

17.1 The Equilibrium Law

Question Paper

Course	DP IB Chemistry
Section	17. Equilibrium (HL only)
Topic	17.1 The Equilibrium Law
Difficulty	Hard

Time allowed: 50
Score: /40
Percentage: /100

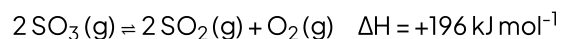
Question 1a

a)

A 0.680 mol sample of SO_3 is introduced into a 3.04 dm^3 reaction container and allowed to reach equilibrium at temperature T .

32% of the SO_3 had decomposed.

Calculate the value for K_c in this reaction, giving your answer to 2 significant figures.



[6]

[6 marks]**Question 1b**

b)

The size of the container for the reaction in part (a) is decreased.

State the effect if any on the equilibrium constant, K_c , and the position of equilibrium. Justify your answer.

[4]

[4 marks]

Question 1c

c)

The temperature of the reaction in part (a) is increased.

State the effect, if any, on the equilibrium constant, K_c , and the position of equilibrium. Justify your answer.

[3]

[3 marks]

Question 1d

d)

Comment on whether the reaction in part (a) is likely to take place spontaneously at temperature T .

[2]

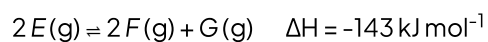
[2 marks]

Question 2a

a)

A mixture of 1.32 moles of E , 1.49 moles of F and 0.752 moles of G were placed into a 5.0 dm^3 container at temperature, T , and allowed to reach equilibrium. At equilibrium, the number of moles of E was 1.86.

Calculate the value of the equilibrium constant, K_c , to 3 significant figures.



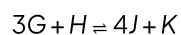
[5]

[5 marks]

Question 2b

b)

Reactants G and H react together to form products J and K according to the equation



A beaker contained 35 cm^3 of 0.18 mol dm^{-3} of an aqueous solution of G .

8.41×10^{-3} moles of H and 3.1×10^{-3} moles of J were also added to the beaker. The equilibrium mixture contained 4.1×10^{-3} moles of G .

Calculate the number of moles of H , J and K at equilibrium.

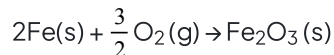
[5]

[5 marks]

Question 2c

c)

Using sections 1 and 2 of the data booklet, calculate the equilibrium constant at 300 K for the oxidation of iron:



$$\Delta H^\ominus = -824.2 \text{ kJ mol}^{-1}$$

$$\Delta S^\ominus = -270.5 \text{ J mol}^{-1}$$

[3]

[3 marks]

Question 2d

d)

Suggest what the value for K_c calculated in part (c) suggests about the equilibrium position for the oxidation of iron.

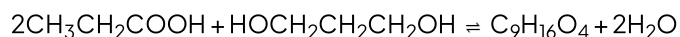
[1]

[1 mark]

Question 3a

a)

Diesters are compounds often used as synthetic lubricants for machinery such as compressors. The reaction below shows the formation of a diester from propanoic acid and propane-1,3-diol.



At equilibrium, the reaction mixture contained 3.25 moles of $\text{CH}_3\text{CH}_2\text{COOH}$, 1.15 moles of $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH}$, and 1.18 moles of $\text{C}_9\text{H}_{16}\text{O}_4$.

The value for K_c at temperature, T , is 1.29.

Calculate the concentration of water in the reaction mixture at equilibrium. Give your answer to 3 significant figures.

[3]

[3 marks]

Question 3b

b)

A student deduced that in order to calculate the value of K_c for the reaction in part (a) you must work out the concentrations using the overall volume.

Is the student correct? Justify your answer.

[2]

[2 marks]

Question 3c

c)

Using sections 1 and 2 of the data booklet, determine the value for ΔG for the reverse reaction in part(a) given that temperature $T = 30^\circ\text{C}$. Give your answer, in kJ, to 2 significant figures.

[2]

[2 marks]

Question 3d

d)

The reverse reaction in part (a) is slightly endothermic. At a different temperature, T_2 , the value for ΔG decreases to $-0.52 \text{ kJ mol}^{-1}$.

State whether the new temperature, T_2 , is higher or lower than the original temperature.

Justify your answer.

[4]

[4 marks]

