Part 1

A

1. (21 points) Draw a plot of temperature v. time for the last 18,000 years to show how temperature has changed. Be sure to indicate warm and cold direction on X axis, and 18K to present on Y axis.

2. (12 points) Explain how any two methods of reconstructing ELAs work. Use diagrams.
B.
1. The location of the equilibrium line on a valley glacier can be approximated by:
   a. the snow line at the beginning of the melt season
   b. the snow line at the end of the winter season
   c. the snow line at the end of the melt season
   d. the upper limit of transverse crevasses

2. In the accumulation zone, the amount of discharge through a given cross section of the glacier ________ down glacier:
   a. increases
   b. decreases
   c. neither increases nor decreases

3. Surface features that indicate compressive flow in a glacier include (NOTE: MORE THAN ONE ANSWER IS POSSIBLE):
   a. transverse crevasses
   b. medial moraines
   c. ogives
   d. longitudinal crevasses

4. In the middle of winter, the temperature of glacier ice typically:
   a. increases with depth
   b. decreases with depth
   c. decreases to a point, then increases
   d. remains the same from top to bottom

5. The most important variables that produce differences in shear stress at the bed of a glacier are:
   a. ice thickness and density
   b. ice thickness and surface slope
   c. surface slope and ice density
   d. bedrock slope and surface slope

6. The downward transfer of heat in a glacier occurs most efficiently by:
   a. conduction
   b. latent heat transfer
   c. diffusion
   d. subduction

7. The glacial/interglacial cycles of the last million years were driven by:
   a. the movement of Antarctica to a polar position.
   b. rising and falling of sea level.
   c. variations in the earths orbit.
d. El Nino oscillations.

8. Extending flow tends to occur (circle all correct answers)
a. in the ablation zone 
b. where a valley narrows 
c. up ice from a knob on the bed 
d. behind a calving margin 
e. behind a land-based margin 

9. Our calendar starts Jan. 1. A reasonable date to pick for the start of a mass balance year for a northern hemisphere glacier is:
a. Dec. 15 
b. Mar. 15 
c. June. 15 
d. Sept. 15 

10. When two tributary glaciers join, 
a. surging occurs 
b. a medial moraine usually forms 
c. an end moraine forms 
d. ogives always form 
e. transverse crevasses occur 

11. Temperate glaciers 
a. are only found in Alaska 
b. are at the melting point throughout their entire ice thickness at some point during the year 
c. only move by internal deformation 
d. usually contain less debris than polar glaciers 
e. none of the above 

Part 2

A.
1. (21 points) For a classic polar glacier and temperate glacier, using diagrams and text, explain temperature conditions throughout the ice. Show sources of heat and paths of heat transfer.

2. (12 pts) Using diagrams, distinguish between marginal, transverse, and longitudinal crevasses. Be sure to show in words or symbols, why these different types of crevasses occur.

B.
1. The trimline immediately above most modern valley glaciers most likely represents: 
a. the vertical extent of glaciers during oxygen-isotope stage 2
b. the vertical extent of glaciers during the Younger Dryas
  c. the vertical extent of glaciers during the Little Ice Age
  d. a change from frozen to wet-bed conditions over the past 10 years

2. The most important factor in determining glacier calving rate is:
   a. steepness of the ice margin
   b. summer water temperature
   c. water depth at the ice margin
   d. glacier mass balance

3. Consider the following glacier elevation/area diagrams. If the equilibrium-line altitude rises by 100 m (from 1100 to 1200 meters above sea level), which glacier will likely retreat the most?

   a. Mickelsongetscher
   b. Laabsengletscher

4. Which of the following is true for a stagnating glacier?
   a. accumulation ~ ablation.
   b. ablation < accumulation.
   c. ablation > accumulation.

5. Abrasion
   a. results in the formation of medial moraines
   b. is synonymous with plucking
   c. generally occurs on the down ice side of bumps
   d. frequently occurs on the up ice side of bumps
   e. none of the above

6. Crossing striations formed by changing ice flow directions within a single advance can be distinguished from those resulting from separate advances, because those from one advance:
   a. may be formed by bulldozers
   b. should be cut deeper into the rock
1. The direction recorded by striations is the flow direction of ice:
   a. somewhere upstream
   b. at the time till was being deposited
   c. at the time abrasion was taking place
   d. at the time plucking was taking place
   e. none of the above

   Part 3

   A.
1. (11 points) Explain why glacial valleys usually have stepped longitudinal profiles.

2. (11 points) How does the information provided by till fabric differ from that provided by pebble lithology counts?

3. (11 points) Explain the difference between descriptive and genetic classifications of sediment. Give examples.

B.
1. Which of the following is NOT a glacial-erosional feature:
   a. roche moutonnee  
   b. nail-head striation  
   c. end moraine  
   d. whaleback

2. U-shaped, as opposed to V-shaped, valleys are created by valley glaciers because:
   a. glaciers are big and wide  
   b. erosion at the base of a glacier is uniform across the valley bottom  
   c. changes in flow regime  
   d. glacier retreat is accompanied by large floods

3. Melting and refreezing are probably a very important part of both glacier plucking and cirque formation:
   a. true  
   b. false

4. Which of the following can influence flow regime (extending or compressive) in a glacier:
   a. bedrock topography  
   b. valley width  
   c. calving at the terminus  
   d. all of the above

5. Pebble fabric in till:
   a. indicates local ice-flow direction  
   b. is the trend and plunge of elongate clasts
c. forms due to high shear stress during till genesis
d. all of the above
6. In the ablation zone one would expect long axes of pebbles in debris rich ice to plunge
   a. up-glacier
   b. down-glacier

7. High water pressure at the base of a glacier:
   a. reduces glacier sliding
   b. increases effective stress and shear stress at the bed
   c. can cause decoupling of ice from the bed
   d. reduces glacier velocity

8. Diamicton
   a. is synonymous with till
   b. is only associated with glacial deposits
   c. is a descriptive term
   d. implies genesis
   e. none of the above

9. The best indicator of provenance is
   a. lithology (i.e. pebble count)
   b. fabric
   c. the nature of the contact
   d. striation orientation
   e. grain size

10. Supraglacial sediment
    a. always has a weak fabric, but represents the regional ice flow direction
    b. always has strong fabric and represents the regional ice flow direction
    c. has a more variable fabric than basal till and doesn’t represent the regional ice flow direction
    d. is always well sorted
    e. none of the above

11. Sorting refers to
    a. separation of different mineral types.
    b. describing the kind of sediment present.
    c. separation of grain sizes.
    d. determining what sort of sediment was deposited.
    e. none of the above