Vecka 14 Lektion 1
Bac 2008 Uppgift A1

a) i.

Reaktioner	*Syra / bas*
$CH_3 - NH_2(aq) + H_2O \rightleftharpoons CH_3 - NH_3^+(aq) + OH^-$	$CH_3 - NH_3^+(aq)$ / $CH_3 - NH_2(aq)$, H_2O / OH^-
$CO_3^{2-}(aq) + H_3O^+(aq) \rightleftharpoons HCO_3^-(aq) + H_2O$	$HCO_3^-(aq)$ / $CO_3^{2-}(aq)$, $H_3O^+(aq)$ / H_2O
$HCO_3^-(aq) + CH_3 - NH_2(aq) \rightleftharpoons CO_3^{2-} + CH_3 - NH_3^+(aq)$	$HCO_3^-(aq)$ / $CO_3^{2-}(aq)$, $CH_3 - NH_3^+(aq)$ / $CH_3 - NH_2(aq)$

Syra	Konjugerande Bas	pK_a	pK_b
$H_3O^+(aq)$	$H_2O(l)$	-1.74	15.74
$HCO_3^-(aq)$	$CO_3^{2-}(aq)$	10.3	3.7
$CH_3 - NH_3^+(aq)$	$CH_3 - NH_2(aq)$	10.6	3.4
$H_2O(l)$	$OH^-(aq)$	15.7	-1.7

ii.

1. OH^-
2. $CH_3 - NH_2(aq)$
3. CO_3^{2-}
4. H_2O

iii. H_2O $(\rightarrow OH^-)$, $(\rightarrow H_3O^+)$
HCO_3^- $(\rightarrow CO_3^{2-})$, $(\rightarrow H_2O_3)$

b) i. $pH(CH_3 - NH_2(aq)):\ 11.2$

	$CH_3 - NH_2(aq) + H_2O \rightleftharpoons CH_3 - NH_3^+ + OH^-$		
I	$1.00 * 10^{-2}\ mol/dm^3$	$-$	$-$
C	$-x$	$+x$	$+x$
E	$1.00 * 10^{-2} - x$	x	x

$$x = \frac{10^{-14}}{10^{-pH}} = 10^{-14-(-pH)} = [OH^-]$$

$$x = 0.0015848932 \approx 1.5 * 10^{-3}\ mol/dm^3$$

$$K_b = \frac{[CH_3 - NH_3^+] * [OH^-]}{[CH_3 - NH_2]}$$

$$K_b = \frac{x^2}{1.00 * 10^{-2} - x}$$

$$K_b = \frac{(1.5 * 10^{-3})^2}{1.00 * 10^{-2} - 1.5 * 10^{-3}} = 2.9 * 10^{-4}$$

$pH(NH_3(aq)):\ 10.6$

	$NH_3(aq) + H_2O \rightleftharpoons NH_4^+ + OH^-$		
I	$1.00 * 10^{-2}\ mol/dm^3$	$-$	$-$
C	$-x$	$+x$	$+x$
E	$1.00 * 10^{-2} - x$	x	x

$$x = \frac{10^{-14}}{10^{-pH}} = 10^{-14-(-pH)} = [OH^-]$$

$$x = 3.9810717 * 10^{-4} \approx 4.0 * 10^{-4}\ mol/dm^3$$

$$K_b = \frac{[NH_4^+] * [OH^-]}{[NH_3]}$$

$$K_b = \frac{x^2}{1.00 * 10^{-2} - x}$$

$$K_b = \frac{(4.0 * 10^{-4})^2}{1.00 * 10^{-2} - 4.0 * 10^{-4}} = 1.65060496 * 10^{-5}$$

ii., iii. $(K_b(NH_3(aq)) = 1.65 * 10^{-5}) < (K_b(CH_3 - NH_2(aq)) = 2.98 * 10^{-4})$

c) i. $NH_3(aq) + HCl(aq) \rightarrow NH_4^+ + Cl^-$

ii. $V(NH_3) = 150\ cm^3 = 0.150\ dm^3$
$V(HCl) = 50.0\ cm^3 = 0.050\ dm^3$

$C(NH_3) = 1.00 * 10^{-2}\ mol/dm^3$
$C(HCl) = 1.50 * 10^{-2}\ mol/dm^3$

$C = \frac{n}{V} \rightarrow n = C * V$

$n(NH_3) = 0.010 * 0.150 = 0.0015\ mol\ = 1.5 * 10^{-3}\ mol$
$n(HCl) = 0.0150 * 0.050 = 0.00075\ mol\ = 7.5 * 10^{-4}\ mol$

iii. ICF tabell i mol:

	$NH_3 + HCl \rightarrow NH_4^+ + Cl^-$			
I	$1.50 * 10^{-3}$	$7.5 * 10^{-4}$	–	–
C	$-x$	$-x$	$+x$	$+x$
F	$1.50 * 10^{-3} - x$	$7.5 * 10^{-4} - x$	x	x

x är lika med antal mol av den molekylen med minst partiklar

NH_3 är A^- och NH_4^+ är HA

$x = 7.5 * 10^{-4}\ mol$

$pH = pK_a + log\left(\frac{[A^-]}{[HA]}\right) \rightarrow pK_a = pH - log\left(\frac{[A^-]}{[HA]}\right)$

