This sheet provides a general outline of the topics covered on your upcoming exam. This is not an exhaustive list, but is simply a general list of key points. In other words, most exam questions will be based on the topics listed here, but I reserve the right to also include questions about topics from the textbook and items not specifically on this list.

**Disclaimer:**
I will never provide equations that can be easily figured out by dimensional analysis

<table>
<thead>
<tr>
<th>e.g.</th>
<th>$v = \frac{d}{t}$,</th>
<th>$f = \frac{x}{t}$,</th>
<th>$F = ma$,</th>
<th>$D = \frac{m}{v}$, etc...</th>
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I also will not provide any unit conversion factors (e.g. 1 in = 2.54 cm). You should know how to convert units from the dimensional analysis lab. I also assume that everyone knows their metric abbreviations e.g. $m = 10^3$, $c = 10^2$, $k = 10^3$, $M = 10^6$, $G = 10^9$, etc...

**Materials covered on this exam:**
- Textbook Chapters 6-7 (recall that we did not cover sections 7.9 - 7.12), the portion of Chapter 14 that covers Ground-Penetrating Radar (pgs. 227-230).
- The lecture material on the earthquake cycle will appear on this exam. Some of this material is not directly in your textbook, but some parts of Chapter 5 will be helpful to review the earthquake cycle.
- Lab material is designed to supplement lecture topics, so I would highly recommend studying your previous lab assignments. Below are some good topics to know about for the exam.

**Know all of the basic stages of the earthquake cycle and be able to describe each one.**

**What is elastic rebound? Be able to describe this process.**

**Who is credited with applying elastic rebound to earthquakes and what event led to this discovery?**

**Be familiar with the details of interseismic, coseismic, and geologic (long term) deformation.**
  - Know the patterns of surface displacements away from a strike-slip fault for each of these stages.
Know the patterns of strain for these stages.

Be able to interpret plots of surface displacements from these stages.
  - What is the slip / slip rate
  - What is the strain / strain rate

How does each stage relate to the other two stages mathematically?

Be able to describe what is happening on the fault during each stage of the earthquake cycle.
  - Where is slip occurring in each stage? How does this relate to the locking depth?

The interseismic solution that we used...
  - What are the primary assumptions of this model? When would these assumptions not be valid?
  - How does changing slip rate or locking depth change the deformation pattern?

What is displacement? What is slip? How are these two quantities similar and how are they different? Which one do geologists almost always measure? Why? Which one does GPS measure?

When attempting to determine the seismic hazard of a fault, is displacement or slip more important to know? Why?

How do geologists and geophysicists map coseismic ruptures?

What parameters control the potential earthquake magnitude for a given fault? Why?
  - What type of faults can produce the largest earthquakes? Why?

With respect to earthquakes...What is intensity? What is magnitude? How are these terms different and how are they the similar?
  - What factors control intensity? What factors control magnitude?
  - What are the various magnitude measurements? What are they based on?
  - Why are there multiple magnitude measurements? Which is considered most accurate?
  - What is seismic moment?

What is the difference between seismic hazard and seismic risk?

What are seismic risk assessments based on?

What are seismic gaps? Why are they useful?

**Chapter 6: Refraction Seismology**

Know Snell’s law inside and out.

What is critical refraction?

What are (Huygen’s) wavelets? Why are wavelets important to seismic refraction?

What are head waves and how/why do they form?

Know the details associated with the direct ray, reflected ray, and the refracted ray.

Know which ray will be the first arrival at any given location. Which ray is never first?

