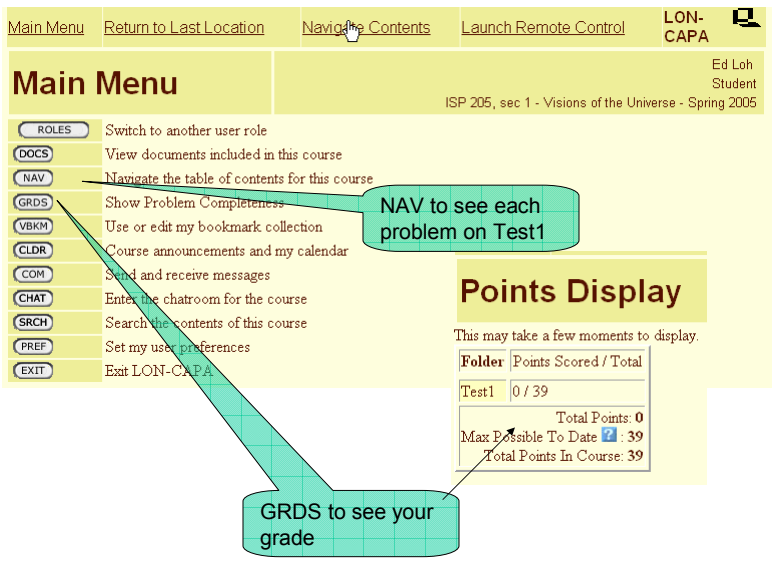
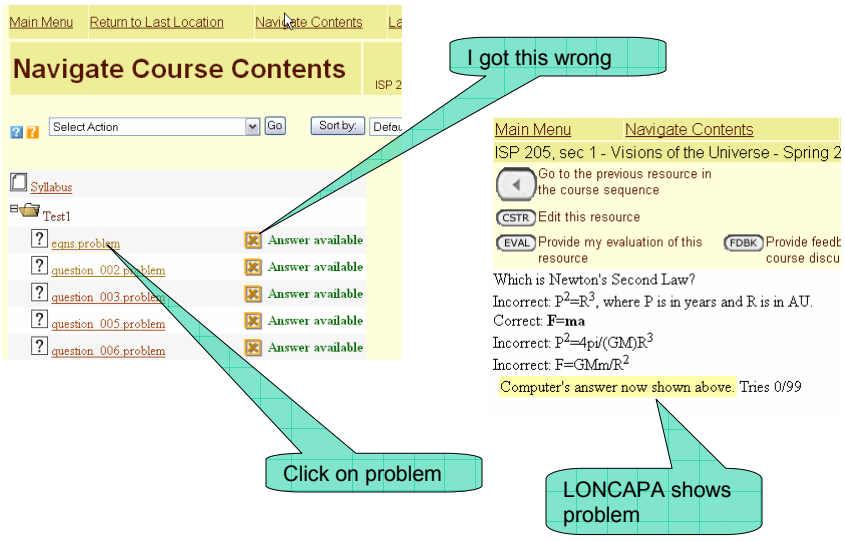
Atmosphere of Earth & Venus

- Test1
  - Log on to LONCAPA www.loncapa.msu.edu
- Processes that shape earth
  - Losing gases in atmosphere
  - Gaining gases in atmosphere
- Venus
- Goldilocks Paradox

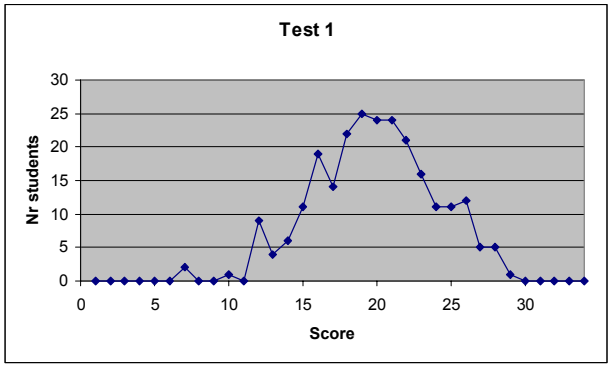
Using LONCAPA





Test 1

- Average 20/34
- Grades
  - 4.0 23; 3.0 21; 2.0 17
  - This is only 15% of course grade.
- Preparing for the next test
  - Purpose of homework & practice test is to check your understanding.
    - Think about key idea for each question.
  - Ideas are important; answers are not. Do not remember the answers.
  - Models are important; answers are not. Do not remember the answers.



- Q1 50% remembered the answer from practice test. 42% got it correct. **Main idea**: Think about quantities in Law of Gravity.
- Q2 72% remembered answer from practice test. Use **model,** which incorporates main idea.

1 pt Which is Newton's Law of Gravity?

