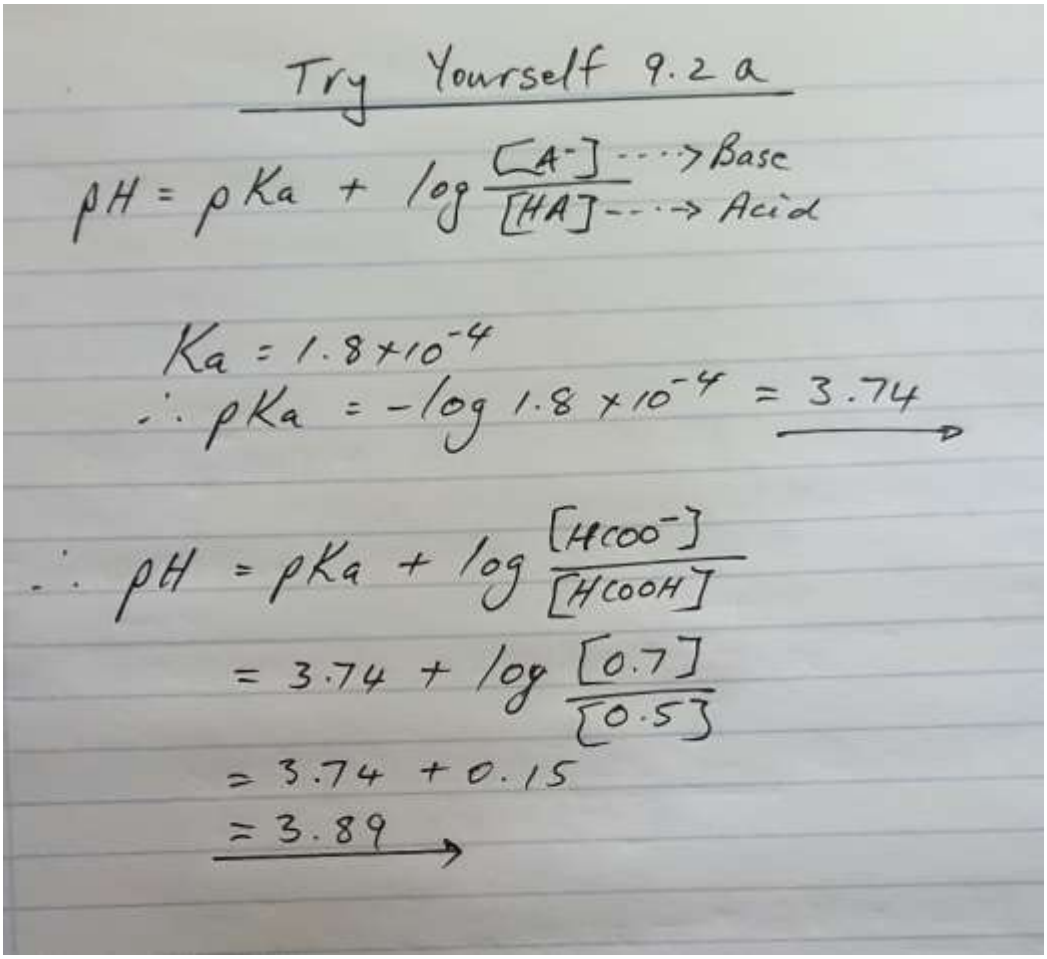
ANSWER TO "TRY YOURSELF" PROBLEM FROM STUDY SECTION 9.2

Try Yourself 9.2a

Calculate the pH of a buffer solution with 0.5 mol/L HCOOH and 0.7 mol/L $HCOO^-$. K_a for formic acid (metanoic acid) = 1.8×10^{-4}.



