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(64.3)



**МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
имени М.В.ЛОМОНОСОВА**

Вариант _____

Место проведения Красноярск
город

ПИСЬМЕННАЯ РАБОТА

Олимпиада школьников Ломоносов 2024
наменование олимпиады

по Химии
профиль олимпиады

Фролякиной Арии Тимофеевны
фамилия, имя, отчество участника (в родительном падеже)

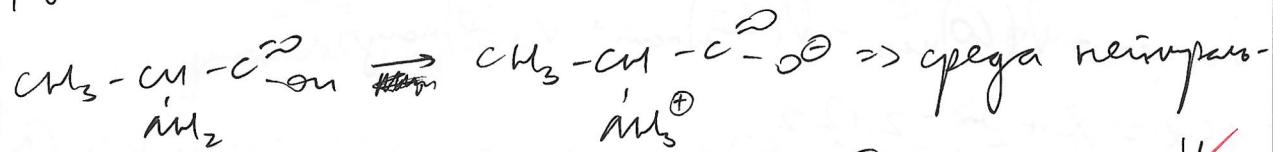
Дата

« 3 » марта 2024 года

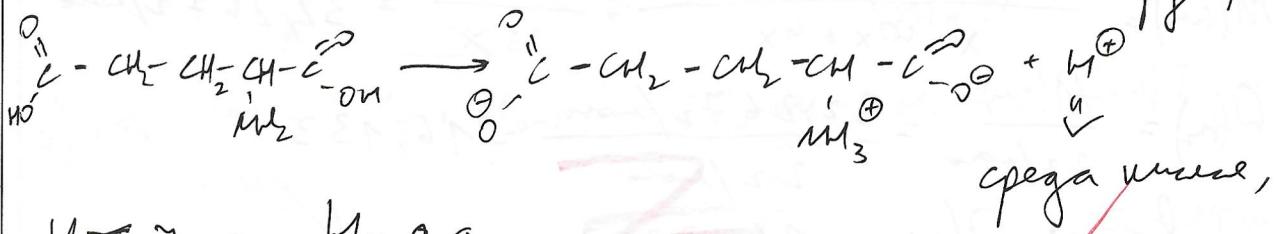
Подпись участника

✓ 1.5

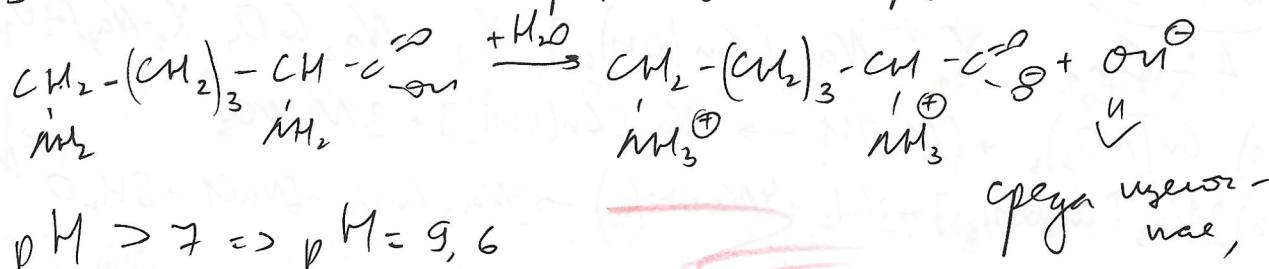
1 Банка - АЛАМИН, т.н. в р-ре гидролизуется:



2 Банка - ГЛУТАМИНОВАЯ КИСЛОТА, т.н. в р-ре гидролизуется:



3 Банка - АЗИДА, в р-ре гидролизуется:



✓ 2.1

$$\text{D(H}_2\text{)} = 21,2 = \frac{M(\text{an})}{22/\text{моль}} \Rightarrow M(\text{an}) = 21,2 \cdot 22/\text{моль} = 42,42/\text{моль}$$

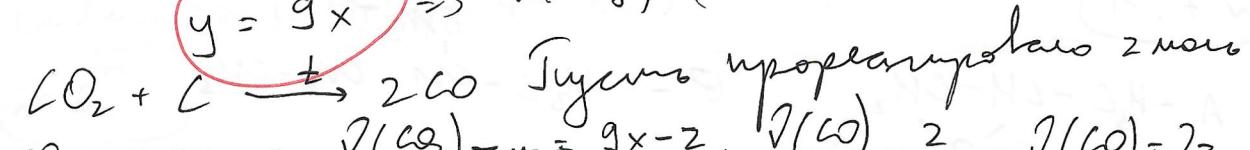
$$M(\text{an}) = \frac{m(\text{CO}) + m(\text{CO}_2)}{\text{J(CO)} + \text{J(CO}_2)} \quad \text{Также J(CO) = } x \text{ моль, тогда } m(\text{CO}) = (28x)_2, \text{ J(CO}_2) = y \text{ моль,}$$

$$\text{тогда } m(\text{CO}_2) = (44y)_2$$

$$42,4 = \frac{28x + 44y}{x + y}$$

$$1,6y = 14,4x \Rightarrow J(\text{один}) = (10x) \text{ моль}$$

$$y = 9x$$



$$\text{CO}_2, \text{ тогда } J(\text{CO}_2)_{\text{осн}} = 9x - 2, \frac{J(\text{CO})}{J(\text{CO}_2)} = \frac{2}{7} \Rightarrow J(\text{CO}) = 22 \text{ моль}$$

$$\frac{V_{\text{над}}}{V_{\text{внеш}}} = \frac{V_{\text{над}} \cdot V_{\text{над}}}{J_{\text{внеш}} \cdot V_{\text{над}}} = \frac{1}{7,5}$$

