Ay 1: A handy list of study topics, prepared by Io Kleiser, June 2015:

THE ELECTROMAGNETIC SPECTRUM
- know the order in energy or wavelength of the various regimes of the EM spectrum
- know roughly the wavelength range of visible light
- know the relationship between energy or temperature and redder/bluer light

DISTANCE MEASUREMENT
- understand parallax

ORBITS
- what is the relationship between the period and semimajor axis of a planet's orbit around a star?
- understand gravitational force; kinetic & potential energy in orbits
- what happens with the angular momentum over the course of a planet's orbit?

COORDINATES
- know right ascension and declination
- understand why there are seasons (Earth tilt)

TELESCOPES AND DETECTORS
- formula for magnification
- how does collecting power depend on the size of a telescope?
- understand the diffraction limit (or at least the formula) and understand that it is the best you can do with a given telescope at a given wavelength of light
- do ground-based telescopes do better or worse than space-based (assuming the same optics) and why?

ELECTROMAGNETIC RADIATION
- know relations between photon energy, wavelength, and frequency
- different types of radiation: electron transitions, blackbody (thermal), synchrotron...
- know Kirchoff's laws
- know where spectral lines come from and the Bohr model of the atom
- what is the Doppler shift for light?
- what is blackbody radiation conceptually? understand how to draw a few different blackbody spectra of different temperatures in wavelength or frequency space
- what is the temperature of the Sun? what is its peak wavelength?
- what is the relationship between the peak wavelength of a blackbody spectrum and its temperature?
- if you integrate a blackbody spectrum over frequency (or wavelength), what do you get (as an expression for the flux)?
- what is the luminosity of a spherical blackbody of a certain effective temperature?
- what is flux? what is the difference between the flux at the surface of an object (like the Sun) and the flux of that object's light incident on another object (like the Earth)? how do you calculate what fraction of the Sun's luminosity L actually hits Earth?
- know the formula for the magnitude system
- what factors determine how much light is absorbed as it moves through some material?

INTERSTELLAR MATERIAL
- know the phases of the ISM
- what is the (approximate) freefall time for a collapsing gas cloud?
- what are the competing factors that decide whether a proto-stellar cloud collapses? conceptually what are Jeans mass and Jeans length?
- what is the Kelvin-Helmholtz time? what is the exchange between different forms of energy as a cloud collapses slowly?

SOLAR SYSTEM & exoplanets
- what does a planet's temperature depend on without albedo or greenhouse gases?
- understand albedo and how it affects the temperature of a planet absorbing light from a star
- what do greenhouse gases do to heat up the surface of a planet?
- what are the different ways of detecting planets, and what can each one tell you about the properties of that planet?

STELLAR STRUCTURE
- have a basic understanding of where the equations of stellar structure come from (e.g. hydrostatic equilibrium is pressure/gravity balance)
- know that there are different kinds of pressure that may be acting (ideal gas, radiation..)
- know that there are different ways to transport energy out (random-walking photons, convection)
- how do stars produce their energy? how is this different from the source of radiation for a collapsing gas cloud?

STELLAR EVOLUTION
- understand the Hertzsprung-Russell diagram as an observational tool (and its limitations!)
- what does it mean for a star to be on the Main Sequence? understand where stars of various masses lie on the MS and how their lifetimes depend on mass
- how can you use this to figure out the age of a star cluster (assuming all the stars in a cluster were born at the same time)?
- be careful to distinguish between snapshot plots of the HR diagram (e.g. everything on the Main Sequence at the same time) and tracks that stars make on the HR diagram throughout their lives
- why is there an upper mass to the stars that can form?
- after core hydrogen burning is done, what are the subsequent stages of a star's life?

END STATES OF STELLAR EVOLUTION
- understand the various ways stars end their lives, what we observe when they do, and what is left afterward
- what is degeneracy pressure?
- why is there an upper limit to the mass of a white dwarf (what are the two pieces of physics that determine this), and what is that limit?
- what is a Roche lobe?
- know the types of supernovae (II, Ia, Ib/Ic) and which kinds of objects explode to produce them

- how is most of the energy released in a core-collapse supernova (massive star explosion), and why?

