

**CHEMISTRY 225 SEMESTER 04-2016**  
**REVISION ON EQUILIBRIA**

1) Write an expression for the equilibrium constant (K) for each of the following reactions:

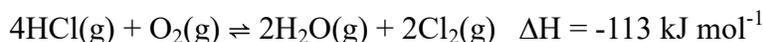
- a)  $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$
- b)  $\text{Cl}_2(\text{g}) + 3\text{F}_2(\text{g}) \rightleftharpoons 2\text{ClF}_3(\text{g})$
- c)  $2\text{Fe}(\text{s}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightleftharpoons 2\text{Fe}^{3+}(\text{aq}) + 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$
- d)  $\text{C}_2\text{H}_5\text{OH}(\text{l}) \rightleftharpoons \text{C}_2\text{H}_5\text{OH}(\text{g})$
- e)  $3\text{O}_2(\text{g}) \rightleftharpoons 2\text{O}_3(\text{g})$
- f)  $\text{Ag}(\text{s}) + \text{Fe}^{3+}(\text{aq}) \rightleftharpoons \text{Ag}^+(\text{aq}) + \text{Fe}^{2+}(\text{aq})$
- g)  $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{CaO}(\text{s})$
- h)  $\text{NH}_4\text{Cl}(\text{s}) \rightleftharpoons \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$

2) In the following questions, consider the equilibrium:



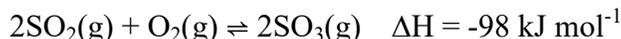
for which  $K_p = 1.70$  at  $250^\circ\text{C}$

- a) If 1 mol of  $\text{PCl}_5(\text{g})$  is placed in a  $1000 \text{ cm}^3$  flask at  $250^\circ\text{C}$  and allowed to come to equilibrium, find the equilibrium partial pressure of each species present.
  - b) If  $\text{PCl}_5$  is 48.5% dissociated at  $200^\circ\text{C}$ , 1 atm, and 97% dissociated at  $300^\circ\text{C}$ , 1 atm, explain whether the decomposition reaction is exothermic, or endothermic.
  - c) If 5 mol of  $\text{PCl}_5(\text{g})$  were initially present as in (a) calculate the equilibrium partial pressure of each species.
  - d) Using your results from (a) and (c) or otherwise calculate the degree of dissociation of the  $\text{PCl}_5$  in each case.
  - e) Proceed as in (a) and (c) for the following initial mixtures of species:
    - i) 1 mol of  $\text{PCl}_3$  and 1 mol of  $\text{Cl}_2$ .
    - ii) 0.5 mol of  $\text{PCl}_5$  and 1 mol of  $\text{Cl}_2$ .
- 3) Suppose 3 mol of  $\text{HCl}$  and 2 mol of  $\text{O}_2$  are introduced into a  $5000 \text{ cm}^3$  vessel and the temperature held constant at  $450^\circ\text{C}$  until equilibrium is attained according to the reaction:



From this data, could the equilibrium constant be calculated? If so, find its value. If not, what further data would be needed?

4) For the system:

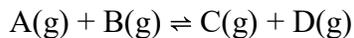


state the effect on individual concentrations, equilibrium position, reaction rates and the value of  $K_c$  of

- a) adding more oxygen.
  - b) increasing the pressure.
  - c) adding finely divided platinum, which acts as a catalyst.
  - d) increasing the temperature.
- 5) Hydrogen and iodine are introduced into a sealed vessel at a temperature at which both are gases and allowed to react until equilibrium is reached. Sketch a graph of concentration against time showing

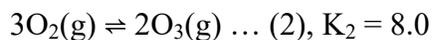
the concentrations of hydrogen, iodine and hydrogen iodide. Sketch a second graph showing the rate of production of hydrogen iodide (one curve) and the rate of its reaction (ie. destruction) as a function of time.

- 6) The equilibrium constant ( $K_c$ ) for the reaction

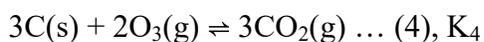


is 4. If in an equilibrium mixture  $[A] = 5$ ,  $[B] = 2$  and  $[D] = 4$ , find  $[C]$

- 7) Given the following equilibria:



Find a relationship between the above equilibria or equilibrium constants, and that for:



and hence, or otherwise, calculate  $K_4$ .