стар 1 из 7

$$\frac{10x}{J_{\text{конеч}}} = \frac{1}{1,5} \Rightarrow J_{\text{конеч}} = (15x) \text{ моль}$$

$$J_{\text{конеч}} = J(CO)_{\text{пар}} + J(CO_2)_{\text{окис}} + J(CO)_{\text{нагр.}}$$

$$15x = x + 9x - 2 + 2x \\ 2 = 5x \Rightarrow J(CO_2)_{\text{окис}} = 9x - 5x = (4x) \text{ моль}$$

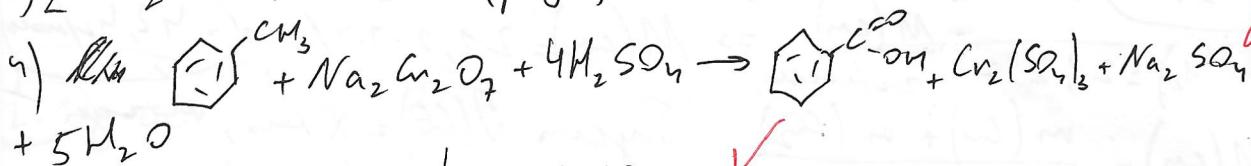
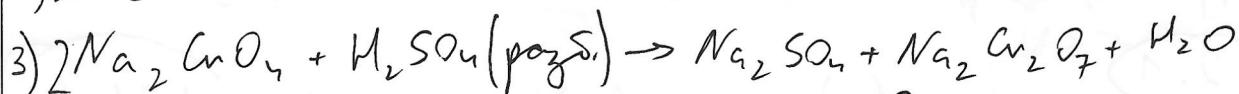
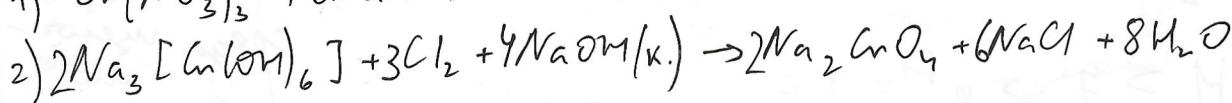
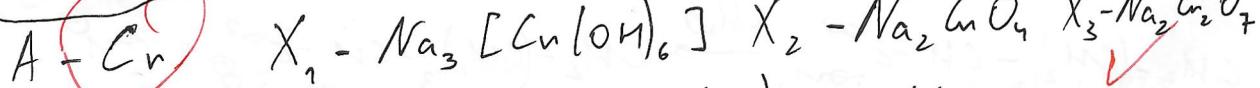
$$J(CO)_{\text{нагр.}} = 2 \cdot 5x = (10x) \text{ моль}$$

$$M(\text{ар}) = \frac{28 \cdot (x + 10x) + 44 \cdot 4x}{x + 10x + 4x} = \frac{484x}{15x} = 32,267 \text{ г/моль}$$

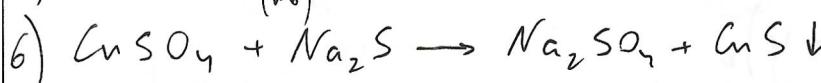
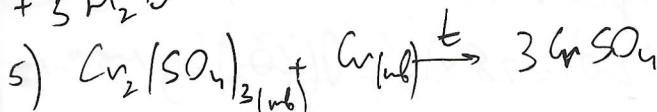
$$D(H_2) = \frac{M(\text{ар})}{22 \text{ г/моль}} = \frac{32,267 \text{ г/моль}}{22 \text{ г/моль}} = 16,133$$

$$\underline{\text{Ответ: }} D(H_2) = 16,133$$

✓ 6.5



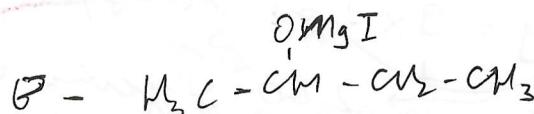
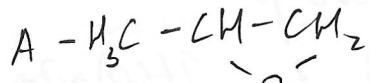
+ 5H₂O



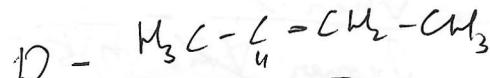
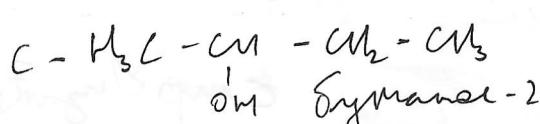
Cr₂S₄ - р-р синего цвета

Cr₂S₄ - серый

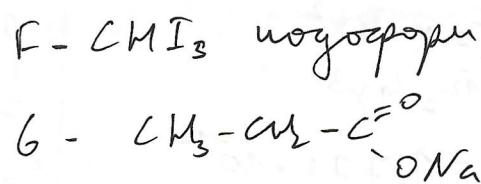
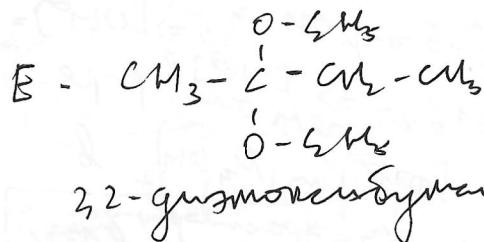
✓ 7.1



этанодиэтилена



\ /
Бутанол
стп 27



- 1) $\text{H}_3\text{C}-\text{CH}=\text{CH}_2 + \text{C}_6\text{H}_5\text{CO}-\text{O}-\text{O}-\text{H} \rightarrow \text{H}_3\text{C}-\overset{\underset{\text{O}^-}{\text{C}}}{{\text{CH}}_2}-\text{CH}_2 + \text{C}_6\text{H}_5\text{CO}-\text{OH}$ ✓
- 2) $\text{H}_3\text{C}-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + \text{C}_6\text{H}_5\text{MgI} \rightarrow \text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2-\text{CH}_3$ ✓
- 3) $\text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + \text{H}_2\text{O} \xrightarrow{\text{H}^+} \text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + \text{Mg(OH)}\text{I}$ ✓
- 4) $5\text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \rightarrow 5\text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + \text{K}_2\text{SO}_4 + 2\text{MnSO}_4$ ✓
- 5) $\text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + 2\text{CH}_3\text{COO}^- \rightarrow \text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2-\text{CH}_3 + \text{H}_2\text{O}$ ✓
- 6) $\text{CH}_3-\overset{\underset{\text{O}^-}{\text{CH}}}{\text{CH}}-\text{CH}_2 + 3\text{I}_2 + 4\text{NaOM} \rightarrow \text{CHI}_3 \downarrow + \text{CH}_3-\text{CH}_2-\overset{\underset{\text{O}^-}{\text{C}}}{{\text{Na}}^+}$ ✓
- $+ 3\text{NaI} + 3\text{H}_2\text{O}$

