

### Exercise 4.61 – Disorder and spontaneity

**Q461-01** Which of the changes below occurs with the greatest increase in entropy?

- A.  $\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq})$
- B.  $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \longrightarrow \text{NH}_4\text{Cl}(\text{s})$
- C.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$
- D.  $\text{C}(\text{s}) + \text{CO}_2(\text{g}) \longrightarrow 2\text{CO}(\text{g})$

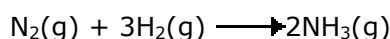
**Q461-02** In which of the following reactions is the entropy change ( $\Delta S$ ) closest to zero

- A.  $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \longrightarrow \text{SO}_3(\text{g})$
- B.  $\text{Br}_2(\text{l}) \longrightarrow \text{Br}_2(\text{g})$
- C.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$
- D.  $3\text{Ca}(\text{s}) + \text{N}_2 \longrightarrow \text{Ca}_3\text{N}_2(\text{s})$

**Q461-03** Estimate, without doing a calculation, the magnitude of the entropy change for the following reaction.



**Q461-04** Consider the following reaction:



The absolute entropy values,  $S$ , at 300K for  $\text{N}_2(\text{g})$ ,  $\text{H}_2(\text{g})$  and  $\text{NH}_3(\text{g})$  are 193, 131 and 192  $\text{JK}^{-1}\text{mol}^{-1}$  respectively. Calculate  $\Delta S^\ominus$  for the reaction and explain the sign of  $S^\ominus$ .

**Q461-05** Which reaction has the greatest positive entropy change?

- A.  $\text{CH}_4(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \longrightarrow \text{CO}(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- B.  $\text{CH}_4(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \longrightarrow \text{CO}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- C.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- D.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

**Q461-06** Which reaction occurs with the largest increase in entropy?

- A.  $\text{Pb}(\text{NO}_3)_2(\text{s}) + 2\text{KI}(\text{s}) \longrightarrow \text{PbI}_2(\text{s}) + 2\text{KNO}_3(\text{s})$
- B.  $\text{CaCO}_3(\text{s}) \longrightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- C.  $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$
- D.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$

**Q461-07** Some chlorine gas is placed in a flask of fixed volume at room temperature. What change will cause a decrease in entropy?

- A. Adding a small amount of hydrogen
- B. Adding a small amount of chlorine
- C. Cooling the flask
- D. Exposing the flask to sunlight

**Q461-08** Which reaction has the largest positive value of  $\Delta S^\ominus$ ?

- A.  $\text{CO}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow \text{CH}_3\text{OH}(\text{g}) + \text{H}_2\text{O}(\text{g})$
- B.  $2\text{Al}(\text{s}) + 3\text{S}(\text{s}) \longrightarrow \text{Al}_2\text{S}_3(\text{s})$
- C.  $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \longrightarrow 3\text{H}_2(\text{g}) + \text{CO}(\text{g})$
- D.  $2\text{S}(\text{s}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{SO}_3(\text{g})$

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**Q461-09** Which equation represents a change with a negative value for  $\Delta S$ ?

- A.  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{g})$
  - B.  $\text{H}_2\text{O}(\text{s}) \longrightarrow \text{H}_2\text{O}(\text{g})$
  - C.  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \longrightarrow 2\text{HCl}(\text{g})$
  - D.  $2\text{NH}_3(\text{g}) \longrightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$
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**Q461-10** Which change does not lead to an increase in entropy?

- A. Mixing nitrogen and oxygen gases at room temperature
  - B. Cooling steam so that it condenses to water
  - C. Heating hexane to its boiling point
  - D. Dissolving sugar in water
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