Review for Exam 3: The Solar System

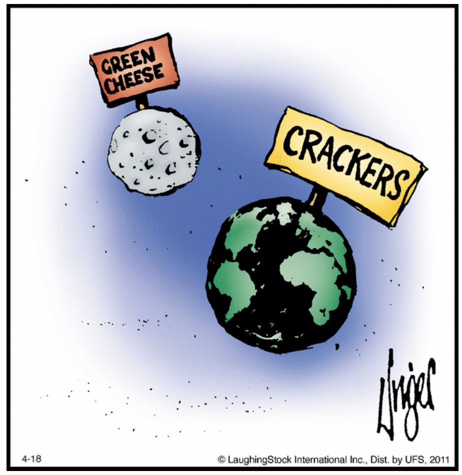
Bring your Field Guide to the exam!

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)

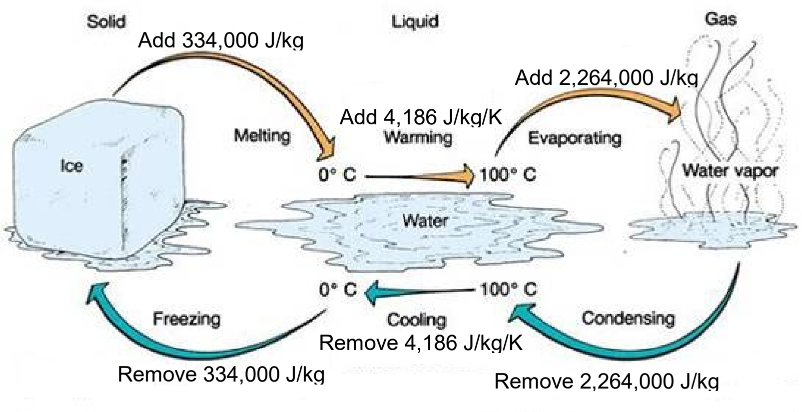
absorbed: solid to liquid (melting) or liquid to gas (evaporating)

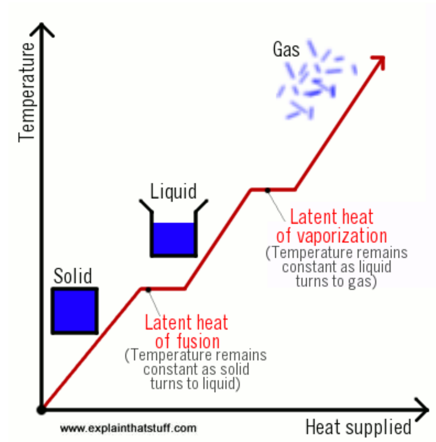
Heat transfer

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

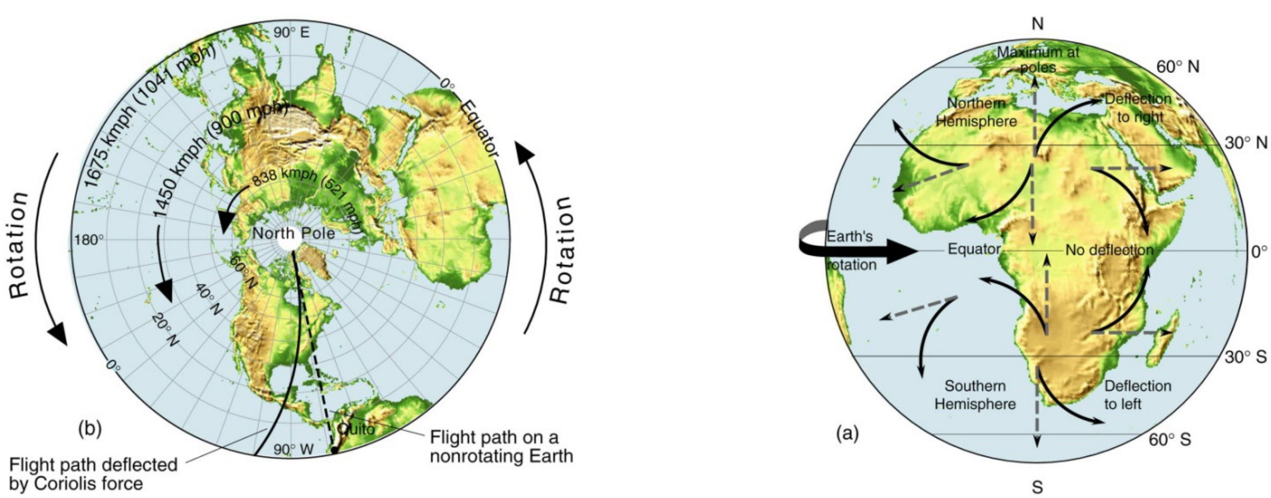
oceans absorbed CO_2, locked it into rocks … what happened on Mars?

