

Vocabulary Matching

1. ΔH_{comb} The energy released when combusting a compound.

2. H_v The heat required to vaporize one mole of a liquid.

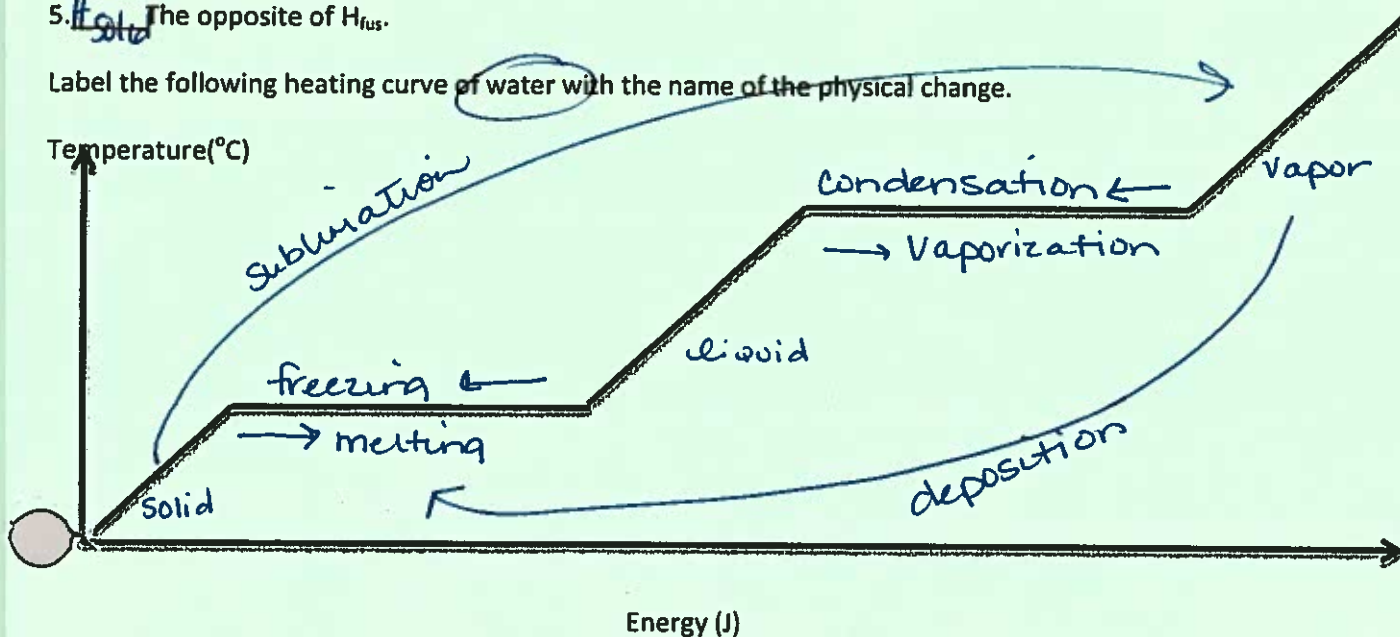
3. H_f The heat required to melt one mole of a solid substance.

4. H_{cond} The opposite of H_{vap} .

5. H_{solid} The opposite of H_{fus} .

ΔH_{comb}
H_{cond}
H_{fus}
H_{solid}
H_{vap}

Label the following heating curve of water with the name of the physical change.



Calculating Energy Released in a reaction.

