Review for Exam 3: The Solar System

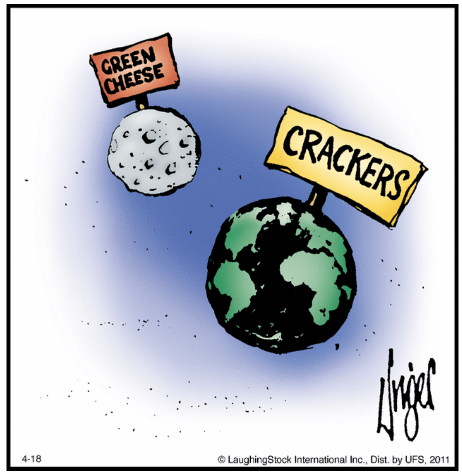
Bring your Field Guide to the exam!

Major Topics:

I. The Celestial Sphere -- appearance and motions in the sky
- Constellations
- Coordinate Systems (horizon, RA & Dec, etc.)
- Daily motion
- Annual motion of the Sun & Stars
- Positions of the planets (sky & orbits)
- Motion and phases of the moon

II. Stars
- The nature of light and structure of matter
- The properties of the stars
- Stellar evolution

III. Solar System
- Worlds
- Planetary processes
- Earth as a planet



I. The Celestial Sphere (you can't forget stuff!)

A. Constellations: *Field Guide* Ch. 4

B. Coordinate systems: *Field Guide* Ch. 15
- horizon – horizon, zenith, nadir, meridian, etc.
- celestial – RA, Dec, NCP, SCP, Celestial Equator

C. Motions in the sky
- daily & annual motion *Cycles* pp. 1-10
- motion and phases of the moon *Cycles* pp. 11-19
- motion and positions of the planets
  planetary longitudes, elongations, times of rising, transit, and setting (Planets Worksheet)

Know how to find elongation (East and West)

Review all the labs
All the Calculations!

Review your notes from the videos!

II. Stars

A. The Sun *Field Guide* Ch. 14

$E=mc^2$

B. Spectroscopy
- The nature of light, inverse square law, electromagnetic spectrum
  - types of spectra and their sources (continuum, emission line, absorption line)
- Spectral Classes: **O B A F G K M**

C. Star Properties (how do we measure or calculate … any needed equations will be given)
- temperature, distance, size, flux and luminosity

D. HR diagram *Field Guide* Appendix 3

E. Stellar evolution *Field Guide* Ch. 5 (p. 144-167)
- Star Birth (*e.g.* Great Nebula in Orion, Eagle Nebula: Pillars of Creation, Trifid Nebula)
- Main Sequence Stars
- Red Giant Stage (*e.g.* Betelgeuse, Antares, Aldebaran)
- Star Death (*e.g.* Planetary Nebulae, SN Remnants, WDs, NSs & pulsars, BHs)

F. Stellar Power: Nuclear Fusion (Power From Fusion Worksheet)

III. The Solar System

- worlds (**expect images** … study the power points and your Field Guide Ch. 8 - 14)
    Be able to describe the basic nature (rocky, icy, gas, atmosphere, craters, volcanoes, etc.) of the
        Planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
        Moons: Io, Europa, Ganymede, Callisto, Titan, Enceladus, Mimas, Miranda, Triton, and Luna.
    Also know where to find (as in, the world) the largest impact crater, largest volcano, and largest mountain. What is each world made of? What characterizes each?

