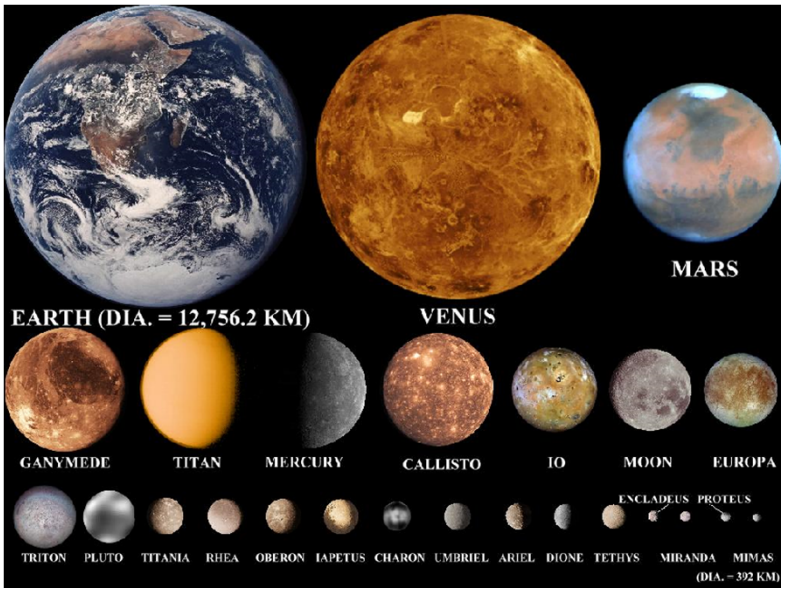
Terrestrial planets—14 Jan

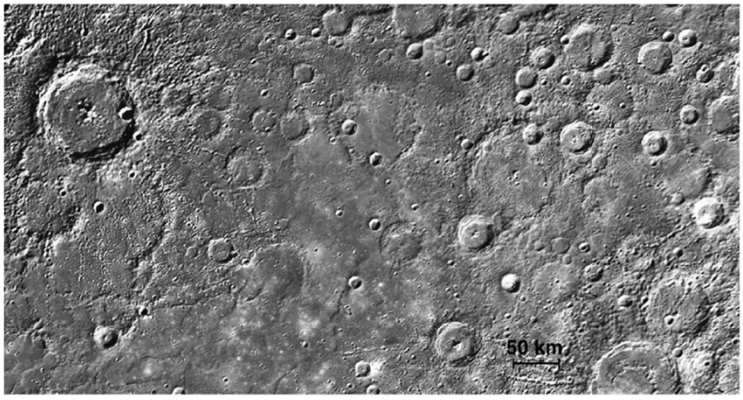
- Homework 1 is due on Fri, 21 Jan.
  - Download it from angel
- Observations
- Gravitational heating

Moons & terrestrial planets



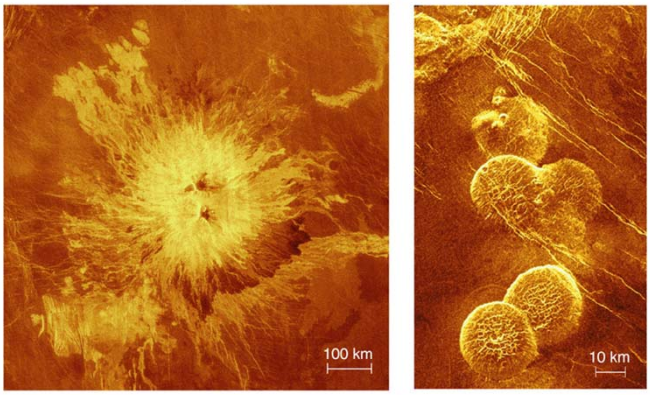
Mercury

- What do you see? What is unusual?
- What does that tell you about Mercury's history?



Venus

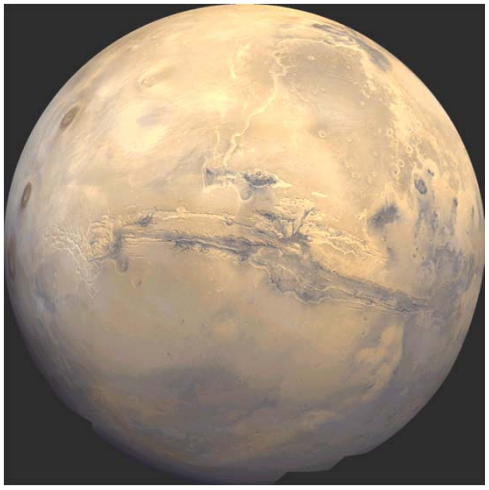
- What is this?
- What does this tell you about Venus' history?



"Pancake" volcanoes, due to very thick lava

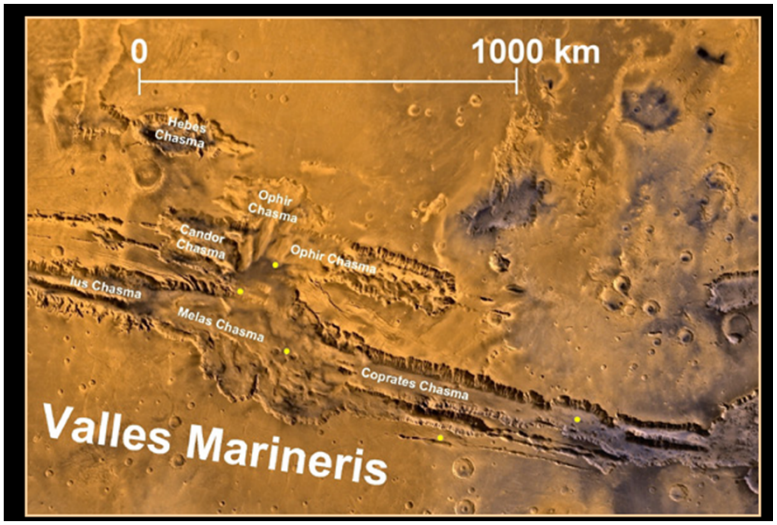
Mars

- What does the Valles Marineris tell you about the history of Mars?



