The Energy of Reactions

AP Biology

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| --- | --- | --- |
| **General rule** | **Endergonic** | **Exergonic** |
| Energy input or energy released? |  |  |
| Anabolic or catabolic? |  |  |
| Increasing complexity or decreasing complexity? |  |  |
| Change in G positive or negative? |  |  |
| Spontaneous or non-spontaneous? |  |  |
| Molecule complexity greatest in product or reactant? |  |  |
| ATP coupled process, or ATP produced? |  |  |
| Greater energy in the reactants or products? |  |  |
| Dehydration or hydrolysis? |  |  |
| Photosynthesis or respiration? |  |  |
| ATP formed, or ADP + P? |  |  |
| Entropy increased or decreased? |  |  |
| High energy bonds formed, or broken? |  |  |
| Decomposition or synthesis? |  |  |
| Energy of reactants vs products same or different? |  |  |
| Atoms of reactants vs products same or different? |  |  |

Gibbs Free Energy S’math practice

AP Biology

Notes:

• Enthalpy is expressed in kJ (kilojoules)/mol, entropy in J/K (joules/kelvin), and temperature in K. Cancel the Kelvins, and convert J to kJ by dividing by 1000 to find G in kJ.

• Standard temperature is 298K (25C), but some problems use 20C (293K)

• Free energy is calculated using Δ G = Δ H - T ( Δ S) where a negative G value is exergonic (spontaneous) and a positive is endergonic (non-spontanteous)

• Practice Problems:

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| --- | --- | --- | --- | --- |
| *Rxn* | *Δ enthalpy (kJ/mol)* | *Δ entropy (J/K)* | *Δ Free energy (kJ/mol)* | *Ender- or exergonic?*  *Spontaneous or not?* |
| A + B -> AB | +12 | -5 |  |  |
| CD -> C + D | -32 | +25 |  |  |
| CH4 + 2O2 -> CO2 + 2H2O | -890 | -243 |  |  |
| N2 + 3H2 -> 2NH3 | -92 | -199 |  |  |
| Hydrolysing ATP ->  ADP + Pi | - | - | -0.31 |  |
| Phosphorylation of Glucose (glucose + Pi) | - | - | +14 |  |
| \* 2COCl2 + H2O ->  CO2 + 2HCl | -223 | +284 |  |  |

\* Phosgene, COCl2, was used as a weaponized gas during World War I. It reacts with moisture in the lungs to produce HCl, which causes the lungs to fill with fluid, leading to death. Use the energy values above, at a **body temp of 37C (310K)** to see if this reaction is spontaneous or not.