NEUTRON STARS, PULSARS, BLACK HOLES
- what are the similarities and differences between neutron stars and white dwarfs? how do their radii compare (and how do they compare to other familiar objects like the Sun, Earth, etc.)?
- understand the reasons pulsars are observed to pulsate
- how can you use the classical escape velocity to calculate the Schwarzschild radius of a black hole?
- think about the different ways you COULD detect a black hole, even if the black hole itself does not radiate
- how do we know about the existence and mass of our central supermassive black hole (Sgr A*)?
- understand how to calculate the energy released by accretion onto a black hole and how to find the efficiency of that radiation

THE MILKY WAY
- what are the components of the Milky Way?
- know what is meant by Population I and Population II stars. where are each of these more likely to be found in our galaxy?
- what is a rotation curve? what information does it give us about spiral galaxies?
- how does the rotation curve look for different mass distributions? how was this used to infer the existence of dark matter?
- what possible explanations are there for dark matter?
- what are spiral density waves and what do they have to do with star formation?

GALAXY FORMATION/EVOLUTION/PROPERTIES
- be familiar with Hubble's classification scheme for galaxies. were the "early-type" and "late-type" galaxies aptly named?
- how are dwarf galaxies different from other galaxies?
- where is star formation most likely to happen and why?
- when galaxies collide, what components of each galaxy interact?
- spiral galaxies have rotation curves, but what is the analogous measurement for ellipticals?
- what is the Virial Theorem? what kinds of systems does it apply to?
- understand how the Virial Theorem can be used (along with a couple other assumptions) to figure out the Fundamental Plane and Tully-Fisher relation

LARGE SCALE STRUCTURE
- compare the size of the solar system to the size of the galaxy to the size of a galaxy cluster to the size of the observable universe
- what is the difference between dissipationless collapse and collapse in which dissipation is important? how does this help you figure out how structures of different sized form?
- what is the Sunyaev-Zeldovich effect?

QUASARS AND AGN
- what is the source of energy for quasars and AGN?

- what do we think is the origin of the differences in types of AGN?
- what are the types of radiation that come from accretion disks around black holes?
- understand the different ideas for galaxy + supermassive black hole formation

THE EXPANDING UNIVERSE
- understand what is meant by the expansion of space. is it expanding into something? how are analogies of expanding balloons and rising raisin bread relevant?
- understand homogeneity and isotropy
- what is the difference between comoving and proper coordinates?
- how does expansion cause light to redshift?
- what is meant by closed and open universes? what about flat and curved universes?
- what is the hubble parameter? if you take the inverse of H_0, what timescale does this remind you of?

THE EARLY UNIVERSE
- how do densities of matter, radiation, and dark energy scale with the expansion parameter R (sometimes denoted as a)
- when were these different densities dominant?
- understand the difference between luminosity distance and angular diameter distance and try to figure out where the the factors of (1+z) come from. what weird/non-intuitive thing happens with the angular diameter of an object at very large cosmological distances?
- make a timeline of significant events in the early universe
- what is the CMB, and what temperature is it? why does it represent the edge of the observable universe (and the farthest we can look back in time)?
- understand the basic idea of inflation and the observational problems it tries to solve
- what is antimatter?
- what are some methods and tests for determining the age of the universe?

COSMOLOGICAL DISTANCES
- what are the different 'rungs' in the distance ladder and where are they each useful? why is it called a ladder?
- know Hubble's law and where it is useful; what are its limitations?
- what are standard candles, standard rulers, and other cosmological tests?
- which supernovae can be used as standard(izable) candles?
- how do we know the expansion of the universe is actually accelerating? why would we assume this not to be the case, and what is invoked to explain this?

DARK MATTER, DARK ENERGY, CONCORDANCE COSMOLOGY
- what are ALL the components of the universe and what are their densities?
- how does gravitational lensing work, and how can we use it to infer the presence of dark matter?