Progress test 2

Multiple choice questions

- Which of the following solutions has the highest boiling point?
  - NaCl 0.1m
  - HCl 0.2m ✓
  - K_2SO_4 0.1m
  - Glucose 0.2m

- When does an osmotic equilibrium take place between two solutions separated by a semi-permeable membrane?
  - In case the two solutions have the same molar concentration
  - In case the two solutions have the same osmolar concentration ✓
  - In case the two solutions have the same molality
  - In case the two solutions have the same ionic strength

- How does the solubility of a gas into a liquid vary?
  - It is always the same for all the gases
  - it depends on the pressure of the gas over the liquid ✓
  - it is independent of the solvent's nature
  - it is independent of the pressure of the gas over the liquid

- Given the reaction: $N_2+3H_2 \leftrightarrows 2NH_3$, how can this equilibrium be reached in a closed flask of 1L at 500°C?
  - In case there are only stoichiometric amounts of N_2 , H_2 and NH_3
  - In case there is only NH_3 ✓
  - in case there is only N_2
  - in case there is only H_2

- On which parameter does Kc depend?
  - Pressure
  - concentration of reagents
  - temperature ✓
  - none of the above

Exercise 6

Which is the molar concentration of a solution prepared by diluting with water 0.5ml of a commercial solution of ammonia (NH_3, 30%w, d=0.91g/ml) up to a volume of 250ml?

30%w means 30 g of NH_3 in 100g of solution

Molar concentration = mol of NH_3 in 1L of solution

→ First we need to convert the weight of solution in volume *via* the density

d=g/V → V = g/d = 100/0.91 = 109.9 ml = 0.11 L
M= 30/ (17·0.11) = 16.04 M

Then we need to dilute the stock solution: $C_1V_1 = C_2V_2$
C2 = (C1V1) / V2 = (16.04·0.5) / 250 = 0.032 M

Exercise 7

0.743g of a covalent compound are dissolved in 150ml of water at 15°C. This solution has π=1.535atm, calculate the formula weight of the compound.

$\pi = CRT = (gRT) / (FW \cdot V)$

$\rightarrow FW = (gRT) / \pi V = (0.743 \cdot 0.082 \cdot 288) / (1.535 \cdot 0.15) =$

$= 17.55 / 0.23 = 76.30$ Da

Exercise 8

1L of a solution of glucose (FW=180) exerts π=2.7atm. Once 3g of NaCl (FW=58) are added to this solution, the osmotic pressure doubles. How many grams of glucose were in the first solution?

$\pi_1 = C_1RT = 2.7$ atm

$\pi_2 = C_2RT = 2 \cdot \pi_1 = 5.4$ atm

$C_2RT = 2 \cdot C_1RT$ but $C_2 = (n_{glucose} + n_{NaCl}[1+\alpha(\nu-1)]) / V$

$\rightarrow (n_{glucose} + 2n_{NaCl}) = 2\, n_{glucose}$

$(g/180) + (2 \cdot 3/58) = 2g/180$

$g_{glucose} = 180 \cdot 0.103 = 18.62$ g

Exercise 9

2mol of PCl_5 are heated in a volume of 2L. At equilibrium, 40% of PCl_5 has dissociated in PCl_3 and Cl_2. Calculate Kc.

$$PCl_5 \leftrightarrows PCl_3 + Cl_2$$

$n(1-\alpha)$ $\quad n\alpha \quad n\alpha$

$$Kc = \frac{\frac{n\alpha}{V} \cdot \frac{n\alpha}{V}}{n\frac{(1-\alpha)}{V}} = \frac{n \cdot \alpha^2}{V(1-\alpha)} = \frac{2 \cdot 0.16}{2 \cdot 0.6} = 0.27\, M$$

Exercise 10

3 mol of SO_2 and 1.5 mol of O_2 are mixed in an empty cylinder of 2L at 1350K. When the reaction $2SO_2 + O_2 \leftrightarrows 2SO_3$ reaches the equilibrium, there are 0.9 mol of O_2. Calculate Kc.

no.mol	SO_2	O_2	SO_3
At start	3	1.5	0
Cons./prod.	-2x	-x	+2x
At equilibrium		0.9	

1.5-x = 0.9 $\quad \rightarrow$ x = 1.5-0.9 =0.6

$[SO_2] = (3-2x)/2 = (3-1.2)/2 = 0.9$ M

$[O_2] = 0.9/2 = 0.45$ M

$[SO_3] = 2x/2 = 0.6$ M

$$Kc = \frac{[SO_3]^2}{[SO_2]^2 \cdot [O_2]} = \frac{0.6^2}{0.9^2 \cdot 0.45} = \frac{0.36}{0.364} = 0.99\, M^{-1}$$