Astronomy 110 Final Review
There may be one or more questions which require that you identify a picture from among others. Pictures could include planets, galaxies, comets, moons, etc There will NOT be subtle differences like a crater on the Moon vs a crater on Mercury. On the other hand, you should be able to tell the Sun from Mercury, or tell from Io from an elliptical galaxy.

There may be one or more "travel agent" questions. These are questions where you would be deciding among destination for travelers based on matching what they want to experience. You might make a 3x5 card for each of the planets and the important moons, so that you can summarize their features. Look at the matching list to see some of the important properties.

Check the last week of class to be certain of how far we get in the class. The final will start after test 2. The final parts: stars, galaxies and the universe will be covered only briefly at best. The lecture will summarize what you need to know about galaxies etc.

EARTH Castle Ch 10, Units 35, 36, 48
Have an overall idea of the age of the Earth, how the continents have moved and how life and the atmosphere have evolved. I don't stress the layers of the atmosphere or the types of rocks. I do stress landforms (mountains, volcanoes, lava flows) etc. in lecture and the relationship between the Earth's atmosphere and life.

We will discuss radioactive dating using several elements (including Carbon 14, for previously living material only). We will talk about daughter elements, the results of radioactive decay of parent atoms (by fission). Be able to find the age of a sample given a plot of the amounts of parent and daughter at different time. You will not need to memorize the half life of anything. Understand the differences between convection, conduction, and radiation.

Earth questions (including radioactive decay and heat transfer)
E-1 The age of the Earth (based on geological evidence) is approximately
a) 10 Billion years b) 16 Billion years c) 4.5 Billion years d) 1 Billion years e) 10 Million years

E-2 The Earth's atmosphere includes a substantial fraction of Oxygen. Is this the original composition of the atmosphere? If not, what was the earlier atmosphere?

E-3 Which of the following is evidence for a molten interior of the Earth?
a) Deserts b) Rivers c) Sandstones d) Volcanoes e) Glaciers

E-4 Plate tectonics is
a) Breaking and bending of plates b) The science of ice ages c) The science of finding the ages of things d) The motion of the divisions of the Earth's crust
e) The way in which mountains form from volcanoes and get worn down

E-5 The greenhouse effect is
a) A way of keeping plants from getting weeds
b) Destruction of the ozone layer by pesticides and fertilizers used in greenhouses
c)The way air circulates from the equator to the poles which keeps the poles comparatively warm
d) A method whereby carbon dioxide keeps the Earth warm by preventing radiation
e) A method for determining how old previously living things are based on the amount of carbon they have

E-6 How long do we think there has been life on the Earth?
a) 1 Million years b) 250 Million years c) 500 Million years
d) 3.8 Billion years e) 4.3 Billion years

E-7 Why do we think that the continents have not always been in the same place?
a) Because there used to be ice in the temperate regions
b) Because we can measure the motion
c) Because the surface of the Earth has been getting smaller as it cools, so the continents are coming closer together
d) Because human languages are related, so we probably all came from the same location

e) Because beaches and entire continents are getting washed away by hurricanes

E-8 What is the major constituent of the Earth's atmosphere?
a) Oxygen b) Hydrogen c) Nitrogen d) Carbon Dioxide e) Ozone

E-9 What is the most common land form on the earth?
a) Volcanic plains b) Polar deposits
c) Cratered terrain d) Volcanic constructs e)Platform deposits

E-10 How does the greenhouse effect work? How does it affect the planet's temperature?

E-11 Why do we care about the Ozone in the Earth's atmosphere?

E-12 What causes the Earth's magnetic field, according to current theories?

E-13 How are most mountains on the Earth formed?

E-14 What is a P wave?

E-15 What evidence do we have that the center of the Earth includes molten material?

E-16 What causes the aurora?

E-17 When heat is transferred by radiation, what carries the heat?

E-18 When heat is transferred by convection, what carries the heat?

E-19 When heat is transferred by conduction, what carries the heat?

