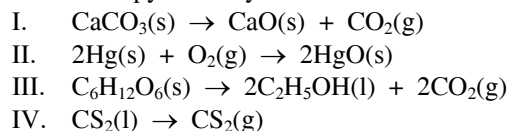


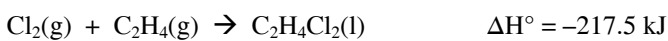
1. Which of the following statements is true?
- In any spontaneous process, the entropy of the system always increases.
  - All spontaneous processes are exothermic.
  - Any spontaneous process is accompanied by a positive free energy change.
  - In order for a process to be spontaneous, the process must be exothermic *and* the entropy of the system must increase.
  - None of the statements above are true.

2. Which of the following reactions involve(s) an increase in the entropy of the system?



- I and II
- II only
- III and IV
- I, III, and IV
- I and IV

3. Consider the following thermochemical equation:



When is this reaction expected to be spontaneous?

- spontaneous only at low temperatures
- spontaneous only at high temperatures
- spontaneous at all temperatures
- not spontaneous at any temperature
- not enough information given

4. At what temperature will the following process be spontaneous?

$$\Delta H = -45 \text{ kJ and } \Delta S = -95 \text{ J/K}$$

- at  $T < 368 \text{ K}$
- at  $T > 368 \text{ K}$
- at  $T < 474 \text{ K}$
- at  $T > 474 \text{ K}$
- This process is spontaneous at all temperatures.

5. For ammonia, the enthalpy of fusion is 5.65 kJ/mol and the entropy of fusion is 28.9 J/K.mol. What is the approximate melting point of ammonia?

- 132 K
- 168 K
- 184 K
- 196 K
- 227 K

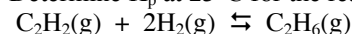
6. Consider the condensation of water at 25°C. What are the signs of  $\Delta H$ ,  $\Delta S$ , and  $\Delta G$  for this process?

	$\Delta H$	$\Delta S$	$\Delta G$
a)	+	-	-
b)	+	+	-
c)	+	-	+
d)	-	-	+
e)	-	-	-

7. Given the following free energies of formation at 25°C:

	$\Delta G^\circ_f$
$\text{C}_2\text{H}_2(\text{g})$	209.2 kJ/mol
$\text{C}_2\text{H}_6(\text{g})$	-32.9 kJ/mol

Determine  $K_p$  at 25°C for the reaction:



- $9.07 \times 10^{-1}$
- 97.2
- $1.24 \times 10^{31}$
- $2.72 \times 10^{42}$
- Not enough information is given.

8. Use the thermodynamic data below to determine the standard free energy change,  $\Delta G^\circ$ , for the following reaction at 25°C.

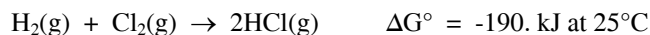


The standard molar entropies of these substances at 25 °C are as follows:

$\text{CaO}(\text{s})$	$S^\circ = 39.7 \text{ J/K}$
$\text{CO}_2(\text{g})$	$S^\circ = 213.6 \text{ J/K}$
$\text{CaCO}_3(\text{s})$	$S^\circ = 92.9 \text{ J/K}$

- 160 kJ
- +47.6 kJ
- +3830 kJ
- 226 kJ
- 131 kJ

9. Consider the following reaction:



What is the value of  $\Delta G$  for this reaction at 25°C given the following partial pressures?

0.500 atm $\text{H}_2$
0.500 atm $\text{Cl}_2$
10.0 atm HCl

- 233 kJ
- 175 kJ
- 233 kJ
- 14.7 kJ
- 103 kJ

**Answers:**

- |      |      |      |
|------|------|------|
| 1. e | 4. c | 7. d |
| 2. d | 5. d | 8. e |
| 3. a | 6. e | 9. b |