**Heat Day Two**

* **Enthalpy (ΔH)**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + **ΔHreaction = Hproducts - Hreactants**
  + ΔHreaction is \_\_\_\_\_\_\_\_\_\_\_\_\_\_ for exothermic reactions. *Why?*
  + ΔHreaction is positive for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_reactions. *Why?*
* **Nature favors lower energy → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Law of Conservation of Energy**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

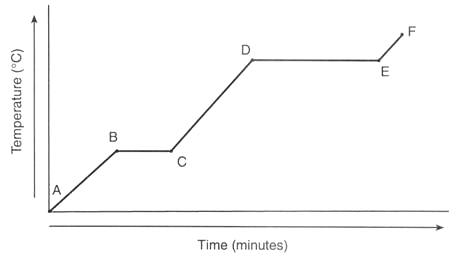
**Example:** 2H2 (g) + O2 (g) → 2H2O (l) ΔH = -572 kJ

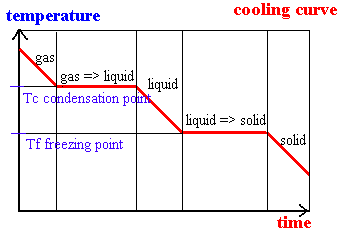
2H2O (l) → 2H2 (g) + O2 (g) ΔH = +572 kJ

**Endothermic or Exothermic?** Phase changes are physical changes (no new substance is formed)…

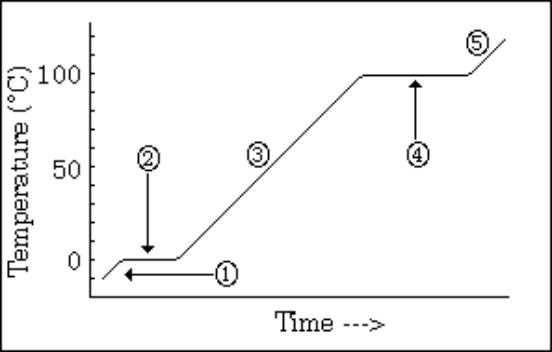
* 1. Melting
  2. Freezing
  3. Vaporization/Boiling
  4. Condensation

**Heating Curve**

Label the curve….Energy changes also occur in physical processes. **Cooling Curve**



**Applying Q when heating a substance across different phases:** Label each below.

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**Specific Heat (C)**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Use the Reference Tables*

**q = mCΔT** (+q = endothermic, -q = exothermic)

* q = heat (joules or calories)
* m = mass (grams)
* C = specific heat → Unit = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* ΔT = change in Temperature = Tf - Ti (oC)

Remember!!!

* **Temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_!** (Energy goes into pulling molecules farther apart.)
* *Therefore, we cannot use this equation for phase changes:* ***q = mCΔT***

**Latent Heats**

* **Heat of Vaporization (Hv)**:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **q = mHv**
* Hv = heat of vaporization \_\_\_\_\_\_\_\_\_\_\_\_( unit)
* *Hv of water = 2260 J/g*

**Heat of Fusion (Hf)**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + *(Or the heat released when 1 gram of liquid → solid.)*

**q = mHf**

* Hf = heat of fusion (J/g)
* *Hf of water = 334 J/g*

**Example Problems – Level One**

1. How much heat is added if 100 grams of liquid water increases in temperature from 30oC to 70oC?

2. How much heat is absorbed if 200 g of ice increases in temperature from -15oC to -5oC?

1. How much heat is released if 80 grams of water vapor is decreases in temperature from 150oC to 125oC?

4. How much heat is absorbed when 30 g of ice is changed into liquid water at 0oC?

5. How much heat is released when 50 grams of water vapor is changed into liquid water at 100oC?

**Example Problems – Level Two**

6. How much heat is absorbed if 30 grams of ice at -10oC is converted into liquid water?

**2 steps:** (1) heat the ice and (2) melt ice → liquid

(1) q = mCΔT q = (30g)(2.05 J/goC)(0o – -10o)

q = 615J

(2) q = mHf q = (30g)(334J/g)

q = 10,020J

7. How much heat is absorbed if 45 grams of water at 80oC is converted into steam at 105oC?

**3 steps**: (1) heat water, (2) water → steam, (3) heat steam

8. How much heat is released if 500 grams of vapor at 120oC changes to liquid water 70oC?

**3 steps**: cool the vapor, condensation, cool the liquid

**Calorimetry:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How much heat is released by the reaction if 10 grams of water is heated from 20oC to 60oC.

q = mCΔT q = (10g)(4.18J/goC)(60o – 20o) q = 1,672J → amount absorbed by water.

Therefore, -1,672J was released by the reaction.

2. What is the mass of the water if a release of 650 J of heat causes the water to increase in temperature by 15oC?

(Water absorbed 650J of heat from the reaction.) 650J = m(4.18J/goC)(15oC) m = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. What is the final temperature of 15 g of water if the water starts at 20oC and loses 300 J of heat?

\*\*Losing heat means q is negative -300J = (15g)(4.18J/goC)(Tf – 20o) Tf = \_\_\_\_\_\_oC

4. Determine the substance if a sample of 20 grams increases in temperature from 10oC to 28oC when it absorbs 368.3 Joules of energy.

368.3J = 20g(C)(28o – 10o C = 1.023 J/goC → \_\_\_\_\_\_\_\_\_\_\_\_\_ (see ref.pack)

**Entropy (S):** a measure of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the particles in a system.

* + *Systems tend to become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Entropy increases when:**

* + solid → liquid → gas (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a reaction (1A + 2B → 3C + 3D)
  + Temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Predicting Changes in Entropy**

* *Predict whether ΔSsystem will be positive or negative:*

1. H2O (l) → H2O (g)

2. CH3OH (s) → CH3OH (l)

3. Increase the temperature of a substance

4. Dissolving of a gas in a solvent  
CO2 (g) → CO2 (aq)

5. What happens when the number of gaseous product particles is greater than the number of gaseous reactant particles?  
2SO3 (g) → 2SO2 (g) + O2 (g)

6. Generally, when a solid or liquid dissolves to form a solution?  
NaCl (s) → Na+ (aq) + Cl- (aq)

**Spontaneous Reactions A reaction is spontaneous if:**

* 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (energy is released = exothermic)  
       
     AND 2. Disorder \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(positive entropy).

Ex. Wood burning