM

All objects fall at the same rate under the influence of gravity.
On the surface of the earth, a = g = 9.8m/s/s
The only reason that a feather falls slower than a bowling ball is that they need to travel through air, but if there is no air, (vacuum), they would both fall at the same rate.

F=ma
F = g(mm/r^2)
Ma = g(mm/r^2)
A = G(m/r^2)

Mass: a measure of how much stuff something is made of
Weight: a measure of the gravitational force exerted on it. This is dependent on the masses of both the object and what is attracting it (like earth)
The mass of an average human is 80 kg
The mass of the earth is 6x10^24 kg

G = 6.7 x 10^-11 (m^3)/[(kg)(s^2)]

$$p^2 = a^3$$

$$p^2 = \left[\frac{4\pi^2}{G(m_1 + m_2)}\right] a^3$$

10 / 19 / 07

Friday, October 19, 2007
9:59 AM

$$P^2 = a^3$$

$$P^2 = \left[\frac{4\pi^2}{G(m_1+m_2)}\right]a^3$$

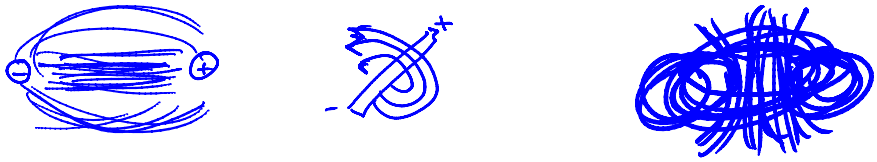
REVIEW MONDAY @ 8:30 PM
Bring Scantron, calculator, pink full-sized

Electricity, Magnetism, and Light - What is it?

- James Clerk Maxwell - realized there was a connection between the three
- If something is electrically charged, you know there is an inbalance between number of protons and electrons
- Electric fields and forces are produced by objects with a net electric charge
- Any two charges will attract or repel each other with a force equal to: (culombs law)

$$F_{electric} = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{q_1 q_2}{r^2}$$

- The electric field is a useful concept in visualizing how electric forces from an arrangement of charges act in a region of space
- The direction of the arrows indicate the direction in which a "test charge" would be pushed.



- Electrons traveling in a direction create magnetic fields
- If a moving charge, or current, is placed in a magnetic field, there will be a force induced on it. The direction of the force is determined by the right-hand rule.
- Maxwell's Equations
  - 4 Equations which describe magnetism
  - Faraday's equation, etc. based on these
  - Poetry for physics
  - Combined all equations into one
    - Results in Wave Equation
  - Oscillating electric fields can be paired with Oscillating magnetic fields to create EM fields
  - Found the Velocity of light based on his equations

$$\nabla \cdot E = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot B = 0$$

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times B = \mu_0 j + \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$$

- Light is an oscillation of electric and magnetic fields
- Different electromagnetic waves have different wavelengths
- Gamma rays shortest distance, radio waves, longest
  - Radio, Microwaves, infrared, visible light, ultraviolet light, x-rays, gamma rays
  - ALL ARE EM WAVES, just different wavelengths.

10 / 22 / 07

Monday, October 22, 2007
10:16 AM

Frequency and Wavelength

An electromagnetic wave can be described by either its wavelength or its frequency.
Wavelength is expressed in meters and frequency is expressed in Hertz (or cycles per second)

Lambda (m) = [c(m/s)]/[f(1/s)]

F = c / L c = f x L

- You can produce radiation simply by heating it up.
- Spectra tells you the relative intensity (brightness) of an object relative to its wavelength
- The universe itself is the only perfect blackbody itself (especially in its early state)
- Most objects (clumps of matter) emit electromagnetic radiation (like light) is just because of their temperature above absolute zero.
- An object like this, that emits radiation due to its temperature is called a blackbody
- The amount and color of electromagnetic radiation emitted by a blackbody is determined by its temperature.

All blackbodies will have a spectrum similar to the one below.

The spectrum tells you how much radiation is emitted at each wavelength. This plot show the spectrum of an incandescent light bulb.

