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Chapter test

Chapter 1 Equilibrium

Name: _____

Class: _____

Time permitted: 50 minutes

	Section	Number of questions	Marks available	Marks achieved
A	Multiple choice	15	15	
B	Short answer	5	15	
	Total	**20**	**30**	

Grade: _____

Scale:

A+	29–30	A	26–28	B	23–25	C	19–22	D	15–18	E	9–14	UG	0–8

Comments:

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Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

1 Which of the following is not a dynamic equilibrium?

  A Water evaporating and condensing in a closed bottle of water

  B Water evaporating and condensing in an open bottle of water

  C A reaction where the concentration of reactants and products is unchanging

  D Two different reactions proceeding at the same rate in the same closed container

2 Collision theory states a successful reaction can occur when:

  A particles collide.

  B the reactants are heated strongly.

  C the particles collide with sufficient energy to break bonds.

  D sufficient energy is released during the reaction.

3 A reaction can be sped up in several ways, including increasing the temperature, concentration and surface area and introducing a catalyst.

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g) + energy$$
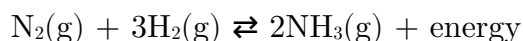
Which of these would *not* affect the reaction above?

  A Temperature change

  B Temperature change and pressure change

  C Addition of more reactants

  D None of the above

**4** What is the correct equilibrium expression for the following reaction?

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$$

  A $\dfrac{[CaO][CO_2]}{[CaCO_3]}$

  B $\dfrac{[CaCO_3]}{[CaO][CO_2]}$

  C $[CO_2]$

  D $[CaCO_3]$

5 In an equilibrium reaction:

  A all reactants become products.

  B products do not form as they quickly return to reactants.

  C the amount of reactants and products are the same.

  D the rate of forward and reverse reactions are the same.

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6 The equilibrium expression equals $[O_2]$ for which of the following reactions?

A $O_2(l) \rightleftharpoons O_2(g)$ and $3O_2(g) \rightleftharpoons 2O_3(g)$

B $O_2(l) \rightleftharpoons O_2(g)$

C $2H_2O_2(aq) \rightleftharpoons 2H_2O(l) + O_2(g)$

D $O_2(l) \rightleftharpoons O_2(g)$ and $2H_2O_2(aq) \rightleftharpoons 2H_2O(l) + O_2(g)$

7 Equilibrium can occur in:

A chemical reactions only.

B physical changes only.

C both chemical and physical changes.

D all chemical reactions.

8 Activation energy:

A determines whether a reaction can be reversible or not.

B only affects the rate of a reaction.

C is unaffected by catalysts.

D of a reverse reaction is the same as the forward reaction at equilibrium.

9 Dynamic equilibrium:

A occurs only at certain temperatures.

B is unaffected by temperature change.

C is when the concentrations of all species are the same.

D occurs when the concentrations of all species is constant.

10 Equilibrium has occurred in which of the following graphs of concentration?
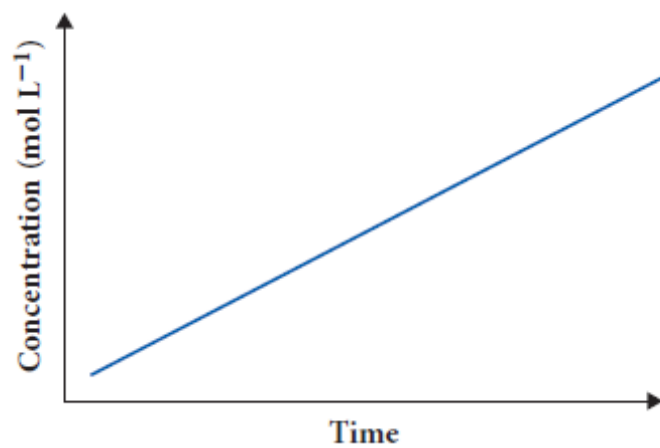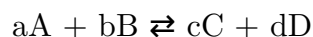
A