Rotating Mars

Valles Marineris

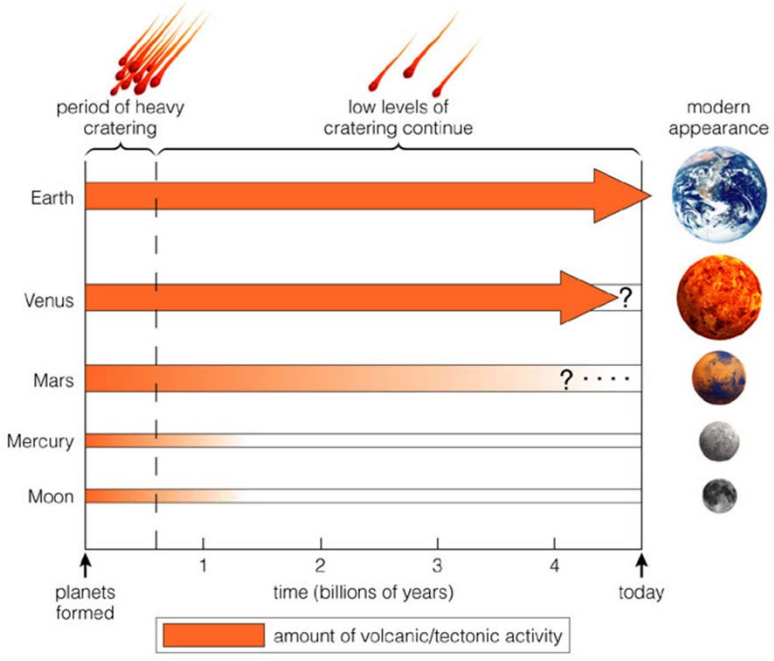


200km wide. 7km deep

The surface of Venus

- Age dating of surface
  - Only 15% as many craters as lunar maria.
- Oldest terrain only 800 million yrs old
  - compare to 3.8 billion yr on Earth
- Constant resurfacing by volcanic action.
  - Ceased ~ 500 million yr ago

Magellan Radar Imaging.



How are heating and meteors related?

- We have seen craters, volcanoes, lava flows, and cracks.
  - Volcanoes, lava flows, and cracks indicate heat.
  - Cratering history indicates meteors were much more frequent in the early history of the solar system.
  - How are heating and meteors related?

What is the temperature of a meteor?

- Meteors carry energy. What is its temperature?
- The gravitational potential energy

$$PE = -GMm/R$$

  - M is mass of earth
  - m is mass of meteor
  - R is distance from center of Earth
  - G is Newton's gravitational constant, $6.67\times10^{-11}\ m^3kg^{-1}s^{-2}$

How to read math

- The gravitational potential energy
$$PE = -GMm/R$$
  - *M* is mass of earth
  - m is mass of meteor
  - *R* is distance from center of Earth
  - *G* is Newton's gravitational constant
- Ask yourself
  - What does potential energy depend on?
  - If the mass doubles, the potential energy ___.
  - How does potential energy depend on distance from the center of Earth? What is it at R=∞? At small R?
  - What are constants and important only when I compute a number?

How to read math

1. If the mass of a meteor doubles its potential energy
   A. Doubles
   B. Halves
   C. Does not change
2. Close to earth, the potential energy of a meteor
   A. Is close to zero
   B. Is large and positive
   C. Is large and negative

Kinetic energy

- The kinetic energy is
$$KE = \frac{1}{2}mv^2$$
  - M is mass of meteor
  - v is speed
- When a meteor falls, its total energy (PE+KE) does not change. The meteor moves faster by
$$KE_{later} - KE_{earlier} = -PE_{later} + PE_{earlier}$$

A meteor falls from a large distance

$$KE_2 - KE_1 = -PE_2 - PE_1$$

- Assume meteor moves very slowly when it is at a large distance. $KE_1 = 0$.
$$PE_1 = 0$$
$$KE_2 = -PE_2$$
$$v^2 = 2GM_{earth}/R$$
- Answer: A meteor falls from to earth a great distance. Its speed is 11.2km/s.

How are energy and temperature related?

- If all of the kinetic energy is converted to heat, then the temperature T is found from
- $KE = \frac{3}{2}NkT$
  - N is number of particles in the meteor
  - T is temperature
  - K is Boltzmann's constant, $1.3806503 \times 10^{-23}$ m^2 kg s^{-2} K^{-1}

What is the temperature of a meteor?

- A meteor falls to earth, and all of its energy is converted to heating up the meteor. Assume it is made of iron. What is its temperature?

$$KE = \frac{3}{2}NkT$$

$$\frac{1}{2}mv^2 = \frac{3}{2}NkT$$

1. Does the temperature depend on the mass of the meteor?
   A. Y
   B. N
2. If the meteor is made of calcium, is the temperature higher or lower?
   A. Higher
   B. Lower

What is the temperature of a meteor?

- A meteor falls to earth, and all of its energy is converted to heating up the meteor. Assume it is made of iron. What is its temperature?
- Answer: 290,000K
- What conclusions can we draw about the history of the terrestrial planets from the calculation of the temperature of the meteor?