Ch12 # ENTHALPY and ENTROPY

Name____________________

Enthalpy

In any chemical reaction, the side having **minimum enthalpy** (minimum energy) is said to be favoured because molecules tend to go to or remain at a state of minimum energy. Thus, there is a tendency for **exothermic reactions** to be **spontaneous**. Note that a spontaneous change is a change which occurs by itself, without outside assistance.

For each of the following reactions, decide whether the **reactants** or the **products** have the lesser enthalpy (energy) and would therefore be favoured:

1. $2N_2O_{(g)}$ -----> $2N_{2(g)} + O_{2(g)} + 164\ kJ$ ___products___
2. $2CO_{(g)}$ -----> $2C_{(s)} + O_{2(g)}$ $\Delta H = 221\ kJ$ ___reactants___
3. $2HCl_{(g)} + 184\ kJ$ -----> $H_{2(g)} + Cl_{2(g)}$ ___reactants___
4. $2NO_{(g)} + Cl_{2(g)}$ -----> $2NOCl_{(g)}$ $\Delta H = -76\ kJ$ ___products___
5. $C_2H_2Cl_{4(l)}$ -----> $C_2H_{2(g)} + 2Cl_{2(g)}$ $\Delta H = 386\ kJ$ ___reactants___
6. $CH_{4(g)} + O_{2(g)}$ -----> $CO_{2(g)} + 2H_2O_{(g)} + 394\ kJ$ ___products___

Entropy

In all chemical and physical changes there is a tendency for the system to attain a state of **maximum entropy** or randomness. The randomness of phases from greatest to least is: **gases >> solutions > liquids >> solids**. In general, the side of the equation favoured is the side having the most particles of the most random phase.

For each of the following reactions, decide whether the **reactants** or the **products** have the greater entropy and would therefore be favoured. There may also be **no significant change**.

7. $Na_2CO_{3\cancel{(s)}}$ -----> $2Na^+_{(aq)} + CO_3^{2-}{}_{(aq)}$ ___products___
8. $H_2O_{\cancel{(s)}}$ -----> $H_2O_{(l)}$ ___products___
9. $CaO_{\cancel{(s)}} + SO_{2(g)}$ -----> $CaSO_{3\cancel{(s)}}$ ___reactants___
10. $2HI_{(g)}$ -----> $H_{2(g)} + I_{2(g)}$ ___no significant___ change
11. $Ag^+_{(aq)} + Cl^-_{(aq)}$ -----> $AgCl_{\cancel{(s)}}$ ___reactants___
12. $2Al_{\cancel{(s)}} + 3Br_{2\cancel{(s)}}$ -----> $2AlBr_{3\cancel{(s)}}$ ___reactants___
13. $2N_2O_{5(g)}$ -----> $4NO_{2(g)} + O_{2(g)}$ ___products___
14. $N_{2(g)} + 3H_{2(g)}$ -----> $2NH_{3(g)}$ ___reactants___

For each of the following reactions, use enthalpy and entropy considerations to decide whether a reaction in the direction shown will be **spontaneous**, reach a state of **equilibrium**, or **not occur**. Assume that the system is closed.

15. $2Na_{(\cancel{s})} + 2H_2O_{(l)} \text{ -----> } 2Na^{+}_{(aq)} + 2OH^{-}_{(aq)} + H_{2(g)} + 368\text{ kJ}$

enthalpy favours products

entropy favours Products

spontaneous
answer

16. $C_2H_{4(g)} + 3O_{2(g)} \text{ -----> } 2CO_{2(g)} + 2H_2O_{(l)} \quad \Delta H = -1411\text{ kJ}$

enthalpy favours products

entropy favours reactants.

equilibrium
answer

17. $N_{2(g)} + 2O_{2(g)} \text{ -----> } 2NO_{2(g)} \quad \Delta H = 68\text{ kJ}$

enthalpy favours reactants

entropy favours reactants

not occur
answer

18. $CaCl_{2(\cancel{s})} + H_2O_{(g)} + 217\text{ kJ} \text{ -----> } CaO_{(s)} + 2HCl_{(g)}$

enthalpy favours reactants

entropy favours products

equilibrium
answer

19. $2HI_{(g)} + F_{2(g)} \text{ -----> } 2HF_{(g)} + I_{2(\cancel{s})} \quad \Delta H = -595\text{ kJ}$

enthalpy favours products

entropy favours reactants

equilibrium
answer

20. $SO_{2(g)} + 4HF_{(g)} \text{ -----> } SF_{4(g)} + 2H_2O_{(l)} \quad \Delta H = 828\text{ kJ}$

enthalpy favours reactants.

entropy favours reactants

not occur
answer

$\xleftarrow{\quad\quad} \Delta S$

This is different: Predict whether the equilibrium $4HCl_{(g)} + O_{2(g)} \text{ <---> } 2H_2O_{(g)} + 2Cl_{2(g)}$ is exothermic or endothermic and explain your reasoning. $\Delta H = \longrightarrow$

exothermic! To be at equilibrium the products must be favoured to be opposite the ΔS (reverse) reaction.