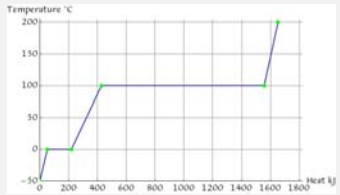


[TP] The figure below shows temperature versus heat absorbed for water initially at −50 °C. Based on the heating curve, compared to the enthalpy of fusion, the enthalpy of vaporization is …

33% 1. smaller

33% 2. about the same

33% 3. larger



BOSTON UNIVERSITY

Lecture 25 CH101 A1 (MWF 9 am)

Monday, November 7, 2016

- Temperature equilibration (heat leveling)
- Heating curves
- Enthalpy change of reaction, $\Delta_r H$

Next lecture: [Calorimetry, pp 231–232, done in lab]; Hess's law; Standard states and standard $\Delta_r H$; Standard enthalpy of formation, $\Delta_f H°$; using $\Delta_f H°$'s to compute any $\Delta_r H$; bond enthalpies, $\Delta_b H$; Using $\Delta_b H$'s to *estimate* $\Delta_r H$.

BOSTON UNIVERSITY

Temperature equilibration (heat leveling)

BOSTON UNIVERSITY

Temperature equilibration (heat leveling)

When a piece of hot metal is placed in cold water, what happens?

Heat flows from the metal into the cold water, and so …

the metal cools and the water warms.

The process continues until the metal and water come to the same, intermediate (equilibrium) temperature.

BOSTON UNIVERSITY

Temperature equilibration

We anticipate the final, equilibrium temperature will be affected by …

- how hot the metal is and how cold the water is,
- how much of the metal there is and how much of the water there is, and
- the heat capacity of the metal and of the water.

BOSTON UNIVERSITY 9

Temperature equilibration

$q_{\text{hot}} = m_{\text{hot}}\, c_{\text{hot}}\, \Delta T_{\text{hot}} = m_{\text{hot}}\, c_{\text{hot}}\, (T_{\text{equil}} - T_{\text{hot}})$

$q_{\text{cold}} = m_{\text{cold}}\, c_{\text{cold}}\, \Delta T_{\text{cold}} = m_{\text{cold}}\, c_{\text{cold}}\, (T_{\text{equil}} - T_{\text{cold}})$

How to get the expression for the equilibrium temperature T_{equil}?

Solve $q_{\text{cold}} = -q_{\text{hot}}$ for T_{equil}

BOSTON UNIVERSITY 12

Heating curves

BOSTON UNIVERSITY 14

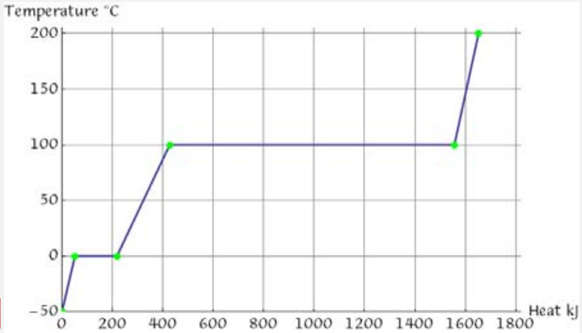
Heating $H_2O(s)$ from −50 ˚C to gas at 200 ˚C

Sketch how temperature changes with energy added to the water.

BOSTON UNIVERSITY 16

Heating $H_2O(s)$ from −50 ˚C to gas at 200 ˚C

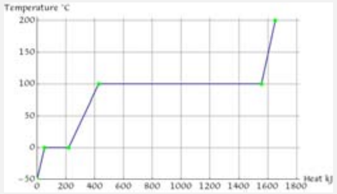
Sketch how temperature changes with energy added to the water.



BOSTON UNIVERSITY

[TP] The figure below shows temperature versus heat absorbed for water initially at −50 ˚C. Based on the heating curve, compared to the enthalpy of fusion, the enthalpy of vaporization is …

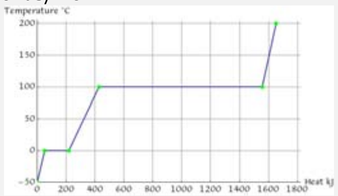
33% 1. smaller
33% 2. about the same
33% 3. larger



BOSTON UNIVERSITY

[Quiz] The figure shows temperature versus heat absorbed for water initially at −50 ˚C. The line between 0 ˚C and 100 ˚C is less steep than the lines below 0 ˚C and above 100 ˚C because …

25% 1. $H_2O(l)$ has the smallest heat capacity
25% 2. $H_2O(l)$ has the largest heat capacity
25% 3. $H_2O(l)$ has the most hydrogen bonds/mol
25% 4. Some other reason



BOSTON UNIVERSITY

Enthalpy change of reaction, $\Delta_r H$

BOSTON UNIVERSITY

Enthalpy change of reaction, $\Delta_r H$

$$2\ NO(g) + O_2(g) \longrightarrow 2\ NO_2(g) \quad \Delta_r H = -114.1\ kJ$$

"114.1 kJ of heat are released for each 2 mol of $NO_2(g)$ formed."

"114.1 kJ of heat are released for each 2 mol of $NO(g)$ consumed."

"114.1 kJ of heat are released for each 1 mol of O_2 consumed."

"114.1 kJ of heat are released for each reaction unit."

"114.1 kJ of heat are released for each mol of reaction."

BOSTON UNIVERSITY

Enthalpy change of reaction, $\Delta_r H$

$$2\ NO(g) + O_2(g) \longrightarrow 2\ NO_2(g) \quad \Delta_r H = -114.1\ kJ$$

If 2.90 mol $NO(g)$ reacts completely with excess oxygen, what is q_P?

q_P = 2.90 mol NO × (−114.1 kJ / (2 mol NO))

= −165 kJ

If 11.5 g $NO(g)$ reacts completely with excess oxygen, what is q_P?

q_P = 11.5 g × (mol NO / (30.0 g)) × (−114.1 kJ / (2 mol NO))

= −21.8 kJ

BOSTON UNIVERSITY

[TP] The enthalpy change of reaction for

$$2\ A + 3\ B \rightarrow 4\ C + D$$

is $\Delta_r H = -45$ kJ. If 2 mol of A reacts with 2 mol of B with 100% yield, then q_P for the process is …

20% 1. −90 kJ
20% 2. −45 kJ
20% 3. −30 kJ
20% 4. −15 kJ
20% 5. something else

BOSTON UNIVERSITY