$$\mathcal{I}(\text{CuH}_8\text{O}) = \frac{m}{M} = 0,15 \text{ моль}$$

$$\frac{\mathcal{I}(\text{CuH}_8\text{O})}{\mathcal{I}(\text{CHI}_3)} = \frac{1}{1} \Rightarrow \mathcal{I}(\text{CHI}_3) = 0,15 \text{ моль}$$

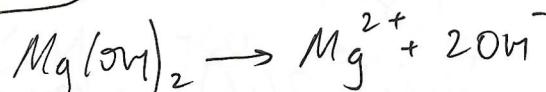
моль

$$\mathcal{I}_{\text{нр}}(\text{CHI}_3) = 0,15 \text{ моль} \cdot 0,75 = 0,1125 \text{ моль}$$

$$M(\text{CHI}_3) = 44,325 \text{ г}$$

$$\underline{\text{Очевидно: }} m(\text{CHI}_3) = 44,325 \text{ г}$$

№ 5.1



$$\text{Таким образом } [\text{Mg}]^{2+} = xM \text{ моль/л } [\text{Mg(OH)}_2] = xM, [\text{OH}^-] = 2xM$$

$$\text{НР} = [\text{Mg}^{2+}] \cdot [\text{OH}^-]^2$$

смр 3 из 7

$$7,1 \cdot 10^{-12} = x \cdot 4x^2$$

$$7,1 \cdot 10^{-12} = 4x^3$$

$$x^3 = 1,775 \cdot 10^{-12}$$

$$x = 1,2108 \cdot 10^{-4} \checkmark$$

расчл-римость $Mg(OH)_2 = \frac{1,2108 \cdot 10^{-4} \text{ моль/л}}{130,6 \text{ г/моль} \cdot \frac{\text{расчл-римость}}{\text{расчл-римость в 130,6}}} \text{ г/моль} \checkmark$

$$[OH^-] = 2x = 2,4216 \cdot 10^{-4} M$$

$$pOH = -\lg [OH^-] = 3,6159$$

$$pH = 14 - pOH = 10,3841$$

Однако: $pH = 10,3841 \checkmark$

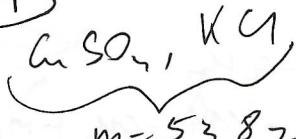
$pH = 12,5 \Rightarrow pOH = 1,5 \Rightarrow [OH^-] = 0,031622 \Rightarrow [OH^-] \text{ б-ре}$
б-ре $[OH^-]_{\text{он}} \text{ и } Mg(OH)_2 \text{ б-ре}$

$130,6 \text{ г/моль} \cdot \frac{\text{расчл-римость}}{\text{расчл-римость в 130,6}} \text{ г/моль} \checkmark$

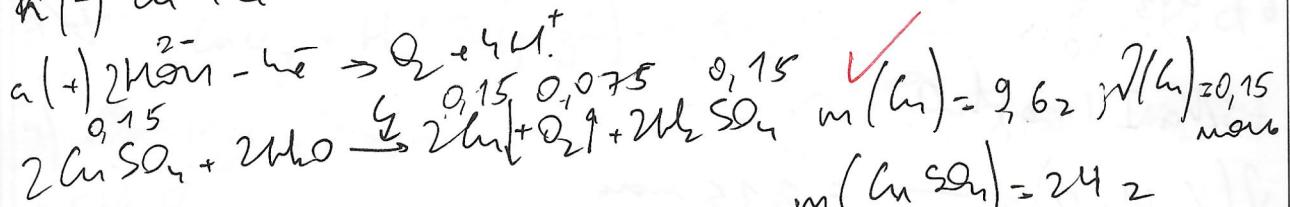
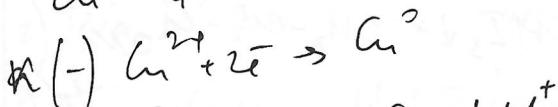
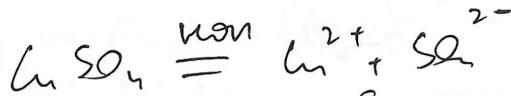
б-ре $\subset pH = 12,5$
из-за базисной $[OH^-]$

$Mg(OH)_2$ будет расчл-римое гораздо хуже, чем в к-ре. Количественно?

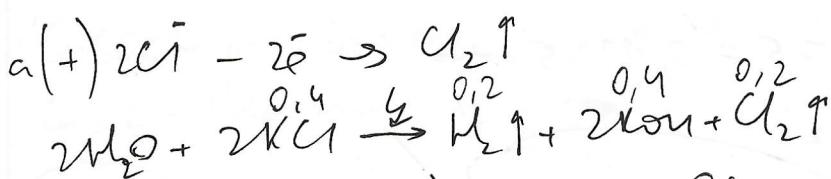
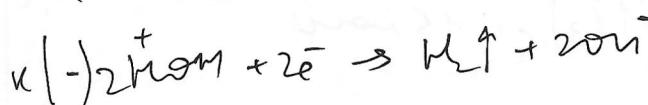
8.4



$$m = 53,82$$



$$m(CuSO_4) = 24,2$$



$$\frac{V(\text{газа на анион})}{V(\text{газа на катион})} = \frac{2}{3} = \frac{V(\text{газов}). V_{\text{ан}}}{V(\text{газов}). V_{\text{кат}}}$$

$$\frac{2}{3} = \frac{V(O_2) + V(Cl_2)}{V(H_2)}, \text{ т.к. } V(Cl_2) = V(H_2), \text{ то катионное соединение нейтрально} \rightarrow \text{стар 4 из 7}$$

