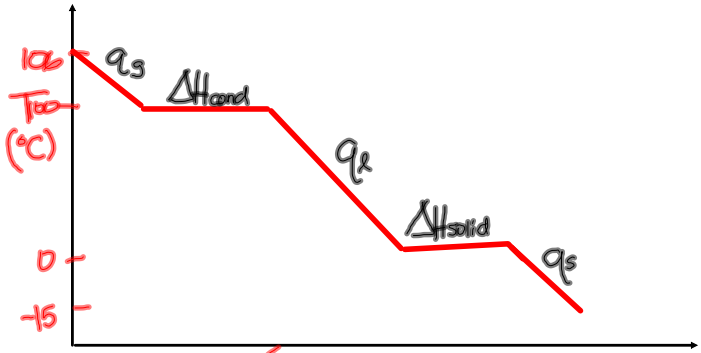
Energy Changes

- Heat ($q = mC\Delta T$)
- Enthalpy changes ($\Delta H = nH$)
- Phase changes
- Total Energy changes
- Heating / Cooling curves
- Calorimetry
- Lab - Molar Enthalpy of Solutions

Determine the amount of energy required to cool 110. g of steam at 106 °C to ice at -15.0°C.



$\Delta E_T = q_g + \Delta H_{cond} + q_\ell + \Delta H_{solid} + q_s$

Step 1: q_g

$q_g = mC\Delta T$

$q_g = (110g)\left(2.01 \frac{J}{g°C}\right)(-6.0°C)$

$q_g = -1326.6\ J$

Step 2: ΔH_{cond}

$\Delta H_{cond} = n\Delta H_{cond}$

$\Delta H_{cond} = \left(\frac{110.g}{18.02 g/mol}\right)\left(-40.7 \frac{kJ}{mol}\right)$

$\Delta H_{cond} = -248.4\ kJ$

Step 3: q_ℓ

$q_\ell = mC\Delta T$

$q_\ell = (110g)\left(4.19 \frac{J}{g°C}\right)(-100.0°C)$

$q_\ell = -46090\ J$

Step 4: ΔH_{solid}

$\Delta H_{solid} = n\Delta H_{solid}$

$\Delta H_{solid} = \left(\frac{110g}{18.02 g/mol}\right)\left(-6.01 \frac{kJ}{mol}\right)$

$\Delta H_{solid} = -36.7\ kJ$

Step 5: q_s

$q_s = mC\Delta T$

$q_s = (110g)\left(2.01 \frac{J}{g°C}\right)(-15.0°C)$

$q_s = -3316.5\ J$

$\Delta E_T = (-1.3266\ kJ) + (-248.4\ kJ) + (-46.090\ kJ) + (-36.7\ kJ) + (-3.3165\ kJ)$

$\Delta E_T = -336\ kJ$

A 50.0 g block of copper at 95.0°C is dropped into a calorimetry containing 100.g of water at 21.0 °C. Determine the final temperature of the system.

Cu

$m = 50.0\,g$

$T_i = 95.0°C$

H_2O

$m = 100.g$

$T_i = 21.0°C$

$T_f = ?$

$$q_{Cu} = -q_{H_2O}$$

$$m_{Cu} C \Delta T = -m_{H_2O} C \Delta T$$

$$(50.0g)\left(0.385 \tfrac{J}{g°C}\right)(T_f - 95.0°C) = -(100.g)\left(4.19 \tfrac{J}{g°C}\right)(T_f - 21.0°C)$$

$$19.25 \tfrac{J}{°C}(T_f - 95.0°C) = -419 \tfrac{J}{°C}(T_f - 21.0°C)$$

$$19.25 \tfrac{J}{°C} T_f - 1828.75\,J = -419 \tfrac{J}{°C} T_f + 8799\,J$$

$$19.25 \tfrac{J}{°C} T_f + 419 \tfrac{J}{°C} T_f = 1828.75\,J + 8799\,J$$

$$438.25 \tfrac{J}{°C} T_f = 10627.75\,J$$

$$\boxed{T_f = 24.3°C}$$

Energy Changes Worksheet