

Problem discussed in the videos:

Videos (4) – (7)

Tea time on the mountain

After a grueling climb to the top of Mount Dinali, an intrepid British mountaineer decides to celebrate with a cup of tea. At this high altitude, the boiling point of water is  $T_{\text{boil}} = 77^\circ\text{C}$ . After he pours his tea, the mountaineer places the kettle directly on the snow, which is very cold,  $T_{\text{snow}} = -23^\circ\text{C}$ . The kettle initially contains 2kg of steam at  $77^\circ\text{C}$ . The top of the kettle is well insulated so that no heat is exchanged between the kettle and the air.

- a) How much heat,  $Q$ , must be exchanged between the snow and the kettle to condense all the steam in the kettle into liquid water at  $77^\circ\text{C}$ ? The latent heat of vaporization for water at this altitude is  $L_{\text{vapor}} \approx 2 \times 10^6 \text{ J/kg}$ . Take care with signs and clearly indicate whether heat enters or leaves the kettle.
- b) What is the change in entropy inside the kettle due to the condensation of the steam?
- c) What is the change in entropy of the snow during this process?
- d) What is the change in entropy in the universe as a result of this process? Please indicate whether this is positive, negative, or zero.