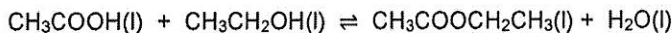




# K<sub>c</sub> CALCULATIONS 2

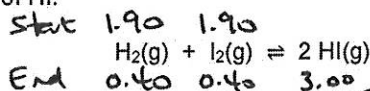
- 1 The equilibrium below was established by allowing 2.00 moles of ethanol and 1.00 moles of ethanoic acid to react at 25°C. At equilibrium the mixture contained 0.845 moles of ethyl ethanoate. Calculate K<sub>c</sub> at this temperature.



Start	1.00	2.00			$\checkmark K_c = \frac{[\text{ester}][\text{H}_2\text{O}]}{[\text{acid}][\text{alcohol}]}$
Change	-0.845	-0.845	+0.845	+0.845	
End	0.155	1.155	0.845	0.845	$\checkmark = \frac{0.845 \times 0.845}{0.155 \times 1.155}$
[End]	0.155	1.155	0.845	0.845	$\checkmark = 3.99$

(4)  
(A2 BBoF 29)

- 2 1.90 mol of hydrogen and 1.90 mol of iodine were allowed to reach equilibrium at 710 K. The equilibrium mixture contained 3.00 mol of HI.



- a) Write an expression for the equilibrium constant K<sub>c</sub>.  $K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$   $\checkmark$

(1)

- b) Calculate the value of the equilibrium constant at 710 K.

$$K_c = \frac{(3.00/\sqrt{V})^2}{(\frac{0.40}{\sqrt{V}})(\frac{0.40}{\sqrt{V}})} = 56.3 \quad (\text{no units})$$

(3)

- c) What, if anything, would be effect on the position of the equilibrium of increasing the total pressure?  $\checkmark$  no effect

(1)  
(A2 BBoF 31)

- 3 a) What is meant by the phrase *dynamic equilibrium*?

- $\checkmark$  both forward + reverse reactions occur simultaneously
- $\checkmark$  at the same rate
- $\checkmark$  concentration of all reactants + products remain constant

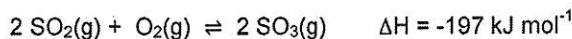
(3)

- b) What is the difference between a *homogeneous* and a *heterogeneous* equilibrium?

- $\checkmark$  homogeneous: all reactants + products in same phase/state
- $\checkmark$  heterogeneous: " " " " not in same phase/state

(2)

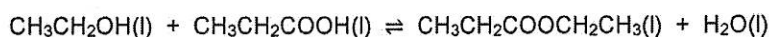
- c) State Le Châtelier's principle. ....  
 if the conditions of a system at equilibrium are changed,  
 position of equilibrium moves to oppose change ✓✓ (2)
- d) For the equilibrium below what would be the effect on both the equilibrium position and  $K_c$  of the each of the changes below, explaining your reasoning in each case.



- i) What effect would increasing the pressure have? .....  
 ✓ equilibrium position moves right  
 ✓ to side with less gas molecules to reduce pressure  
 ✓  $K_c$  no change
- ii) What effect would increasing the amount of  $\text{O}_2$  have? .....  
 ✓ equilibrium position moves right  
 ✓ to remove added  $\text{O}_2$   
 ✓  $K_c$  no effect
- iii) What effect would increasing the temperature have? .....  
 ✓ equilibrium position moves left  
 ✓ in endothermic direction to lower temperature  
 ✓  $K_c$  gets smaller

(9)  
 (A2 BBoF 23)

- 4  $K_c$  for the equilibrium below is 7.50 at  $50^\circ\text{C}$ . If 50.0 g of ethanol is mixed with 50.0 g of propanoic acid, what mass of ethyl propanoate will be formed at equilibrium?



Start	$\frac{50.0}{46.0}$	$\frac{50}{74.0}$		
	1.087	0.676		

Eq	$1.087 - x$	$0.676 - x$	$x$	$x$
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$$K_c = \frac{x^2}{(1.087-x)(0.676-x)} = 7.50$$

$$7.50(1.087-x)(0.676-x) = x^2$$

$$7.50(0.734 - 1.763x + x^2) = x^2$$

$$5.51 - 13.22x + 7.5x^2 = x^2$$

$$6.5x^2 - 13.22x + 5.51 = 0$$

$$x = \frac{13.22 \pm \sqrt{13.22^2 - 4(6.5 \times 5.51)}}{2(6.5)}$$

(4)  
 (A2 BBoF 38)

$$= \frac{13.22 \pm 5.61}{13.0}$$

$$x = 0.585 \quad (\text{as } x < 0.66)$$

$$\therefore \text{mass ester} = 0.585 \times 102.0 = 59.7 \text{ g}$$