B

C

D

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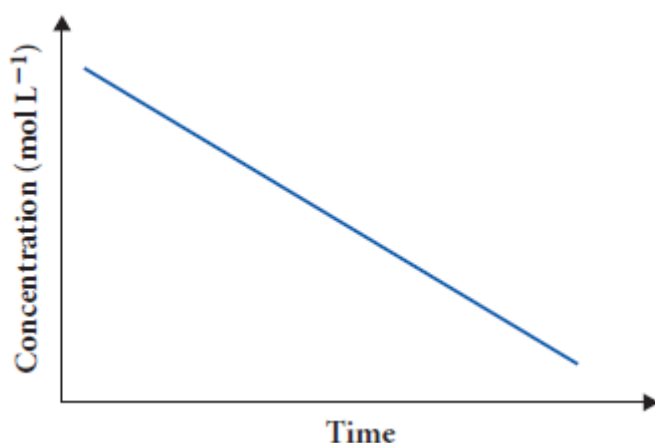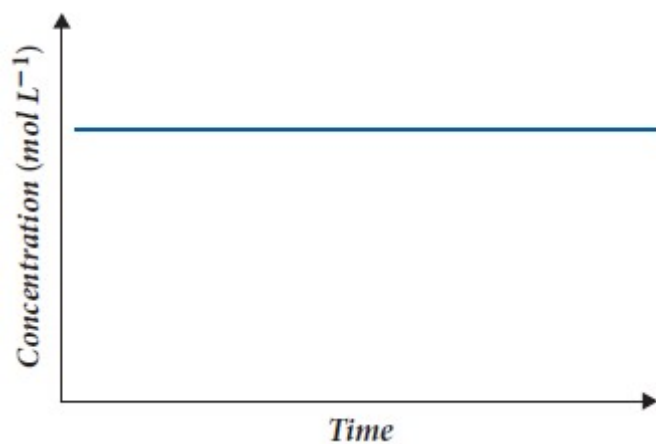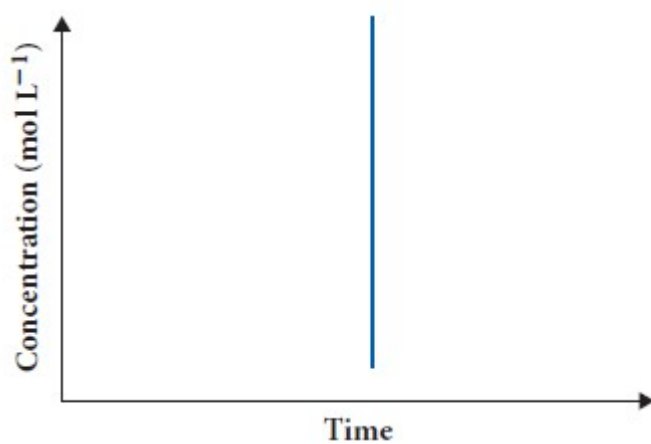
11 The equilibrium expression, *K*, is based on the equation below. Which one of the expressions shown does it equal?

$$aA + bB \rightleftharpoons cC + dD$$

A $\dfrac{[A]^a [B]^b}{[C]^c [D]^d}$

B $\dfrac{[C]^c [D]^d}{[A]^a [B]^b}$

C $\dfrac{[A][B]}{[C][D]}$

D $\dfrac{[aA][bB]}{[cC][dD]}$

12 The reaction quotient, *Q*, equals the equilibrium quotient, *K*, at equilibrium. Which of the following is also correct?

   A If $Q > K$, then there are more products than reactants.

   B If $Q < K$, then there are less products than reactants.

   C If $Q > 1$, then there are more reactants than products.

   D If $K < 1$, then there are more products than reactants.

