

Equilibrium Analysis of Metal Carbonate Decomposition

<https://gemini.google.com/app/2e4753d644c0d336>

Response: To determine the incorrect statement, let's analyze the reaction and the given graph:

Reaction & Equilibrium Analysis

1. Chemical Equation:



2. **Equilibrium Constant Expression (K_c):** Since $\text{MCO}_3(\text{s})$ and $\text{MO}(\text{s})$ are pure solids, their activities are unity:

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

Similarly, $Q_c = [\text{CO}_2(\text{g})]$.

3. Graph Features:

- **Origin to Point A:** The initial amount of $\text{MCO}_3(\text{s})$ is insufficient to produce enough $\text{CO}_2(\text{g})$ to reach K_c . All the added $\text{MCO}_3(\text{s})$ completely dissociates into $\text{MO}(\text{s})$ and $\text{CO}_2(\text{g})$, leaving no remaining $\text{MCO}_3(\text{s})$ at the end. Because pure solid reactant is not present, equilibrium cannot be established along this line segment.
- **At and Beyond Point A (horizontal plateau):** The amount of initial $\text{MCO}_3(\text{s})$ is sufficient to fully reach equilibrium. Solid $\text{MCO}_3(\text{s})$, solid $\text{MO}(\text{s})$, and gaseous $\text{CO}_2(\text{g})$ coexist. Here, $[\text{CO}_2(\text{g})] = K_c$, and the gas concentration (and hence pressure) remains constant.
- **Point B:** This point lies above the equilibrium curve, so $[\text{CO}_2(\text{g})]_{\text{B}} > K_c \implies Q > K$.
- **Point C:** This point lies below the equilibrium curve, so $[\text{CO}_2(\text{g})]_{\text{C}} < K_c \implies Q < K$.

Evaluation of Options

- (1) "The equilibrium, $\text{MCO}_3(\text{s}) \rightleftharpoons \text{MO}(\text{s}) + \text{CO}_2(\text{g})$ is established only after the point A." — **Correct statement.** Equilibrium requires the presence of reactants and products; before point A, all reactant is exhausted.

- (2) "At the point B, $Q > K$." — **Correct statement.** $[\text{CO}_2(\text{g})]$ at B is higher than the equilibrium concentration.
- (3) "At the point C, $Q < K$." — **Correct statement.** $[\text{CO}_2(\text{g})]$ at C is lower than the equilibrium concentration.
- (4) "Beyond the point A, pressure of the system does not change." — **Correct statement.** Since volume, temperature, and $[\text{CO}_2(\text{g})]$ are constant beyond point A, $P = [\text{CO}_2]RT$ remains constant.
- (5) "At both points B and C, $Q = K$." — **Incorrect statement.** At point B, $Q > K$, and at point C, $Q < K$.

Conclusion

The **incorrect** statement about this system is (5).
