Chapters 1, 2 & 25 (Planetary Geology and Plate Tectonics)

1. How do the formation of light elements (up to Fe) differ from that of heavier elements?
2. What are the three most abundant elements in the Earth's crust? bulk Earth?
3. In what ways does the bulk composition of the Moon differ from that of Earth and why?
4. Sketch a cross section of Earth, showing the layering based on chemical properties and based on physical properties. Label the depths of the various boundaries.
5. What are the various pathways by which igneous, metamorphic and sedimentary rocks can be generated from each other?
6. What is meant by the term isostasy? Give an example of isostatic adjustment of Earth's crust in recent geologic time.
7. How might you determine relative motion across a plate boundary?
8. What are the three types of plate boundaries? What surface features distinguish each type of plate boundary?
9. What is the basic source of energy for plate tectonic motions? What is thought to be the major driving force of plate motion?
10. In what ways do the inner and outer planets of our solar system differ and why?
11. What process in earth history is thought to account for the compositional difference between the bulk earth, crust and core?
12. What is the essential characteristic of a lithospheric plate? how does this differ from the asthenosphere?

Chapter 3 (Minerals)

1. definitions: mineral, polymorph, polymerization
2. Many mafic silicate minerals, such as olivine and pyroxene, show extensive solid substitution between an Fe-rich and a Mg-rich endmember. What properties of Fe and Mg ions allow this substitution?
3. Mica minerals (e.g. muscovite, biotite) have one perfect cleavage and low hardness. What aspect(s) of the crystal structure of micas accounts for these properties?
4. Pyroxenes and amphiboles both exhibit two cleavages, but the angle between these cleavages allows the two types of minerals to be distinguished. What are the cleavage angles for these two mineral groups and what aspect of their silicate structures accounts for these different cleavage angles?
5. Be able to match the various classes of silicate minerals with the structures and know an example of each group.
6. Graphite and diamond have the same chemical composition (C) and yet differ in several physical properties. Explain these differences in terms of the crystal structure of the two minerals.
8. Aragonite, with a density of 2.9 g/cc, has exactly the same chemical composition as calcite, with a density of 2.7 g/cc. Which of these minerals is more likely to have formed under high pressure and why?
9. Silicate minerals account for more than 95% of Earth's crust. What accounts for the dominance of silicate minerals?

Chapters 4&5 (Igneous/Volcanic Processes)

1. Definitions: magmatic differentiation, phenocryst, mafic/felsic, dike, sill, aa, pahoehoe, pillow lava, batholith, stratovolcano, shield volcano, pluton
2. What are the essential mineralogical differences between a granite and a gabbro?
3. How might you differentiate between an intrusive and an extrusive rock?
4. Lavas erupted at mid-ocean ridges have remarkably uniform composition. What physical process is primarily responsible for the generation of these lavas and how does this process account for the compositional uniformity?

5. In what tectonic setting are you most likely to find andesitic lavas? What physical process is responsible for the generation of these lavas and how do these melts differ from those produced at ridge crests?
6. Why is simple increase in temperature an unlikely mechanism for melting the mantle?
7. You observe two lava flows, flow A has olivine, pyroxene and plagioclase phenocrysts and flow B has plagioclase, hornblende and biotite phenocrysts. Which flow represents a higher temperature melt? which is more felsic? how would the composition of the plagioclase crystals in these two flows compare?
8. In what tectonic setting would you most expect to find explosive volcanoes? divergent/convergent/mid-plate?
9. The plagioclase phase diagram is often used to illustrate partial melting and fractional crystallization. Using a sketch and a few sentences, show how this diagram illustrates that a partial melt can have a very different composition than the parent solid. Label the fields and axes.
10. Andesitic/rhyolitic lavas tend to be more explosive than basaltic lavas. What factors are responsible for this difference in eruptive style?
11. Use Bowen's reaction series to provide a qualitative description of the major minerals found in rhyolitic, andesitic and basaltic lavas.
12. Although granitic/rhyolitic melts can be produced by extreme fractional crystallization this is probably not the dominant mechanism by which granites are produced. What alternative mechanism probably provides a more general explanation for the abundance of granitic rocks?