E-20 What do we think is the mechanism to carry heat within the core of the Earth?

E-21 What do we think is the mechanism which carries heat within the Earth'smantle

E-22 What causes the motions of the continents associated with plate tectonics?

E-23 How old are the oldest stromatolites? What are they?

E-24 What is viscosity? How does it affect the shape of volcanoes?

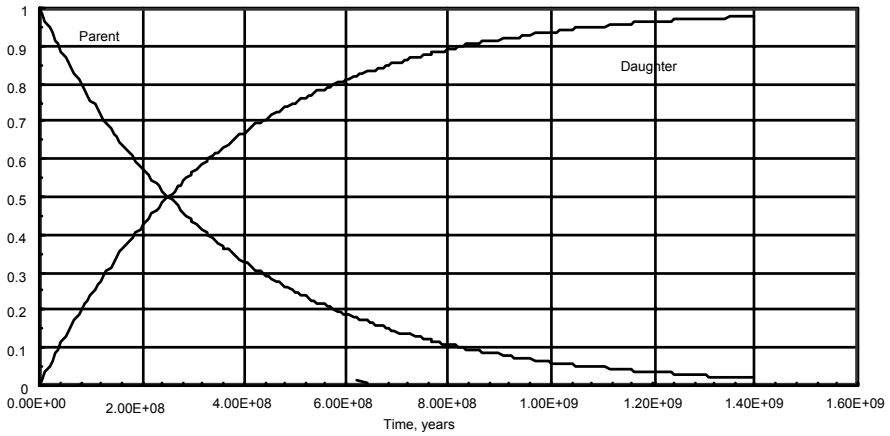
E-25 What distinguishes between a valley made by a glacier from one made by a river?

E-26 What can be deduced from the density of the Earth or another planet?

E-27 What is hydrostatic equilibrium?

E-28 If you are examining a rock and find that there is 87.5% parent and 12.5% daughter, how many half lives has it been since the rock formed?

E-29 What is the half life of the species shown in the figure below?



E-30 How old would a rock be if it had 15% daughter and 85% parent of the radioactive species in the figure above?

Earth's Moon (Unit 37)
Moon-1) How thick is the Moon's crust likely to be?
Moon -2) Why does the Moon have more craters than does the Earth?
Moon -3) What does a mare region consist of?
Moon -4) What are some differences between the side of the Moon facing Earth and the other side?
Moon -5) Does the Moon have an overall magnetic field, as far as we know?
Moon -6) What is a rille?
Moon -7) What is a basin? How is it different from a crater?
Moon -8) What is the current theory of how the Moon formed? What argurments support this theory?
Moon -9) Which is older, a mare region or a highland (terra) region? How do we know?
Moon -10) What can be told from the density of craters on a portion of the surface of the Moon?
Moon -11) What is the evidence for and against water on the Moon?

Venus and Mercury (Units 38, 39)
VM-1) How long is the solar day on Mercury? Why is it so different from the sidereal rotation period?
VM-2) Has ice been observed on Mercury? How can it survive the heat?
VM-3) What is Ishtar Terra?
VM-4) What is Aphrodite Terra? What might have caused it?
VM-5) What is the Caloris Basin?
VM-6) Describe a scarp
VM-7) Which planet would you be most likely to mistake for our Moon if you were on the surface? Why?
VM-8) Why are there few impact craters on Venus/
VM-9) What is an arachnoid?
VM-10) What is the reason that Venus is so much hotter than the Earth, according to current theory?
VM-11) Mercury is very dense for such a small planet. What do we think has caused it to be so dense?
VM-12) How is it possible for ice to exist on Mercury? What is the evidence is there for ice?
VM-13) Why is it that the day and night temperatures on Venus are so similar?
VM-14) The Magellan vehicle used radar to observe Venus. Why didn't it use visible light?
VM-15) What is the evidence that there might be crustal motion on Venus?

