GEOL/ESS 2000: Exam I STUDY GUIDE

There are some basic preliminaries that are worth stating:

1) You do not have to memorize the equations we have looked at in class or in lab; I am interested in whether or not you understand the general concept – I'll give you equations or data that you may need for a calculation.
2) In general, it is obvious that the first exam will cover the supplementary material on the origin of the elements, nucleosynthesis, radioactive decay, and the origin of the universe and solar system. It will also cover Chapter 1 of the book (available on the class website, address found in the syllabus).
3) There may be concepts from the labs and problem sets that appear on the exam:
   Simple radioactive decay problems
   Steady state problems

Overall outline of material covered

a) Structure of the atom and the nucleus, radioactive decay
b) Fusion in stars, formation of the elements
c) The Big Bang
d) The structure of the solar system, patterns within it
e) The solar nebula model and the equilibrium condensation model
f) Tests of the formation models using meteorites and asteroids
g) Reasons for different levels of activity on planets

The following outline lists the major topics and questions we covered:

Structure of atoms and nuclei
- Components of the atom: nucleus and electrons
- Components of the nucleus: protons and neutrons

Role of the nuclear strong force, nuclear weak force, and Coulomb (electrostatic) force in determining stability of nucleus (and in fusion and radioactive decay reactions)
Types of radioactive decay (beta, alpha, gamma)
Use of radioactive age dating techniques, simple half-life and decay ideas
Understand the Rb/Sr isochron diagram (from Lab 1)
The basic processes in solar fusion:
- Need for high energy (high T) collisions
- Need for weak force to convert proton to neutron

Other types of fusion at higher T or in stars where H has run out
The generation of heavier elements and their expulsion back into space
The R and S process, and in which stars R vs. S occurs
The Big Bang, "Hubble expansion" and its implications for early universe
Observational predictions resulting from Big Bang
Cosmic Microwave Background radiation
Abundances of the elements (including amount of helium, He)
Overall structure of the solar system
Patterns in location/motion of the planets
- All (except Pluto) in near-circular orbits, in almost the same plane
- All revolve (and most rotate) counterclockwise as seen from the N side of Solar System

Patterns in composition

Inner terrestrial vs. outer Jovian planets

Compositional trends within terrestrial and Jovian planets

Small bodies (comets, asteroids, meteorites, small moons) as "fossil" record of early composition

Patterns in activity

Large worlds active longer, small worlds cool faster

Solar nebula model plus condensation model as explanation of above patterns

Evidence of similar nebulae around forming stars

How solar nebula model explains above patterns in location/motion (counterclockwise motion, common plane, regular spacing)

Why material collapses to form a disk

Role of strong stellar wind in eventually clearing gas

General pattern in condensation as nebula cools

Initial high temperature appearance of Ca, Al, Ti rich oxides

Lower T appearance of Mg rich silicates, Ca rich plagioclase, and metallic Fe

Still lower T appearance of other silicates and Fe rich minerals

Still lower T appearance of OH bearing silicates plus sulfates, carbonates, and carbonaceous compounds

Still lower T appearances of ices: H_2O then NH_3 and CH_4

Simple model: Subsequent gas loss but solid material preservation fixes final composition of each region

Why the condensation of ice beyond the "snow line" can lead to the formation ofthe gas giant (Jovian) planets

Tests of the condensation model using meteorites

Classification of meteorites into undifferentiated (chondrites) and differentiated (irons, stony-irons, achondrites)

Origin of differentiated meteorites in differentiated asteroids

How carbonaceous chondrites represent an "unequilibrated" mix of components from different temperature states of the condensation model:

CAI's (Calcium-Aluminum rich inclusions), Chondrules, Matrix of Phyllosilicates, FeO, Fe, FeS, C compounds

The strange flash-heating events which melt chondrules

Rough timescales for the assembly of the meteorites and their parent bodies, and the planets

Chapter 1:

-Timescales of global change (change happens on all time scales); slow inexorable events over long times, and sudden events like asteroid/comet impacts