

1. A particular chemical reaction has $\Delta H^\circ = +5 \text{ kJ mol}^{-1}$ and $\Delta S^\circ = +25 \text{ J K}^{-1} \text{ mol}^{-1}$. Assuming that these values do not change with temperature, in what temperature range is ΔG° negative?
- at all temperatures
 - at no temperature
 - $T > 200 \text{ K}$
 - $T < 200 \text{ K}$
 - $T < -200 \text{ K}$
2. An ideal gas receives 245 J of heat and expands by 1.30 L against an external pressure of 60.0 kPa. What is the change in internal energy of the system?
- +167 J
 - +323 J
 - 323 J
 - 167 J
 - 0 kJ as there are no forces between ideal gas molecules
3. Use the data below to calculate $\Delta S^\circ_{\text{total}}$ for the deposition of iodine at 298 K.

	$\Delta_f H^\circ$ (kJ mol ⁻¹)	S° (J K ⁻¹ mol ⁻¹)
I ₂ (s)	0.00	116
I ₂ (g)	62	261

- 353. J K⁻¹ mol⁻¹
 - 63.1 J K⁻¹ mol⁻¹
 - +63.1 J K⁻¹ mol⁻¹
 - +353 J K⁻¹ mol⁻¹
 - +377 J K⁻¹ mol⁻¹
4. In which one of the following processes does the entropy of the system decrease? Assume constant temperature and pressure unless specifically indicated otherwise.
- CO₂(s) → CO₂(g)
 - 1 mol H₂(g) at 10 atm → 1 mol H₂(g) at 1 atm
 - O₂(g) + 2CO(g) → 2CO₂(g)
 - C₂H₅OH(l) at 20 °C → C₂H₅OH(l) at 40 °C
 - C₈H₁₄(l) → C₄H₆(g) + C₄H₈(g)

Questions 5 and 6 refer to the following reaction: $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
 $K = 7.1$ at $25\text{ }^\circ\text{C}$ and $K = 5.5$ at $70\text{ }^\circ\text{C}$.

5. Which one of the following statements is true?
- a) $\Delta H^\circ < 0$ and lowering the temperature favours products.
 - b) $\Delta H^\circ > 0$ and raising the temperature favours products.
 - c) $\Delta H^\circ > 0$ and raising the temperature favours reactants.
 - d) $\Delta H^\circ < 0$ and lowering the temperature favours reactants.
 - e) There is insufficient information to work out the sign of ΔH° .

6. What is the value of K for the following reaction at $25\text{ }^\circ\text{C}$?

- a) -7.1 $\frac{1}{2}\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons \text{NO}_2(\text{g})$
- b) -3.6
- c) 0.14
- d) 0.37
- e) 0.020

7. Given the following thermochemical data, what is the enthalpy of formation $\Delta_f H^\circ_{298}$ for $\text{C}_2\text{H}_5\text{OH}(\text{l})$ at 298 K and 100 kPa ?

- a) $+277\text{ kJ mol}^{-1}$ $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$ $\Delta H^\circ = -393\text{ kJ mol}^{-1}$
- b) -277 kJ mol^{-1} $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$ $\Delta H^\circ = -286\text{ kJ mol}^{-1}$
- c) -688 kJ mol^{-1} $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 3\text{H}_2\text{O}(\text{l}) + 2\text{CO}_2(\text{g})$ $\Delta H^\circ = -1367\text{ kJ mol}^{-1}$
- d) $+688\text{ kJ mol}^{-1}$
- e) $+542\text{ kJ mol}^{-1}$

8. What is the oxidation number of C in NaHCO_3 ?

- a) +IV b) +II c) 0 d) -II e) -IV

9. Samples of A (2.0 mol) and B (3.0 mol) are placed in a 10.0 L container and the following reaction takes place $2\text{A}(\text{g}) \rightleftharpoons 3\text{B}(\text{g})$

At equilibrium, the concentration of A is 0.14 M. What is the value of K ?

- a) 3.0 b) 0.33 c) 2.4 d) 0.42 e) 6.8

10. For the reaction in question 9, what is the effect of increasing the volume of the container at constant temperature?

- a) K increases because all the reactant and product concentrations increase.
- b) The reaction proceeds towards the reactants.
- c) No change because the reaction does not alter the total number of moles present.
- d) The reaction proceeds towards the products.
- e) There is insufficient information provided to make a prediction.