1. **A**◯$F=ma$
   B◯$F=GMm/r^2$
   C◯$P^2=4\pi/(GM)P^3$
   D◯$P^2=P^3$ for P measured in years and R in AU.

1 pt The energy of levels 1-4 of hydrogen are 0, 10.2, 12.1, and 12.8 electron volts (eV), respectively. The hydrogen is warm enough so that some atoms have an electron in level 2, and some atoms have an electron in level 1. Does the hydrogen gas absorb photons with energy 1.9 eV? Does the gas absorb photons with energy 10.2 eV?

2. **A**◯No for 1.9-eV photons; yes for 10.2-eV photons.
   B◯Yes for 1.9-eV photons; no for 10.2-eV photons.
   C◯Yes for 1.9-eV photons; yes for 10.2-eV photons.
   D◯No for 1.9-eV photons; no for 10.2-eV photons.

- Q3. (#10) There are many ways to express right answer. Use a **model**.
- Q4. (#13) **Main idea**: What did Newton learn that Kepler did not know when he derived Kepler's 3rd law?
  a. K's 3rd law depends on mass of sun.
  b. K's 3rd law depends on mass of big mass.
  c. Nothing
  d. K's 3rd law depends on mass of little object.

1 pt Mars moves in retrograde motion when it is

10. **A**◯in the west just after sunset.
    B◯rising at sunrise.
    C◯high in the sky just after sunset.
    D◯rising at sunset.

1 pt Consider Kepler's Third Law, P^2=constant R^3, where P is the period and R is semi-major axis, applied to the moons of Jupiter. The value of the constant depends primarily on the —

13. **A**◯mass of the sun.
    B◯mass of Jupiter.
    C◯The constant does not depend on any mass.
    D◯mass of the moon.

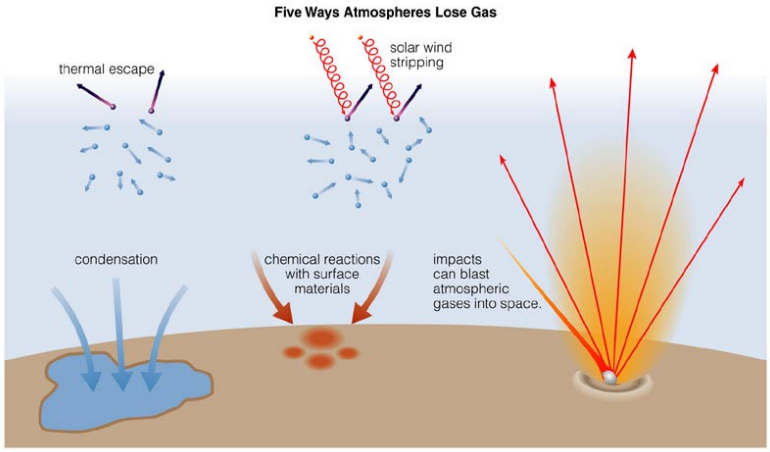
Atmosphere of planets: loss of gases

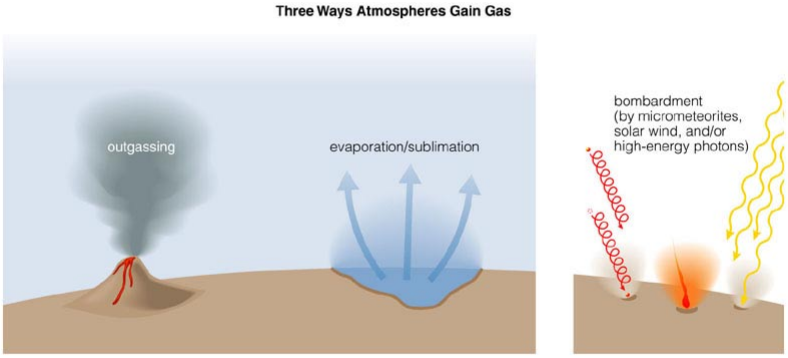
- Planets formed from the same material but now have very different atmospheres.
  - Earth has little helium; Jupiter has a lot of helium
  - Mercury has little atmosphere
- Think of gas molecules as baseballs moving and colliding. How do baseballs escape from the earth's gravity?
- Average kinetic energy of gas molecule
  - KE = 3k/2 Temperature
  - KE = ½ mass speed^2

Important: Hotter means more kinetic energy.
Not important: 3k/2

- Q: Oxygen molecules (m=32) in the air move at an average speed of 300m/s. Helium (m=4) moves at an average speed of
  a. 40 m/s
  b. 300 m/s
  c. 850 m/s
  d. 2400 m/s
- Baseball can escape if Kinetic Energy > Potential Energy
  - speed^2 > $2GM_{Earth}/R_{Earth}$
  - Escape speed from earth is 11,000 m/s. How can helium escape?

