

EARTH AND SPACE SCIENCES**431** *PRINCIPLES OF GLACIOLOGY***505** *THE CRYOSPHERE***Autumn 2017**

4 Credits, SLN 14841

4 Credits, SLN 14862

Midterm Exam Practice Questions: Accumulation, Ablation, and Balance**Vocabulary, ideas, and equations you should be able to talk about intelligently:**

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| 1) Components of the cryosphere | 2) Remote sensing techniques in the cryosphere |
| 3) Densities of ice and water | 4) H ₂ O molecular bond angle |
| 5) Phase diagram of Ice | 6) Energy / temperature / phase transition curve |
| 7) Fourier's Law | 8) Thermodynamic properties / units |
| 9) Intuition behind the latent heats (magnitudes) | 10) Cloud / Ice Condensation Nucleii |
| 11) Vapor pressure (curvature? temperature?) | 12) Crystal growth as a function of humidity |
| 13) Types of snowpack metamorphism | 14) Surface energy balance (sources and sinks?) |
| 15) Constitutive relation / Glen's Flow Law | 16) Conceptual understanding of strain-rates |
| 17) Weertman Sliding (Regelation / EC) | 18) Effect of distributed vs. channelized hydrology |
| 19) Primary ablation mechanisms for Ant/Gre | 20) Marine Ice Sheet Instability |
| 21) The role of ice shelves on ice flow | 22) Surging glaciers |

Practice Calculations

1) A 100m thick glacier has a surface temperature of -20°C. The thermal conductivity of glacial ice is 2.3 W/(m°C) and the heat flux into the base of the ice is 0.06 W/m². What is the temperature at the base of the glacier?

2) How much energy does it take to raise 10g of ice 20°C? How much energy does it take to raise 10g of water 20°C? How much energy does it take to melt 10g of ice? How much energy is released when 10g of water vapor condenses to dew?

3) What is the shear stress at the base of a glacier with uniform thickness of 300m, sitting on a bed sloping at 5° ? What is the strain rate at the base of that glacier, assuming a rate factor of $2 \cdot 10^{-16} \text{ (Pa}^{-3} \text{ A}^{-1}\text{)}$? What are the units of strain rate?

4) A square with side length 15m is being sheared by a glacier. Given the following shear strain rates ($\dot{\epsilon}_{xz}$), compute the perimeter for the box after the stated amount of time:

- a) 0.1 a^{-1} , 5 years b) 0.05 a^{-1} , 20 years c) 10^{-4} a^{-1} , 30 years d) 0.3 a^{-1} , 12 years

5) In the accumulation zone of a glacier, the average accumulation rate is 0.1m/a over a rectangular area 200m x 100m. What is the average speed through the equilibrium line, given a glacier width of 100m and an average ice thickness of 30m? Is this a dynamic framework for thinking about glacier flow or a kinematic framework?

6) Compute the sliding speed (by regelation) for ice flowing past Weertman tombstones with side length 0.02m, spaced every 0.5m, with a driving stress equal to 10^5 Pa. Assume the thermal conductivity of the tombstone is $2 \text{ W/(m}^\circ\text{C)}$.