

Phase Changes and Heating Curves

Energy, temperature and changes of state

Name _____ Class _____ Date _____

DATA FOR WATER

$c(\text{ice}) = 2.09 \text{ J/(g}\cdot\text{°C)}$ · $c(\text{water}) = 4.184 \text{ J/(g}\cdot\text{°C)}$ · $c(\text{steam}) = 2.01 \text{ J/(g}\cdot\text{°C)}$ · $M = 18.02 \text{ g/mol}$

$\Delta H(\text{fus}) = 6.01 \text{ kJ/mol at } 0 \text{ °C}$ · $\Delta H(\text{vap}) = 40.7 \text{ kJ/mol at } 100 \text{ °C}$

Ethanol: $M = 46.07 \text{ g/mol}$ · $\Delta H(\text{vap}) = 38.6 \text{ kJ/mol}$

Use $q = mc\Delta T$ for temperature changes and $q = n\Delta H$ for phase changes. Convert everything to kJ before adding.

A. Ideas

1. Name the phase change, and say whether it is endothermic or exothermic: (a) dew forming on grass (b) ice cubes shrinking in a freezer (c) a puddle drying (d) frost forming on a window (e) wax solidifying

2. Explain why the temperature of a pot of boiling water stays at 100 °C while the burner is still on.

B. One-step calculations

3. Calculate (a) the heat needed to melt 100. g of ice at 0 °C (b) the heat released when 50.0 g of water freezes at 0 °C.

4. Calculate the heat needed to vaporize 10.0 g of ethanol at its boiling point.

C. Multi-step calculations

5. Calculate the heat needed to turn 10.0 g of ice at $-20.0\text{ }^{\circ}\text{C}$ into liquid water at $50.0\text{ }^{\circ}\text{C}$.

6. A drink is cooled by adding 200. g of ice at $0\text{ }^{\circ}\text{C}$. Calculate the heat the ice absorbs as it melts and the meltwater warms to $20.0\text{ }^{\circ}\text{C}$.

D. Vapour pressure and boiling

7. At the top of Mount Everest the air pressure is about one third of an atmosphere, and water boils at about $70\text{ }^{\circ}\text{C}$. Explain why, and why cooking pasta there takes longer.

E. Challenge

8. Compare the heat released to skin at $37\text{ }^{\circ}\text{C}$ by 10.0 g of steam at $100\text{ }^{\circ}\text{C}$ and by 10.0 g of water at $100\text{ }^{\circ}\text{C}$. Use your answer to explain why steam burns are so severe.