Introduction to Astronomy

Introductory Astronomy provides an ideal tool for teaching the nature of science and the scientific method. In particular, the paradigm shifts are well-known (e.g. geocentric vs. heliocentric models of the solar system) and the relationship between progress in science and invention of new technologies is clear. However, while the use of an astronomy course for teaching the nature of science necessitates teaching some basic physics concepts, it does not require specific subtopics within astronomy to be learned.

What follows is a list of both the physics concepts and astronomical topics that are deemed essential to an astronomy course whose aim is to convey the nature and methods of science.

I. Physics Concepts

The first exit competency must be to specify which physics concepts are essential to understanding the nature of science as taught in astronomy. They include:

1) Newton's laws
2) the nature of light (both waves and particles)
   a) color, wavelength and energy
   b) Doppler effect
3) electronic structure of atoms
4) spectroscopy and the relationship between (2) and (3)
5) blackbody radiation

In all cases, students should be able to demonstrate an understanding of the concepts and the meaning of the equations, though a rigorous mathematical understanding of formulas is not necessary. That is, they should know that the gravitational force between two bodies is proportion to the masses and inversely proportional to separation squared; they should know that the nature of a blackbody is such that the total power output is proportional to both the size (radius) and the temperature of an object, but that the effect of temperature is stronger than that of size.

II. Astronomical Concepts

1) Students should be able to explain how the motion of astronomical objects is viewed across the sky on various timescales (e.g. daily, monthly, yearly, etc.). Students should:
   a) Know how these apparent motions are manifest themselves in terms of seasons and lunar phases.
   b) Know that scientific relevance of the Zodiac constellations is simply that these constellations define the ecliptic plane (where the sun and planets travel on the sky).

2) Students should know the properties of planetary motion as described by Newton's Laws and Kepler's Laws. They should know how these properties allow us to derive planetary (and in fact stellar) masses.

3) Students should know what the fundamental measurable properties of stars are, such as distance (where applicable), brightness, temperature, and derivable properties such as mass, radius, etc. They should:
   a) Know how those properties are derived.
   b) Know what the Hertzsprung-Russell diagram is and what can be represented on it (populations of stars, evolutionary paths of stars).
   c) Know star nomenclature (main sequence, giant, supergiant, dwarf, etc.).

4) Students should know the hierarchical structure of the universe (solar system, galaxies, cluster galaxies, universe) and the methods of measuring astronomical scales (especially parallax and standard candles, but also Doppler shift and its relationship to Hubble's Law).

5) Students should know what Hubble's Law is and how it was determined. They should know how it can be used both to determine the history and to extrapolate the probable evolution of the universe.