Mars (Unit 40**)**
Mars-1) What is the evidence that there has been liquid water on the surface of Mars in the past?
Mars-2) What is the evidence that there cannot be liquid water on the surface of Mars at present?
Mars-3) Why does Mars appear especially red during the Martian winter?
Mars-4) What are the Martian polar caps made of?

Mars-5) How are the Martian volcanoes different from those on the Earth and on Venus?
Mars-6) What is the weather on Mars like?
Mars-7) How would you distinguish between a run-off channel and an outflow channel?
Mars-8) How does the viscosity of lava on Mars compare with the viscosity of lava on the Moon?
Mars-9) If you wanted to find an impact crater on Mars, where would you look?
Mars-10) Does Mars have moons? What are they like?
Mars-11) What is the major constituent of Mars atmosphere?

Jupiter and Saturn (Unit 43,44)
We will talk about tidal stretching in class. Fix uses "Roche distance" for the distance where tidal stretching matches the internal gravitational binding of a moon. I call this the "Roche limit".
JS-1) What is the evidence that the rings of Jupiter and Saturn are not solid bodies?
JS-2) What is the evidence that Jupiter and Saturn generate substantial internal energy? Does either generate more energy than they get from the Sun?
JS-3) What do we believe is the source of the internal energy of Jupiter and Saturn?
JS-4) Why are Jupiter and Saturn hot on the inside?
JS-5) Is the Great Red Spot a feature pinned to the core of Jupiter? How do we know?
JS-6) What is the indication of convection on Jupiter?
JS-7) What are Jupiter and Saturn made of?
JS-8) Where would you find metallic hydrogen? How is it different from the usual hydrogen gas we are used to ?
JS-9) How do we come to have information about the internal layers of the Jovian planets?
JS-10) What makes Saturn's rings so flat?
JS-11) What causes the spokes in Saturn's rings? Why can't they just be colored regions in the rings?
JS-12) What happens at the Roche limit? (or distance) What would happen to a body which comes closer to a large body than this distance?
JS-13) Why is it that Jupiter's rings appear brighter when sunlight shines through them, while Saturn's rings are brighter when the Sun is behind the observer?
JS-14) What does it mean to say that two bodies have orbits which are in resonance?
JS-15) What does the resonance do to their orbits?

The Outer Planets (Units 44, 45, 46)
I would not ask picky details of the discoveries of the planets. I might ask about the general method used. I would not ask about previous theories of the planets' internal structures, only current ones.
UNP-1) What causes the blue color seen on Uranus and Neptune?
UNP-2) What do we think the internal structure of Uranus and Neptune is like?
UNP-3) What are shepherding satellites?
UNP-4) How do Uranus' rings appear different when seen in forward scattering rather than backscattering?
UNP-5) Which of the planets rotates retrograde? Which of their moons orbits the same direction as the planets rotate?
UNP-6) What is the appearance of the surface of Pluto?
UNP-7) Why is it that we were not able to find Charon when Pluto was first discovered?0

Jovian Planets and Moons (Units 43-46)
JPM-1) What features are found in the atmosphere of the Jovian planets? (e.g. rings, bands, craters, spots)
JPM-2) How fast do the Jovian planets rotate?
JPM-3) Which of the planets emits more heat than they receive from the Sun?
JPM-4) How do Pluto and Charon differ from the Jovian planets? From the terrestrial planets?
JPM-5) What causes the gaps in Saturn's rings?
JPM-6) What makes us think that the rings are very flat?
JPM-7) What makes us think that the rings are younger than the planet itself?

