The final exam will be comprehensive and multiple-choice. This review sheet is a guideline only – there may be a few questions on the exam not specifically addressed here but covered in class, the assigned reading, or the homework.

**Things to help you study:**
- Class notes
- Homework assignments
- Assigned reading
- Animations posted on the web
- This Study Guide
- Practice Exam

**Asteroids, Meteors, and Comets (Space Junk)**
- General definition/description of asteroids, meteors, comets
- Where do they come from?
- Composition, general sizes
- Exploration of asteroids (NASA missions)
- Meteor showers & relationship to comets
- Major impacts (Chicxulub, Meteor Crater)
- Comet tails – what are they made of, what controls their size & direction?
- What they can tell us about the solar system?

**Hydrology**
- Hydrologic cycle: evaporation, transpiration, condensation, precipitation, transport
- River development, erosion, types
- Sediment transport: bed load, suspended load
- Floods, 100-yr flood
- Hydrological features: stream patterns, alluvial fans, river terraces & deltas

**Water in El Paso & Groundwater**
- Flooding, interaction of Franklin Mts & Rio Grande, aquifers in El Paso
- Water table, porosity, permeability, saturation,
- Aquifers & aquicludes, springs, water wells
- Groundwater flow, recharge, & discharge
- Changes in landscape: dissolution, sink holes, caves
- Environmental problems
Oceanography
- General ocean facts: coverage, avg. depths, composition
- Salts & Salinity: balancing water & salt, ions
- Ocean variations in depth: shallow, middle, bottom zones
- Thermocline, halocline
- Ocean currents: cold vs. warm water conveyor belt
- Currents & winds
- Coriolis effect
- El Nino, La Nina

Tides, Beaches, Tsunamis
- Role of gravity: mass vs distance (radius)
- Tidal effects of the Moon (daily changes)
- Tidal effects of the Moon & Sun (monthly changes): spring vs. neap tides
- Wave characteristics: crest, trough, wavelength, wave height
- Wave motions, types of waves
- Beaches: sandy vs. rocky coastlines
- Tsunamis: definition, what causes them?

Astrobiology
- What is it?
- 4 conditions for life
- Biomarkers – gas emissions
- Bodies being investigated for life: Mars, Europa, Titan
- Goldilocks conditions – why is Earth just right for life?
- Why can’t gas giants support life? Mercury & the Moon?
- What does the Drake Equation calculate?
Atoms, Elements, and Minerals
- General definitions
- Components of an atom: neutrons, protons, electrons
- Ions, compounds
- Major elements in the crust
- Physical properties of minerals: hardness, cleavage, streak, etc...
- Crystals: definition, shapes
- Mineral classes: silicates, carbonates.

The Rock Cycle
- General definition
- Processes that relate different rock types

Igneous Rocks
- General definitions, vocabulary
- Sources of igneous rocks
- Intrusive vs. extrusive igneous rocks, properties

Metamorphic Rocks
- General definitions, vocabulary
- Ways that rocks transform into a metamorphic state
- Types of metamorphism: contact, burial, regional dynamothermal, hydrothermal

Sedimentary Rocks:
- General definitions, vocabulary
- Types and compositions: clastic, organic, chemical, bioclastic rocks
- Clastic sedimentary rock formation process: weathering, transport, sedimentation, lithification
- Shape and sort: what they tell us about sedimentary rocks
- Lithification processes
- Types of clastic rocks (conglomerate, sandstone, shale), how we classify them (size).

Sedimentary Structures:
- General definitions, vocabulary
- Types: ripple marks, bedding, cross-bedding, mud cracks

Fossils
- General definitions, vocabulary
- Types of fossils
- What we use fossils for
Weathering & Erosion
- General definitions, vocabulary
- Mechanical weathering: frost wedging, pressure-release fracturing, thermal expansion & fracturing, abrasion, organic activity
- Chemical weathering: dissolution, oxidation, hydrolysis
- Primary “agents” of erosion: wind, water, gravity, ice

Determining Geologic Ages:
- Relative ages: Principles of Original Horizontality, Superposition, Cross-cutting Relationships, Faunal Succession
- Types of unconformities
- Correlation
- Absolute ages: radioactive dating methods, what a half-life is, how to calculate the age of a sample given its half-life and the amount of decay

Mass Extinctions & Geologic Time
- What they are
- What causes them
- When the major ones were.
- Geologic time: be familiar with major divisions and the important things that occurred during them: Precambrian, Paleozoic, Mesozoic, Cenozoic

General Astronomy Topics
- Where are we in the universe?
- Historical Astronomers: Ptolemy, Copernicus, Galileo, Kepler
- Electromagnetic waves (light): how do we use light to look at universe?
- Optical vs. radio telescopes

Solar System
- Basics about the planets: names, size, inner (rocky) vs. outer (gas) planets
- Standard model – what is it?
- How do the planets relate to one another? What do they have in common?

Celestial Motions
- Seasons – what causes them? Why does the northern hemisphere experience different seasons at different times of the year compared to the southern hemisphere?
- Eclipses – solar, lunar, why are they infrequent?

The Moon
- Exploration: important missions
- Lunar samples: what can they tell us?
- Rotation and orbit periods, how are they linked?
Why do we see the same side of the Moon?
- Geography – highlands, maria, near side/far side differences
- Craters - formation, characteristics, how do we use them to establish relative ages of regions?
- Formation and evolution of the Moon

**Mercury**
- Exploration: Mariner 10, Messenger
- Spin-orbit coupling of Mercury
- Magnetic field observations and possible origin of magnetic field
- Cratering on Mercury compared with the Moon

**Venus**
- Exploration: Magellan, when, types of data set (radar, topography, etc.)
- Rotation, orbit (day vs. year)
- Atmosphere (composition) and surface conditions (temperature, pressure)
- Earth and Venus - similarities and differences in basic properties, processes
- Venus surface features: volcanoes, craters
- Craters: implications for surface age

**Mars**
- Exploration: Pathfinder, MERs
- General geography (names of major features), north vs. south hemisphere differences
- Moons
- Olympus Mons, Tharsis, Valles Marineris – what are they?
- Evidence for past water

**Jupiter**
- Exploration: Galileo, Voyager, etc.
- Internal structure, molecular vs. metallic hydrogen
- Magnetic field: source, size
- Great Red Spot
- Atmospheric features (clouds, belts)
- Rings

**Jovian (Galilean) Satellites**
- Tidal heating: what is it, which moons are most impacted by it?
- Magnetic field (which ones?)
- Volcanism (which one?)
- Major internal structure (layers) and density
- Possibility for life (which one?)
- Surface ages (which ones are “old”, which are “young”?)
- Important characteristics of each
Saturn
- Composition (like which other planet?)
- Low density
- Rings – names, overall composition, characteristics
- Moons – are they all the same?
- Titan – why are we interested in it? (what is special about it?)
- Cassini-Huygens Mission (flybys + surface probe)

Neptune, Uranus, Pluto
- Compositions, density, reason for color
- Discovery of each
- Rings: how many, characteristics
- Uranus’s odd rotation
- Neptune’s active atmosphere: white spot, clouds
- Magnetic fields?
- Pluto: pros & cons for ‘planet’ status
- Charon