Temperatures has 2 effects

The spectrum of a blackbody is determined by its temperature
As you heat up a blackbody to a higher temperature
Its total luminosity, the total amount of radiation emitted increases, the luminosity is equal to the area under the blackbody curve
The peak wavelength of its spectrum shifts to shorter wavelength.

Wien's Law
The peak wavelength of emission for a blackbody at a temperature T can be calculated with this law
When using this law, it is important to express temperature in Kelvin's
Lambda Max (M) = 0.0029 k (m) / T (K)

Stephan Boltzmann law
Energy Flux: the amount of energy emitte4d per second by each square meter of the surface of a blackbody at a temperature T.
F = sigma T ^4 sigma = 5.67 x 10 ^ -8 (W) / (m^2)(K^4)

Luminosity: the total rate at which an object emits energy

$L = A \times F = A\sigma T^4$
$A_{sphere} = 4\pi r^2$
$L_{sphere} = 4\pi r^2 \sigma T^4$

10 / 26 / 07

Monday, October 22, 2007
8:48 PM

To calculate luminosity of the sun, we luminosity calculate the energy flux and multiply it by the surface area of
the sun

Energy flux is the amount of energy radiated by one square meter of the surface of a blackbody per second

$$F_{sun} \cdot \sigma T^4_{sun}$$
$$A_{sun} = 4\pi r^2$$
$$L_{sun} = F_{sun} A_{sun}$$

A watt is a unit used to quantify the rate at which something uses energy
One watt = 1 joule per second
A joule is a unit of energy. It is equal to the amount of energy requred to lifea one newton weight to a height of one meter
A newton is a unit of force. It is equal to the amount of force that is requires to accelerate a one killogram mass by one meter per second per second. One newton is equal to .22 pounds.

Watts are a unit of luminosity

Albedo: the fraction of the incident light is reflected away rather than absorbed.
- Water has high albedo
- Snow has high albedo

Greenhouse effect keeps surface warmer by about 40 degrees… allows liquid water to exist.

10 / 29 / 07

Monday, October 29, 2007
9:56 AM

Photons and Atoms

Blackbody radiation from the sun maintains the temperature of the earth. (Earth should be 280 Kelvin)

Albedo: earth doesn't absorb all incident light from the sun. A portion is reflected (albedo = this fraction) (Earth should be 250 Kelvin - below freezing)

Greenhouse effect: allows almost all visible light through from the sun to heat up the earth.

$$I(\lambda, T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \qquad E_{photon} = \frac{hc}{\lambda}$$

1905 - Albert Einstein proposed that light is composed of particles called photons. This description of light provides an interpretation of the photoelectric effect, and it provides a physical basis for Plank's assertion that the energy of blackbody radiation is quantized.

Each type of metal has a particular value for a quantity called the work function. The work function is a quantity of energy that must be provided to an individual electron in order to liberate it from the surface of a metal.

1911 - Ernest Rutherford determined that most of the mass of an atom and all of its positive charge is located in a tiny central region, named the nucleus later. R atom = 10 e-10 R nucleus= 10 e-14

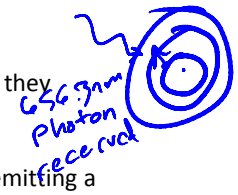
1913 - Niels Bohr modified Rutherford's model of the atom by insisting that the orbiting electrons are confined to a set of stable orbits each with a certain energy.

10 / 31 / 07

Wednesday, October 31, 2007
10:01 AM

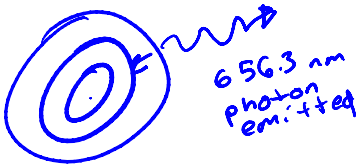
If you can release an electron from the surface of the metal plate. You do this by providing the electons with a quantity of energy. Depending on what type of metal it is, there will be a different quantity of energy needed to liberate an electron. This value is called the work function.

1913 - Niels Bohr modified Rutherford's model of the atom by insisting that the orbiting electrons are confined to a set of stable orbits each within a certain energy.