Satellites Overview (U 45, 46)
You will not be expected to know every satellite that was in the travel brochure homework, but be certain to be able to recognize the Phobos, Deimos, the Galilean satellites of Jupiter, Titan,

Mimas, Miranda, Triton, and Charon, from their descriptions or their pictures. Be aware of the icy satellites like Ariel, Enceladus.
Sat-1) How do we tell what satellites are made of ?
Sat-2) What do we think causes Io to have volcanic eruptions
Sat-3) Which of the satellites have evidence for ice on their surfaces? Water under the surface?
Sat-4) How do we know that Io has a younger surface than, say Ganymede?
Sat-5) Several satellites have craters and grooves on their surfaces. Which are they?
Sat-6) What is unique about Miranda?
Sat-7) Which satellite has geysers?
Sat-8) What does the presence of geysers indicate about the interior of a body?
Sat-9) When a satellite orbits a planet retrograde, what does it indicate about the origin of the satellite? Was it formed with the planet?
Sat-10) What is likely to happen to the orbit of a retrograde satellite as a result of the tidal

Planets Overview The following are overview questions for all the planets.
planets-1) What is the density of the earth? Of the other terrestrial planets?
planets-2) What can we deduce from the density of the planets?
planets-3) What is the structure of a Jovian planet? How does it differ from that of a terrestrial planet.

Match (not one for one)

1) Mercury	a) Atmosphere
2) Venus	b) Craters
3) Moon	c) Lava Flows
4) Mars	d) Folded mountains
5) Earth	e) Rays
6) Jupiter	f) Rilles
7) Saturn	g) Scarps
8) Uranus	h) Metallic Hydrogen
9) Neptune	i) Iron core
10) Pluto	j) Icy surface
11) Deimos	k) Greenhouse effect
12) Io	l) Dust storms
13) Europa	m) Volcanoes
14) Ganymede	n) Polar caps
15) Triton	o) Tidal lock between rotation and revolution
16) Mimas	p) Magnetic field
17) Enceladus	q) Retrograde rotation
18) Phobos	r) Have satellites
19) Titan	s) Is a satellite
20) Charon	t) Has Water
21) Miranda	u) Has evidence of once having had water

Asteroids and Comets (41, 47 U41 prob 1;U47 probs 1,2,3,4)
AC-1) Widmanstatten figures are crystals of iron. Where do they occur? What do they indicate about the history of the body?
AC-2) What are the three main types of meteors? Which is the most common in terms of the total mass?
AC-3) What direction does the tail of a comet point? Why?
AC-4) What is the Kuiper Belt? What is the Oort Cloud?
AC-5) How long do comets survive?
AC-6) How do we tell what comets are made of?
AC-7) What determines the date of meteor showers?
AC-8) What causes Kirkwood gaps? What causes them?
AC-9) What is significant about a carbonaceous chondrite?
AC-10) What causes meteor showers?
AC-11) What is a meteoroid? How is it different from a meteor?
AC-12) How would you distinguish a comet from an asteroid, should you see one?
AC-13) If we were out near Pluto, could we see a nearby comet with a complete tail? Why or why not?

The Sun (U 49, 50, 51)
Sun-1) What is the source of energy for the Sun? How do we know?
Sun-2) Why is the corona hot?
Sun-3) What is the solar cycle? What changes over the solar cycle?
Sun-4) What will the (approximate) latitude of spots be in the year 2007? (see the Butterfly diagram p406)
Sun-5) When will the next solar maximum be?
Sun-6) What is the Maunder minimum?
Sun-7) What do we think causes sunspots and solar activity?
Sun-8) How fast does the sun rotate i.e. what is its period?
Sun-9) What is the solar wind?
Sun-10) How does the latitude of a sunspots change over the course of a cycle?
Sun-11) What is the Butterfly diagram?
Sun-12) What is the source of energy for the Sun? Why do we think so?
Sun-13) How old is the Sun? How has its brightness changed?
Sun-14) How hot is the exterior of the Sun? The core?
Sun-15) Why do we expect a particular number of neutrinos from the Sun?
Sun-16) How do we explain the current number of neutrinos received?

Stellar Spectra, H-R Diagram, Masses of Stars (Units 58, 59)
Know the order of the spectral types, from hottest to coolest.
You will still need to remember the concepts of what an absorption spectrum looks like and the idea of Doppler shift. Get the idea that more massive stars live a SHORTER time.