нужен \downarrow ножи, когда все было разложено
 $2H_2O \xrightarrow{0,5x} H_2 + O_2$

Рисунок 2 (на схеме-2) - хром

$$m(KA) = 53,8_2 - 24_2 = 29,8_2; \vartheta(KA) = 0,4 \text{ моль}$$

$$\frac{\vartheta(KA)}{\vartheta(Ch)} = \frac{2}{1} \Rightarrow \vartheta(Ch) = 0,2 \text{ моль} = \vartheta(H_2)$$

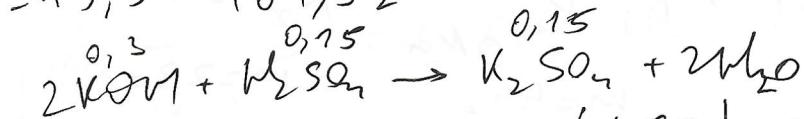
$$\frac{2}{3} = \frac{\vartheta(O_2) + \vartheta(Ch) + \vartheta(H_2)}{\vartheta(H_2) + \vartheta(H_2)} = \frac{0,075 + 0,2 + 0,5x}{0,2 + x}$$

$$0,4 + 2x = 0,825 + 1,5x$$

$$0,5x = 0,425$$

$$x = 0,85$$

$$m(\text{п-фа ноже } \downarrow) = 450 + 53,8 - 9,6 - 24 - 9,4 - 17,2 - 15,3 = 461,9_2$$



$$\vartheta(K_2Cr_2O_7)_{\text{сост}} = 0,1 \text{ моль} \quad m(K_2Cr_2O_7) = 26,1_2$$

$$m(K_2Cr_2O_7) = 5,6_2$$

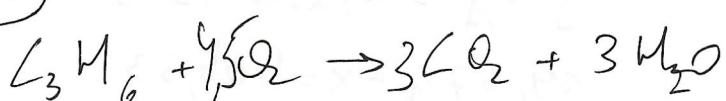
$$\vartheta(K_2Cr_2O_7) = \frac{5,6_2}{461,9_2} \cdot 100\% = 1,21\%$$

$$\vartheta(K_2SO_4) = \frac{26,1_2}{461,9_2} \cdot 100\% = 5,65\%$$

Ответ: $\vartheta(K_2Cr_2O_7) = 1,21\%; \vartheta(K_2SO_4) = 5,65\%.$

реакции

(4.4)



$$Q_x \cdot p = Q_{\text{водр}}(CO_2) \cdot 3 + Q_{\text{водр}}(H_2O) \cdot 3 - Q_{\text{водр}}(C_3H_6) \underset{\text{смр } 5 \text{ кг}}{=} 3 \cdot 393,5 +$$

$$3 \cdot 247,8 + 20,4 = 1926,3 \text{ кДж} = 1,9263 \cdot 10^6 \text{ Дж} \quad \checkmark$$

$$Q = C \cdot m \cdot \Delta t = C \cdot m \cdot (t_2 - t_1) \quad t_1 = 25^\circ \Rightarrow T_1 = 298 \text{ K}$$

геликис

$$Q = C(O_2) \cdot m(O_2)_{\text{акт}} \cdot \Delta t + C(CO_2) \cdot m(CO_2) \cdot \Delta t + C(H_2O) \cdot m(H_2O) \cdot \Delta t$$

$$= 7062 \Delta t + 23220 \Delta t + 28315,2 \Delta t = 37699,2 \Delta t$$

$$1,9263 \cdot 10^6 = 37699,2 \cdot \Delta t$$

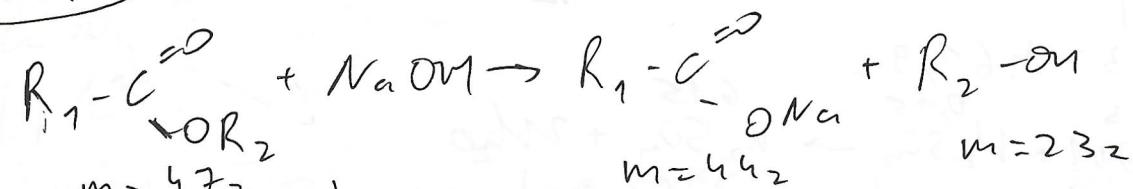
$$\Delta t = 51$$

~~$$t_2 - t_1 = 51^\circ$$~~

$$t_2 = 76^\circ \text{C}$$

~~$$\text{Ответ: } \underline{\underline{76^\circ \text{C}}} \quad (349 \text{ K})$$~~

N 3, 5



Пусть $M(R_1) = x \text{ г/моль}$, $M(R_2) = y \text{ г/моль}$

$$\frac{J(K-\text{моль})}{J(\text{эквивалент})} = \frac{1}{1} \Rightarrow J(K-\text{моль}) = J(\text{эквивалент}) = J(\text{стюдия})$$

$$J(\text{эквивалент}) = \left(\frac{47}{x+y+44} \right) \text{ моль}; \quad J(K-\text{моль}) \cdot \left(\frac{44}{x+67} \right) \text{ моль}$$

$$J(\text{стюдия}) = \left(\frac{23}{y+17} \right) \text{ моль}$$

$$\frac{47}{x+y+44} = \frac{44}{x+67} \Rightarrow 47x + 3149 = 44x + 44y + 1936$$