Correct answers: 1C, 2A, 3C, 4C, 5A, 6D, 7B, 8A, 9A, 10D

1. A particular chemical reaction has $\Delta H^\circ = -5 \text{ kJ mol}^{-1}$ and $\Delta S^\circ = +25 \text{ J K}^{-1} \text{ mol}^{-1}$. Assuming that these values do not change with temperature, in what temperature range is ΔG° negative?
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2. An ideal gas receives 245 J of heat and contracts by 1.30 L against an external pressure of 60.0 kPa. What is the change in internal energy of the system?
- +167 J
 - +323 J
 - 323 J
 - 167 J
 - 0 kJ as there are no forces between ideal gas molecules

3. Use the data below to calculate $\Delta S^\circ_{\text{total}}$ for the sublimation of iodine at 298 K.

	$\Delta_f H^\circ$ (kJ mol ⁻¹)	S° (J K ⁻¹ mol ⁻¹)
I ₂ (s)	0.00	116
I ₂ (g)	62	261

- 353. J K⁻¹ mol⁻¹
 - 63.1 J K⁻¹ mol⁻¹
 - +63.1 J K⁻¹ mol⁻¹
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4. In which one of the following processes does the entropy of the system increase? Assume constant temperature and pressure unless specifically indicated otherwise.
- CO₂(g) → CO₂(s)
 - 1 mol H₂(g) at 1 atm → 1 mol H₂(g) at 10 atm
 - 2CO₂(g) → O₂(g) + 2CO(g)
 - C₂H₅OH(l) at 40 °C → C₂H₅OH(l) at 20 °C
 - C₄H₆(g) + C₄H₈(g) → C₈H₁₄(l)

Questions 5 and 6 refer to the following reaction: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
 $K = 0.14$ at $25\text{ }^\circ\text{C}$ and $K = 0.18$ at $70\text{ }^\circ\text{C}$.

5. Which one of the following statements is true?

- a) $\Delta H^\circ > 0$ and raising the temperature favours products.
- b) $\Delta H^\circ < 0$ and lowering the temperature favours products.
- c) $\Delta H^\circ > 0$ and raising the temperature favours reactants.
- d) $\Delta H^\circ < 0$ and lowering the temperature favours reactants.
- e) There is insufficient information to work out the sign of ΔH° .

6. What is the value of K for the following reaction at $25\text{ }^\circ\text{C}$?

- a) 7.1
 - b) -3.6
 - c) 51
 - d) 0.14
 - e) 0.37
- $4\text{NO}_2(\text{g}) \rightleftharpoons 2\text{N}_2\text{O}_4(\text{g})$

7. Given the following thermochemical data, what is the enthalpy of formation $\Delta_f H^\circ_{298}$ for $\text{PF}_5(\text{g})$ at 298 K and 100 kPa ?

- a) $+582\text{ kJ mol}^{-1}$
 - b) -1163 kJ mol^{-1}
 - c) -1257 kJ mol^{-1}
 - d) -1594 kJ mol^{-1}
 - e) -2513 kJ mol^{-1}
- $2\text{P}(\text{s}) + 3\text{F}_2(\text{g}) \rightarrow 2\text{PF}_3(\text{g}) \quad \Delta H^\circ = -1838\text{ kJ mol}^{-1}$
 $\text{PF}_3(\text{g}) + \text{F}_2(\text{g}) \rightarrow \text{PF}_5(\text{g}) \quad \Delta H^\circ = -675\text{ kJ mol}^{-1}$

8. What is the oxidation number of Te in $\text{K}_2\text{H}_4\text{TeO}_6$?

- a) +VI
- b) +IV
- c) +II
- d) -IV
- e) -VI

9. Samples of A (4.0 mol) and B (2.0 mol) are placed in a 5.0 L container and the following reaction takes place $3\text{A}(\text{g}) \rightleftharpoons 2\text{B}(\text{g})$

At equilibrium, the concentration of A is 0.82 M. What is the value of K_c ?

- a) 0.27
- b) 0.31
- c) 2.4
- d) 4.0
- e) 30.

10. For the reaction in question 9, what is the effect of decreasing the volume of the container at constant temperature?

- a) K increases because the product concentration increases.
- b) K decreases because the reactant concentration increases.
- c) No change because the reaction does not alter the total number of moles present.
- d) The reaction proceeds towards the products.
- e) The reaction proceeds towards the reactants.

Correct answers: 1A, 2B, 3B, 4C, 5A, 6C, 7D, 8A, 9A, 10D