

**Chemistry**  
**Standard level**  
**Paper 1A**

Practice paper

**Topic: Equilibrium**

**Chemistry**

**Standard level**

**Paper 1A**

Specimen paper

45 minutes

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**Instructions to candidates**

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the best answer.
- A clean copy of the chemistry data booklet is required.
- The maximum mark for this paper is [20 marks].

## Section A

- Which macroscopic property remains constant when a chemical system is in a state of dynamic equilibrium?
  - The rate of the forward reaction only
  - The concentrations of all reactants and products
  - The physical state of all particles
  - The total pressure unconditionally
  
- What is the correct equilibrium constant expression,  $K_c$ , for the reaction:  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ ?
  - $K_c = [\text{NH}_3] / ([\text{N}_2][\text{H}_2])$
  - $K_c = [\text{NH}_3]^2 / ([\text{N}_2][\text{H}_2]^3)$
  - $K_c = (2[\text{NH}_3]) / ([\text{N}_2] + 3[\text{H}_2])$
  - $K_c = ([\text{N}_2][\text{H}_2]^3) / [\text{NH}_3]^2$
  
- A reaction reaches equilibrium. If the reaction quotient,  $Q_c$ , is found to be greater than  $K_c$ , what will happen?
  - The reaction will shift to the right to produce more products.
  - The reaction will shift to the left to produce more reactants.
  - The reaction will stop completely.
  - The value of  $K_c$  will decrease to equal  $Q_c$ .
  
- Consider the exothermic reaction:  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ . Which change will increase the equilibrium yield of  $\text{SO}_3$ ?
  - Increasing the temperature
  - Decreasing the pressure
  - Adding a solid catalyst
  - Decreasing the temperature
  
- How does the addition of a catalyst affect a system at dynamic equilibrium?
  - It increases the value of  $K_c$ .
  - It shifts the equilibrium position to the right.
  - It increases the rates of both the forward and reverse reactions equally.
  - It decreases the enthalpy change of the reaction.
  
- If  $K_c \gg 1$  for a specific equilibrium system, the reaction mixture will contain:
  - Mostly reactants.
  - Mostly products.
  - Equal amounts of reactants and products.

- D. Only products with no reactants remaining.
7. For the reaction:  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ , what is the effect of increasing the total pressure of the system?
- The equilibrium shifts to the right.
  - The equilibrium shifts to the left.
  - The equilibrium position does not change.
  - The value of  $K_c$  increases.
8. In a closed system, a physical equilibrium establishes between liquid water and water vapor. This means:
- The mass of liquid equals the mass of vapor.
  - The rate of evaporation equals the rate of condensation.
  - All evaporation ceases.
  - The volume of the container restricts further collision.
9. Which of the following describes a closed system?
- Neither energy nor matter can be exchanged with the surroundings.
  - Energy can be exchanged with the surroundings, but matter cannot.
  - Matter can be exchanged with the surroundings, but energy cannot.
  - Both energy and matter can be freely exchanged.
10. For the equilibrium  $2\text{A}_2(\text{g}) + \text{B}_2(\text{g}) \rightleftharpoons 2\text{A}_2\text{B}(\text{g})$ ,  $\Delta H$  is positive. Which conditions favor the highest yield of  $\text{A}_2\text{B}$ ?
- High temperature and high pressure
  - High temperature and low pressure
  - Low temperature and high pressure
  - Low temperature and low pressure
11. What happens to the value of  $K_c$  when the stoichiometric coefficients of a balanced equilibrium equation are halved?
- $K_c$  is halved.
  - $K_c$  is squared.
  - $K_c$  becomes the square root of its original value.
  - $K_c$  remains unchanged.
12. If a system at equilibrium is subjected to an increase in temperature, Le Chatelier's principle predicts that:
- The system will shift to favor the exothermic reaction.
  - The system will shift to favor the endothermic reaction.

- C. The pressure will automatically decrease.  
D. No shift will occur unless a catalyst is present.
13. Consider a reaction  $A(aq) + B(aq) \rightleftharpoons C(aq)$ . Adding water to dilute the entire equilibrium mixture will:
- Shift the equilibrium to the right.
  - Shift the equilibrium to the left.
  - Have no effect on the equilibrium position.
  - Increase the value of  $K_c$ .
14. What is the effect of removing some of the product from an equilibrium mixture at constant temperature?
- $K_c$  decreases.
  - $K_c$  increases.
  - The equilibrium shifts to the right to replace the product.
  - The equilibrium shifts to the left to consume the remaining product.
15. For the reaction  $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$ , the  $K_c$  expression is:
- $K_c = ([CO][H_2]) / [H_2O]$
  - $K_c = ([CO][H_2]) / ([C][H_2O])$
  - $K_c = ([C][H_2O]) / ([CO][H_2])$
  - $K_c = [H_2O] / ([CO][H_2])$
16. Which are characteristics of a dynamic equilibrium?
- Macroscopic properties remain constant.
  - Both forward and reverse reactions occur at equal rates.
  - The system must be open to the surroundings.
- I and II only
  - I and III only
  - II and III only
  - I, II and III
17. Which factors will alter the numerical value of the equilibrium constant  $K_c$ ?
- Changing the temperature
  - Changing the pressure
  - Adding a catalyst
- I only
  - I and II only
  - II and III only
  - I, II and III

18. For the endothermic equilibrium  $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ , which changes will shift the equilibrium to the right?

- I. Increasing the temperature
  - II. Decreasing the total pressure
  - III. Adding more  $\text{PCl}_3(\text{g})$
- A. I and II only  
B. I and III only  
C. II and III only  
D. I, II and III

19. Which statements are correct regarding the reaction quotient  $Q_c$ ?

- I. It is calculated using the same expression as  $K_c$ .
  - II. It can be calculated at any time during the reaction.
  - III. If  $Q_c < K_c$ , the reaction shifts to the right.
- A. I and II only  
B. I and III only  
C. II and III only  
D. I, II and III

20. Which adjustments relate to Le Chatelier's principle when a system at equilibrium is compressed (volume decreased)?

- I. The system shifts to the side with fewer moles of gas.
  - II. The total pressure of the container initially increases.
  - III.  $K_c$  becomes smaller.
- A. I and II only  
B. I and III only  
C. II and III only  
D. I, II and III