Review for Examination #1

This is intended to be an outline of principal topics, facts, and ideas as an aid to review; it is not intended to replace the text, the lectures, or your own notes! (Did you compile a glossary?) So far this semester we have considered the following topics in the classroom lectures and the assigned readings:

The Celestial Sphere

*General appearance of the sky as a dome. Nomenclature such as zenith, nadir, horizon, meridian, cardinal directions, etc. Astronomical and meteorological phenomena. Other phenomena (aurorae, etc.).

*The fixed stars: Constellations, diurnal motions, rising & setting, circumpolar stars, seasonal changes.

*The celestial sphere: celestial poles, celestial equator. Orientation and observer's latitude. Apparent (diurnal) motion of the celestial sphere and seasonal changes.

*The luminaries: Sun, Moon, planets, and their motions. What distinguishes them from the fixed stars?

*The motion of the Sun: Ecliptic, equinoxes, and solstices. Seasons. Rising and setting directions.

*The Moon: Motions, phases, eclipses, tides. Synodic and sidereal months.

*The planets: Names. General appearances and colors. Direct and retrograde motions. Brightness variations. Synodic periods (as distinct from orbital periods).

*Early applications of astronomy: Primitive timekeeping and navigation; tides.

You should have a basic sense of the appearance of the sky and the motions and appearances of the naked-eye astronomical objects upon it. Using your monthly star maps should really help.)

Early Astronomy in the Mediterranean Area

*Early mythologies and cosmologies. Ideas concerning the structure of the universe. Pythagoras, Philolaus, Anaxagoras, Democritus, etc. Mysticism and mathematics. The influence of Euclid's geometry. The idea of a model of the motions.

*Aristotle: Explanation of lunar phases and eclipses. Arguments for a spherical but immobile Earth. The problem of the stellar parallax. Aristotle's ideas about physics.

*The first astronomical distance measurements: Sizes and distances of Sun and Moon (Aristarchus), the size of the Earth (Eratosthenes). Triangulation of the lunar distance (Ptolemy)

*Prediction and position: Hipparchus and the the motions of the Sun and Moon. Geometrical models. Assumptions (circles, etc.) (Off-center Sun. Epicycles and deferents for the Moon's motions.)

*The Great Synthesis: Ptolemy and the Ptolemaic System. Basic assumptions and the resulting geocentric (and geostationary) system of deferents and epicycles. Virtues and problems of System. Complexity; (mis-) predictions of brightnesses of the planets.

You should understand of what the Ptolemaic System tried to "explain" and how it did so. How did it succeeded and where did it fail? How were lunar phases, eclipses, and motions on the sky explained?

We then more-or-less skipped over about 13 centuries of European history (why?) until:

European Astronomy: Renaissance and the Copernican Revolution

*Copernicus: Failings of the Ptolemaic System. Copernicus' heliocentric cosmology. The connection between synodic and orbital periods. Retrograde motions and brightness variations in the Copernican System. Tests: Ptolemaic and Copernican prediction differences include planetary phases, brightnesses, and apparent sizes variations - and the stellar parallax (Aristotle!).
The first two took Galileo and the telescope to test, the second wasn't seen until 1830. Until then, the only distinguishing test was brightness variations - and that could maybe be "explained away."
The Copernican system, unlike that of Ptolemy, is heliocentric and geodynamic. (It moves!)

*Tycho: Precision astronomical measurements; length of year, etc. Comets and novae. Tychonic system.

*Kepler: Orbits deduced from observation (triangulation). Aristotelian (and Copernican) assumptions about uniform circular motions shown false. Kepler's Laws (Three of 'em) provide a correct description of how planets are arranged and how they move in our solar system (and in others).

* Digges: A space full of of stars ("suns") at various distances (not all "on" a celestial sphere)

• Social and political issues of the Renaissance. Theological assumption of Aristotelean ideas.

You should have a basic understanding of the Ptolemaic, Copernican, and Keplerian models - what they described, how they worked, and how they differed. You should understand what Kepler's laws mean.

The Beginnings of Modern Astronomy

Galileo

Experimental physics. Experiments in mechanics and optics. The "law of inertia". Several disproofs of Aristotelian physics *via* experiments. Development of the telescope. Discovery of the gibbous phases of Venus (a disproof of the Ptolemaic system). Other telescopic discoveries (Jovian moons, Saturn's rings, Lunar craters, *etc.*). Galileo's perception of the planets as disks showing phases indicated that the planets were, in fact, spheres shining by reflected sunlight. This alone suffices to show that the Ptolemaic system is wrong since it mis-predicts the brightness variations of the planets. Moreover, observed phases and apparent sizes vary as predicted by the heliocentric Copernican model.

The words "Copernican" and "heliocentric" are used almost interchangeably. Kepler's correct description of planetary motions in elliptical orbits about the Sun (located at a focus of the orbital ellipse, not its center) is considered both heliocentric and Copernican. Strictly speaking, though, the Copernican System is that heliocentric system in which the orbits are described by combinations of circles.
Understand how Galileo's observations disproved the Ptolemaic view and lent support to the Copernican picture. Galileo's experiments also disproved much of Aristotelian physics. How?

Newton

Experiments in optics, mechanics, fluid dynamics. Newton's (3) Laws of Mechanics. Newton's Law of Gravity. The generality of these laws. Explanation of why the planets and other bodies move as they do. Explanation of tides. Newton's explanation (and correction) of Kepler's laws.

Newton's Laws of Mechanics provide a means for predicting/describing/calculating the detailed motion (location, velocity, accelerations, etc.) of any object acted upon by any force. To do this one needs to know certain properties (*e.g.*, the mass, charge, etc.) of the object, the nature of the force (strength, direction, dependence upon object properties, *etc.*) and some initial conditions (where the object was and what it was doing when things started). The mathematical tools required might be complicated; Newton invented the calculus just to do these sorts of problems.
*Gravity is one of the four fundamental forces of nature - the strong nuclear force, the weak nuclear force, the electromagnetic force, and gravity. $F = GMm/r^2$ is Newton's "Law of Gravity". An inverse-square law force, gravity is always attractive and directed along the line joining the bodies. Vectors and scalars.

Light and its Measurement

*Light and astronomy. Basics of direction, brightness, and color. Historical views on the nature of light.
*Light as a particle: *Photons* and energy. Light in a vacuum.
*Light as a wave: Propagation of light. The "æther"? Amplitude, wavelength, frequency and speed.
*Basic wave phenomena: Diffraction and interference.
*Measurement of light: The electromagnetic spectrum. From gamma-rays to radio waves.
*The speed of light. Measurements and their implications. (Einstein's Special Theory of Relativity.)
*Phenomena: Light in a vacuum. Brightness and distance-the Inverse-Square Law.
Wavelength and motion - the Doppler effect.
You should understand both of these. The first is a consequence of the fact that light travels in straight lines, nothing more. The second is a manifestation of light's wavelike properties.

Light and Matter

*Optics: Reflection, refraction, dispersion. Mirrors, lenses; telescopes and other useful devices.
*Emission, absorption, and scattering by matter.
*Spectra of solids and liquids: Continuous spectra. Luminosity and color versus area and temperature. "Black Body" radiation. (Light as produced by matter.)
* Spectra of gases: Emission line and absorption line spectra. Spectral "fingerprints."
*Atomic Structure and line spectra. The components and structure of atoms. The "rules" of quantum mechanics. The "why" of the spectra of different materials.
*Review: What can its light and spectrum tells us about an object? (Temperature, composition, motion,....)