In Bohr's model of the atom, the electrons can transition up from one stable orbit to another if they absorb a photon of light with just the right energy.

Atoms with electrons in excited orbits will spontaneously transition down to the lowest orbit, emitting a photon during each transition.

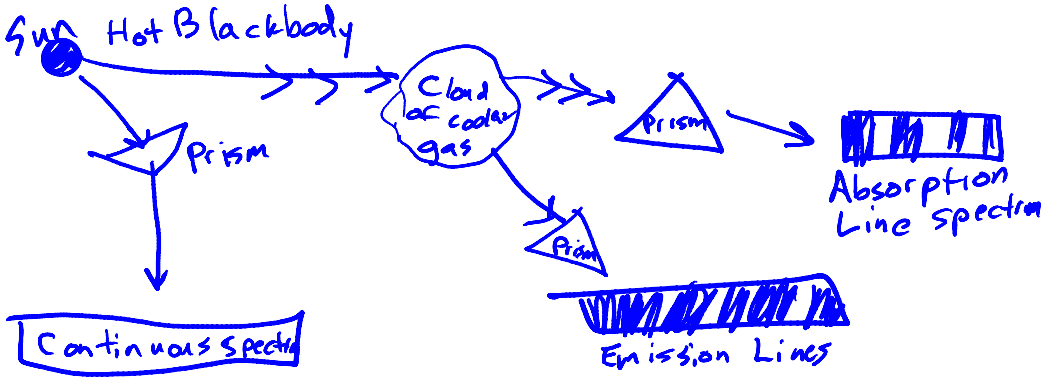


In order for an electron transition to occur, the atom must absorb or emit a photon with an energy exactly equal to the difference between the respective energies of its electron orbits.

Bohr discovered a simple formula that produces all of the photon wavelengths in the spectrum of hydrogen

$$\frac{1}{\lambda} = R\left(\frac{1}{N^2} - \frac{1}{n^2}\right)$$

Bohr's model provides a phsyical interpretation of Kirchhoff's laws.



F = c /lambda delta(t) = 1 / f = lamda / c

$$\Delta x = v \Delta t$$
$$\lambda = \lambda_0 + \Delta x$$

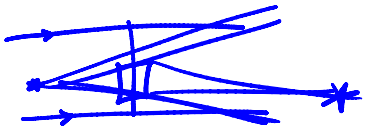
$$\lambda = \lambda_0 + v \Delta t$$
$$\lambda = \lambda_0 + v \frac{\lambda_0}{c}$$
$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$$

11 / 02 / 07

Friday, November 02, 2007
10:06 AM

Optics:

When light passes through a transparent substance, like glass or water, it slows down



V = c / n

N = index of refraction:

Air	1
Water	1.3
Glass	1.6
Diamond	2.5

A beam of light is bent at the interface between two transparent substances according to Snell's Law

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Dispersion: occurs because any tpe of glass will have slightly different refractive indexes for different wavelengths of light

Since glass bends blue light more than red light, a single glass lens will have different focal lengths for these two colors of light. This effect is called chromatic aberration.

This effect can be partially corrected for by using more than one lens.

A refracting telescope is made by combining a large, long focal length objective lens with a small, short focal length eyepiece.

The apparent size of a distant object is magnified by a factor $M = \frac{f_{objective}}{f_{eyepiece}}$

Reflection

When a beam of light reflects off a flat surface, the angle of the reflected beam is equal to the angle of the incident beam. Both angles are measured with respect to a line perpendicular to the plane

If the reflecting surface is cut into a concave shape, then parallel rays of light will be flrected through a common focus.