- arrangement, size, and formation of the solar system
    Handy Websites: http://photojournal.jpl.nasa.gov/
    http://solarviews.com/

The Astronomical Unit (AU)

1 *AU* = mean Earth-Sun distance
= 150,000,000 km (150 million km)
= 93,000,000 mi (≈ 100 million miles is close enough)

NAME	SYMBOL	SIZE	DISTANCE FROM SOL	LENGTH OF DAY	LENGTH OF YEAR
MERCURY	☿	0.4 $R_\oplus$	0.4 AU	60 $d_\oplus$	$\frac{1}{4}$ $y_\oplus$
VENUS	♀	0.95 $R_\oplus$	0.7 AU	243 $d_\oplus$ (R)	0.6 $y_\oplus$
EARTH	⊕	1.0 $R_\oplus$	1.0 AU	1$d_\oplus$	1 $y_\oplus$
MARS	♂	0.5 $R_\oplus$	1.5 AU	1.03 $d_\oplus$	2 $y_\oplus$
ASTEROIDS		0.1 $R_\oplus$	3 AU	-----	5 $y_\oplus$
JUPITER	♃	11 $R_\oplus$	5 AU	10 $h_\oplus$	12 $y_\oplus$ (≈ ONE CONSTELLATION OF THE ZODIAC PER YEAR)
SATURN	♄	9.5 $R_\oplus$	10 AU	10.25 $h_\oplus$	30 $y_\oplus$
URANUS	♅	4.1 $R_\oplus$	20 AU	17 $h_\oplus$ (R)	85 $y_\oplus$
NEPTUNE	♆	3.9 $R_\oplus$	30 AU	16 $h_\oplus$	165 $y_\oplus$

- Earth as a planet

-- interior
    (https://pubs.usgs.gov/gip/dynamic/dynamic.html, www.livescience.com/topics/earth-s-interior/)
    interior layers: names, composition, phase (solid, liquid, plastic)
    be able to explain the driving force of plate tectonics & source of the magnetic field
-- surface
    geology:
        cratering (Barringer, Chicxulub, Manicouagan http://www.solarviews.com/eng/tercrate.htm)
        volcanism (http://volcano.oregonstate.edu/)
            types of volcanos: shield, cinder cone, composite & examples of each
        plate tectonics & the motion of the continents
            (http://www.ucmp.berkeley.edu/geology/tectonics.html)

-- oceans on Earth, Mars, Europa

importance of water in the evolution of the atmosphere & life

Specific heat:

Energy required to raise (or lower) the temperature of 1 kg of stuff

Latent heat:

Heat released or absorbed when something (water) changes state

released: gas to liquid (condensation), liquid to solid (freezing)

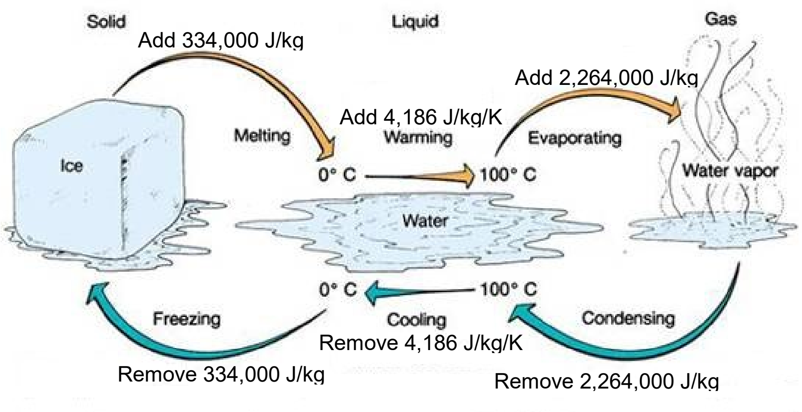
absorbed: solid to liquid (melting) or liquid to gas (evaporating)

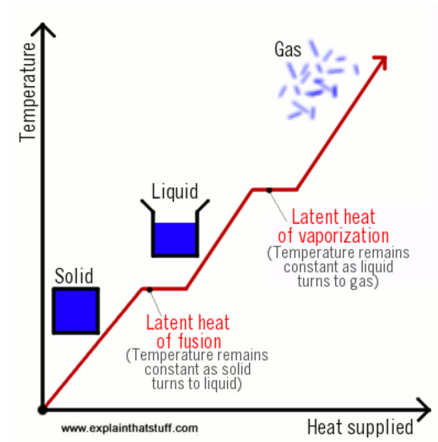
Heat transfer

Conduction: Hot stuff heats neighbors (inefficient!)

