

## 105 Chapter 7 Review Notes

- The **minor bodies** of the solar system include asteroids and comets
- Kepler's 3 laws:
  - Planets (and all other objects in gravitational orbits) move in elliptical orbits, with the Sun (or whatever body they orbit) at one focus
  - A line connecting the Sun to a planet would sweep out equal areas of space in equal times
  - The square of a planet's orbital period is proportional to the cube of its semimajor axis (the proportionality factor,  $k$ , depends on the mass of the body being orbited)
- The **semimajor axis** of an ellipse is half the length of its longest dimension (the semiminor axis is half the length of its shortest dimension)
- The **eccentricity** ( $e$ ) of an ellipse is a measure of how noncircular the ellipse is. The number ranges from 0 (perfect circle) to approaching 1 (extremely long, skinny ellipse)
- The **perihelion** and **aphelion** are the points in a planet's orbit where it is nearest to and farthest from the Sun, respectively
- The eccentricity is the fractional difference between the semimajor axis of an orbit and the perihelion and aphelion
  - A planet with a semimajor axis ( $a$ ) of 1 billion km, and an eccentricity ( $e$ ) of .01, would have a perihelion of 0.99 billion km, and an aphelion of 1.01 billion km
- The Earth orbits the Sun in a counterclockwise (when viewed from above our North pole) direction (defined as the **prograde** direction) in a plane known as the **ecliptic**
- Most other planets orbit in planes that are very close to the ecliptic, as a result of that plane being the one of the original nebular disk during formation of the solar system
- Any deviation from this plane is known as the **inclination** ( $i$ ) of the orbit of that planet or small body
  - Prograde orbits have inclination values between  $0^\circ$  and  $90^\circ$ ; **retrograde** orbits (those that circle the Sun in a clockwise direction when viewed from above Earth's North pole) have inclination values between  $90^\circ$  and  $180^\circ$
- Any deviation from this plane is known as the **inclination** ( $i$ ) of the orbit of that planet or small body
- **Tidal heating** is produced by the massaging effect of differential gravity forces as a planet orbits in an elliptical path, with the magnitude and direction of the gravitational pull changing and migrating across the surface of the rotating planet (or moon) throughout the orbit – maximum tidal stresses are produced for bodies in very eccentric orbits that are close to very massive bodies – Jupiter's moon Io is in the ideal position to be heated in this way and has been largely melted inside due to this process!
- **Asteroids** are small (<1000 km in diameter) solid (primarily rocky, but some icy materials (water ice) may also be present) bodies that orbit the Sun
- Most asteroids are herded into orbits within the **main belt** between Mars and Jupiter (due to Jupiter's large mass and gravitational force), but other groups also exist, including the **Near Earth Asteroids** (NEAs), some of which actually cross Earth's orbit, and are thus considered potentially hazardous asteroids (PHAs)
- The asteroids range in size from kms (or less) up to 913 km (Ceres); the smaller the diameter size, the more objects there are in that size range

- Asteroids are divided into types (classes) based on their spectral characteristics, which give an idea of their compositions
  - C – type: dark, probably carbonaceous (carbon-compound-rich); “primitive”
  - D-type: very dark and red (absorb light better at shorter wavelengths); “primitive”
  - E-type: much brighter, probably composed largely of silicate mineral enstatite (pyroxene); “differentiated/evolved”
  - M-type: metallic (primarily iron and nickel); “differentiated/evolved”
  - P-type: pseudo-M type – probably large metallic fraction; “differentiated/evolved”
  - S-type: stony or stony-iron; “differentiated/evolved”
- Asteroids’ compositions are inferred based on reflectance spectra (telescopic observations of how light over a range of wavelengths is absorbed and reflected) and the compositions of known meteorites
- So far, 6 asteroids have been observed by passing spacecraft:
  - 951Gaspra (Galileo – 1991)
  - 243Ida (Galileo – 1993)
  - 253Mathilde (NEAR – 1997)
  - 433Eros(NEAR–2000-2001)–orbiter/lander
  - 9969Braille (Deep Space 1 – 1999)
  - 5535AnneFrank (Stardust – 2002)
- We also have reasonably good shape models of 2 other asteroids from radar imaging:
  - 216 kleopatra
  - 4179toutatis
- And Hubble Space Telescope images of 1Ceres and 3Vesta
- All asteroids imaged by spacecraft have shown impact craters
- 243Ida was the first small body discovered to have a moon (Dactyl – 1 km)
- Ida, Gaspra and Eros have been observed to have boulders on their surfaces
- Eros has lots of dust and small “channels” that might represent places where material is draining into interior fractures (it may be a “rubble pile”)