

1. (a) Liquids are more disordered than solids. Entropy increases.

(b) Entropy decreases

(c) Entropy increases

(d) Entropy decreases

(e) Entropy decreases

(f) Entropy increases

(g) Entropy increases

(2) (a) Li(l) has larger entropy value since liquids have higher entropy value than solids

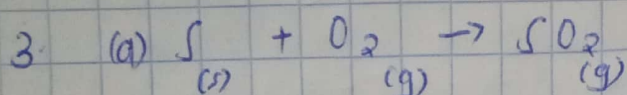
(b) $\text{CH}_3\text{OCH}_3(\text{l})$ has larger entropy value due to the hydrogen bonding present.

(c) Xe(g) has large entropy value since 1 mol of Ar(g) is less than 1 mole of Xe(g)

(d) $\text{CO}_2(\text{g})$ has large entropy value since it has more O atoms than CO

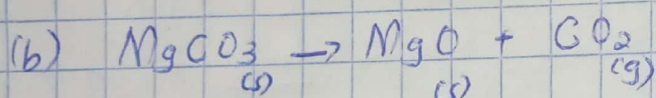
(e) $\text{O}_3(\text{g})$ has more entropy since it has more O atoms than $\text{O}_2(\text{g})$

(f) $\text{N}_2\text{O}_4(\text{g})$ has large entropy value since it is a dimer of NO_2

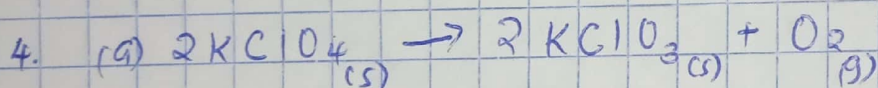


$$\Delta S^\circ_{\text{rxn}} = \Delta S^\circ_{\text{product}} - \Delta S^\circ_{\text{reactant}}$$

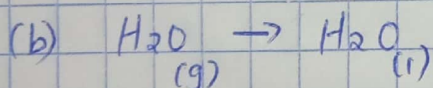
$$\begin{aligned} &= 248.5 - [31.88 + 205] \\ &= 248.5 - 236.88 \\ &= 11.62 \text{ J/K} \end{aligned}$$



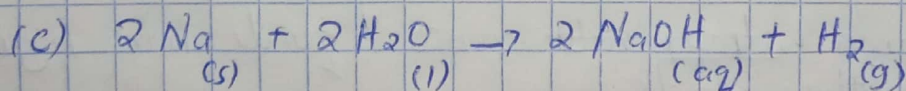
$$\begin{aligned} &= [26.78 + 213.6] - 65.69 \\ &= 174.69 \text{ J/K} \end{aligned}$$



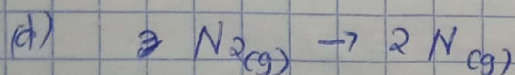
The entropy change is positive since a gaseous product is formed.



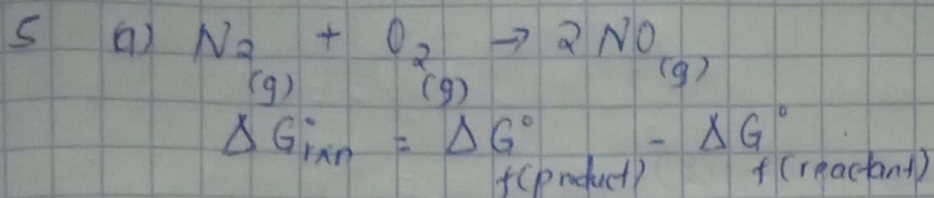
Entropy change is negative since the product is liquid.



The entropy change is positive since aqueous and gaseous products are formed.



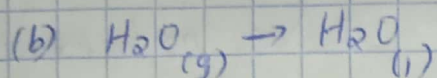
Entropy change is positive since the number of moles of products is higher than that of reactants.



$$= 2\Delta G_{fNO}^\circ - [\Delta G_{fN_2}^\circ + \Delta G_{fO_2}^\circ]$$

$$= 2(86.55) - [0 + 0]$$

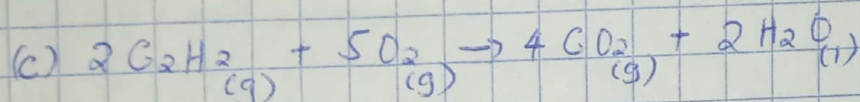
$$= 173.1 \text{ kJ/mol}$$



$$= \Delta G_{f(H_2O, l)}^\circ - \Delta G_{f(H_2O, g)}^\circ$$

$$= -228.6 + 237.2$$

$$= 8.6 \text{ kJ/mol}$$



$$= [4\Delta G_{f(CO_2)}^\circ + 2\Delta G_{f(H_2O)}^\circ] - [2\Delta G_{f(C_2H_2)}^\circ + 5\Delta G_{f(O_2)}^\circ]$$

$$= [4(-394.4) + 2(-237.2)] - [2(209.2) + 5(0)]$$

$$= -2052 - 418.4$$

$$= -2470.4 \text{ kJ/mol}$$

6. Reaction A

$$\Delta H = 10.5 \text{ kJ/mol}$$

$$\Delta S = 30 \text{ J/K} \cdot \text{mol}$$

$$T = 25 + 273 = 298 \text{ K}$$

$$\Delta G = \Delta H - T\Delta S$$

$$= 10.5 \times 10^3 - 298 \times 30$$

$$= 1560 \text{ J/mol}$$

Reaction A is non-spontaneous reaction

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = 0$$

$$\Delta H = T\Delta S$$

$$T = \frac{\Delta H}{\Delta S} = \frac{10.5 \times 10^3}{30} = 350 \text{ K}$$

$$T = 350 - 273 = 77^\circ\text{C}$$

Reaction B

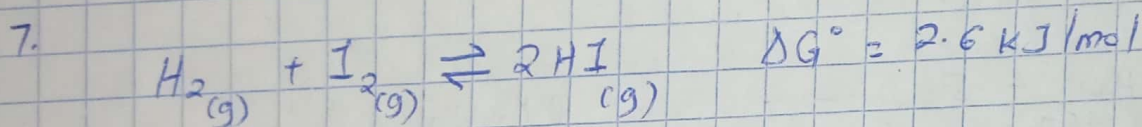
$$\begin{aligned}\Delta G &= \Delta H - T\Delta S \\ &= 1.8 \times 10^3 - 298(-113) \\ &= 35474 \text{ J/mol}\end{aligned}$$

Reaction B is non-spontaneous reaction

$$\Delta G = \Delta H - T\Delta S \quad \Delta G = 0$$

$$\begin{aligned}\Delta H &= T\Delta S \\ T &= \frac{\Delta H}{\Delta S} = \frac{1.8 \times 10^3}{-113} = -15.9 \text{ K} \Rightarrow \text{Does not exist}\end{aligned}$$

Reaction B is non-spontaneous throughout.



$$\Delta G = RT \ln(K_p)$$

$$K_p = e^{\left(\frac{-\Delta G}{RT}\right)}$$

$$= e^{-\left(\frac{2.6 \times 10^3}{8.3144 \times 298.15}\right)}$$

$$= 0.3504$$

8.

$$\begin{aligned}\text{Maximum number of ATP molecules} \\ &= 2880 \times \frac{1}{31} = 93 \text{ moles}\end{aligned}$$

9. Exothermic water is

9. Freezing water is exothermic. The heat put out will lead to increase the entropy, whether the system is more ordered or not

10. The standard entropy is zero at the absolute zero. A substance can never have a negative standard entropy.