|  |
| --- |
| **Thermodynamically favorable** |
| Increases the entropy of the universe |
| entropy of the system/reaction may or may not increase |
| Often exothermic (common driving force) |
| ΔG = - |
| ΔS = + ΔH = - |
| ΔS = - ΔH = - (sometimes) |
| ΔS = + ΔH = + (sometimes) |
| Bomb exploding |
| Water decomposing at high temperatures |
| ΔSuniv = + |
| Shifts right from starting conditions |
| Will “go” in the forward direction |
| K >1 (if ΔG is measured at standard conditions) |
| E = + |
| An exothermic, gas-producing reaction |
| Solid melting above its melting point |
| Driving force is either increasing entropy of the system or exothermicity or both |

|  |
| --- |
| **Thermodynamically unfavorable** |
| Decreases the entropy of the universe |
| entropy of the system/reaction may or may not increase |
| ΔG = + |
| ΔG = 0 |
| ΔS = - ΔH = + |
| ΔS = - ΔH = - (sometimes) |
| ΔS = + ΔH = + (sometimes) |
| Cookies baking |
| House being built |
| Water decomposing at low temperatures |
| ΔSuniv = - |
| Shifts left from starting conditions or is at equilibrium |
| K ≤ 1 (if ΔG is measured at standard conditions) |
| E = - |
| Solid melting below its melting point |
| Liquid boiling below its boiling point |

|  |
| --- |
| ΔGrxn |
| Determines if a reaction is thermodynamically favorable |
| Gibbs (Free) Energy |
| Tells whether a reaction shifts right or left from starting conditions |
| H - TΔS  |
| **-** = spontaneous/ thermodynamically favorable |
| **+** = nonspontaneous/ not thermodynamically favorable |
| Units are in kJ/mol |

|  |
| --- |
| ΔSrxn |
| Entropy |
| Reflects the number of microstates (or degree of “disorder") |
| **+** is good for spontaneity (driving force) |
| **+** = increasing disorder (more microstates) |
| **-** = increasing order (fewer microstates) |
| Units are J/mol K |

|  |
| --- |
| ΔHrxn |
| A measure of heat energy released or required |
| Enthalpy |
| **-** is good for spontaneity (driving force) |
| **-** = exothermic |
| Related to the change in entropy of the surroundings |
| **+** = endothermic |
| Units are kJ/mol |