2011/2012 õ.a. keemiaolümpiaadi lõppvooru ülesannete lahendused

10. klass

1. a) $[H^+]=10^{-1,8}=0,0158...\approx 0,02$ M

b) $H^+ + HCO_3^- = H_2O + CO_2\uparrow$

c) $N = 80ml \cdot \frac{0,016\frac{mol}{l}}{1000\frac{ml}{l}} \cdot \frac{6,02\cdot 10^{23}}{1mol} \approx 8\cdot 10^{20} molekuli$

d) i) Alla 7.

ii) Kuna happe kontsentratsioon on väga madal, tuleb arvutuses arvestada ka vee autoprotolüüsi. Laengu jäävuse seadusest lähtuvalt:

$[H^+] = [Cl^-] + [OH^-]$
Kloriidioonide kontsentratsioon on võrdne veele lisatava vesinikkloriidhappe kontsentratsiooniga, sest HCl dissotsieerub täielikult. $[Cl^-]=c_{HCl}$. $[OH^-]=K_w/[H^+]$, sest $[H^+][OH^-]=K_w$
Seega saame need liikmed asendades võrrandi $[H^+] = c_{HCl} + K_w/[H^+]$
Korrutades selle läbi $[H^+]$-ga ja viies kõik liikmed vasakule poole, saame järgmise ruutvõrrandi:
$[H^+]^2 - c_{HCl}\cdot[H^+] - K_w = 0$
Pannes arvud võrrandisse asemele, tuleb ruutvõrrandi lahenduseks $[H^+]=1,08\cdot 10^{-7}$ M ja seega **pH=6,97**

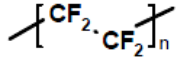
e) Valkude denatureerimine. See paljastab valkudes olevad peptiidsidemed neid lõhustavatele ensüümidele.

2. a)
X - F, fluor
A - F_2, fluor
B - O_2, hapnik
C - SiF_4, ränitetrafluoriid
D - HF, vesinikfluoriidhape
E - HOF, hüpofluorishape
F - CaF_2, kaltsiumfluoriid
G - KHF_2, kaaliumvesinikfluoriid

b)

1) $F_2 + H_2 \rightarrow 2HF$
2) $2F_2 + 2H_2O \rightarrow 4HF + O_2$
3) $SiO_2 + 2F_2 \rightarrow SiF_4 + O_2$
4) $F_2 + H_2O \rightarrow HOF + HF$
5) $2HOF \rightarrow 2HF + O_2$
6) $CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$
7) $KHF_2 \rightarrow KF + HF$

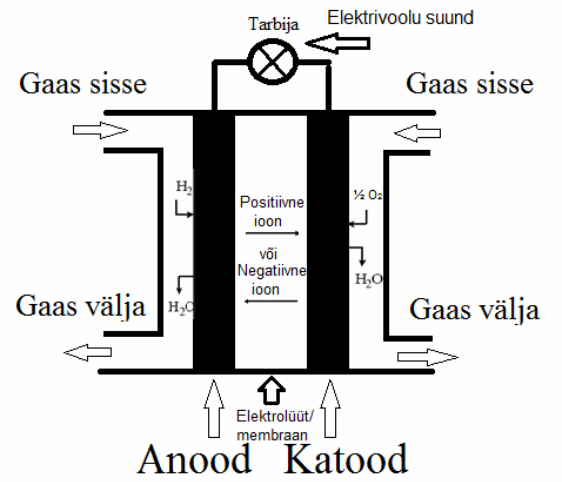
c) Teflon ehk polütetrafluoroetüleen



3.

a) Anood: $H_2 \rightarrow 2H^+ + 2e^-$
Katood: $O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

b



c) $A = N \cdot t = 20000 \cdot 2,5 \cdot 60 \cdot 60 = 1,8 \cdot 10^8\ J$

$$V = \frac{1{,}8 \cdot 10^8\ J \cdot 22{,}4 \frac{l}{mol}}{237{,}13 \frac{kJ}{mol} \cdot 1000 \frac{L}{m^3} \cdot 1000 \frac{J}{kJ}} = 17{,}0 m^3$$

d) Ballooni kohta:

$$\%H = \frac{m(H_2)}{m(H_2) + m(balloon)} \cdot 100\% = \frac{3{,}90}{3{,}90 + 85{,}9} \cdot 100\% = 4{,}34\%$$

$$V = \frac{mRT}{Mp} = \frac{3900g \cdot 8{,}314 \frac{J}{K \cdot mol} \cdot 293{,}15K \cdot 1000 \frac{dm^3}{m^3}}{2{,}02 \frac{g}{mol} \cdot 700bar \cdot 100000 \frac{Pa}{bar}} = 67{,}2 dm^3$$

