Name: KEY Official Class: _____ Date: _____

Teacher: _____ Period: _____ Class: _____

Entropy

YOYO: Looking at the gif of the dog sledding, make a prediction, which process is spontaneous, which is non-spontaneous. Write at least 2 complete sentences explaining your reasoning.

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Spontaneous Reactions vs. Non-Spontaneous Reactions

- Spontaneous reaction is one that is able to proceed without needing an outside source of energy (exothermic reaction)
- non-spontaneous needs an input of energy. (endothermic reaction)

Spontaneous reactions happen when…

- Less energy (lower enthalpy): exothermic reactions are favored
- Greater randomness, disorder

entropy → randomness

increase in entropy (S)

enthalpy → heat

Entropy

- Entropy is the measure of disorder or randomness in a system
- In nature greater entropy is favored.

Solid Liquid Gas

Entropy Increases…

- When the number of molecules increases during a reaction.
  - $NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
- With an increase in temperature
- When a gas is formed from a liquid or a solid.

This is why we don't teach our children about entropy until much later...

Entropy Regents Questions

1. Given the balanced equation representing a phase change:
   $C_6H_4Cl_{2(s)}$ + energy → $C_6H_4Cl_{2(g)}$ (endo)
   Which statement describes this change?
   a. It is endothermic, and entropy decreases.
   b. It is endothermic, and entropy increases.
   c. It is exothermic, and entropy decreases.
   d. It is exothermic, and entropy increases

energy as reactant = endo

S → g = ↑ randomness/entropy

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2. The entropy of a sample of H_2O increases as the sample changes from a
   a. gas to a liquid ↓
   b. gas to a solid ↓
   c. liquid to a gas ↑
   d. liquid to a solid ↓

entropy ↑ S → L → G (least → most)

3. Which 1-mole sample has the least entropy?
   a. $Br_{2(s)}$ at 266 K
   b. $Br_{2(l)}$ at 266 K
   c. $Br_{2(l)}$ at 332 K
   d. $Br_{2(g)}$ at 332 K

↳ solids @ low temp

4. A thermometer is in a beaker of water. Which statement best explains why the thermometer reading initially increases when LiBr(s) is dissolved in the water?
   a. The entropy of the LiBr(aq) is greater than the entropy of the water.
   b. The entropy of the LiBr(aq) is less than the entropy of the water.
   c. The dissolving of the LiBr(s) in water is an endothermic process.
   d. The dissolving of the LiBr(s) in water is an exothermic process.

5. In terms of energy and entropy, systems in nature tend to undergo changes toward
   a. higher energy and higher entropy
   b. higher energy and lower entropy
   c. lower energy and higher entropy
   d. lower energy and lower entropy

More Entropy Practice

Reaction	Change in Entropy	Reasoning
$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	↓	solid formed
$H_2O_{(l)} \rightarrow 2\ H_{2(g)} + O_{2(g)}$	↑	gas formed
$CO_{(g)} + 3\ H_{2(g)} \rightarrow CH_{4(g)} + H_2O_{(g)}$	↓	4 mol stuff in reactants & 2 mol stuff in products
$2\ NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$	↑	gas formed / more stuff
$CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$	no change	same # each side - still 2 gas
$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$	↑	gas formed
$2NH_{3(g)} + CO_{2(g)} \rightarrow NH_2CONH_{2(aq)} + H_2O_{(l)}$	↓	gas → liquid
$H_2O_{(l)} \rightarrow H_2O_{(s)}$	↓	liquid → solid