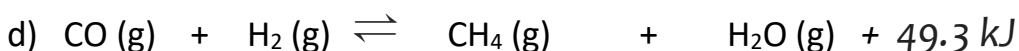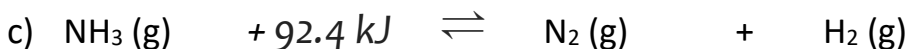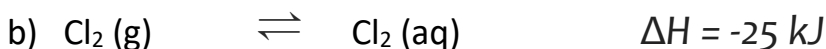# Taking another look at Enthalpy vs. Entropy

1) Tell whether each of the following chemical reactions
   is endothermic or exothermic and state whether
   the reactants or the products are favoured by minimum enthalpy.
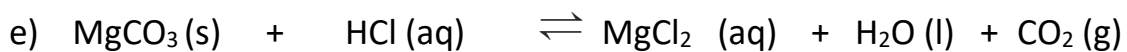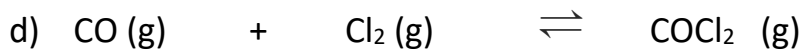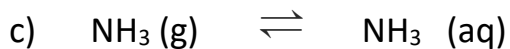   **YOU MUST BALANCE THE EQUATIONS YOURSELF!!!!**

a) PCl_5 (g) $\rightleftharpoons$ PCl_3 (g) + Cl_2 (g) $\Delta H = 92.5\ kJ$

b) Cl_2 (g) $\rightleftharpoons$ Cl_2 (aq) $\Delta H = -25\ kJ$

c) NH_3 (g) $+ 92.4\ kJ$ $\rightleftharpoons$ N_2 (g) + H_2 (g)

d) CO (g) + H_2 (g) $\rightleftharpoons$ CH_4 (g) + H_2O (g) $+ 49.3\ kJ$

2) For each of the above reactions, state whether enthalpy is increasing or
decreasing *in the forward direction,* and if this is favourable.

	Increases/ decreases		*is / is not*	
a) Enthalpy _____	to the right. This	_____	favourable.
b) Enthalpy _____	to the right. This	_____	favourable.
c) Enthalpy _____	to the right. This	_____	favourable.
d) Enthalpy _____	to the right. This	_____	favourable.

3) Tell whether reactants or products show maximum entropy.

   Give as many reasons as apply, to justify your choice.

   YOU MUST BALANCE THE EQUATIONS YOURSELF!!!!

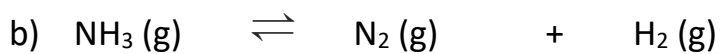   a) I_2 (s) $\rightleftharpoons$ I_2 (aq)

   b) NH_3 (g) $\rightleftharpoons$ N_2 (g)   + H_2 (g)

   c) NH_3 (g) $\rightleftharpoons$ NH_3 (aq)

   d)   CO (g)   + Cl_2 (g) $\rightleftharpoons$ $COCl_2$ (g)

   e) $MgCO_3$ (s)   +   HCl (aq) $\rightleftharpoons$ $MgCl_2$ (aq)   + H_2O (l) + CO_2 (g)
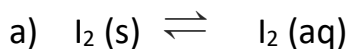
4) Based on your answers to #3, if all of those 5 reactions are to be in DYNAMIC EQUILIBRIUM (also called CHEMICAL EQUILIBRIUM), *meaning that they are reversible,* then state whether the reaction must be endothermic or exothermic to facilitate the reversibility of the reaction. Remember that the drive for enthalpy and entropy must oppose each other for a reaction to be reversible.

Also, add a sentence justifying why this would make sense.

(Why would the energy have to be the side of the reaction that you indicated?)

a) I_2 (s) $\rightleftharpoons$ I_2 (aq)

b) NH_3 (g) $\rightleftharpoons$ N_2 (g)   + H_2 (g)

.

c) NH_3 (g) $\rightleftharpoons$ NH_3 (aq)

d)   CO (g)   + Cl_2 (g) $\rightleftharpoons$ $COCl_2$ (g)

e) $MgCO_3$ (s)   + HCl (aq) $\rightleftharpoons$ $MgCl_2$ (aq)   + H_2O (l) + CO_2 (g)
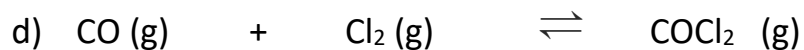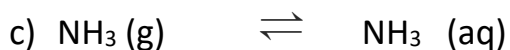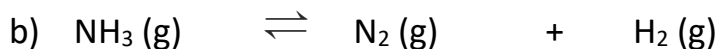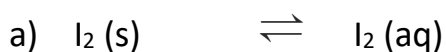
5) For each of the following reactions, decide:
- which has minimum enthalpy (reactants or products)
  Give a reason to justify WHY.
- and which has maximum entropy (reactants or products**)**
  Give a reason to justify WHY.

You may assume that every reaction listed BELOW is DEFINITELY reversible, and that all reactions occur in a CLOSED SYSTEM (the container has a secure lid / stopper on it).

YOU MUST BALANCE THE EQUATIONS YOURSELF!!!!

a) PCl_3 (g)   + Cl_2 (g) $\rightleftharpoons$ PCl_5 (g) ΔH =- 92.5 kJ

b) NO_2 (g) $\rightleftharpoons$ N_2O_4 (g)   + kJ

c) PbO (s)   + NO_2 (g) + O_2 (g) $\rightleftharpoons$ $Pb(NO_3)_2$ (s) ΔH =- 597 kJ

d) HCl (g)   + kJ $\rightleftharpoons$ H^+ (aq)   + Cl^+ (aq)

e) Na_2CO_3 (s)   +   HCl (aq) $\rightleftharpoons$ NaCl (aq) + CO_2 (g) + H_2O (l)   + 27.7 kJ