Metallisulami kohta:

$$\%H = \frac{6{,}5 \cdot M(H)}{M(LaNi_5H_{6{,}5})} \cdot 100\% = 1{,}50\%$$

$$V = \frac{3{,}90kg \cdot 100\% \cdot 1000 \frac{dm^3}{m^3}}{1{,}495\% \cdot 6380 \frac{kg}{m^3}} = 40{,}9 dm^3$$

e) $$m(H_2) = \frac{17000dm^3 \cdot 2{,}02 \frac{g}{mol}}{22{,}4 \frac{dm^3}{mol} \cdot 1000 \frac{g}{kg}} = 1{,}53kg$$

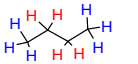
$$m(sulam) = \frac{17000dm^3}{22{,}4 \frac{dm^3}{mol}} \cdot \frac{2{,}02 \frac{g}{mol}}{1{,}495\%} \cdot \frac{100\%}{1000 \frac{g}{kg}} + 5kg = 118kg$$

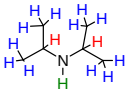
$$V(sulam) = \frac{1{,}533kg \cdot 100\% \cdot 1000 \frac{dm^3}{m^3}}{1{,}495\% \cdot 6380 \frac{kg}{m^3}} = 16{,}1 dm^3$$

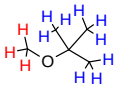
$$m(balloon) = 1{,}53kg + 85{,}9kg = 87{,}4kg$$

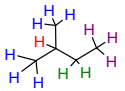
$$V(balloon) \frac{mRT}{Mp} = \frac{1533g \cdot 8{,}314 \frac{J}{K \cdot mol} \cdot 293{,}15K \cdot 1000 \frac{dm^3}{m^3}}{2{,}02 \frac{g}{mol} \cdot 700bar \cdot 100000 \frac{Pa}{bar}} = 26{,}4 dm^3$$

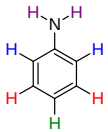
4. a)


3+6 piiki


2+7+1 piiki


1+1 piiki


2+9+5+3 piiki


2+3+3+1 piiki

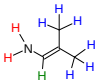
b)


X1 - 1+1 piiki


X2 - 3+5+1 piiki


X3 - 1+3+2 piiki


X4 - 3+1+1 piiki


X5 - 1+1+1 piiki

5.

$$M = N_C \cdot 12 + N_N \cdot 14 + N_O \cdot 16 + N_H \cdot 1$$

a) $$M = \frac{N_C \cdot 12}{0{,}37} = \frac{N_N \cdot 14}{0{,}185} = \frac{N_O \cdot 16}{0{,}423} = \frac{N_H \cdot 1}{0{,}022}$$

$$N_C \cdot 32{,}4 = N_C \cdot 75{,}7 = N_O \cdot 37{,}8 = N_H \cdot 45{,}45$$

Jagada läbi väikseima korrutajaga (32,4):

$$N_C = N_N \cdot 2{,}34 = N_O \cdot 1{,}17 = N_H \cdot 1{,}40$$

Leida väikseim täisarvuline süsinike aatomite arv (N_C) et võrrand kehtiks ning avaldada teiste elementide aatomite arvud:

N_C = 7 aatonit
N_N = 3 aatomit
N_O = 6 aatomit
N_H = 5 aatomit

b) $$M = \frac{N_C \cdot 12}{0{,}37} = 227 \frac{g}{mol}$$

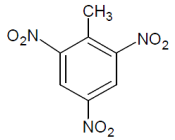
c)

$$M(X) = 0{,}066 \cdot 227\frac{g}{mol} = 15\frac{g}{mol}$$

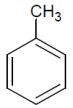
$$M(Y) = \frac{0{,}608 \cdot 227\frac{g}{mol}}{3} = 46\frac{g}{mol}$$

X – CH_3, metüülrühm
Y– NO_2, nitrorühm

d)



aine A



tolueen

tri**n**itro**t**olueen ehk TNT

6.a)

i) Kaaliumdikromaat - **$K_2Cr_2O_7$**,
kaaliumnitraat - **KNO_3**
ii) Lahus on kollakasoranž

b) Et vett oli täpselt 100 g, siis kristalliseerus välja

m($K_2Cr_2O_7$) = 56,7 g - 12,6 g = **44,1 g**

c) i) $m(S) = 56{,}7g \cdot \frac{100\%}{90\%} = 63{,}0g$

p $m(KNO_3) = 56{,}7g \cdot \frac{100\%}{90\%} \cdot \frac{10\%}{100\%} = 6{,}30g$

d) %(KNO_3 segus P)=(6,3 g)/(6,3 g+12,6 g)*100%≈33,3 %

e) 20 ℃ L(KNO_3) = 31,7 g
70 ℃ L($K_2Cr_2O_7$) = 56,7 g
%(KNO3) > 35,9 %