$$44y - 3x = 1213$$

$$44,67y - x = 404,33$$

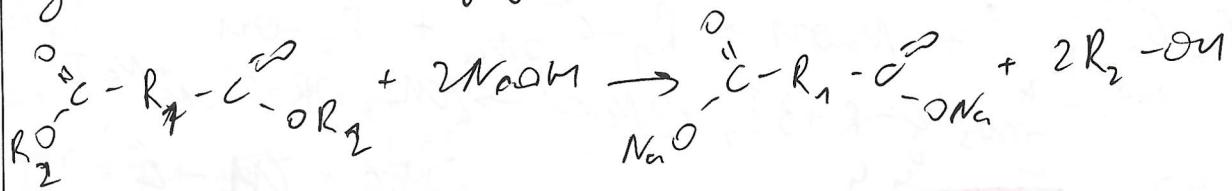
$$\frac{44}{x+67} = \frac{23}{y+17} \Rightarrow 44y + 748 = 23x + 1549$$

$$44y - 23x = 793$$

студ 6 ур

$$\begin{cases} M_67y - x = 404,33 \\ 44y - 23x = 793 \end{cases} \quad \begin{cases} x = 21 - \text{не суть} \\ y = 29 - \text{суть} \end{cases}$$

значим иона глюкозонат:

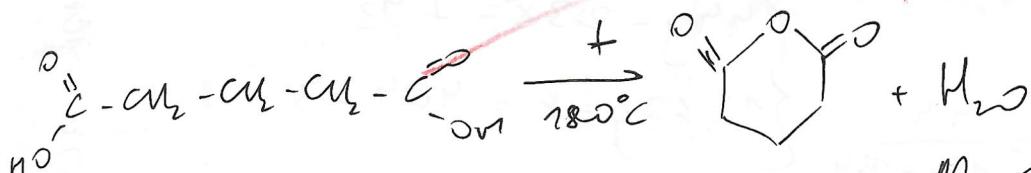
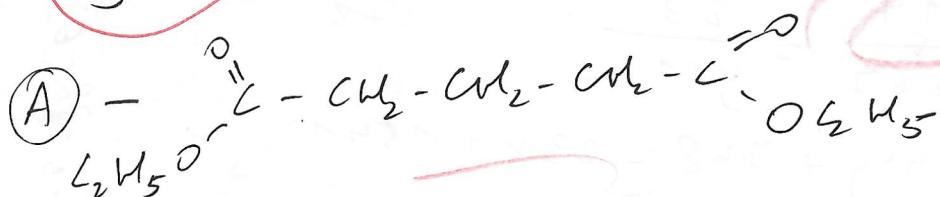


$$\left\{ \begin{array}{l} \frac{47}{x+2y+88} = \frac{44}{134+x} \\ 2 \end{array} \right.$$

$$\left\{ \begin{array}{l} \frac{44}{134+x} = \frac{23}{y+17} \\ 2 \end{array} \right.$$

$$\left\{ \text{м.н.} \quad \frac{\mathcal{D}(\text{умн})}{\mathcal{D}(\text{сумма})} = \frac{1}{2} \Rightarrow \mathcal{D}(\text{умн}) = 2\mathcal{D}(\text{сумма}) \right.$$

$$\left\{ \begin{array}{l} x = 42 \Rightarrow -(CH_2)_3- \\ y = 29 \Rightarrow C_2H_5- \end{array} \right.$$



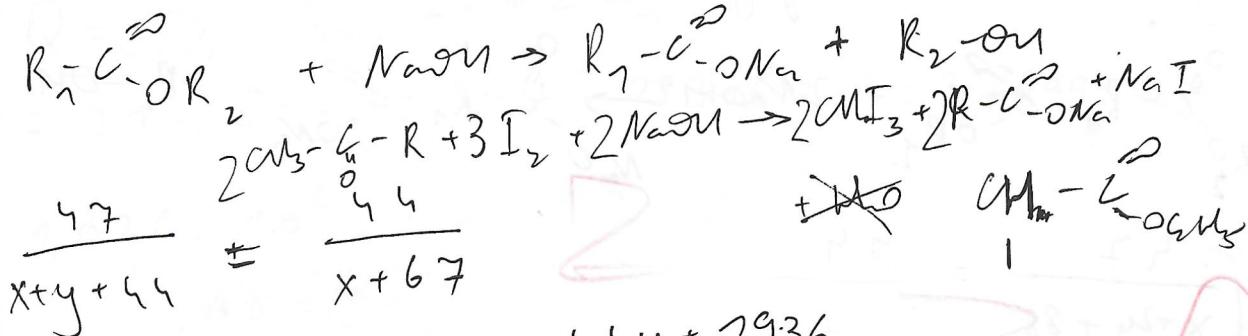
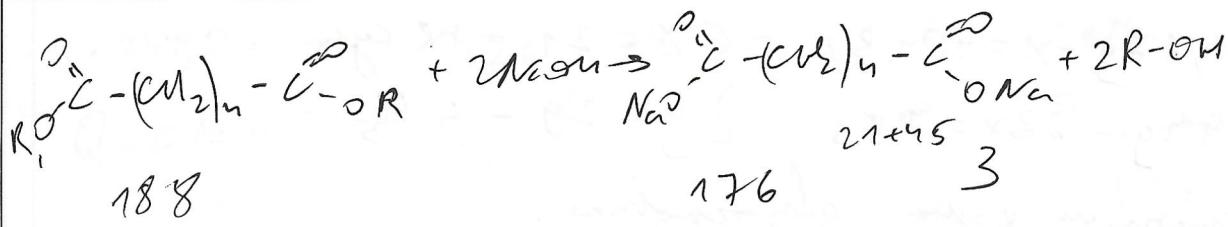
$$M = 132 \text{ г/моль}$$

$$M = 182 \text{ г/моль}$$

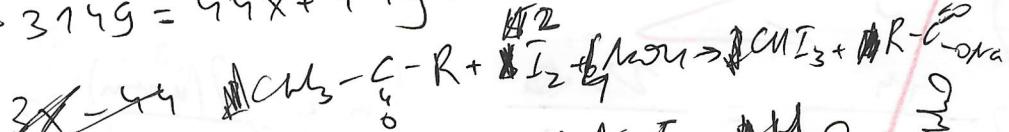
$$\omega = \frac{182 \text{ г/моль}}{132 \text{ г/моль}} \cdot 100\% = 13,69\%$$

