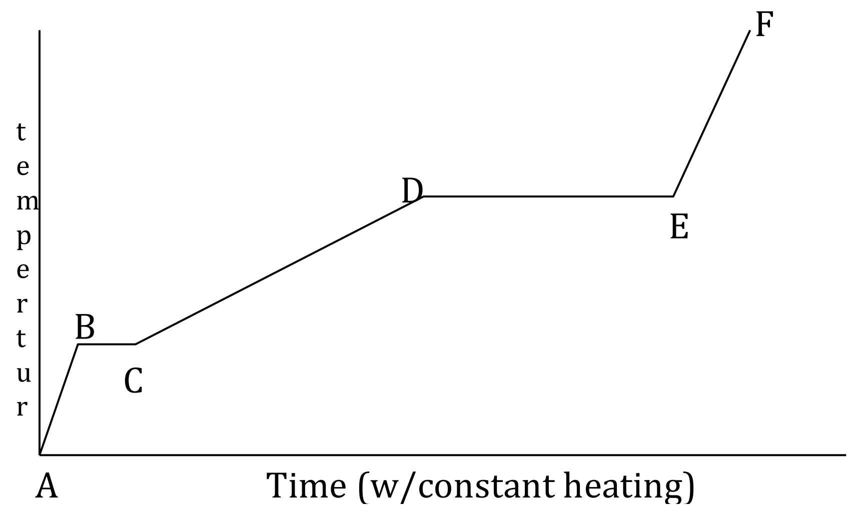
# Unit 8

**Understand and be able to use a heating curve diagram.**




a) Label the line with the following: solid, liquid, vapor, melting, freezing, condensation, vaporization

Solid: A – C    Only Solid: A-B

Liquid: B – E    Only Liquid: C – D

Gas: D – E    Only Gas: E – F

Melting: B – C    Freezing: C – B    Condensation: E – D    Vaporization: D – E

b) Why are the slopes in the graph different?

The slopes on the graph show that each phase (solid, liquid, and gas) absorbs heat differently and temperature changes different (specific heat capacity).

c) Why do the plateaus have different lengths?

The plateaus are different lengths of time because each phase change requires different amounts of energy for a substance to change from one state to another.

d) When would you use a Q equation? What about a q equation?

Use you Q for phase changes (plateaus) and q for single states of matter (slopes).

e) How would you determine if a phase change is endothermic and exothermic?

A phase change is exothermic if it is moving from right to left on the graph (←) and releasing energy.

A phase change is endothermic if it is moving from left to right on the graph (→) and absorbing energy.

**Be able to identify when to use Q and q equations and how to calculate molar enthalpy, energy, and specific heat.**

a) How much heat is lost when a 640 gram piece of copper cools from 375°C to 26°C? The specific heat of copper is 0.385 J/g°C.

$q = m \cdot c \cdot \Delta t$

$q = (640\ grams) \cdot (0.385\ \text{J/g°C.}) \cdot (-349)$ = -85993.6 J or 85.99 kJ

b) 8750 J of heat are applied to a 170 grams sample of metal, causing a 56°C increase in its temperature. What is the specific heat of the metal?

$q = m \cdot c \cdot \Delta t$

$c = \frac{q}{m \cdot \Delta t} = \frac{8750\ J}{170\ grams \cdot 56°C}$ = 0.919 J/g°C

c) How many kilojoules of heat energy are required to heat all the aluminum is a roll of aluminum foil, 500 grams, from room temperature, 22°C, to the temperature of a hot oven, 250°C. Aluminum has a specific heat of 0.902 J/g°C.

$q = m \cdot c \cdot \Delta t$

$q = (500\ grams) \cdot (0.902 J/g°C) \cdot (228°C)$ = 102828 J or 102.828 kJ

d) Calculate the quantity of heat gained or **lost** when 3.50 moles of water freezes at 0°C.

$Q = m\,\Delta H$

$Q = (3.50\ moles)(-6.01\ kJ/moles)$ = -21.035 kJ

e) Calculate the energy gained or lost when 100 grams of water vaporizes from 35°C to 120°C.

Combo Problem

| | | |
|---|---|---|
| 35 to 100 | $q = m \cdot c \cdot \Delta t$ | $q = (100\ grams) \cdot (4.18 J/g°C) \cdot (65°C)$ = 27.17 kJ |
| 100 | $Q = m\,\Delta H$ | Q = (5.55 moles) (40.79 kJ/mole) = 226.38 kJ |
| 100 to 120 | $q = m \cdot c \cdot \Delta t$ | $q = (100\ grams) \cdot (1.87\ J/g°C) \cdot (20°C)$ = 3.74 kJ |
| | | **Energy = 257.29 kJ** |

f) Calculate the molar enthalpy of **condensation** for oxygen gas when 50.0 grams of $O_2$ gas turns into a liquid at its boiling point when 68,500 Joules of energy are released in the process. Is this endothermic or **exothermic**?

$Q = m\,\Delta H$

$-68.5\ kJ = (1.563\ moles)(\Delta H)$ = -43.83 kJ/mole

$CH_4\,(g) + 2\,O_2\,(g) \rightarrow 2\,H_2O\,(g) + CO_2\,(g)$ $\Delta H$= +802.7 KJ

g) Using the above equation, calculate the heat evolved when 3.05 grams of water is produced in the reaction.

$Q = m\,\Delta H$

$Q = (0.169\ moles)(401.35\ kJ/moles)$ = -67.83 kJ