1. A bomb calorimeter is useful for measuring the energy released in a combustion reactions. The reaction is carried out in a constant volume bomb with a high pressure of oxygen. How much heat is evolved when 54.0g glucose is burned according to this equation? $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ $H_{\text{comb}} = -2808 \text{ kJ}$ molar mass = 180.18 g/mol.

$$54.0 \text{ C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ mol}}{180.18 \text{ g}} = 3.00 \text{ mol C}_6\text{H}_{12}\text{O}_6$$

$$H_{\text{comb}} \times \text{Mol} = -2802 \text{ kJ} \times 3 = \boxed{-8406 \text{ kJ}}$$

2. Calculate the heat required to melt 25.7 g of solid methanol, CH_3OH , at its melting point. $H_{\text{fus}} = 3.22 \text{ kJ/mol}$

$$25.7 \text{ g CH}_3\text{OH} \times \frac{1 \text{ mol}}{32.05 \text{ g}} = 0.802 \text{ mol}$$

$$\Delta H_f \times \text{Mol} = 3.22 \frac{\text{kJ}}{\text{mol}} \times 0.802 \text{ mol} = \boxed{2.58 \text{ kJ}}$$

3. How much heat is released when 275 g of ammonia gas (NH_3) condenses to a liquid at its boiling point? $H_{\text{vap}} = 23.3 \text{ kJ}$

$$275 \text{ g NH}_3 \times \frac{1 \text{ mol}}{17.04 \text{ g}} = 16.1 \text{ mol}$$

$$H_v \times \text{Mol} = -23.3 \text{ kJ} \times 16.1 = \boxed{-375.13 \text{ kJ}}$$

16.4 Section Review AND 16.5 Section Review

Vocabulary Matching

- A A measure of disorder or randomness (S).
- E A physical or chemical change that occurs with no outside intervention.
- C States that adding two or more thermochemical equations to produce a final equation for a reaction, then the sum of the enthalpy changes for the individual reactions is the enthalpy change for the final reaction.
- F The change in enthalpy that accompanies the formation of one mole of the compound in its standard state from its constituent elements in their standard states.
- D The second law of thermodynamics: spontaneous processes always proceed in such a way that the entropy of the universe increases.
- B The energy that is AVAILABLE to do work.

A Entropy
B Gibb's free energy
C Hess's law
D Law of disorder
E Spontaneous reaction
F Standard enthalpy (heat) of formation

Calculation Practice

1. Use the standard enthalpies of formation to calculate the H_{rxn}° for each of the following reactions.

Use the Appendix C Table C-13 for the heat of formation values.



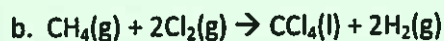
$$\rightarrow -1(-1206.9) + (-635.1) + (-393.509)$$

$$= 178.29 \text{ kJ}$$

$$\text{CaCO}_3 = -1206.9 \text{ kJ/mol}$$

$$\text{CaO} = -635.1 \text{ kJ/mol}$$

$$\text{CO}_2(\text{g}) = -393.509 \text{ kJ/mol}$$



$$[-1 \times -74.81] + (0) + -128.2 + 0$$

$$74.81 - 128.2$$

$$= -53.39 \text{ kJ}$$

$$\text{CH}_4 = -74.81$$

$$\text{Cl}_2 = 0$$

$$\text{CCl}_4(\text{l}) = -128.2$$

$$\text{H}_2 = 0$$

2. Given ΔH_{system} , T , and ΔS_{system} determine if each of the following processes or reactions is spontaneous or nonspontaneous. (Remember, if G_{system} is positive, the reaction is nonspontaneous) $\Delta G_{\text{sys}} = \Delta H_{\text{sys}} - T\Delta S$

a. $\Delta H_{\text{system}} = -75.9 \text{ kJ}$, $T = 273$, $S_{\text{system}} = 138 \text{ J/K}$

$$\Delta G = -75.9 \text{ kJ} - 273(138 \text{ J/K})$$

$$-75900 \text{ J}$$

$$= 38,226 \text{ J}$$

Nonspontaneous

b. $\Delta H_{\text{system}} = -27.6 \text{ kJ}$, $T = 535 \text{ K}$, $S_{\text{system}} = -55.2 \text{ J/K}$

$$\Delta G = -27.6 \text{ kJ} - 535(-55.2 \text{ J/K})$$

$$-27,600 \text{ J}$$

$$= 1932 \text{ J}$$

nonspontaneous