

Equilibrium constants and shifts

AP Chemistry · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test lasts 45 minutes and covers K and Q, ICE tables, K_p and K_c, and Le Chatelier's principle. A calculator is allowed. Use R = 0.08206 L atm mol⁻¹ K⁻¹ when needed. Show your working; the total is 20 marks.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 7

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Writing K (2 marks)

Write K_c for each.

- a. $2 \text{NO(g)} + \text{O}_2\text{(g)} \rightleftharpoons 2 \text{NO}_2\text{(g)}$ (1 mark)
- b. $\text{CaCO}_3\text{(s)} \rightleftharpoons \text{CaO(s)} + \text{CO}_2\text{(g)}$ (1 mark)

Question 2 Reaction quotient (3 marks)

$\text{N}_2\text{(g)} + 3 \text{H}_2\text{(g)} \rightleftharpoons 2 \text{NH}_3\text{(g)}$ has K_c = 0.50 at a certain temperature. A mixture has [N₂] = 0.50 M, [H₂] = 0.20 M and [NH₃] = 0.10 M.

- a. Calculate Q. (2 marks)
- b. Predict the direction of change. (1 mark)

Question 3 ICE table (3 marks)

$2 \text{HI(g)} \rightleftharpoons \text{H}_2\text{(g)} + \text{I}_2\text{(g)}$, K_c = 1/64 = 0.0156. Start with 0.80 M HI. Calculate the equilibrium concentrations of all species.

Question 4 Le Chatelier (2 marks)

$\text{N}_2\text{O}_4\text{(g)} \rightleftharpoons 2 \text{NO}_2\text{(g)}$, ΔH > 0. State the direction of shift for each.

- a. Raise the temperature. (1 mark)
- b. Compress the gas mixture. (1 mark)

Question 5 Catalyst and inert gas (2 marks)

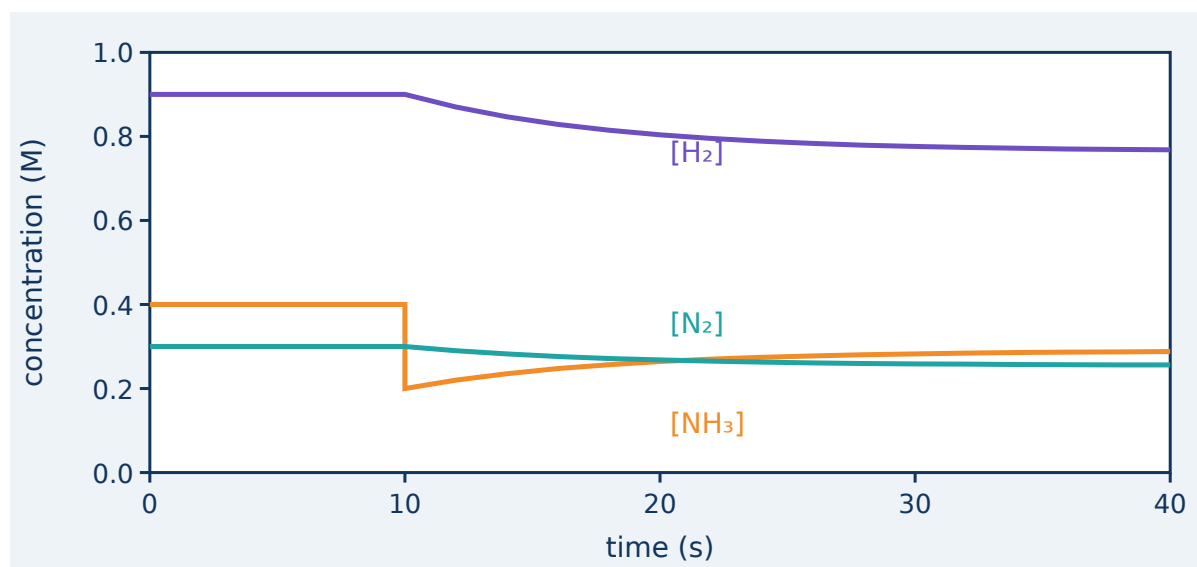
Explain why adding a catalyst, or adding argon at constant volume, does not shift an equilibrium.

Question 6 K_p and K_c (3 marks)

$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$. At equilibrium at 500 K, $P(\text{PCl}_5) = 0.40$ atm and $P(\text{PCl}_3) = P(\text{Cl}_2) = 0.60$ atm.

- Calculate K_p . (1 mark)
- Calculate K_c using $R = 0.08206$ L atm mol⁻¹ K⁻¹. (2 marks)

Question 7 Reading a disturbance (3 marks)



Equilibrium $\text{N}_2 + 3 \text{H}_2 \rightleftharpoons 2 \text{NH}_3$ disturbed at 10 s.

- Identify the disturbance at 10 s. (1 mark)
- State the direction of the shift and justify it from the graph. (1 mark)
- State what happens to K . (1 mark)

Question 8 Temperature and K (2 marks)

For an exothermic reaction, $K = 100$ at 300 K. Predict whether K at 500 K is greater or smaller, and explain.