Quiz 1 Review, Astronomy 1144

1 Observational Astronomy - The Night Sky

- What are constellations?
  1. They are collections of stars which are close together on the sky.
- What is special about the constellations called "the zodiac"?
  1. They lie along the ecliptic, so that the Sun passes through them.
- What is the ecliptic plane?
  1. The plane of the Sun's path along the sky. Since all the planets have low inclination, it is also where they lie, as well as the zodiac.
- Why is the ecliptic tilted with respect to the celestial equator? How big is this tilt in degrees?
  1. Because the Earth's rotation is tilted with respect to its revolution around the Sun.
  2. 23.5 degrees.
- What are the primary coordinates for finding a place on Earth? What about the celestial sphere?
  1. Earth: latitude and longitude.
  2. Celestial sphere: declination and right ascension.
- Why did the ancients keep track of the planets?
  1. Because they move with respect to the background stars.
- What are the two main periods of a planet, and how are they defined?
  1. Synodic period: the apparent orbital period of a planet as viewed from Earth. This is the time from conjunction to conjunction, or opposition to opposition. The synodic periods of the outer planets are just over one year.
  2. Sidereal period: the time it takes an object to return to the same place with respect to the background stars; also the true orbital period of a planet around the Sun.
- What is the angular size of an object? What is it for the Moon?
  1. It is the angle subtended in your field of view by the object.
  2. The Moon is about 30', or 0.5 degrees, in the sky. This is roughly the same size as the Sun.
- How big is an arcminute? An arcsecond?
  1. 1' = 1/60th of a degree.
  2. 1" = 1/60th of 1' = 1/3600th of a degree.

2 Greek Astronomy

- How did Greek astronomers first conclude that the Earth was spherical?
  1. The Earth's shadow, as seen during a lunar eclipse, is round.
- What did Eratosthenes do? How did he do it?
  1. Estimated the circumference of the Earth.
  2. He measured the length of the shadows cast at noon in two different locations separated by a known North-South distance. The difference in these lengths gave him the angle between the two locations along Earth's surface, allowing him to calculate the circumference of the Earth.
- What is stellar parallax? Why is it useful?
  1. Stellar parallax is the apparent change in the position of stars brought about by the motion of the Earth around the Sun.
  2. It can be used to determine the absolute distance to stars.
- Why did the Greeks reject the heliocentric model?
  1. They could not see stellar parallax.
- Why couldn't they see stellar parallax?
  1. Even for the nearest star, the parallax is far too small to see with the naked eye.

3 The Heliocentric Model

- In simple terms, what are the geocentric and heliocentric models?
  1. Geocentric - the planets and Sun all orbit around the Earth.
  2. Heliocentric - the planets, Earth included, all orbit around the Sun.
- Who was the first major proponent of the heliocentric model? What were the key facets of his model?
  1. Copernicus.
  2. His model had a central Sun with the planets orbiting it. It also included epicycles, like Ptolemy's geocentric model, to preserve circular motion.
- Explain the main observational problem that Mars presented for the geocentric and early heliocentric models.
  1. Retrograde motion - Mars would abruptly change its direction of motion on the sky and then fli back periodically.
- What did Ptolemy add to the geocentric model to explain this problem?
  1. By adding epicycles, i.e. circular orbits within circular orbits, to the planets' motion around the Earth.
- Who correctly solved this problem? How? Using whose data?
  1. Johannes Kepler solved this by incorporating elliptical orbits rather than perfectly circular ones, compiled from Tycho Brahe's data.
- What is the cause of retrograde motion? Where will a superior planet be during this time?

1. An inferior planet moves faster in its orbit than one superior to it, and thus laps the outer planet. This causes the outer/superior planet to appear to move backwards in the sky.
2. Opposition.

- Which of Galileo's observations supported the heliocentric model?

1. Phases of Venus.
2. Satellites of Jupiter (something else in the Solar System has objects orbiting it besides the Earth).

- Define: superior planet, inferior planet, conjunction, opposition, quadrature, perihelion, aphelion, and eccentricity.

1. Superior planet - one whose orbit around the Sun is outside that of the Earth's.
2. Inferior planet - one whose orbit around the Sun is internal to that of the Earth's.
3. Conjunction - occurs when the Sun is directly between the Earth and a superior planet (superior conjunction), an inferior planet is between the Earth and the Sun (inferior conjunction), or the Sun is between an inferior planet and the Earth (also superior conjunction).
4. Opposition - occurs when the Earth is directly between the Sun and a superior planet. The superior planet then appears opposite the Sun in the sky (rises at sunset, sets at sunrise), hence the name.
5. Quadrature - occurs when the Sun and a superior planet are 90 degrees apart in the sky.
6. Perihelion - the closest a body comes to the Sun in its orbit.
7. Aphelion - the furthest a body goes from the Sun in its orbit.
8. Eccentricity - a measure of how an orbit deviates from being a perfect circle. Is 0 for a circle, 1 for a parabola. For elliptical orbits, is determined by the ratio of the distance from the center of the ellipse to one focus and the semimajor axis.

- Explain Kepler's 3 Laws.

1. 1st Law - All the planets are on elliptical orbits, with the Sun at one of the foci.
2. 2nd Law - In their orbits around the Sun, every planet sweeps out equal area in equal time. Equivalently, planets move more slowly when further away from the Sun.
3. 3rd Law - The square of the period, P, of any orbit is proportional to the semimajor axis, a, of said orbit to the third power, or $P^2 \propto a^3$.

4 Gravity, Galileo, and Newton

- What are some things Galileo observed through his telescope?

1. The phases of Venus.
2. Sunspots.
3. Lunar mountains and craters.
4. The largest and brightest moons of Jupiter.
5. That the Milky Way is made up of many individual stars.

- Galileo also studied gravity. How did he do so, and what did he discover?

1. He timed cannonballs rolling down a slope to measure the acceleration of gravity.
2. He found that the acceleration of gravity was the same for any object, no matter its mass.

- What are Newton's 3 Laws?
    1. Law of Inertia: A body either stays at rest or moves in a straight line unless acted upon by an external force. Mass is a measure of this inertia.
    2. Law of Acceleration: For a given mass, its acceleration is proportional to the force applied - $F = ma$. More massive objects are more resistant to acceleration.
    3. Law of Action equals Reaction: For every action there is an equal and opposite reaction - momentum is conserved.
- What is meant by "conservation of momentum"?
    1. The momentum (mass times velocity) of an object or system is the same, or conserved, before and after an event.
    2. Example: If you and a friend stand facing each other on roller skates and you push them, you travel backwards at the same time your friend does.
- What is Newton's Law of Gravity?
    1. The gravitational force between two objects is proportional to the product of their masses, and inversely proportional to the square of the distance between their centers; $F_g = Gm_1m_2/r^2$, where G is a constant.
- What point do two objects orbiting each other revolve around? Where does it lie?
    1. The barycenter, or their mutual center of mass.
    2. An orbiting object's distance from the barycenter is inversely proportional to its mass: more massive objects lie closer to the barycenter.
    3. For example, in the Earth-Moon system, the barycenter is below Earth's surface, but is not at the center of the Earth.
- What is the energy associated with your position with respect to a source of gravity called?
    1. Gravitational potential energy.