Convection: Hot stuff moves

Radiation: Heat, itself moves





-- atmosphere

composition

primarily N_2 (78%), O_2 (21%), Ar (1%), CO_2 (0.037%)

differs from Mars, Venus (How? Why?)

evolution of composition

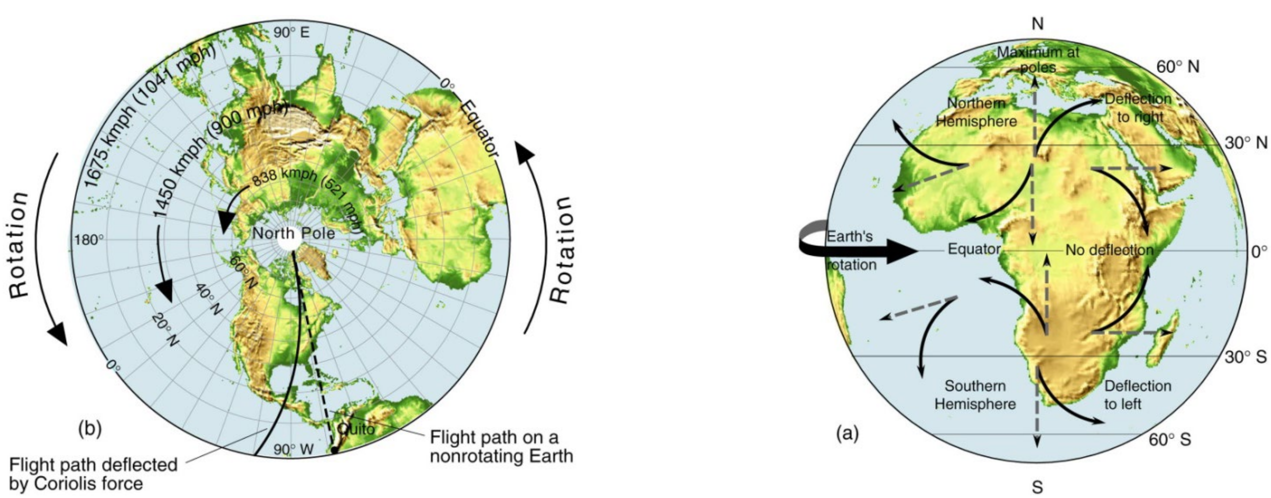
oceans absorbed CO_2, locked it into rocks … what happened on Mars?

Plant & animal life generated and maintains O_2 composition, evolution, circulation

forces on air

pressure gradient force (air moves from high to low pressure)

coriolis force (acts only on *moving* objects)