Ответ: 13,69 %

стор 7 из 7

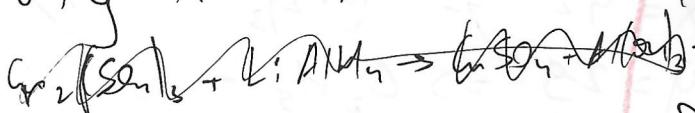


$$47x + 3149 = 44x + 44y + 1936$$



~~$$44y - 3x = 1213 + 3\text{NaI} + \text{H}_2\text{O}$$~~

~~$$14,67y - x = 404,33$$~~



~~$$\frac{47}{x+67} = \frac{44}{y+17} \quad 176$$~~

~~$$44y + 748 = 23x + 1541$$~~

~~$$\left\{ \begin{array}{l} 44y - 23x = 793 \\ 14,67y - x = 404,33 \end{array} \right.$$~~

~~$$\frac{47}{m_n + 2x + 88} = \frac{44}{14n + 134}$$~~

~~$$658n + 6298 = 616n + 88x + 3872 \quad -293,47y = -8506,59$$~~

~~$$42n - 88x =$$~~

~~$$88x - 42n = 2426$$~~

~~$$y = 29 \Rightarrow \text{CH}_3-\overset{\text{O}}{\underset{\text{C}}{\text{C}}}-\text{R}-\overset{\text{O}}{\underset{\text{C}}{\text{C}}}-\text{ONa}$$~~

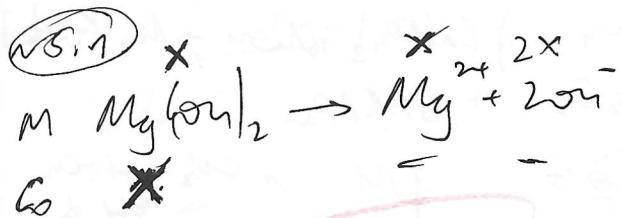
~~$$x = 21$$~~

~~$$\text{CH}_3-\overset{\text{O}}{\underset{\text{C}}{\text{C}}}-\text{R}-\overset{\text{O}}{\underset{\text{C}}{\text{C}}}-\text{ONa} \quad \frac{44}{14n + 134} = \frac{23}{x+17}$$~~

~~$$44x + 748 = 322n + 3082$$~~

ЧЕРНОВИК

Смр 1 из 5



суп. бор

cp

$$\Pi P = 7,1 \cdot 10^{-12} = [\text{Mg}^{2+}] \cdot [\text{OH}^-]^2$$

$$7,1 \cdot 10^{-12} = x \cdot 4x^2$$

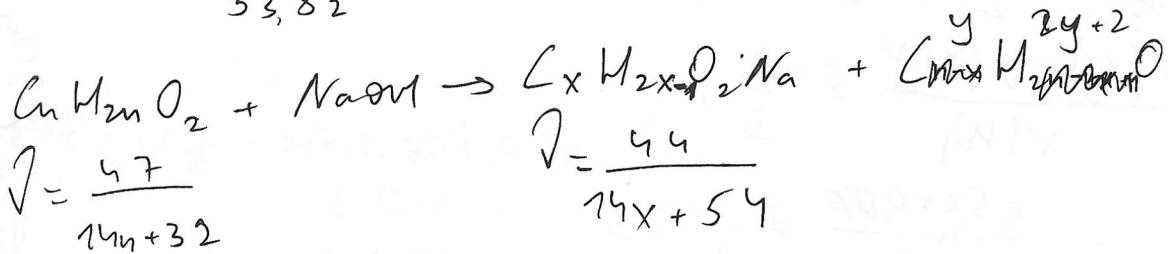
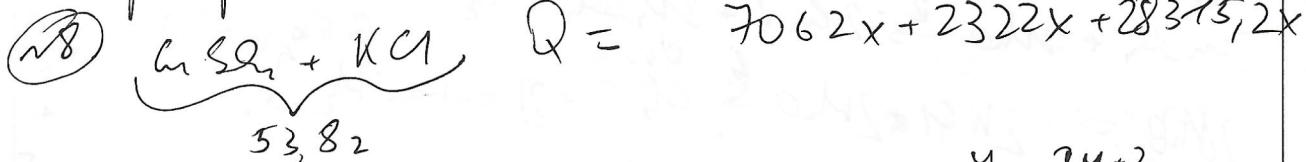
$$x = 1,21 \cdot 10^{-4}$$

$$\text{pH} = -\lg [\text{OH}^-] = 3,616 \quad ([\text{OH}^-] = 3,42 \cdot 10^{-4})$$

$$\text{pH} = 10,384$$

$$\text{pH} = 13,5 \Rightarrow \text{pOH} = 1,5 \Rightarrow [\text{OH}^-] = 0,03162$$