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)



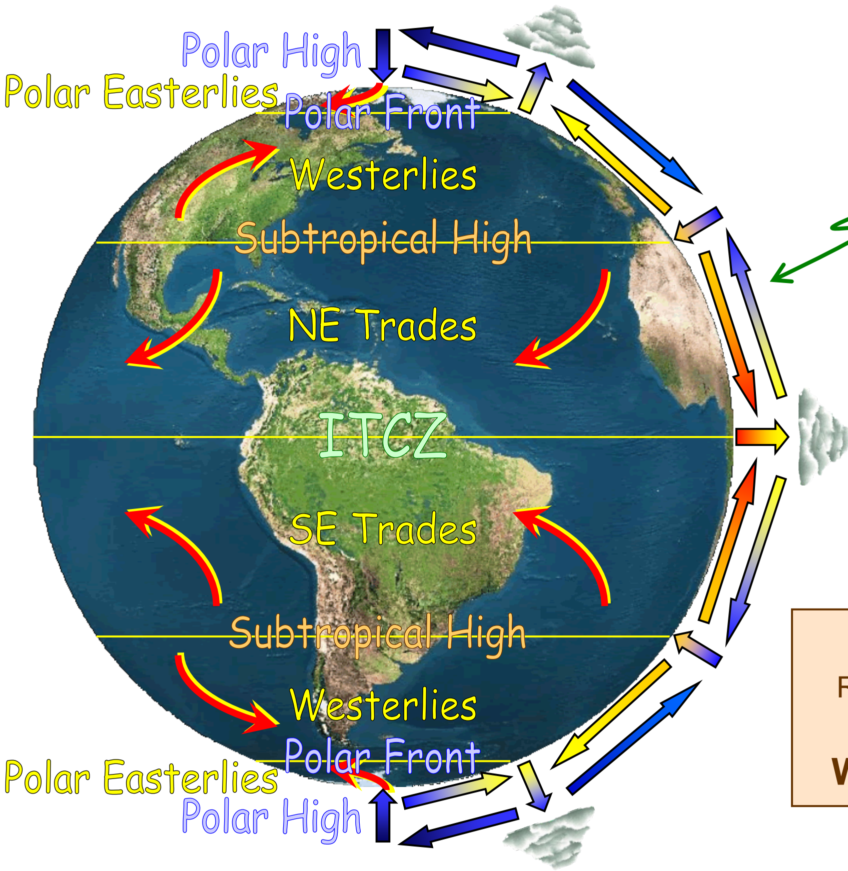
-- global circulation

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!

WHERE ARE THE ITCZ, RAINFORESTS, DESERTS, TRADES, WESTERLIES, AND EASTERLIES? WHY ARE THEY WHERE THEY ARE?