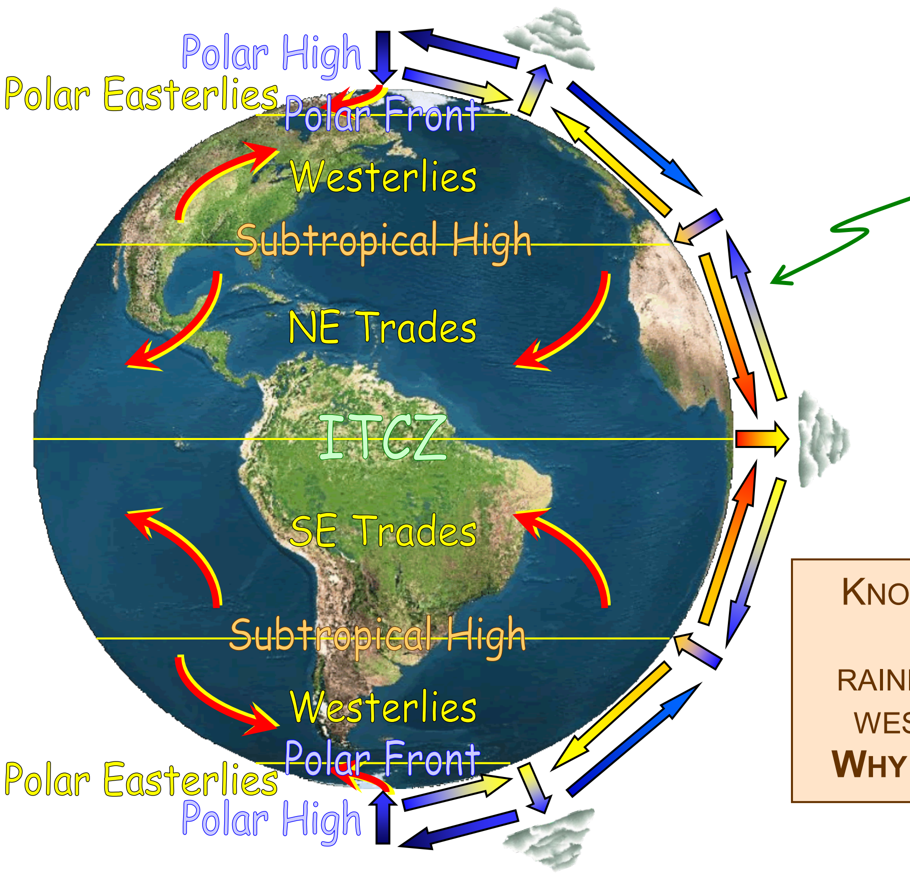
-- global circulation

PARTLY DRIVEN BY SUNLIGHT HEATING SURFACE AIR AT SUBSOLAR LATITUDE

1. Air rises at ITCZ
   - Rising Air = Low Pressure
   - Cools -- moisture condenses -- precipitation
   - Spreads north and south aloft and continues cooling
2. Air sinks at about 30° N and S (Subtropical High)
   - Sinking Air = High Pressure
   - Dry since it lost moisture when rising
   - Spreads north and south, coriolis deflection creates Trade Winds & Westerlies

PARTLY DRIVEN BY VERY COLD AIR SINKING AT POLES

3. Air Sinks at Poles (Polar High)
   - Moves southward (northward) & deflects right (left) along surface
   - Polar Easterlies
4. Convergence Zone at 60° N and S (Polar Front)
   - Rising Air = Low Pressure
   - Cools -- moisture condenses -- precipitation
   - Spreads north and south aloft and continues cooling



BE ABLE TO RECREATE THIS DIAGRAM WITH NO HINTS!

KNOW HOW THE CONTINENTS FIT! WHERE ARE THE ITCZ, RAINFORESTS, DESERTS, TRADES, WESTERLIES, AND EASTERLIES? **WHY** ARE THEY WHERE THEY ARE?

Greenhouse Effect

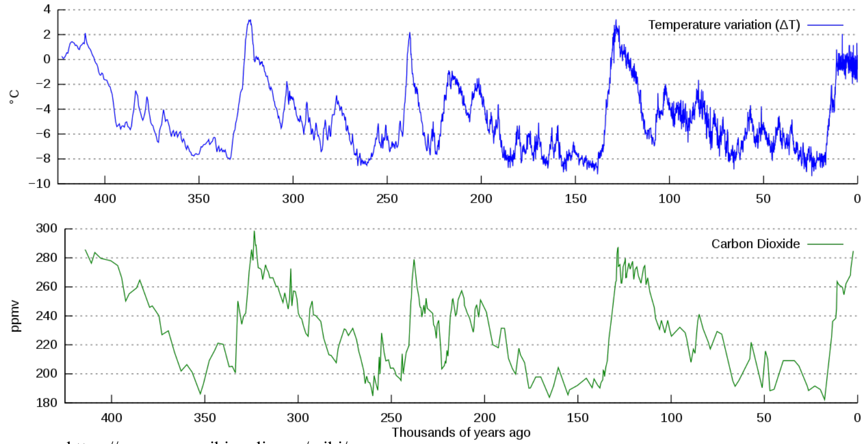
Sunlight absorbed by ground heats it. Ground radiates IR that's absorbed by atmosphere.