а при растворении



$$658x + 2538 = 676n + 1408$$

$$676n - 658x = 1130$$

$$\frac{47}{14n+32} = \frac{23}{14n-14x+16}$$

$$658n - 658x + 2538 = 322n + 736$$

$$336n - 658x =$$

$$\frac{47}{14n+32} = \frac{23}{14y+18}$$

$$658y + 846 = 322n + 736$$

$$658y - 322n =$$

суп. 2y5

$$322n - 658y = 120$$

ЧЕРНОРИК

~~11,77~~ ~~11,77~~, ~~11,77~~

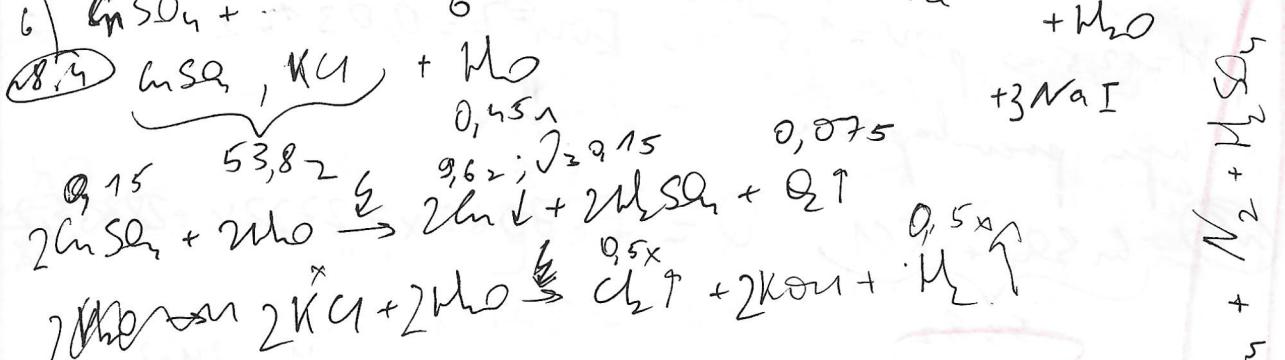
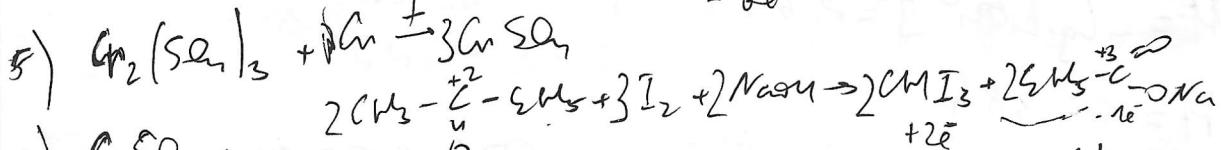
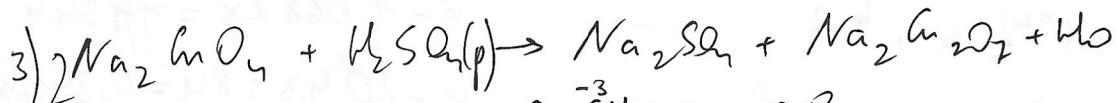
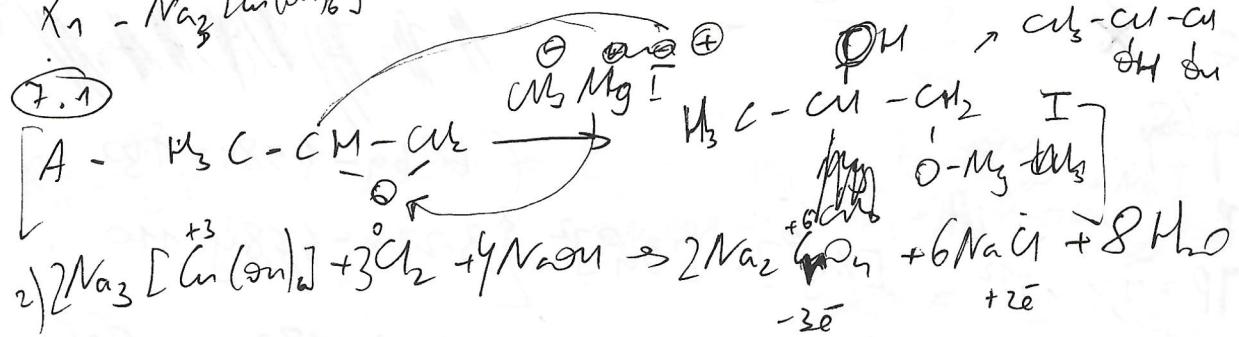
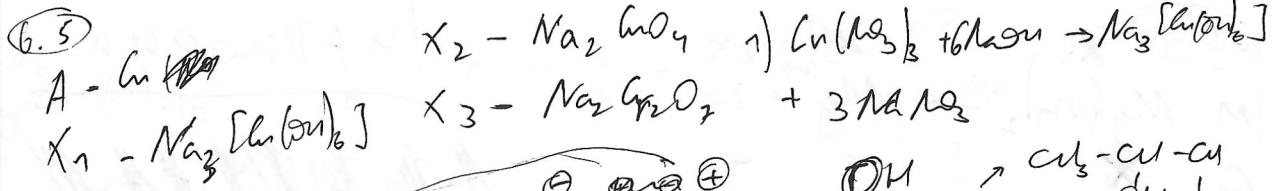
$$676n - 658x = 1130$$

$$322n - 658y = 120$$

$$n - 1,0682x = 18344$$

$$n - 204348y = 0,341625$$

ЛИСТ-ВКЛАДЫШ

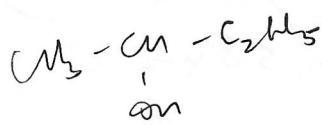
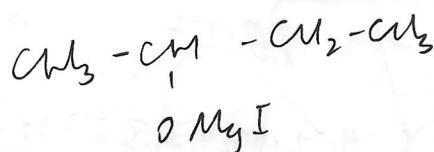
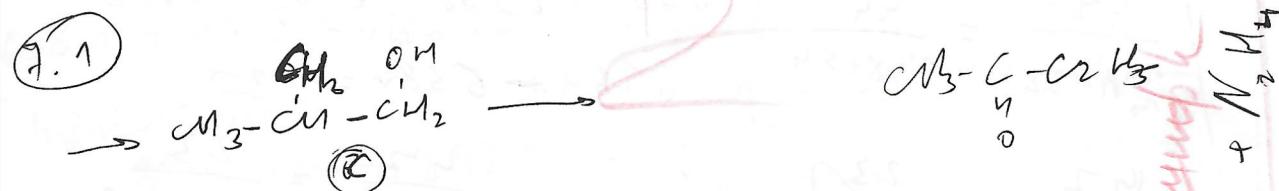