- How can helium escape from earth? By chance, a helium atom gets much more speed than the average and escapes.
  - Average 850 m/s
  - Very rare 12,000 m/s
  - On earth, each molecule get a new try every billionth of a second.
- Q: S1: It is easier to lose a lighter gas. S2: It is easier to lose gas from a hotter planet. S3: It is easier to lose gas from a more massive planet.
  a. T T T
  b. F T T
  c. T F T
  d. T T F
  e. Two are false

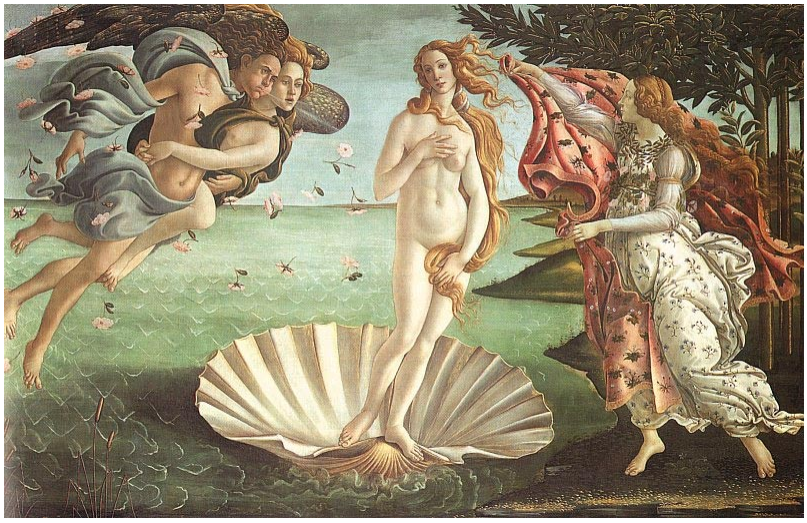




Venus is too hot for life. What went wrong?

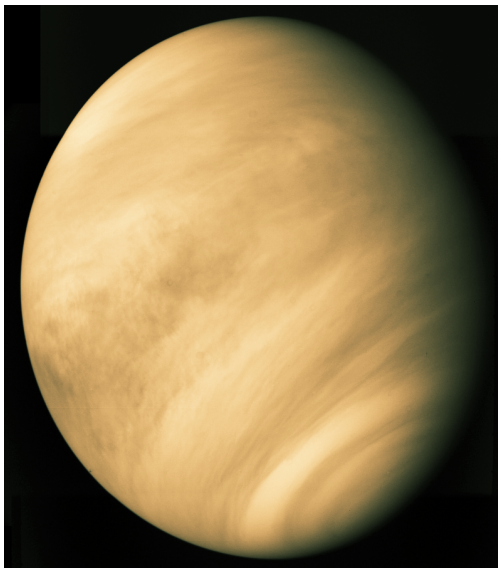
- Description of Venus
- Atmosphere of Venus
- What went wrong?

Venus
(according to Botticelli)



Astronomer's Venus

	Venus	Earth
Diameter	0.95	1
Mass	0.81	1
Semi-major axis	0.72	1
Density	0.96	1
Rotation (days)	-243	1
Orbit period (days)	224	365



Venera Landers
(USSR)

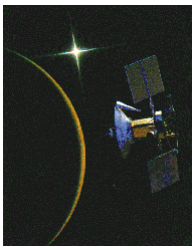
Venera 7 (1970)
Venera 10,11 (1975)
Venera 11,12 (1978)
Venera 13,14 (1981)

Venera 13, 14 soil samples: basalts

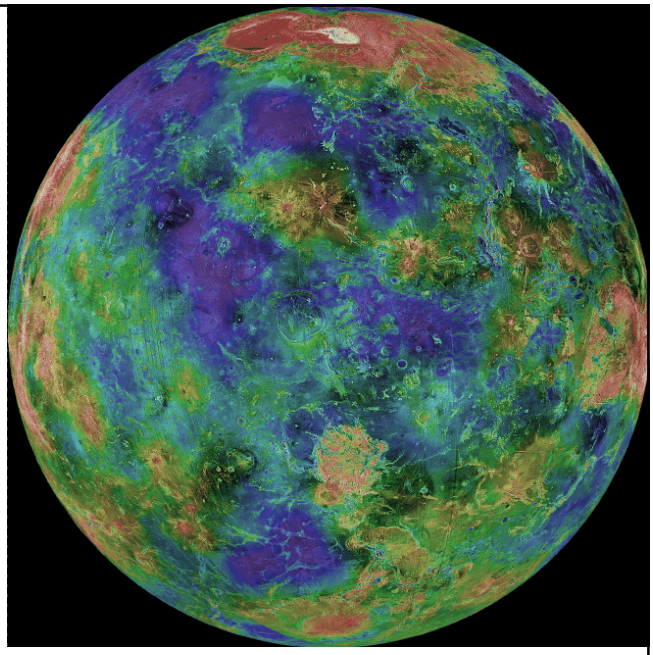
The view from Venera 14

Radar Map of Venus

Made by Magellan orbiter in 1991-93.



