7.8 Representations of Equilibrium

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

KEY WORDS particle diagram • snapshot • reaction quotient • count • equilibrium mixture • represent

Objective

Build the skills to answer exam questions on **representations of equilibrium** : particle diagrams over time, counting particles to find Q and K.

You must be able to:

- decide from a series of particle diagrams when equilibrium is reached
- convert particle counts into concentrations
- calculate Q and K from particle diagrams
- predict the direction of change by comparing Q with K

1 Key knowledge and worked examples

■ Pictures of equilibrium

idea	rule
equilibrium in pictures	the numbers of each kind of particle stop changing from one picture to the next
concentration	(number of particles) × (moles per particle) ÷ volume
K	use the counts from a picture at equilibrium
Q	use the counts from any picture; compare with K
conservation	the total number of atoms is the same in every picture

Worked example: a box. For $A_2 \rightleftharpoons 2A$, an equilibrium box (1.0 L, each particle 0.10 mol) has 3 A_2 and 4 A.

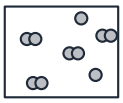
1. $[A_2] = 0.30$ M; $[A] = 0.40$ M.
2. $K = \dfrac{(0.40)^2}{0.30} = 0.53$.

Answer shapes: count carefully, convert to M, then use the expression.

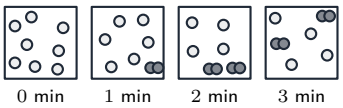
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2 Practice

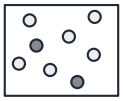
2.1 For $X_2 \rightleftharpoons 2X$, an equilibrium box (1.0 L, each particle 0.10 mol) contains 4 X_2 and 2 X. Calculate K_c. [2]



2.2 Snapshots of a reaction mixture are taken at four times. State how you can tell from the snapshots when equilibrium is reached. [2]



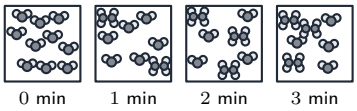
2.3 For $A \rightleftharpoons B$, $K = 1.0$. A box contains 6 A and 2 B. Calculate Q, and predict the direction of change. [2]



3 Exam-style questions

3.1 The snapshots show a sealed 1.0 L flask of NO_2 forming N_2O_4: $2NO_2(g) \rightleftharpoons N_2O_4(g)$. Each particle represents 0.10 mol.

(a) State the time by which equilibrium is reached, and explain. [2]



(b) Calculate K_c. [2]

(c) Calculate Q_c at 1 min, and use it to explain the change between 1 min and 2 min. [2]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

$[X_2] = 0.40$ M, $[X] = 0.20$ M; $K_c = \dfrac{(0.20)^2}{0.40} = \mathbf{0.10}$

2.2

the numbers of each kind of particle stop changing; from that snapshot on, the pictures have the same counts

2.3

$Q = \dfrac{2}{6} = 0.33$; $Q < K$, so the reaction goes forward (more B)

3.1

(a) by 2 min; the counts at 2 min and 3 min are the same (4 NO_2, 3 N_2O_4)

(b) $[NO_2] = 0.40$ M, $[N_2O_4] = 0.30$ M; $K_c = \dfrac{0.30}{(0.40)^2} = \mathbf{1.9}$

(c) $Q_c = \dfrac{0.20}{(0.60)^2} = 0.56$; $Q < K$, so the forward reaction is faster and more N_2O_4 forms

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