

CHEM 36
General Chemistry
Quiz #3

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1. Is the melting of ice an exothermic or endothermic process? *Briefly explain.*

Endothermic. Energy must be added to solid water in order to disrupt the intermolecular forces which establish the solid structure.

2. Is the entropy change associated with the melting of ice positive or negative? *Briefly explain.*

DS for the process will be positive. Entropy increases with increasing disorder (increased number of microstates) - liquid water is more disordered than solid water, so it has more microstates and, hence, a greater entropy than solid water. Thus, the melting process takes water from a more highly ordered state (lower entropy) to a less highly ordered state (higher entropy) and entropy increases.

3. Why is the melting of ice a spontaneous process at 37°F (the expected high temperature for today!), but is not spontaneous at 7°F (tonight's expected low temperature)? Your explanation should be based on thermodynamic terms (e.g., enthalpy, entropy, etc.).

Take a look at the Gibbs-Helmholtz relationship:

$$DG = DH - TDS$$

When *DH* is positive and *DS* is positive (as it is for this process), then *DG* will only be negative above a temperature at which the *TDS* term is greater than the *DH* term. This occurs only at temperatures greater than 273.15 K (0°C or 32°F), at which point the melting of ice becomes spontaneous. At temperatures below 273.15 K, *DG* is positive and the melting of ice is not spontaneous.