$[A^-] = 1.50 * 10^{-3}\ mol$
$[HA] = 7.5 * 10^{-4}\ mol$
$pH = 9.24$

$pK_a = 9.24 - log\left(\frac{1.50 * 10^{-3}}{7.5 * 10^{-4}}\right)$

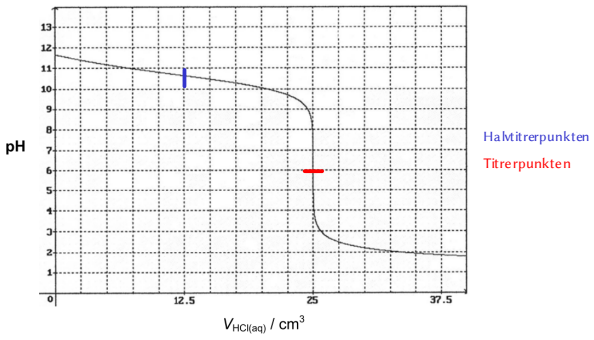
$pK_a = 8.93897$

d)

$CH_3 - NH_2 + HCl \rightarrow CH_3 - NH_3^+ + Cl^-$

Molekyl	V_{init}	C_{init}	n_{init}	$V_{\frac{1}{2}eq}$	$C_{\frac{1}{2}eq}$	$n_{\frac{1}{2}eq}$	C_{eq}	V_{eq}	n_{eq}
$CH_3 - NH_2$		x		?					
HCl			0.1	0.0125				0.025	
$CH_3 - NH_3^+$									
H_3O^+									

i. $C(HCl) = 1.00 * 10^{-1}\ mol/dm^3$
$V(CH_3 - NH_2)_{init} = 50\ cm^3 = \ 0.050\ dm^3$
$pH(eq) = 6$
$V(HCl)_{eq} = 25\ cm^3$



ii. $pH = pK_a + log\left(\frac{[A^-]}{[HA]}\right)$ $A^- = CH_3 - NH_2$ $HA = CH_3 - NH_3^+$

$CH_3 - NH_3^+ + H_2O \ \rightarrow \ CH_3 - NH_2 + H_3O^+$

iii. $C(CH_3 - NH_2) = x$

Molekyl	C_{init}	n_{init}	$C_{\frac{1}{2}eq}$	$n_{\frac{1}{2}eq}$	C_{eq}	n_{eq}
$CH_3 - NH_2$	0.0025	0.05	0.4	0.025	–	–
HCl	–	–	–	–	–	–
$CH_3 - NH_3^+$	–	–	0.4	0.025	$3.3 * 10^{-2}$	0.0025
OH^-	$6.3 * 10^{-3}$	0.126	$5.0 * 10^{-4}$	$8.0 * 10^{-3}$	$1.0 * 10^{-8}$	$1.3 * 10^{-7}$
Total volym	$V_{init} = 0.050$		$V_{\frac{1}{2}eq} = 0.05 + 0.0125$		$V_{eq} = 0.050 + 0.025$	

$C = \frac{n}{V} \ \rightarrow \ V = \frac{n}{C} \ \rightarrow \ n = C * V$

$pH = pK_a + log\left(\frac{[A^-]}{[HA]}\right)$

$K_b = \frac{[CH_3-NH_3^+]*[OH^-]}{[CH_3-NH_2]}$

$log(K_b) = log\left(\frac{[CH_3-NH_3^+]*[OH^-]}{[CH_3-NH_2]}\right)$

$-pK_b = log\left(\frac{[CH_3-NH_3^+]}{[CH_3-NH_2]}\right) + log([OH^-])$

$-pK_b = log\left(\frac{[CH_3-NH_3^+]}{[CH_3-NH_2]}\right) - pOH$

$pK_b = log\left(\frac{[CH_3-NH_3^+]}{[CH_3-NH_2]}\right) + pOH$

$pOH = pK_b + log\left(\frac{[CH_3-NH_3^+]}{[CH_3-NH_2]}\right)$

$C_{init}(OH^-) = 10^{-(14-pH)} = 6.3 * 10^{-3} \ mol/dm^3$

$C_{\frac{1}{2}eq}(OH^-) = 10^{-(14-pH)} = 5.0 * 10^{-4} \ mol/dm^3$

$C_{eq}(OH^-) = \ 10^{-(14-pH)} = 1.0 * 10^{-8} \ mol/dm^3$

$pOH_{\frac{1}{2}eq} = pK_b + log(1)$
$pK_b = 3.4$

Vid ekvivalenspunkten har vi ingen $CH_3 - NH_2$ kvar, allt har förbrukats av HCl. Vi hällde i 0.025 dm^3 0.1 molarig lösning HCl

$n_{tillsatt}(HCl) \ = \ n_{eq}(CH_3 - NH_3^+) = n_{init}(CH_3 - NH_2)$

$n_{tillsatt}(HCl) \ = \ V(HCl) * C(HCl)$
$n_{tillsatt}(HCl) \ = \ 0.025 * 0.1 = 0.0025 \ mol$