Bac 2012 A3
Vecka 13 lektion 3

Inledning: Det beskrivs 3 olika sätt att producera brom (Br_2):

$$KBr \rightarrow K^+(aq) + Br^-(aq)$$

i. $2Br^-(aq) + Cl_2(g) \rightarrow 2Cl^- + Br_2$

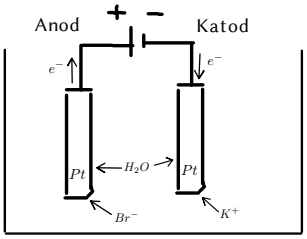
ii.

$$\overset{+IV-II}{MnO_2}(s) + 2e^- + 4H^+ \rightarrow Mn^{+2} + 2H_2O$$

$$2Br^-(aq) \rightarrow 2e^- + Br_2$$

$$MnO_2(s) + 2Br^-(aq) + 4H^+ \rightarrow Br_2 + Mn^{2+} + 2H_2O$$

iii.



Reaktioner som kan ske vid anoden:

$$2Br^- \rightarrow Br_2 + 2e^-$$
$$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$$

Teoretiskt sett oxideras hellre vatten, eftersom vatten har lägre reduktionspotential
Men vi kan observera att det bildas brom.

Reaktioner som kan ske vid katoden:

$$K^+ + e^- \rightarrow K$$
$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

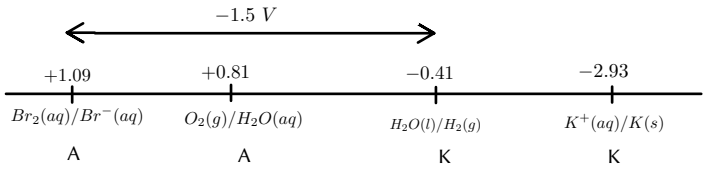
Vatten reduceras etftersom det har en mycket högre reduktionspotential än kalium.

Totala reaktionen:

$$2Br^- + 2H_2O \rightarrow Br_2 + H_2 + 2OH^-$$

v. $E_{cell} = E_{red}(katod) - E_{red}(anod)$

$$E_{cell} = -0.41 - 1.09 = -1.5\ V$$



Man måste ha minst 1.5 V mellan anoden och katoden

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vi. $n = \frac{m}{M}$

$M(Br_2) = 2 * 79.9 \ = \ 159.8 \ g/mol$
$m(Br_2) = 1.00 \ Kg = 1000 \ g$

$n(Br_2) = \frac{1000}{159.8} \ = \ 6.2578222778 \ mol$
$n(e^-) = 2 * n(Br_2) = 12.5156445556 \ mol$

$Q = n(e^-) \ * \ F$
$Q = 12.5156445556 * 9.65 * 10^4 = 1207759.6996154000 \ C$

$I = \frac{Q}{t} \ \rightarrow \ t = \frac{Q}{I}$

$t = \frac{1207759.6996154000}{12.0} = 100646.6416346166 \ s$

$\approx 28 \ h$

b) Step 1:
$Br_2 \ + \ H_2O \ \rightarrow \ HBr(aq) \ + \ HBrO(aq)$

Step 2:
$HBrO(aq) \ + \ KOH(aq) \ \rightarrow \ KBrO(aq) \ + \ H_2O$

c) i. $HBrO(aq) \ + \ NaOH(aq) \ \rightarrow \ NaBrO \ + \ H_2O$

ii. Molförhållande: 1:1
$n(HBrO) : n(OH^-)$

$C(HBrO) = 1.00 * 10^{-1} \ mol/dm^3$
$V(HBrO) = 25.0 \ cm^3 \ = \ 0.025 \ dm^3$

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

$n(HBrO) = 0.025 * 0.1 = 0.0025 \ mol$

ICF-tabell i mol:

$V = 0.025 \ dm^3$	$HBrO(aq) \ + \ OH^-(aq) \ \rightarrow \ BrO^- \ + \ H_2O$			
I	0.0025	x	−	−
C	$0.0025 - x$	$x - x$	$+x$	$+x$
F	0	0	x	x

Eftersom allt ska reagera och molföhållandet är 1:1 är $x = 0.0025$

$C(NaOH) = 8.00 * 10^{-2} = 0.08 \ mol/dm^3$
$n(NaOH) = 0.0025 \ mol$
$V = \frac{n}{C}$
$V(NaOH) = \frac{0.0025}{8.00 * 10^{-2}} = 0.03125 \ dm^3 = 31.25 \ cm^3$

iii. $n(HBrO)_{initial} = 0.025 * 0.1 = 0.0025\ mol$

ICE-tabell (i mol):

$V = 0.025\ dm^3$	$HBrO \overset{H_2O}{\rightleftharpoons} BrO^- + H^+$		
I	0.0025	$-$	$-$
C	$0.0025 - x$	$+x$	$+x$
E	$0.0025 - x$	x	x
Koncentration vid jämvikt	$\frac{0.0025 - x}{V} \approx 0.1\ mol/dm^3$	$\frac{x}{V} = 1.4 * 10^{-6}\ mol/dm^3$	$\frac{x}{V} = 1.4 * 10^{-6}\ mol/dm^3$

$C(H^+)_{eq} = \frac{x}{V} = 1.4 * 10^{-6}\ mol/dm^3$.