11 / 02 / 07 - Page 2

Friday, November 02, 2007
10:35 AM

Spherical Mirrors blur light in telescopes but they are cheapest to make
- Have a wider field of view
- Light disperses a little

Parabolic Mirrors focus all light on one point, but do not accept light from off center very will
- Sharpest focus on center
- Focuses all light on one point
- Narrower Field of View

Spherical Mirror (with Corrective Lens)
- Corrects for dispersion of light

Regardless of how well a telescope is designed and focused, there is a big physical limitation to its angular resolution which is based on how big the telescope's objective is and what wavelength of light it is being used to observe. This limitation is caused by the diffraction of light.

$$\theta = 1.22 \frac{\lambda}{D}$$

Turbulence in the Earth's atmosphere will blur any astronomical image to the angle of 1.3 arcseconds.

11 / 07 / 07

Wednesday, November 07, 2007
10:10 AM

- The Sun is a typical star, and is a good subject to study the nature of stars.
- 1 AU = 1.5 x 10^8 = 150,000,000 km
- D = theta x Distance
- Kelvin-Helmholtz Contraction
    - The sun is a giant ball of hydrogen gas. A general property of a gas is that when it is compressed its temperature goes up.
- Energy is conserved so this energy that the sun is radiating away must come from somewhere. The sun must have some mechanism for producing energy.
- Checmical reactions involve the rearrangement of atoms and molecules. If energy is released in a chemical raction, it comes from the electrical forces between the charged particles that make up atoms.
- The typical energy released in a chemical reaction like burning fuel is a few electron bolts (energy of a visible photon) per atom.
- To calculate the luminosity of the sun, we first calculate the sun's energy flux and then multiply it by the surgace area of the sun.
- Remember the enrgy flux is the amount of energy radiated by one square meter of the surface of a blackbody in one second F = sigma T^4

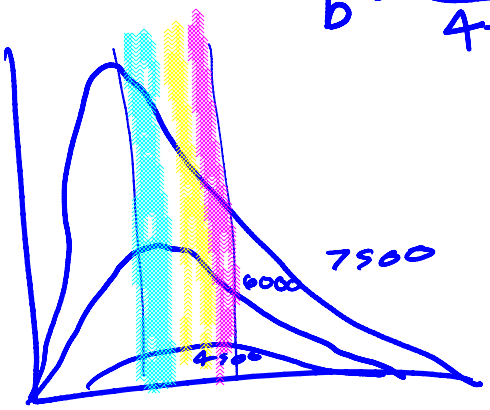
11/16/07

Friday, November 16, 2007
10:09 AM

Red Stars are cooler

Blue Stars are hotter

$$b = \frac{L}{4\pi d^2}$$



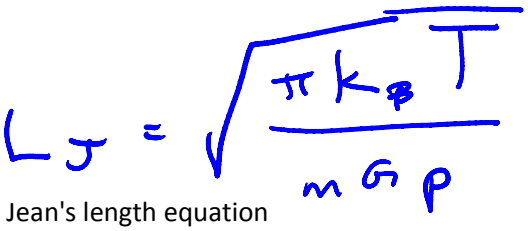
11 / 26 / 07

Monday, November 26, 2007
10:03 AM

- Most of the light in the known universe exists in the form of microwave radiation
  - Cosmic Microwave background
  - Neutrinos and other particles are also present
- The further you look back in time, the less clumpier the universe was
- Before galaxies and stars had formed, all the radiation and matter were evenly distributed in space
- Universe is about 5 times older than the earth and sun
- 75% hydrogen to 25% helium ratio
- Most photons were ultraviolet photons at the beginning of the universe
- The more massive the star is, the shorter its lifetime
- Heavier elements are created in supernova explosions
- Our sun is a recycled star because we see other heavier elements

- Star Formation

- Where are new stars forming?
  - In galaxies, not empty space
  - 100 billion to 1 trillion stars
- Conditions to form a star
  - Low temperature
  - Lower density



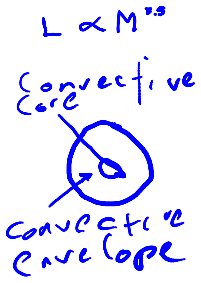
Jean's length equation

- The gravitational collapse of a molecular cloud into a protostar can be triggered by stellar winds, a collision with a spiral arm or the shcok wave from a nearby supernova explosion

