Entropy – Measure of disorder, randomness, chaos

ΔS = change in entropy = entropy of products minus entropy of reactants

Positive ΔS = entropy was gained = products have more entropy than reactants

Negative ΔS = entropy was lost = products have less entropy than reactants

Entropy will increase in these situations:

1. Solid → liquid → gas
2. Small number of reactant species combine to form a larger number of product species (coefficients)
3. More moles of gas are produced
4. Volume of a gas is increased/pressure of a gas is decreased
5. Solid dissolving in water
6. Temperature increases

Process	Increase or Decrease in Entropy?	ΔS (positive or negative?)
1. Snow melting	increase	+
2. Salt dissolving in H_2O	increase	+
3. Liquid cooling	decrease	−
4. H_2O (l) → H_2O (s)	decrease	−
5. 2 Al (s) + 3 I_2 (s) → 2 AlI_3 (s)	decrease	−
6. N_2 (g) + 3H_2 (g) → 2 NH_3 (g)	decrease	−
7. Ag^+ (aq) + Cl^- (aq)→ AgCl(s)	decrease	−
8. Dissolving of sugar in hot coffee	increase	+
9. Sublimation of a solid	increase	+
10. Increasing the volume of a gas	increase	+
11. Condensation of water	decrease	−
12. H_2(g) + Br_2(l) → 2 HBr(g)	increase	+
13. $CuSO_4$(s) → Cu^{2+}(aq) + SO_4^{2-}(aq)	increase	+

Thermochemistry Practice Name:_____

Determine if the reaction is endothermic or exothermic, the signs of ΔH and ΔS.

Reaction	Endo or Exo?	ΔH (positive or negative?)	ΔS (positive or negative?)
1. $H_2(g) + S(s) + 2O_2(g) \leftrightarrow H_2SO_4(l)$ $\Delta H = -811$ kJ	EXO	−	−
2. $2C(s) + 2Fe_2O_3(s) + 464\text{ kJ} \leftrightarrow 4Fe(s) + 3CO_2(g)$	Endo	+	+
3. $2H_2O(l) \leftrightarrow 2H_2(g) + O_2(g)$ $\Delta H = +572$ kJ	Endo	+	+
4. $C(s) + 2H_2(g) \leftrightarrow CH_4(g) + 75$ kJ	EXO	−	−

Problems: Use the reactions above to solve the following problems.

5. For reaction #1, how much heat (kJ) is evolved when 5.63 g of oxygen react?

$$5.63\text{ g } O_2 \left| \frac{1\text{ mol } O_2}{32\text{ g } O_2} \right| \frac{811\text{ kJ}}{2\text{ mol } O_2} = \boxed{71.3\text{ kJ}}$$

6. For reaction #2, how many grams of CO_2 will be produced when 2.5×10^4 kJ of heat is applied?

$$2.5 \times 10^4\text{ kJ} \left| \frac{3\text{ mol } CO_2}{464\text{ kJ}} \right| \frac{44.01\text{ g } CO_2}{1\text{ mol } CO_2} = 7114 = \boxed{7.1 \times 10^3\text{ g } CO_2}$$

7. For reaction #3, how much heat is needed to produce 10.1 L of H_2 gas at STP?

$$10.1\text{ L } H_2 \left| \frac{1\text{ mol } H_2}{22.4\text{ L } H_2} \right| \frac{572\text{ kJ}}{2\text{ mol } H_2} = \boxed{129\text{ kJ}}$$

Solve the following problems.

8. 40.0 g of water is heated from 10.0°C to 30.0°C. The specific heat of water is 4.184 J/g°C. How much heat is involved during this process?

$$q = mC\Delta T$$

$$q = (40.0\ g)\left(4.184\ \frac{J}{g\cdot°C}\right)(30.0°C - 10.0°C)$$

$$\boxed{q = 3350\ J}$$

9. 229 joules of heat is needed to raise the temperature of 52 grams of nickel from 25°C to 35°C. What is the specific heat capacity of nickel?

$$q = mC\Delta T$$

$$229\ J = (52\ g)\,C\,(35°C - 25°C)$$

$$\boxed{C = 0.44\ J/g°C}$$

10. How much heat is needed to vaporize 53.8 grams of lead? The heat of vaporization of lead is 178 kJ/mol.

$$53.8\ g\ Pb \left| \frac{1\ mol\ Pb}{207.2\ g} \right| \frac{178\ kJ}{1\ mol\ Pb} = \boxed{46.2\ kJ}$$

11. 25.5 kJ of heat is needed to vaporize 6.0 grams of potassium. What is the heat of vaporization of potassium in kJ/mol?

$$6.0\ g\ K \left| \frac{1\ mol\ K}{39.10\ g\ K} \right. = 0.15\ mol\ K$$

$$\Delta H = \frac{25.5\ kJ}{0.15\ mol}$$

$$\Delta H = 166 = \boxed{170\ kJ/mol}$$

12. Zinc has a specific heat capacity of 0.39 J/g°C. How much heat is needed to raise the temperature of 299 grams of zinc at 25°C to 45°C?

$$q = mC\Delta T$$

$$q = (299\ g)(0.39\ J/g°C)(45°C - 25°C)$$

$$q = 2332 = \boxed{2.3 \times 10^3\ J}$$