Evidence of past climate from ice cores & sea sediments

- Bubbles of ancient air trapped in snow/ice give levels of atmospheric gasses of CO_2, CH_4, etc.
- Isotopes of oxygen and hydrogen give evidence of global ocean temperatures
  - -- ICE CORES: High levels of ^{18}O indicate warm oceans
  - -- SEA SEDIMENTS: High levels of ^{18}O indicate cool oceans

BE ABLE TO EXPLAIN WHY!

Credit: Matt Foley
https://www.facebook.com/adirondackskycenterandobservatory

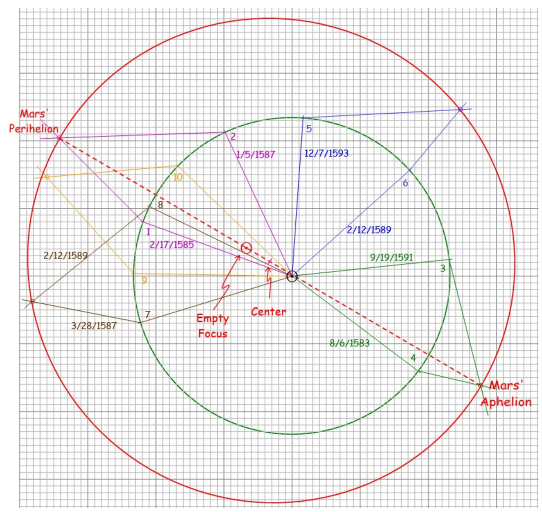


https://commons.wikimedia.org/wiki/File:Vostok_Petit_data.svg

Lab Summary Spring 2024 (Since Exam 2)

22. Scaled Solar System

Taking a large beach ball as the Sun, we scaled the solar system to discover that the Earth on that scale is the size of a small blueberry, 0.7 cm in diameter and it's 92 yards (82.5 m) away from Sol.

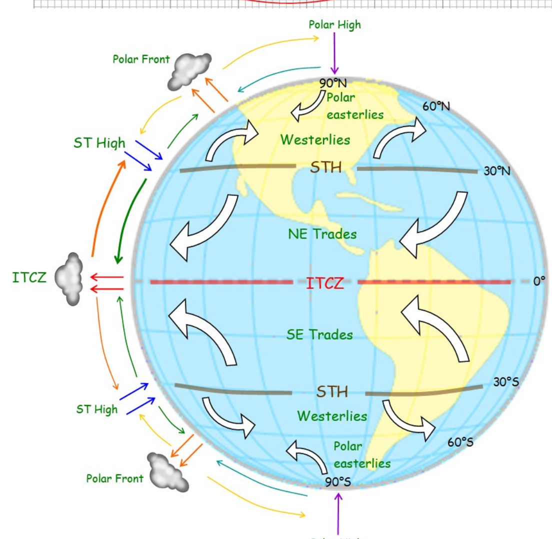


23. S&T, The Orbit of Mars

Using data from Johannes Kepler's *Astronomia Nova*, based on measurements of Mars' position made by Tycho Brahe, we plotted pairs of Earth positions and the associated observed positions of Mars in the same orbital position (observations one Martian year apart). Using these, we were able to plot the orbit of Mars.

24. Plugged in to CO_2

We measured the power used by different light bulbs (incandescent, CFL, LED) and calculated the amount of CO_2 their use releases into the atmosphere over the course of a year.



25. Atmospheric Cirulation Model

We modeled the atmospheric circulation first discussed by Hadley and Ferrel driven by insolation at the sub-solar latitude and intense cold above the poles.