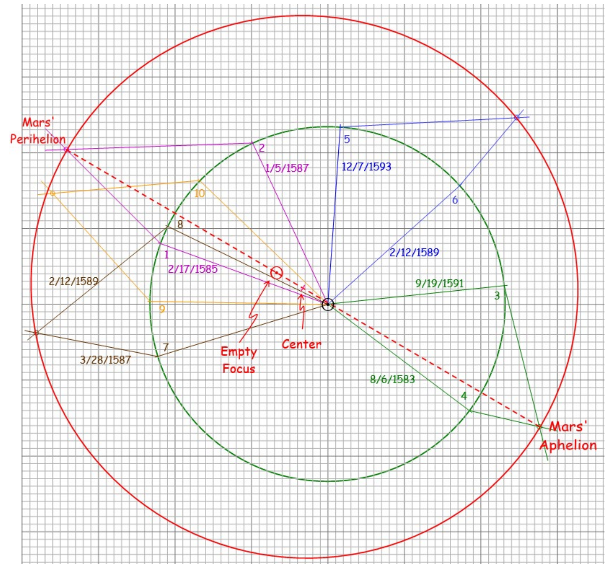
Greenhouse Effect

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

23. 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 bluberry, 0.7 cm in diameter and it's 46 yards (41.3 m) away from Sol.

24. S&T, The Orbit of Mars

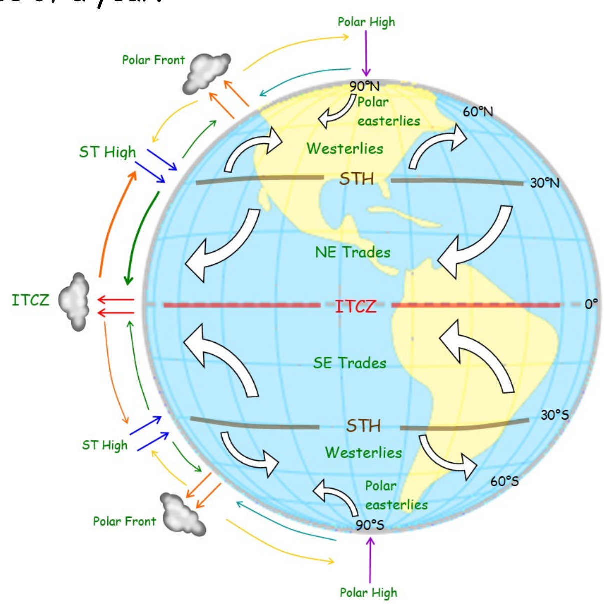


Using data from Johannes Kepler's *Astronomia Nova*, based on measurements of Mars' position made by Tycho Brahe, we plotted pairs of Earth positions and the associated observed positions of Mars when it was in the same orbital position (observations one Martian year apart). Using these, we were able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

25. Plugged in to CO_2

We measured the power used by incandescent, CFL, and LED light bulbs and calculated the amount of CO_2 released into the atmosphere over the course of a year.

26. Atmospheric Cirulation Model



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

26. Stone Soup and Fire & Ice

Using a Lab Pro temperature sensor and Logger Pro software, in *Stone Soup*, we measured the temperature rise once a hot rock was dropped into cold water to explore the high heat capacity of water. We measured the final temperature of the mix and compared it to the measured final temperature. In *Fire & Ice*, we did the same for an ice cube dropped into hot water. In this case we calculated the final temperature for water at the ice's temperature dropped into the hot water and the ice dropped into the hot water to see the effect of the latent heat of fusion as the ice melted. The ice cooled the hot water more than the cold water.

$$T_{final} = \frac{m_{water}c_{water}T_{water} + m_{rock}c_{rock}T_{rock}}{\left(m_{water}c_{water} + m_{rock}c_{rock}\right)}$$

The final temperature after a hot rock is dropped into cold water is given by the top equation to the right. This was 16°C for a 150 g rock at 100°C and 150 g of water at 0°C since the specific heat of water is 4,186 J/K/kg and that of granite is 804 J/K/kg. So the water's temperature changes much less than the rock's. The final temperature of a mixture of ice and hot water is given by the lower equation. This was 69°C for 150g of ice at -2°C and 150g of water at 100°C because it takes energy to melt the ice. If 150g of water at -2°C were added to the hot water, the final temperature would have been 77°C. So it takes about 10°C worth of energy to just melt the ice!

$$T_{final} = \frac{\left(m_{ice}T_{ice} + m_{water}T_{water}\right)c_{water} + m_{ice}L_{fusion}}{\left(m_{ice} + m_{water}\right)c_{water}}$$