

IB • HL • Chemistry

🕒 15 mins    ❓ 15 questions

Multiple Choice Questions

# How Far? The Extent of Chemical Change

The Characteristics of Dynamic Equilibrium / The Equilibrium Law / The Equilibrium Constant / Le Chatelier's Principle / The Reaction Quotient (HL) / Equilibrium Law Problem Solving (HL) / The Equilibrium Constant & Gibbs Energy (HL)

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Total Marks

/15

- 1 Study the following equilibrium reaction and determine which of the statements must be true.



- A.  $[X] \gg [Y]$
- B.  $[X] > [Y]$
- C.  $[X] = [Y]$
- D.  $[X] < [Y]$

**(1 mark)**

- 2 Hydrogen reacts with iodine according to the following equation



The value of  $K_c$  for this reaction has been measured at different temperatures

$$K_c = 60 \text{ at } 355 \text{ }^\circ\text{C}$$

$$K_c = 47 \text{ at } 450 \text{ }^\circ\text{C}$$

From the information given which of the following must be true?

- A. The reaction is exothermic
- B. The reaction is endothermic
- C. The reaction barely proceeds at 355 °C
- D. The reaction almost goes to completion at 450 °C

**(1 mark)**

3 The following  $K_c$  values were obtained for a reaction carried out at different temperatures,  $T_1$  to  $T_4$ .

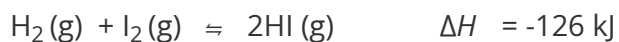
Temperature	$K_c$ value
$T_1$	$1 \times 10^{-2}$
$T_2$	$1 \times 10^1$
$T_3$	1
$T_4$	$1 \times 10^2$

Which of the following gives the correct amount of products in the mixtures from least to most?

- A.  $T_1 < T_2 < T_3 < T_4$
- B.  $T_4 < T_3 < T_2 < T_1$
- C.  $T_4 < T_2 < T_3 < T_1$
- D.  $T_1 < T_3 < T_2 < T_4$

(1 mark)

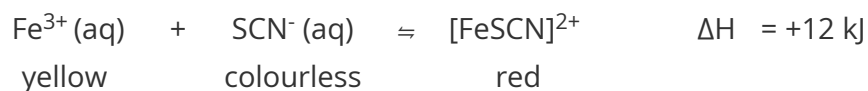
4 Which of the following conditions and reasons will increase the amount of hydrogen iodide produced?



	Condition	Reason	Condition	Reason
<b>A</b>	increase T	exothermic reaction	increase P	two gaseous reactants but only one gaseous product
<b>B</b>	increase T	endothermic reaction	no change in P	equal numbers of moles of gases
<b>C</b>	decrease T	exothermic reaction	decrease P	two moles of gaseous product but only one mole of each gaseous reactant
<b>D</b>	decrease T	exothermic reaction	no change in P	equal numbers of moles of gases

**(1 mark)**

- 5 The blood-red complex iron (III) thiocyanate,  $[\text{FeSCN}]^{2+}$  is formed when iron (III) ions react with thiocyanate ions in the following equilibrium reaction:



Which of the following changes would make the solution go darker?

- I raising the temperature of the solution
- II adding iron(III) chloride solution
- III adding a catalyst

**A.** I and II only

**B.** I and III only

C. II and III only

D. I, II and III

(1 mark)

6 Which of the following features is not a characteristic of a state of equilibrium?

A. Equilibrium is dynamic

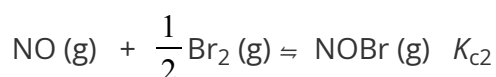
B. Equilibrium is achieved in a closed system

C. Concentrations of reactants and products are equal

D. Equilibrium can be reached from either direction

(1 mark)

7 What is the relationship between  $K_{c1}$  and  $K_{c2}$  in the following reactions?



A.  $2K_{c2} = K_{c1}$

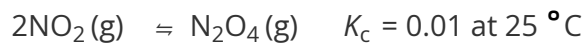
B.  $(K_{c2})^2 = K_{c1}$

C.  $K_{c2} = \frac{1}{\sqrt{K_{c1}}}$

D.  $K_{c2} = \frac{1}{2K_{c1}}$

(1 mark)

- 8 Nitrogen dioxide can react with itself to produce a dimer molecule called dinitrogen tetroxide in the following equilibrium reaction.