Be able to **use** a Hertzsprung-Russell diagram to look up the temperature of a star, or to find its luminosity if given the luminosity class (the Roman numeral). Use the diagrams when answering the questions below.
Stars-1) Why do some stars show only faint lines of hydrogen, when hydrogen is the most common element?
Stars-2) What is the temperature of a B5 star?
Stars-3) What is the most common element in the Universe?
Stars-4) What is the evidence that Hydrogen is the most common element?
Stars-5) How can the rotational velocity of a star be found?
Stars-6) How many times as bright as the Sun would an F5II star be? (and any variation of this)
Stars-7) Which is brighter, a B0V star or a G0I star?
Stars-8) Develop a sequence of steps which a star will go through as it runs out of hydrogen and leaves the main sequence. Make a separate sequence low mass stars and another for high mass stars.
Stars-9) What happens to the outer appearance of a star of 1 solar mass when it runs out of hydrogen in its core?
Stars-10) What happens to the outer appearance of a star of 8 solar masses when it runs out of hydrogen in its core?
Stars-11) What type of stellar remnant will our Sun leave when it dies?
Stars-12) If you were going to look for a star which will explode, what type of star would you look for? (What mass? state of evolution?)
Milky Way and other Galaxies (Units 70, 74, 75)
Get an overall idea that a galaxy is a group of stars with their associated gas, dust, magnetic field. Know how they look, so that you could tell a spiral from a barred spiral from an elliptical in a picture. Don't worry about distinguishing the subtle differences of the types of ellipticals etc. Know where we live in our spiral galaxy.

Understand the Hubble constant and how we deduce the expansion of the Universe from it. Be able to relate distance to velocity. If there was a problem about this, I would tell you a value for the Hubble constant, and ask you for either the distance of the body given the speed, or the speed given the distance.

Get a picture of the number of galaxies in the universe and that they are arranged in clusters and that the clusters are in filaments (the places where the galaxies are located are arranged like the rubber in a sponge, or like the soap film in a bubble bath). Understand that galaxies cluster, how

the clusters may have started, how there are voids and sheets of large numbers of galaxies, how we are developing maps of the distribution of galaxies.
Gals-1) What is the evidence that there is dark matter inside of galaxies?
Gals-2) What is the evidence that the Universe is expanding?
Gals-3) What is the evidence that galaxies collide with one another? In what way are their shapes changed by the collisions?
Gals-4) How do we know that galaxies are distinct groupings of stars and mass, rather than all part of one object?
Gals-5) What are the names of different types of Galaxies?
Gals-6) What is the tuning fork diagram? How does it relate to the evolution of galaxy types?
Gals-7) Are galaxies in the early Universe the same as galaxies today? If not, what are some of the differences?
Gals-8) What is the strongest evidence that there is something in galaxies in addition to all the stars, gas and dust we can detect?
Gals-9) What is the Hubble law?
Gals-10) What is the distance of a galaxy whose radial velocity is 3000km/sec?
Gals-11) What is the local group? Approximately how many members does it have
Gals-12) What is a void?
Gals-13) What do we think is the reason that voids occur ?
Gals-14) What is the evidence that there is dark energy?

Cosmology (Units 80, 82)
Get an overall history of
- Big Bang
- Creation of Some of the Elements
- Creation of the galaxies etc
- Continuing expansion of the entire thing (or Big Bounce??)

Be able to outline the history of the Universe

Cosmol-1) What evidence is there that the Universe is expanding?
Cosmol-2) What would, or wouldn't make it contract again?
Cosmol-3) Why do we think that there is material in the Universe in addition to the stars, gas, and dust which we can see?
Cosmol-4) Where does the Helium in the universe come from? Where does the Iron come from?
Cosmol-5) How does the amount of deuterium in the Universe help us determine the baryon density?
Cosmol-6) What is the Cosmic Background Radiation?
Cosmol-7) Why is it surprising that the early universe was very nearly isotropic (the same density everywhere)?