

Equilibrium constants and shifts

AP Chemistry · Test answers (mark scheme)

Model answers and marking guides follow. Award method marks for correct expressions even if the arithmetic slips, and accept answers to two or three significant figures. A correct comparison of Q and K is required for full marks on direction questions.

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

Question 1 Writing K (2 marks)

(a) $K_c = [\text{NO}_2]^2/([\text{NO}]^2[\text{O}_2])$.

(b) $K_c = [\text{CO}_2]$.

Marking: 1 mark each; solids must be omitted in (b).

Question 2 Reaction quotient (3 marks)

(a) $Q = (0.10)^2/(0.50 \times 0.20^3) = 0.010/0.0040 = \mathbf{2.5}$.

(b) $Q > K$ ($2.5 > 0.50$), so the **reverse** reaction runs.

Marking: 1 for the expression, 1 for the value, 1 for the direction with reason.

Question 3 ICE table (3 marks)

$\text{HI} - 2x$, $\text{H}_2 + x$, $\text{I}_2 + x$: $x^2/(0.80 - 2x)^2 = 1/64$, so $x/(0.80 - 2x) = 1/8$, $8x = 0.80 - 2x$ and $x = 0.080$.

$[\text{H}_2] = [\text{I}_2] = \mathbf{0.080\ M}$; $[\text{HI}] = 0.80 - 0.16 = \mathbf{0.64\ M}$.

Marking: 1 for the ICE changes, 1 for solving, 1 for all three concentrations.

Question 4 Le Chatelier (2 marks)

(a) **To the right** (endothermic direction).

(b) **To the left** (towards 1 mol of gas instead of 2).

Marking: 1 mark each.

Question 5 Catalyst and inert gas (2 marks)

A catalyst lowers the activation energy of both reactions by the same amount, so both rates increase equally and Q , K and the position are unchanged. Argon at constant volume does not change any partial pressure or concentration, so Q stays equal to K .

Marking: 1 for each explanation.

Question 6 K_p and K_c (3 marks)

(a) $K_p = (0.60 \times 0.60)/0.40 = \mathbf{0.90}$.

(b) $\Delta n = +1$, so $K_c = K_p/(RT) = 0.90/(0.08206 \times 500) = 0.90/41.03 = \mathbf{0.022}$.

Marking: 1 for K_p; 1 for using $\Delta n = +1$; 1 for the answer.

Question 7 Reading a disturbance (3 marks)

(a) Ammonia is **removed** (its concentration drops suddenly from 0.40 to 0.20 M).

(b) The shift is **to the right**: [NH₃] rises again while [N₂] and [H₂] fall.

(c) **K does not change** (temperature is constant).

Marking: 1 mark each.

Question 8 Temperature and K (2 marks)

K is **smaller** at 500 K. Raising the temperature favours the endothermic reverse reaction, so the ratio of products to reactants at equilibrium decreases.

Marking: 1 for smaller, 1 for the reasoning.