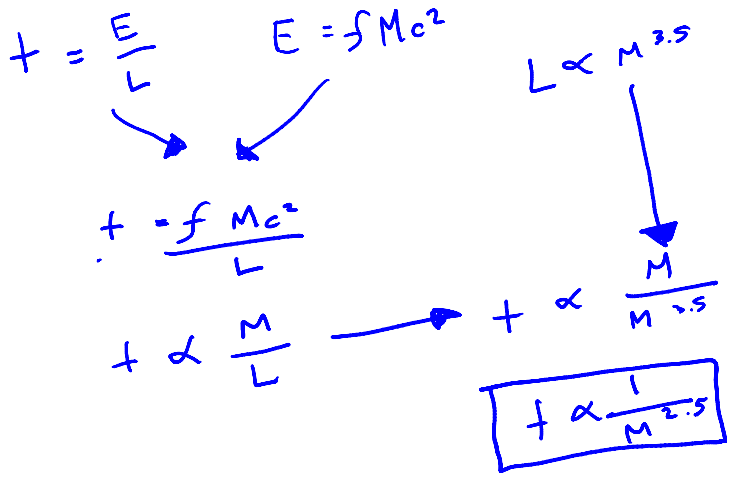
  IN ORDER FOR A STAR TO FORM, GRAVITY NEEDS TO OVERCOME THERMAL PRESSURE

11 / 28 / 07

Wednesday, November 28, 2007
10:12 AM



- A star joins the main sequence once the temperature and pressure in its core is sufficient to allow for the fusion of hydrogen into helium.
- More massive stars are hotter, larger, and therefore more luminous.
- The luminosity of a main sequence star is proportional to its mass to the 3.5 power.
- Low mass stars (less than .4 times the mass of the sun) live categorically different lives because convection occurs throughout their volumes. RED DWARFS
    - A red dwarf is able to convert all of its hydrogen into helium since its hot core is constantly replenished with new stocks of hydrogen. After the last hydrogen atoms are used up, nuclear fusion ceases and the star gradually becomes a cool ball of helium.



- Once all of the hydrogen in the core is converted into helium, nuclear reactions cease, and the core collapses
- As the core collapses it heats up due to Kelvin-helmholtz contraction
- The heat generated in the collapsing core induces hydrogen fusion in the surrounding shells of hydrogen
- The collapsing core has a greater luminosity than it did during the main sequence
- This increased luminosity pushes the outer surface of star our increaseing the stars luminosity and decreasing its temperature

12 / 03 / 07

Monday, December 03, 2007
10:08 AM

- A medium sized star like the sun ends it life as a planetary nebula, leaving behind a core of carbon and oxygen
- The temperature and pressure in the core of a medium sized star are never sufficient to allow for the fusion of heavier elements
- The white dwarf is supported by degenerate electron pressure, as long as it has a mass less than 1.4 solar masses.
- In more massive stars, carbon and oxygen are able to fuse into heaver elements creating shells of increasingly heavy elements
- Iron with 26 protons can not serve as a nuclear fuel since it absorbs energy when it is fused
    - Hydrogen fusing shell
    - Helium fusing shell
    - Carbon fusing shell
    - Neon fusing shell
    - Oxygen fusing shell
    - Silicon fusing shell
    - Iron core (no fusion) (last element you can squeeze energy out of thermonuclear reactions

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12 / 05 / 07

Wednesday, December 05, 2007
10:05 AM

- The disk of our galaxy is about 160,000 light years in diameter
- By observing individual Cepheid variable stars in Andromeda, Edwin Hubble determined that the distance to this nebula is about 1 million light years. More modern observations indicate a distance of about 2.5 million light years
- 1924 - Hubble - first person in the world to measure the distance to an object outside our milky way (andromeda viewed as its own island universe)
- Hubbles data suggested that the radial velocity of a galaxy is proportional to its distance from us
    - V radial = Hod
    - Baed on the most current research, we believe the hubble constant it 70