Try Yourself 9.2b

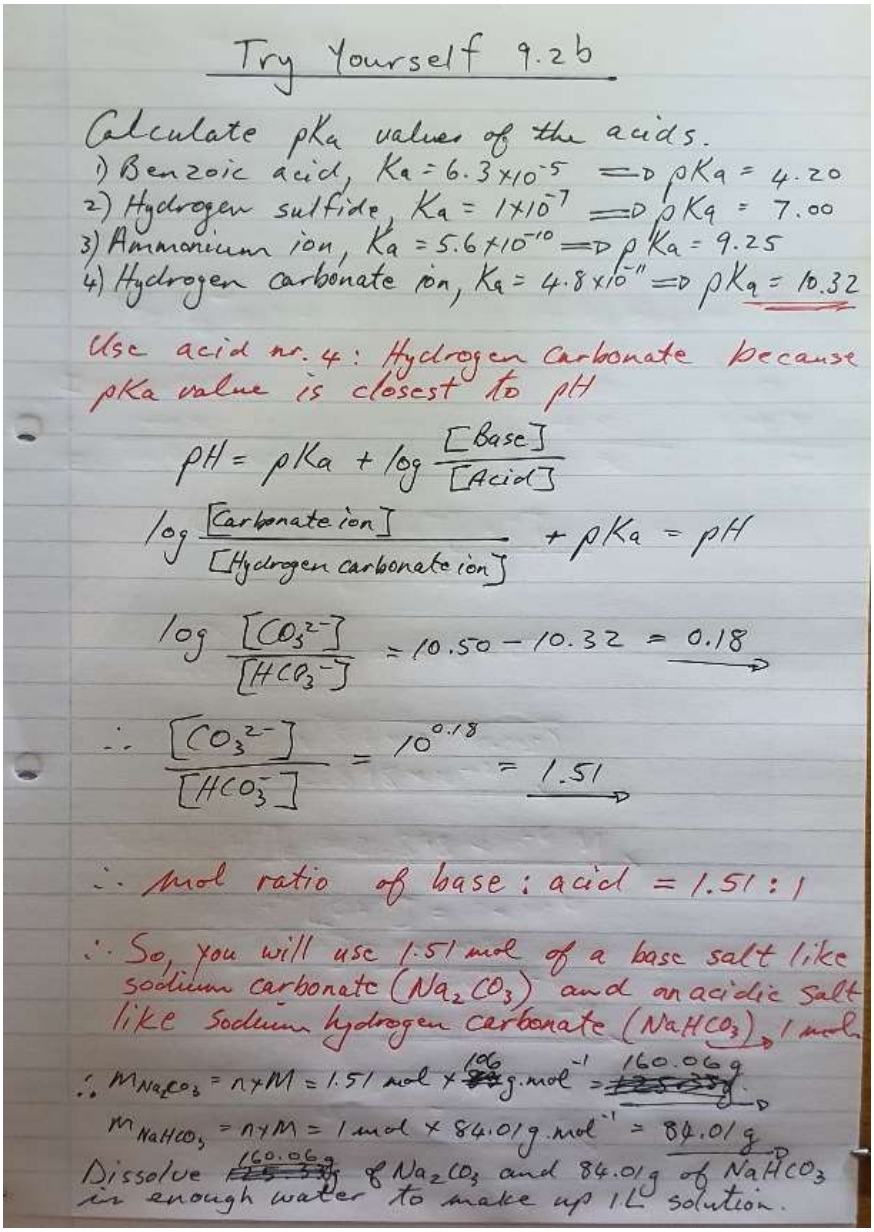
You which to prepare 1000 mL of a buffer solution with a pH of 10.50

A list of possible acids (and their conjugated bases) follows:

Acid	Conjugate base	K_a
Benzoic acid ($C_6H_5CO_2H$)	Benzoate ion ($C_6H_5CO_2^-$)	6.3×10^{-5}
Hydrogen sulfide (H_2S)	Hydrogen sulfide ion (HS^-)	1×10^{-7}
Ammonium ion (NH_4^+)	Ammonia (NH_3)	5.6×10^{-10}
Hydrogen carbonate ion (HCO_3^-)	Carbonate ion (CO_3^{2-})	4.8×10^{-11}

Which combination should be selected and what should be the ratio of acid to conjugate base?

Answer:



Try Yourself 9.2b

Calculate pKa values of the acids.

1) Benzoic acid, $K_a = 6.3 \times 10^{-5} \Rightarrow pK_a = 4.20$

2) Hydrogen sulfide, $K_a = 1 \times 10^{-7} \Rightarrow pK_a = 7.00$

3) Ammonium ion, $K_a = 5.6 \times 10^{-10} \Rightarrow pK_a = 9.25$

4) Hydrogen carbonate ion, $K_a = 4.8 \times 10^{-11} \Rightarrow pK_a = 10.32$

Use acid nr. 4: Hydrogen carbonate because pKa value is closest to pH

$$pH = pK_a + \log \frac{[Base]}{[Acid]}$$

$$\log \frac{[Carbonate\ ion]}{[Hydrogen\ carbonate\ ion]} + pK_a = pH$$

$$\log \frac{[CO_3^{2-}]}{[HCO_3^-]} = 10.50 - 10.32 = 0.18$$

$$\therefore \frac{[CO_3^{2-}]}{[HCO_3^-]} = 10^{0.18} = 1.51$$

∴ mol ratio of base : acid = 1.51 : 1

∴ So, you will use 1.51 mol of a base salt like sodium carbonate (Na_2CO_3) and an acidic salt like sodium hydrogen carbonate ($NaHCO_3$), 1 mol.

$\therefore m_{Na_2CO_3} = n \times M = 1.51\ mol \times 106\ g.mol^{-1} = 160.06\ g$

$m_{NaHCO_3} = n \times M = 1\ mol \times 84.01\ g.mol^{-1} = 84.01\ g$

Dissolve 160.06 g of Na_2CO_3 and 84.01 g of $NaHCO_3$ in enough water to make up 1L solution.