

AST 111
Fall 2009
Hour Exam #1 Review

Format: Short answer, some calculations required; bring your calculator.

Material and concepts from Bennett et al. *The Cosmic Perspective* (5th Ed.) chapters 1, 3, and 4 will be included

You should be familiar with the following material and concepts. Note that this is not meant to be all-inclusive, but merely to act as a framework to help you study:

1. Scale of the Universe

- General order-of-magnitude estimates of sizes of Earth, Sun, solar system, Milky Way Galaxy, Universe
- Familiarity with astronomer's units and scientific notation

2. History of Astronomy and Birth of Science

- Ancient origins of astronomy
- Difference between astronomy and astrology
- Basic observations of motions of sky, Sun, Moon, and planets
 - Sky rotates E→W every day
 - Sun slips W→E among stars, along ecliptic, which runs through zodiac
 - Planets and Moon also stay close to ecliptic
 - Mercury and Venus stay close to Sun
 - All planets move generally W→E among stars, but show occasional retrograde loops
 - No parallax visible to naked eye
- Aristotle: geocentric model of universe: Earth at center, crystal spheres carry Sun, Moon, stars, planets around Earth.
- Ptolemy: added epicycles to explain retrograde motion
- Copernicus: heliocentric model of solar system, still using circles
- Tycho Brahe: careful observations of planet and star positions.
- Kepler:
 - K I: orbits are ellipses with sun at one focus
 - K II: equal areas in equal times (i.e., planets move faster when closer to sun)

- KIII: $P^2 = a^3$ (applies only in solar system, or other system where star has mass $M = 1M_{\odot}$)
- Galileo: first astronomical observations with telescope: moons of Jupiter, craters on Moon, stars in Milky Way, spots on Sun, phases of Venus – supported Copernican view; Earth moves through space!

3. Energy

- Energy is always conserved, even if converted from one form to another
- Units: 1 Joule = 10^7 ergs = $1 \frac{\text{kg} \times \text{m}}{\text{s}^2}$
- Kinetic: $KE = \frac{1}{2}mv^2$
- Thermal E = "heat energy": Sum of KE's of all particles in system being considered
- (vs. Temperature: gives measure of average velocity of particles)
- Potential:
 - Gravitational: $PE = mgh$ (near Earth's surface) or $PE = -\frac{GMm}{r}$ (in general)
 - Mass-Energy: $E = mc^2$
 - Chemical (electron bonds in food, muscles, wood)
- Electromagnetic radiation = light

4. Gravity and Orbits

- Newton I: Inertia
- Newton II: $F = ma$
- Newton III: equal and opposite reaction
- Universal Law of Gravity: $F = \frac{Gm_1m_2}{d^2}$, d measured from center of mass of each object, F in Newtons, where 1 Nt = $1 \frac{\text{kg} \times \text{m}}{\text{s}^2}$
- Orbits and falling bodies – same force
- All objects fall at same speed, $g = 9.8 \text{ m/s}^2$ at Earth's surface (why?)
- Circular motion: $F = mv^2/r$, $a = v^2/r$
- Circular motion under gravity: $v = \sqrt{GM/r}$
- Escape velocity: $v = \sqrt{2GM/r}$
- Orbit shapes ($E = KE + PE$):
 - Bound: ellipse ($E < 0$)
 - Lowest E : circle
 - Escape velocity: parabola ($E = 0$)
 - Unbound: hyperbola ($E > 0$)
- Tides: differential gravitational force of Moon on near and far sides of Earth stretches sphere into oval