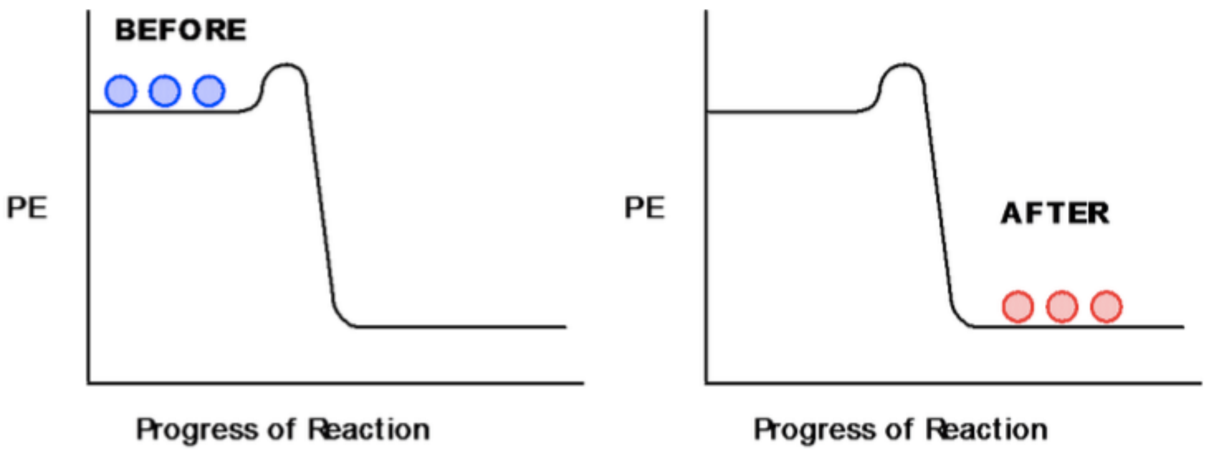
Predicting Spontaneous Reactions

- a SPONTANEOUS reaction is one that will occur by itself without outside assistance
  > spontaneous reaction can occur when the **activation energy barrier is low**



- reactions tend to favour the side of the reaction having **lower energy (enthalpy, ΔH)**
- **EXOTHERMIC** reactions result in a decrease in energy - **products are favoured**
- **ENDOTHERMIC** reactions result in an increase in energy - **reactants are favoured**

EXOTHERMIC reactions (forward or reverse) are favoured because of the tendency to move towards MINIMUM ENTHALPY (ΔH).

- from an energy stand point, exothermic reactions are favoured
- however, some endothermic reactions will occur spontaneously (ex. chemical ice pack)
- reactions have a tendency to **increase disorder or randomness**
  - > this is known as ENTROPY (ΔS)
- when entropy **increases** in the forward direction, **products** are favoured
- when entropy **decreases** in the forward direction, **reactants** are favoured

Reactions that produce the greatest amount of randomness are favoured because of a tendency to move towards MAXIMUM ENTROPY (ΔS).

- entropy can be predicted by examining the phases of the reactants and products:

gases (g) >> solutions (aq) > liquids (l) >> solids (s)

- in general, highly random states are more probable than highly ordered states
- endothermic reactions can be spontaneous when the difference in randomness between reactants and products is so great that it **overcomes** the tendency towards minimum enthalpy - these reactions are said to be "driven" by the entropy of the system

There are two "drives" or "tendencies" for reactions:

a) tendency to **increase randomness (maximum entropy, ΔS)**

b) tendency to **lower energy (minimum enthalpy, ΔH)**

Based on changes in enthalpy and entropy, predict whether each of the following reactions will be spontaneous, non-spontaneous or reach equilibrium.

a) $Zn(s) + 2HCl(aq) \rightleftarrows ZnCl_2(aq) + H_2(g)$ ΔH = –152 kJ

enthalpy - exo - products favoured => Spontaneous

entropy - products favoured

b) $3C(s) + 3H_2(g) \rightleftarrows C_3H_6(g)$ ΔH = +20.4 kJ

enthalpy - endo - Reactants favoured - NON SPONT

entropy - Reactants favoured * look at moles of gas

c) $2Pb(NO_3)_2(s) + 597\ kJ \rightleftarrows 2PbO(s) + 4NO_2(g) + O_2(g)$

enthalpy - endo - reactants EQUILIBRIUM

entropy - products favoured

Based on changes in enthalpy and entropy, predict whether each of the following reactions will be spontaneous, non-spontaneous or reach equilibrium.

a) $6CO_2(g) + 6H_2O(l) + ENERGY \rightarrow C_6H_{10}O_6(s) + 6O_2(g)$

enthalpy - R non. spontaneous

entropy - R

b) $CH_4(g) + H_2O(g) + 49.3\ kJ \rightarrow CO(g) + 3H_2(g)$

2nd enthalpy - R 4 mol

entropy - P EQUIBRIUM

c) $1N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + 92.4\ kJ$

enthalpy - P EQUILIBRIUM

entropy - R