

## Exercise 4.62 – Gibbs free energy

**Q462-01** A certain reaction is spontaneous at low temperatures, but becomes non-spontaneous as the temperature is raised. Based on this information what are the signs of  $\Delta H$  and  $\Delta S$ ?

	$\Delta H$	$\Delta S$
A.	+	+
B.	-	-
C.	+	-
D.	-	+

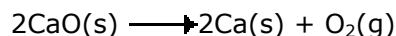
**Q462-02** When  $\Delta G^\circ$  for a reaction is negative, the reaction is:

- A. Fast
- B. Endothermic
- C. Reversible
- D. Spontaneous

**Q462-03** Under what conditions is a reaction spontaneous at all temperatures?

	$\Delta H$	$\Delta S$
A.	+	+
B.	+	-
C.	-	-
D.	-	+

**Q462-04** For the reaction:



at 1 atmosphere the values of  $\Delta H^\circ$  and  $\Delta S^\circ$  are both positive. Which statement is correct?

- A.  $\Delta G^\circ$  is temperature dependent
- B. The change in entropy is the driving force of the reaction
- C. At high temperatures  $\Delta G$  is positive
- D. The reverse reaction is endothermic

**Q462-05** The  $\Delta H^\circ$  and  $\Delta S^\circ$  values for a reaction are both negative. What happens to the spontaneity of the reaction as the temperature is increased?

- A. The reaction becomes more spontaneous as the temperature is increased
- B. The reaction becomes less spontaneous as the temperature is increased
- C. The reaction is spontaneous at all temperatures
- D. The reaction is non-spontaneous at all temperatures

**Q462-06** The following reaction is spontaneous only at temperatures above 850°C:



Which combination is correct for this reaction at 1000°C?

	$\Delta G$	$\Delta H$	$\Delta S$
A.	-	-	-
B.	+	+	+

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C.	-	+	+
D	+	-	-

**Q462-07** For a certain reaction at 298K the values of both  $\Delta H^\ominus$  and  $\Delta S^\ominus$  are negative. Which statement about the sign of  $\Delta G^\ominus$  must be correct?

- A. It is negative at all temperatures
- B. It is positive at all temperatures
- C. It is negative at high temperatures and positive at low temperatures
- D. It cannot be determined without knowing the temperature

**Q462-08** For the reaction:



at 1 atmosphere the values of  $\Delta H^\ominus$  and  $\Delta S^\ominus$  are both positive. Which statement is correct?

- A.  $\Delta G^\ominus$  is temperature dependent
- B. The change in entropy is the driving force of the reaction
- C. At high temperatures  $\Delta G$  is positive
- D. The reverse reaction is endothermic

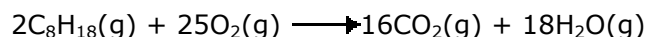
**Q462-09** The standard enthalpy change of formation of  $\text{Al}_2\text{O}_3\text{(s)}$  is  $-1669 \text{ kJmol}^{-1}$  and the standard enthalpy change of formation of  $\text{Fe}_2\text{O}_3\text{(s)}$  is  $-822 \text{ kJmol}^{-1}$ . Use these values to calculate  $H^\ominus$  for the following reaction:



State whether the reaction is endothermic or exothermic.

- a) Estimate, without doing a calculation, the magnitude of the entropy change for this reaction.
- b) Explain your answer.
- c) Explain in terms of  $G^\ominus$ , why a reaction for which both the  $H^\ominus$  and  $S^\ominus$  values are positive can sometimes be spontaneous and sometimes not.

**Q462-10** The following reaction takes place in an internal combustion engine:



What are the signs of  $\Delta H^\ominus$ ,  $\Delta S^\ominus$ , and  $\Delta G^\ominus$  for this reaction?

	$\Delta H$	$\Delta S$	$\Delta G$
A.	-	+	+
B.	-	+	-
C.	-	-	-
D	+	-	-