

1 Mercury and Venus

- Read chapter 8&9 in the textbook
- Exercises: Do all “Review and Discussion” and all “Conceptual Self-Test”

2 Mercury

- similar in size to the moon
- average density 5.4 gm/cm^3 – much denser than the moon
- no appreciable atmosphere – not large enough to hold one so close to the sun
- orbit about 0.4 AU – eccentric (0.206)
- orbital period – 88 earth days
- greatest elongation, only 28°
- stay close to the sun – hard to see
- peak temperature 700K and below 100K in night
- temperature dependent on the latitude – Mercury has negligible axis tilt
- best optical resolution – similar to the moon with the unaided eye
- almost all information about Mercury – Mariner 10 and now MESSENGER
- surface cratered like the moon, but different as well – few lava flow regions
- Mercury’s craters are less densely packed compared to the moon
- crater walls not as high, ejecta material closer to crater – high gravity
- perhaps older craters filled by volcanic activity
- much too be learned – intercrater plains different than the moon – absence of rilles, volcanic activity different than the moon
- scarps – not on moon, but on Mercury – occurred after bombardment
- uplift result of cooling – 4 billion years ago
- no evidence of plate tectonics
- last great geological event – huge crater Caloris Basin
- seismic waves cause weird terrain on the opposite side

- similar to the Orientale Basin on the moon – floor different
- orbital dynamics of Mercury very interesting – resonance
- early astronomers thought Mercury would be tidally locked like the earth-moon system
- 1965, radar observations indicated (Doppler shift) that Mercury rotates once every 59 days – exactly two-third of a Mercury year
- “fine-tuning” – dynamics at work
- orbit is eccentric – tidal locking force diminishes rapidly with distance
- locking shared between aphelion and perihelion
- rotation nearly synchronous at perihelion – same face every other time
- one of many examples of resonances that we will see in the solar system later
- Mercury has a weak magnetic field – could be the result of a small dynamo like the earth
- lack of active surface geology suggests Mercury is solid to a great depth, like the moon – dynamo must be small, if present
- Magnetic field could also be the result of an extinct dynamo
- Mercury’s magnetic field and large average density suggests the planet is differentiated
- Mercury’s core, much bigger relative to the earth (uncompressed density)

3 Venus

- inner planet as well 0.7 AU – very little eccentricity
- orbital period 245 earth days
- mass and size similar to earth – 0.82 earth masses, density 5.2gm/cm^3
- greatest elongation 47°
- brightest object in the sky next to the sun and the moon – can cast a weak shadow
- Venus, highly reflective 70% of sunlight reflected – reason for brightness
- cannot see surface in telescope – just clouds
- hard to determine rotation rate – radar Doppler shift, 243 earth days, retrograde
- south pole upside down, axis tilt 177.4°

- earth's sister planet in size – thought perhaps has similar geology and atmosphere
- early spectroscopic studies indicated mostly CO₂ in the upper atmosphere – hoped that lower regions would contain water vapour – upper atmospheric temperature similar to earth's 240K
- radio observations in 1950s showed that the surface had a blackbody spectrum at 730K – not at all like Earth
- radar probing and satellite observation have mapped Venus to high precision (Venera, Pioneer Venus, Magellan)
- cloud structures revealed in the UV (sulphuric acid)
- large scale topography – different from earth's continental land masses (8%)
- two main continental areas: Ishtar Terra and Aphrodite Terra
- highest peaks 14km above lowest depression
- Maxwell Montes, and Lakshmi Planum indicate geological activity
- no plate tectonics, no spreading like the Mid-Atlantic ridge
- surface is “new”, less than a billion years old – cratering with larger craters much less than the moon
- evidence of lava flows, deep cracks from new crust collapsing
- evidence of buckled a fractured surface
- large scale surface recycling not present, but much evidence for volcanism
- most volcanoes – shield volcanoes)like Hawaii – not from plat boundaries
- formation of caldera (crater) on the summit as dome collapses from lava withdrawal
- formation of large lava domes along with large coronae – suggests convective motion under the crust (similar to Earth, but without tectonics)
- not plate tectonics – energy release catastrophic, reshapes surface
- evidence for ongoing volcanic activity
- surface does possess craters, but even less than earth – thick atmosphere prevents meteors from reaching the surface
- Soviet Venera landers took pictures from the surface
- chemical composition: basaltic and material similar to granite

- Venus's atmosphere very different from Earth
- atmosphere 90 times more massive than Earth
- 90% of the Earth's atmosphere, below 10 km, 50 km on Venus
- temperature drops more quickly with altitude than on Earth
- troposphere extends to 100 km on Venus – reflective clouds at 50 km to 70 km
- below the clouds, layer of sulphuric acid haze
- above the clouds, high speed jet stream (400 km/h) along with sulphuric acid
- wind speeds on the surface 2 m/s
- CO₂ is the main atmospheric gas, 96.5% by volume, 3.5% N₂, trace amounts of other gases
- example of a run-a-way greenhouse effect
- secondary atmosphere on earth result of outgassing – Nitrogen released from interactions with sunlight, water vapour condensed, carbon dioxide and sulphur compounds dissolved and locked up in surface rocks
- cooler conditions on earth results in carbon dioxide becoming locked up
- on Venus, too warm for oceans to condense, carbon dioxide never locked up, water vapour stays in atmosphere, feeding the greenhouse effect, water reacts with sunlight, eventually breaking it apart – no water vapour in Venus's atmosphere today
- Venus has no magnetic field, no dynamo (slow rotation)
- Venus's surface seems like an immature earth – perhaps high surface temperatures have played a role