13 Calculate *K* for the following reaction:

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$[CH_3COOH] = 0.90$ mol L^{-1}

$[CH_3COO^-] = 0.015$ mol L^{-1}

$[H^+] = 0.001$ mol L^{-1}

   A $K = 1.80 \times 10^5$

   B $K = 1.66 \times 10^5$
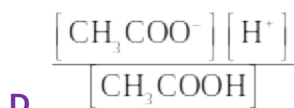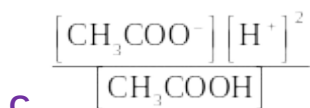
   C $K = 1.67 \times 10^5$

   D $K = 1.70 \times 10^5$

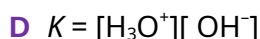**14** What is the correct expression of *K* for the following reaction?
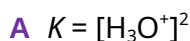
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

A $\dfrac{[CH_3COO^-]^2}{[CH_3COOH]}$

B $\dfrac{[CH_3COOH]}{[CH_3COO^-]^2}$

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C $$\dfrac{\left[CH_3COO^-\right]\left[H^+\right]^2}{\left[CH_3COOH\right]}$$

D $$\dfrac{\left[CH_3COO^-\right]\left[H^+\right]}{\left[CH_3COOH\right]}$$

15 What is the correct expression(s) for the following reaction?

$$H_2O + H_2O \rightleftarrows H_3O^+ + OH^-$$

A $K = [H_3O^+]^2$

B $K = [H_3O^+]^2$, $K = [OH^-]^2$ and $K = [H_3O^+][OH^-]$

C $$K = \dfrac{\left[H_3O^+\right]\left[OH^-\right]}{\left[H_2O\right]\left[H_2O\right]}$$

D $K = [H_3O^+][OH^-]$
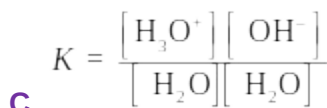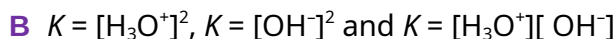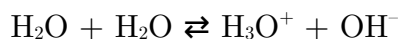
Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1 For the following equilibrium reactions, write out the expression and calculate the constant stating which side of the reaction is favoured.

  a $2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g)$, $[SO_2] = 1$ mol L^{-1}, $[O_2] = 3$ mol L^{-1}, $[SO_3] = 2.5$ mol L^{-1}

  b $N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$, $[N_2] = 0.4$ mol L^{-1}, $[H_2] = 1.5$ mol L^{-1}, $[NH_3] = 0.03$ mol L^{-1}

  c $3O_2(g) \rightleftarrows 2O_3(g)$, $[O_2] = 2$ mol L^{-1}, $[O_3] = 0.5$ mol L^{-1}
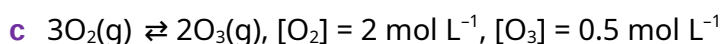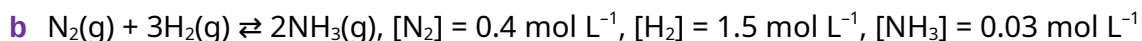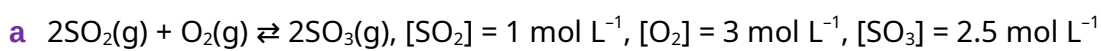
(2 + 2 + 2 = 6 marks)

Use the following information and illustration to answer Questions 2–5.

Two flasks containing equal amounts of gases in each (hydrogen in one and iodine in the other) and joined by a glass tube with a valve. The temperature is 330K.

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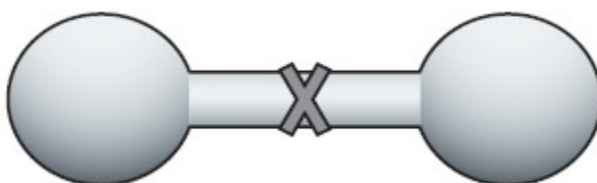
2 When the valve is opened, the gases mix and reach equilibrium. Describe the colours of the gases and what observations will be observed.

(3 marks)

3 Write a balanced chemical equation and an equilibrium expression for the reaction.

(3 marks)

4 How will the equilibrium amount of $H_2(g)$ be affected by the addition of more $I_2(g)$?

(1 mark)

5 How will the equilibrium amount of $H_2(g)$ be affected by an increase in temperature when the enthalpy change for the reaction is +25 kJ mol^{-1}?

(2 marks)