Be an expert at interpreting t-x diagrams.
  - Be able to qualitatively and quantitatively determine
    - Velocity
    - Thickness
- Which parts of the t-x are which ray
- Crossover distance
- Critical distance

- I will provide the various ray equations, but you must know how to use them to solve for various parameters of interest.
- What is seismic refraction useful for? I.e. what properties of the subsurface can we determine with a refraction survey?
- Know the caveats of seismic refraction
- How do we recognize dipping interfaces in a refraction survey? What about undulating interfaces? What about fault offsets or discontinuous interfaces?
- Know how to determine dip direction (qualitatively) from a t-x diagram
- What is ray tracing and how it is different than using a t-x diagram to determine subsurface geometry?
- Know the basic types of refraction surveys

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**Chapter 7: Reflection Seismology**

- How is reflection seismology similar to GPR? How are they different?
- What is reflection seismology useful for?
- Why is reflection seismology so popular?
- Know the various strengths/weaknesses of refraction vs reflection seismology
- Know the caveats of seismic reflection
- What are multiples, what causes them, and how do we recognize them in seismic sections?
- What is moveout? What is normal moveout? What causes moveout?
- Be able to interpret a moveout t-x diagram and calculate various parameters from given data.
- How can one recognize a dipping reflector from the moveout pattern on a t-x diagram?
- What is RMS velocity? Why do the moveout equations produce RMS velocities for cases of multiple reflectors?
- Be able to qualitatively interpret a multi-reflector moveout t-x diagram.
  - Which reflector is deepest?
  - Which layers have slowest and fastest velocities?
- What is stacking in regards to seismic surveys?
  - How is stacking different in reflection seismology as opposed to refraction seismology?
- Know the common geometrical distortions that occur on unmigrated sections and know why they happen. You should be able to look at an unmigrated section and give an sketch of the migrated section.
- Know basic folding terms: anticline, syncline, monocline, fold train.
- Why do folded subsurface layers produce multiple reflections?
- What is migration? Why is migration not always performed? In what cases would you not want to migrate?
- What is diffraction? (you should already know this term from the refraction chapter)
What types of reflectors produce diffracted wave? Why?

What patterns are produced on an unmigrated section due to diffraction in each relevant case?

What is static correction?

Know the basic types of seismic reflection surveys.
- What are the main advantages/disadvantages of marine surveys?
- What are the main advantages/disadvantages of land surveys?
- What is Vibroseis? Why is it the most popular type of land survey?
  - Why is signal to noise less of a problem with Vibroseis?
  - Why is resolution better with Vibroseis?

What are wiggle trace, variable area, and variable density plots?

What parameters control whether an interface produces a reflection?
- What is acoustic impedance?
- What is the reflection coefficient?
- What is the transmission coefficient?

What type of source signal frequency...
- Penetrates the deepest? Shallowest?
- Offers the highest resolution? Lowest resolution?

What are bright spots?

What types of interfaces produce little or no reflections in a seismic survey? Why?

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**Chapter 14: Ground-Penetrating Radar**

You only need to read the portion of Ch14 that covers GPR. We will not cover the other EM techniques because they are far less commonly used.

GPR is very similar to what other geophysical technique?

How is GPR similar/different from seismic reflection in the following ways...
- Source/Receiver(s)?
- Travel time equations?
- Stacking in GPR vs. seismic reflection?

How is radar velocity determined in GPR surveys?
- What does radar velocity depend on?
- What is a fixed offset survey?
- What is a CMP (Common Midpoint) survey and how and why does it work?
  - What are CMP surveys used for?

What controls whether a radar reflection will occur?
- You don’t need to memorize any equations. If needed, I will provide them.

What controls the vertical resolution in GPR surveys?

What controls the vertical penetration depth of GPR waves?
- What material properties cause a GPR wave to rapidly attenuate?
What material property is ideal for GPR waves? Why?
What material property is poorly suited for GPR waves? Why?
Can GPR data be migrated? Are subsurface reflections true/accurate images of subsurface interfaces/objects?
Why might GPR data be left unmigrated?

Lab Stuff

Lab 5: Modeling the Earthquake Cycle
- See bullets above for Chapter N/A / Chapter 5

Lab 6: Seismic Refraction
- See bullets above for Chapter 6

Lab 6.5: Field Refraction
- Know the various types of earthquake waves and how they apply to the
  - Air wave / Ground roll
  - Direct ray / Refracted ray

Lab 7: Seismic Reflection
- See bullets above for Chapter 7