

Answers to Self-Check Questions

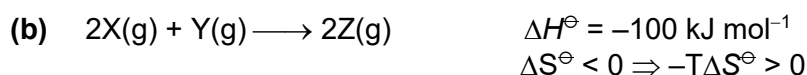
1. $\Delta S^\ominus = -284.6 \text{ J mol}^{-1} \text{ K}^{-1}$
 $\Delta H_f^\ominus = (-314.4) - [(-46.2) + (-92.3)] = -175.9 \text{ kJ mol}^{-1}$
 $\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus = (-175.9) - 298(-284.6/1000) = -91.1 \text{ kJ mol}^{-1}$
 Since $\Delta G^\ominus < 0$, the reaction is spontaneous.

[Note: The reaction is spontaneous despite the decrease in entropy because it is enthalpy-driven as strong ionic bonds are formed.]

2. $\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$



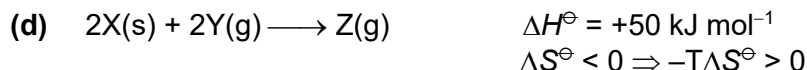
In this case, $\Delta G^\ominus < 0$ when the negative $-T\Delta S^\ominus$ outweighs the positive $\Delta H^\ominus$ at high temperatures. Hence the reaction is thermodynamically feasible at high T where $T > \frac{\Delta H^\ominus}{\Delta S^\ominus}$ such that $\Delta G^\ominus < 0$.



In this case, $\Delta G^\ominus < 0$ when the negative $\Delta H^\ominus$ outweighs the positive $-T\Delta S^\ominus$ at low temperatures. Hence the reaction is thermodynamically feasible at low T where $T < \frac{\Delta H^\ominus}{\Delta S^\ominus}$ such that $\Delta G^\ominus < 0$.



In this case, $\Delta G^\ominus < 0$ at all temperatures because both $\Delta H^\ominus$ and $-T\Delta S^\ominus$ are negative. The reaction is thermodynamically feasible at all T.

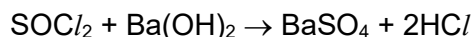


In this case, $\Delta G^\ominus > 0$ at all temperatures because both $\Delta H^\ominus$ and $-T\Delta S^\ominus$ are positive. The reaction is not thermodynamically feasible at all T.

3. Ans: A

According to the equation, there is decrease in number of moles of gas in the forward reaction, thus $\Delta S < 0$. Since H-bonds are formed between CO_2 and H_2O , $\Delta H < 0$.

4. Ans: B



Since a reaction occurs vigorously, $\Delta G < 0$

Since temperature decreases, the reaction is endothermic $\Rightarrow \Delta H > 0$

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

Since $\Delta G < 0$ and $\Delta H > 0$, $-T\Delta S$ is negative. Thus, ΔS is positive.

5. Ans: D

White tin $\rightarrow$ Grey tin

$\Delta H_f^\ominus = -2.09 - 0 = -2.09 \text{ kJ mol}^{-1} = -2090 \text{ J mol}^{-1}$

$\Delta S_f^\ominus = S^\ominus(\text{products}) - S^\ominus(\text{reactants}) = 44.1 - 51.4 = -7.3 \text{ J K}^{-1} \text{ mol}^{-1}$ ←

$\Delta G^\ominus = -2090 - (273+12)(-7.3) = -2090 - 285(-7.3)$

Note:

It is stated in learning outcome (d) that the calculation of $\Delta S^\ominus$ using $S^\ominus$, is **not** required but it is needed here.