Chapter 6 (Weathering)

1. Why are quartz and clay minerals so abundant in clastic sedimentary rocks?
2. Why is seawater so rich in Na, Ca and Mg?
3. What factors control the rate of chemical weathering of a rock?
4. What mechanisms might result in the formation of joints in rocks? What is the role of joints in physical and chemical weathering?
5. Why is the presence of soil an important control on the rate of weathering?
6. What are the major mineral groups that weather to form clays?
7. What is the relationship between the order of crystallization of common silicate minerals and their resistance to weathering?
8. Rank the following rocks in order of the rapidity with which they weather in a warm humid climate: granite, quartz sandstone, limestone, evaporite deposit of halite.
9. Chemical weathering is a function of climate and hence varies with latitude. In what latitudinal band is chemical weathering most intense and why? Why is physical weathering dominant at high latitudes?
10. What are the major soil horizons and what processes are dominant in each?
11. Bauxite is a soil that is extremely rich in aluminum oxide. How do such soils form?

Chapter 7 (Sedimentary Processes)

1. Definitions: sedimentary facies, diagenesis, textural maturity, compositional maturity, lithics (rock fragments)
2. What processes are responsible for the transformation of a sediment to a sedimentary rock?
3. On what characteristics are clastic sedimentary rocks classified? chemical rocks? biogenic rocks?
4. How can you use the sizes and sorting of sediments to distinguish between sediments deposited in an alluvial fan environment and those deposited on a beach?

5. Compare the types of sediments that would be produced by erosion of a basaltic volcano and a granitic pluton.
6. The Sierra Nevada mountain range consists largely of granitic source rocks. The eastern edge of this mountain range is exposed along a major fault and the climate is relatively dry. Compare and contrast the types of sedimentary deposits you might find at a distance of 10 km, 100 km and 1000 km from this fault scarp?
7. How might the sedimentary deposits of granitic rocks exposed in a lower relief mountain belt and wetter climate correspond to those described in question 6?
8. Name several lines of evidence that might be used to infer the distance and location of the source rocks for a sandstone/conglomerate unit. What characteristics of this unit might be used to establish the type of source rock?
9. How does cross stratification form and what does it indicate about the sedimentary environment?
10. What inferences can you draw from the presence of a well sorted, well rounded quartz arenite?
12. How might deep sea fan deposits differ from alluvial fan deposits?
13. On a continental margin you might find marsh muds in the back beach marsh, beach sands in the nearshore environment and finer grained mudstones offshore. What would you expect the vertical sequence of facies to be if there were a relative rise in sea level? a relative fall in sea level?
14. How do graded beds form?
15. What principles are used to determine the relative age of sedimentary rocks?

Chapter 8 (Metamorphic Processes)

1. Definitions: isograd, index mineral, foliation, metamorphic facies
2. How is that high grade metamorphic rocks can be exposed at the surface without reverting to more stable lower temperature mineral phases?
3. How might you determine the degree of metamorphism (pressure and temperature relationships) in a mountain belt composed of rocks originally derived from mudstones? for a mountain belt with mixture of basaltic and andesitic lava flows?
4. What processes contribute to the formation of metamorphic foliation (particularly alignment of micaceous minerals)?
5. What metamorphic facies might you expect to find immediately adjacent to rocks that had begun to partially melt?
6. What kinds of processes are involved in the transition from diagenesis to metamorphism?
7. What is the role of fluids in metamorphism?
8. What are the mineralogical and structural changes associated with increasing metamorphism of a clay rich sediment? how do these compare with the changes in a bioclastic carbonate?
9. In what tectonic setting might you find blueschist metamorphic rocks? hornfels facies rocks? amphibolite facies rocks?