$C(HBrO)_{eq} = \frac{0.0025 - x}{V} = 0.1\ mol/dm^3$

$C(BrO^-)_{eq} = \frac{x}{V}$

$Ka = \frac{[BrO^-] * [H^+]}{[HBrO]} \qquad Ka = 2.00 * 10^{-9}$

$2.00 * 10^{-9} = \frac{\frac{x^2}{V^2}}{\frac{0.0025 - x}{V}},\ V = 0.025\ dm^3$

$2.00 * 10^{-9} = \frac{\frac{x^2}{V}}{0.0025 - x}$

$pH = 14 - 3.15$

$x = 3.53578 * 10^{-7}$

$C(HBrO)_{initial} = 0.1\ mol/dm^3$

$C(BrO^-)_{eq} = \frac{3.5 * 10^{-7}}{0.025} = 1.4 * 10^{-5}\ mol/dm^3$

$pH = -log([H^+])$

$pH = 4.85$ (initiala pH värdet av $HBrO$)

ICE-tabell (med koncentrationer):

$V = 0.025\ dm^3$	$HBrO \overset{H_2O}{\rightleftharpoons} BrO^- + H^+$		
I	0.1	$-$	$-$
C	$0.1 - x$	$+x$	$+x$
E	$0.1 - x$	x	x

$Ka = \frac{[BrO^-] * [H^+]}{[HBrO]} \qquad Ka = 2.00 * 10^{-9}$

$2.00 * 10^{-9} = \frac{x^2}{0.1 - x}$

$x = 1.4 * 10^{-6}$

iv. pH vid ekvivalenspunkten

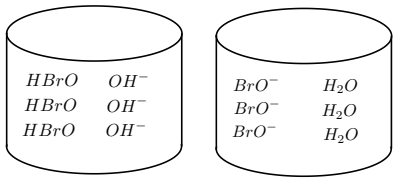
(final = ekvivalenspunkten)

ICF-tabell i mol:

$V_{initial} = 0.025\ dm^3$ $V_{final} = 0.056\ dm^3$	$HBrO(aq)\ +\ OH^-(aq)\ \rightarrow\ BrO^-\ +\ H_2O$			
I	0.0025	x	$-$	$-$
C	$0.0025 - x$	$x - x$	$+x$	$+x$
F	0	0	x	x
slutgiltiga koncentrationen	0	0	$\frac{x}{V_{final}} = 0.044$	$\frac{x}{V_{final}} = 0.044$

$x = 0.0025$

initial final



$n(HBrO)_{initial} = 0.0025\ mol$

$C(HBrO)_{initial} = \frac{0.0025}{0.025} = 0.1\ mol/dm^3$

$C(BrO^-)_{final} = \frac{n(BrO^-)}{V_{final}}$

$C(BrO^-)_{final} = \frac{0.0025}{0.05625} = 0.044\ mol/dm^3$

$V(OH^-) = 0.03125\ dm^3$

$V(HBrO)_{initial} = 0.025\ dm^3$

$V_{total} = V(OH^-) + V(HBrO)_{initial}$

$V_{total} = 0.03125 + 0.025 = 0.05625\ dm^3$

ICE-tabell (med koncentrationer):

$V = 0.05625\ dm^3$	$BrO^-\ +\ H_2O \rightleftharpoons HBrO\ +\ OH^-$		
I	0.044	$-$	$-$
C	$0.044\ -\ x$	$+x$	$+x$
E	$0.044 - x$	x	x

$Ka = 2.00 * 10^{-9}$

$Ka * Kb = Kw$

$Kb = \frac{Kw}{Ka}$

$pKw = 14.0$

$Kw = 10^{-14}$

$Kb = \frac{10^{-14}}{2.00 * 10^{-9}} = 5 * 10^{-6}$

$Kb = \frac{[HBrO] * [OH^-]}{[BrO^-]}$

$5 * 10^{-6} = \frac{x^2}{0.044 - x}$

$x = 4.74 * 10^{-4} = C(OH^-)_{final}$

$pOH = -log([OH^-])$

$pOH = 3.32891$

$pH + pOH = 14$

$pH = 14 - pOH$

$pH = 14 - 3.32891$

$pH = 10.6711$