WORKSHOP#1 - pH, pK, buffers and equilibria

1. How many grams of solid NaOH are required to prepare:

(a) 500 ml of a 0.04 M solution;

(b) 250 mL of a dilute NaOH solution of pH 9.7.

(atomic masses of Na, O and H are 23, 16 and 1g.mol^{-1}, respectively)

2. What is the concentration of water in water ?

(atomic masses of O and H are 16 and 1g.mol^{-1}, respectively)

3. When dissolved in pure water, a weak acid becomes 2% dissociated and the solution pH becomes pH 4.2. Calculate:

(a) the concentration of undissociated acid in the solution;

(b) its acid dissociation constant K_a;

(c) its pK_a.

4. What are the pH and H^+ ion concentration of a solution obtained by adding 0.8 g of sodium hydroxide (M_r = 40 g.mol^{-1}) and 2.7 g acetic acid (M_r = 60 g.mol^{-1}) to 500 mL water ? (K_a of acetic acid = 1.7 x 10^{-5})
What happens to the pH if you dilute the solution by a factor of 5 ?

5. Your factory has accidentally spilled 1078 kg of phosphoric acid into a lake, making it very acidic. How much solid caustic soda (NaOH) would you have to add to get the pH to 8.0.
(atomic masses H_3PO_4 = 98 g.mol^{-1}; NaOH = 40 g.mol^{-1}; pKs of phosphate = 2, 7 and 11).

6. How many mL of 10M HCl are required to decrease the pH of 1 litre of 0.3M acetate buffer from pH 5.0 to 4.5 ? Assume that pK_a = 4.7.

7. The following reaction: $A + B \leftrightarrow 2\ C$, is characterised by ΔG^o = -0.5 kcal.mol^{-1} at 25^{o}C.

a) Write the expression of its equilibrium constant K_e;

(b) Calculate K_e.

8. *In vivo*, an enzyme catalyses the reaction A ↔ B + C with ΔG = -2.28 $kJ.mol^{-1}$. The concentrations in A, B and C have been measured at 200 pM, 0.02 mM and 20 uM respectively.

a) In which direction (left or right) does the reaction progress spontaneously *in vivo*?

(b) Calculate the Gibbs standard free energy (ΔG^o) at 37^{o}C. What conclusion can you draw?