Blue = lower
Brown/red = higher.



The surface of Venus [7.4]

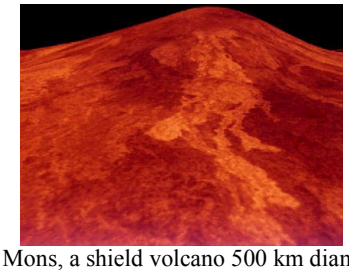
- Impact craters
  - ➔ age dating of surface
    - only 15% as many craters as lunar maria.
- ➔Oldest terrain only 800 million yrs old
  - compare to 3.8 billion yrs on Earth
- Constant resurfacing by volcanic action.
  - but appears to have ceased ~ 500 million yrs ago

Magellan Radar Imaging.

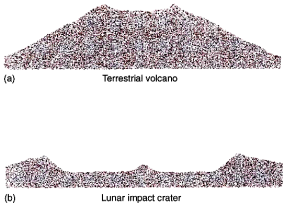
Rotating Venus

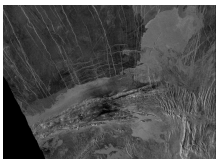
Volcanic Activity on Venus

Radar Imaging: 100 m resolution

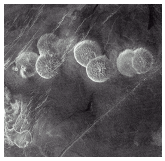


Sif Mons, a shield volcano 500 km diameter x 3 km high.

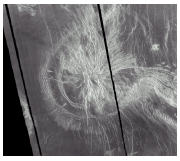




Lava flow



"Pancake" volcanoes, due to very thick lava.

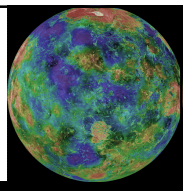


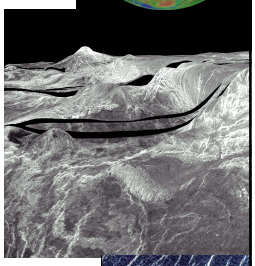
Corona: a collapsed dome over a magma chamber.

Interior Structure

- Similar to Earth
- Iron core 3000 km in radius
- Molten mantle
- Crust

Magellan Radar Images





Lakshmi Planum
Hilly area on Ishtar

Tectonics

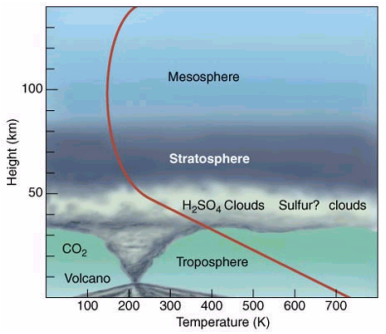
- No plates as on earth
- But much shearing, compression and stretching of crust by convection currents in mantle.
- Has pushed up "continents"
  - Aphrodite and Ishtar
- Rift valleys and cracks

Ridges & cracks

The Atmosphere of Venus

- Surface Pressure = 92 x Earth's
- Surface Temperature = 482° C
  - melting point of lead: 327°
- Sulfuric acid cloud layer at 30-60 km

	Venus	Earth
CO_2	96%	0.03%
N_2	3.5	78.1
Ar	0.006	0.93
O_2	0.003	21.0



Some Surface Temperatures in °F

- Mercury (Mariner 10) 800F
- Venus (Mariner 2; Venera landers) 900F
- Hell (Revelations 21:8) 832F
  - "But the fearful and unbelieving shall have their part in the lake which burneth with fire and brimstone"
  - boiling point of brimstone (sulfur); 832F

Life & the Earth's Atmosphere

- Life started in CO_2 atmosphere, roughly 4 billion yrs ago.
- Life initially only in sea… converted CO_2 to oxygen through *photosynthesis*.
- The released oxygen was swallowed up in interactions with surface material until ~ 2 billion yrs ago.
- After 2 billion yrs ago, oxygen able to build up in atmosphere.
  - + geological activity buried much of the free carbon.
- Atmosphere then converted to today's mix:
  78% nitrogen, 21% oxygen, 1% everything else.
- Free oxygen ➔ ozone

  ➔ protection from ultraviolet light➔ land animals

Life converted Earth's atmosphere from CO_2 to N_2, O_2

- Q for next class: Why did Venus get too hot, even though Earth, its twin, remained temperate?