

## **STUDY GUIDE**

### **A. Glacier Geography**

1. (3 pts) What is the relevance of glaciers to human living conditions? (first day of class)
2. (2 pts) Define a glacier.
3. (2 pts) What is the fundamental condition for glacier formation?
4. (2 pts) Name the continent(s) on which glaciers do not exist.
5. (3 pts) Name the two major ice sheets and, roughly speaking, what is the ratio in areas?
6. (2 pts) Define a tidewater glacier and explain how it differs from an ice shelf.
7. (2 pts) How does an ice cap differ from an ice sheet?
8. (3 pts) For a glacier located in the Wind River Range of Wyoming, please provide three descriptive terms that help to classify it.
9. (3 pts) How does a surging glacier differ from a normal glacier?
10. (3 pts) What is an ice stream and where are they located?
11. (3 pts) What are the thermal descriptions of a glacier and why are they particularly important?
12. (1pt) From an aircraft, how can you tell the difference between a snowfield and a snow-covered glacier?
13. (3pts) Glaciers exist in the Sierra Nevada and reach down to about 10,000 feet. Glaciers in the North Cascades, Washington reach down to about 5,000 feet. Why the difference?

### **B. Glacier Structure**

1. (2 pts) Draw the plan view and side view of the molecular structure of 1h ice. Show the oxygen atoms as solid dots and the hydrogen atoms as open circles. Include in each diagram the direction of the c- and a – axes.
2. (2 pts) Draw a snowflake and indicate the c-axis and a-axes.
3. (3 pts) Why is the c-axes important? Please describe.

4. (4 pts) What is the relationship between pressure and melting temperature of ice? Why is this important, glaciologically speaking?
5. (2 pts) What is the hardness of ice? You don't need to quantify it, just roughly, how hard is it? Can it scratch bedrock?
6. (4 pts) Describe the processes by which snow transforms into ice include both the dry processes and the wet processes. Do dry and wet processes occur on all glaciers? Clarify.
7. (2 pts) Describe compaction.
8. (3 pts) Describe sintering.
9. (3 pts) Once ice forms, the glacier continues to metamorphose. Describe the solid state transformations that recrystallize and reorient glacier ice.
10. (3 pts) How do ice crystals (not snow crystals) in the glacier, initially randomly oriented evolve in a glacier such that near the bottom of the glacier the c-axes are all oriented vertically? Explain both the process that drives the change and the microphysical processes that cause the change.
12. (3pts) Both the size and orientation of ice crystals (not snow crystals) change with depth in an ice sheet or glacier. In what way do they change and why? How does it affect the flow of the ice sheet?
13. (2pts) Snow metamorphoses into ice. What is the metamorphic transitional stage called between snow and ice, and how is it defined?
14. (4 pts) Describe the processes responsible for causing the deterioration of the shape of faceted ice crystals into more rounded shapes. Assume temperatures remain below freezing and the crystal is unaffected by neighboring crystals.
15. (5pts) Explain the transformation process from snow to ice for, (a) temperate glaciers; (b) polar glaciers. Also explain which is faster, and in which setting the transition from snow to ice occurs at shallower depths.

## B. Energy Balance

1. (5 pts) Water phases and transitions.
  - a. Name the three different phases of water (do not include clathrate).

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- b. Name the three kinds of phase transitions and identify the phases involved.  
Please order them from least energy required to greatest energy required.

LEAST \_\_\_\_\_

GREATEST \_\_\_\_\_

- c. Describe why different energies are required for the different phase transitions.
2. (8 pts) Write the basic equation for the energy balance at an ice surface. Don't forget that it sums to zero. Define all terms, of course.
3. (4pts) Write the functional relationship for latent heat flux. (Functional relationship, what variables (not constants) in the numerator/demoninator that govern the physical relation between them and the resulting latent heat)
4. (4pts) Write the functional relationship for sensible heat flux. (Functional relationship, what variables (not constants) in the numerator/demoninator that govern the physical relation between them and the resulting latent heat)
5. (7pts) Define, sensible heat, latent heat, shortwave radiation, long wave radiation, albedo, sublimation, and evaporation.
6. (4pts) All other weather variables the same, what happens to the energy balance when the surface is snow covered versus ice covered?
7. (4pts) All other variables the same, what happens to the energy balance when the wind speed increases?
8. (6pts) Describe how the energy balance on a glacier surface will change with elevation on a glacier. Choose 2 locations, mid ablation zone and mid accumulation zone. Please include an altitude so I know how high you are going.