In an experiment,  $100 \text{ cm}^3$  of nitrogen dioxide is placed in a gas syringe and the barrel is pushed in, meaning the volume is reduced to  $50 \text{ cm}^3$  at constant temperature.

Which of the following statements are true?

- I. The value of  $K_c$  increases
- II. More  $\text{N}_2\text{O}_4$  is formed
- III. The ratio of  $\frac{[\text{NO}_2]}{[\text{N}_2\text{O}_4]}$  decreases

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(1 mark)

9 One of the characteristics of a state of equilibrium, is that equilibria are said to be *dynamic*. What is the meaning of *dynamic* in this context?

- A. The position of equilibrium is constantly changing
- B. The rates of forward and backward reactions change
- C. The reactants and products are continually reacting
- D. The concentrations of the reactants and products continue to change

(1 mark)

10 The reaction shown below has a value of  $K_c = 1.0 \times 10^{-4}$  at 25 °C.



Which of the following relationships is correct about this equilibrium at 25 °C?

- A.  $[\text{NO}] \gg [\text{NOBr}]$
- B.  $[\text{NOBr}] \gg [\text{Br}_2]$
- C.  $2 \times [\text{NOBr}] = [\text{Br}_2]$
- D.  $[\text{NO}] = [\text{NOBr}]$

(1 mark)

11 The Haber process is a key step in the manufacture of fertilisers:

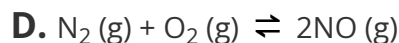
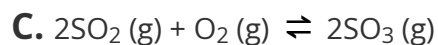
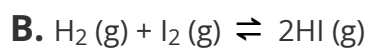
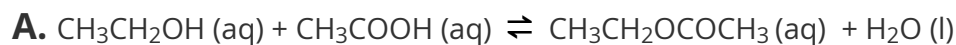


Which is correct about the effect of increasing temperature for this reaction?

	Effect on equilibrium position	Effect on $K_c$
A.	Shifts left	No change
B.	Shifts right	No change
C.	Shifts right	Increase
D.	Shifts left	Decrease

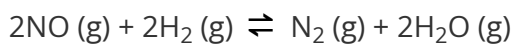
(1 mark)

12 Which equation represents a reaction where the number of moles alone can not be used to calculate the value of  $K_c$ ?



(1 mark)

13 When 0.20 mol NO, 0.08 mol  $\text{H}_2$  and 0.10 mol of  $\text{H}_2\text{O}$  are placed in a 1.0  $\text{dm}^3$  flask, the following equilibrium is established:



At equilibrium, the concentration of  $\text{H}_2(\text{g})$  was found to be 0.02  $\text{mol dm}^{-3}$ .

What is the correct value of  $K_c$ ?

A.  $1.02 \times 10^{-2}$

B. 98.0

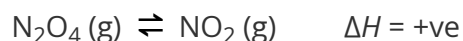
C. 8.3



D. 489.8

(1 mark)

14 Nitrogen dioxide can form a dimer that can also break back down again as part of a reversible reaction:



The reaction reaches an equilibrium at temperature  $T$ , where  $K_c = 1$

What is true for a higher temperature,  $T_2$ ?

	$K_c$ value	$\Delta G^\ominus$ value
A.	Increases	Increases
B.	Decreases	Increases
C.	Decreases	Decreases
D.	Increases	Decreases

(1 mark)

15 Which would be the correct way to plot a graph and then calculate  $\Delta G^\ominus$  from experimental data of  $K_c$  and temperature values?

$$\Delta G^\ominus = -RT \ln K$$

	y-axis	x-axis	$\Delta G^\ominus =$
A.	$1 / T$	$\ln K$	$-R \times \text{gradient}$
B.	$\ln K$	$1 / T$	$-R \times \text{gradient}$
C.	$\ln K$	$1 / T$	$R / \text{gradient}$
D.	$1 / T$	$\ln K$	$R / \text{gradient}$

(1 mark)