$$\frac{V(\text{O}_2) + V(\text{Cl}_2)}{V(\text{H}_2)} = \frac{2}{3}$$

$$\frac{0,5x + 0,075}{0,5x} = \frac{3}{2} \Rightarrow x = 0,3$$

$$m = 22,35$$

$$x + 0,15 = 1,5x$$

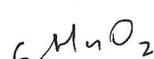
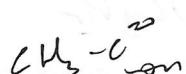
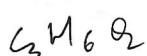
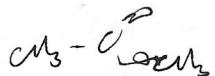
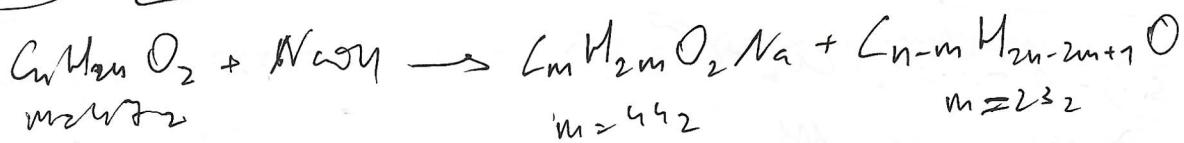


чертеж 3 из 5

Черновик

(3, 5)

Черновик



$$J(1) = \frac{47}{14n+32}$$

$$J(2) = \frac{44}{14m+55}$$

$$J(3) = \frac{23}{14n+14m+17}$$

$$658m + 2585 = 616n + 7708$$

$$658m = 616n - 658$$

$$616n - 658m = 1177$$

$$\frac{42}{14m+32} = \frac{44}{14m+55}$$

~~$$1177 = 1,0682 \cdot 1,9107$$~~

$$616n - 616m + 748 = 322m + 7265$$

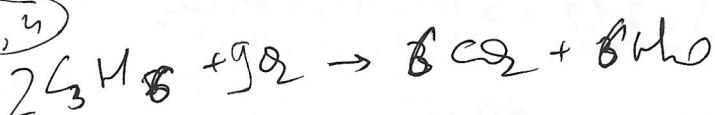
$$616n - 938m = 517$$

$$n = 1,52273m - 0,8393$$

$$0,45453m = 1,0774$$

$$m = 236 -$$

(4, 4)

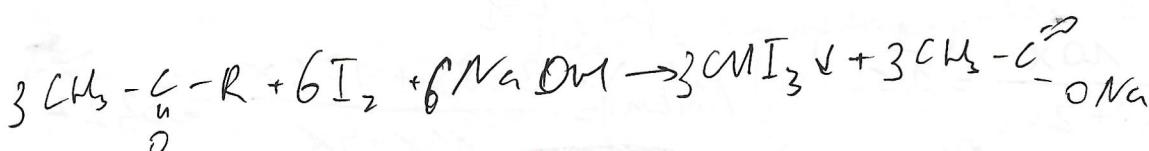


$$Q_{\text{изр}} = -20,4 \quad - \quad 393,5 \quad 241,8$$

$$Q_{\text{х.п.}} = 38536 \text{ Дн}$$

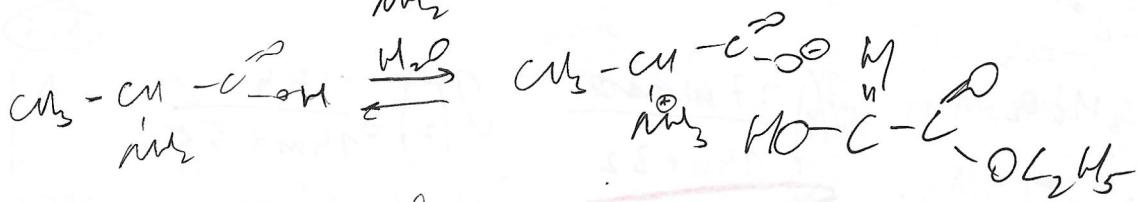
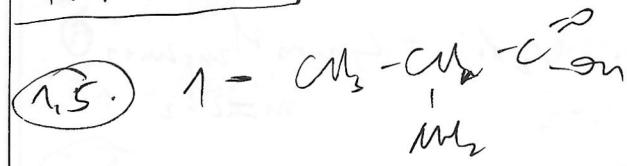
$$\left. \begin{array}{l} Q_{\text{х.п.}} = Q_{\text{изр}} - Q_{x.p} \\ Q_{\text{х.п.}} = Q_{\text{изр}} - Q \end{array} \right\} Q = 1926,3 \text{ кДн}$$

$$Q = C \cdot M \cdot \Delta t = 1,9263 \cdot 10^6 =$$

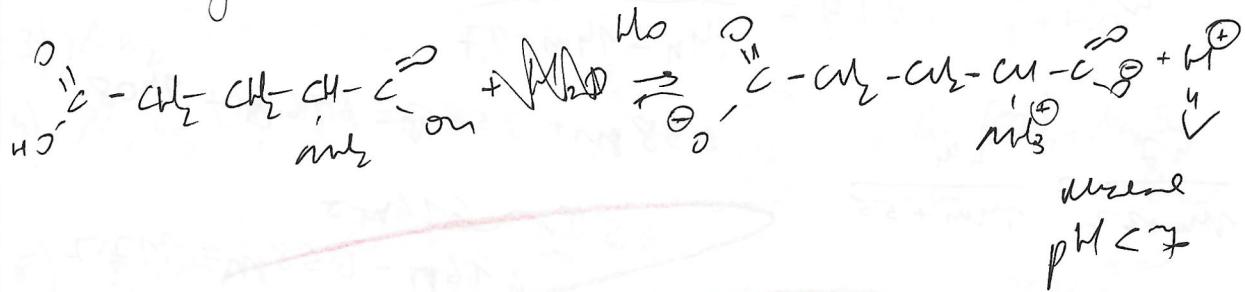


смл 4 из 5

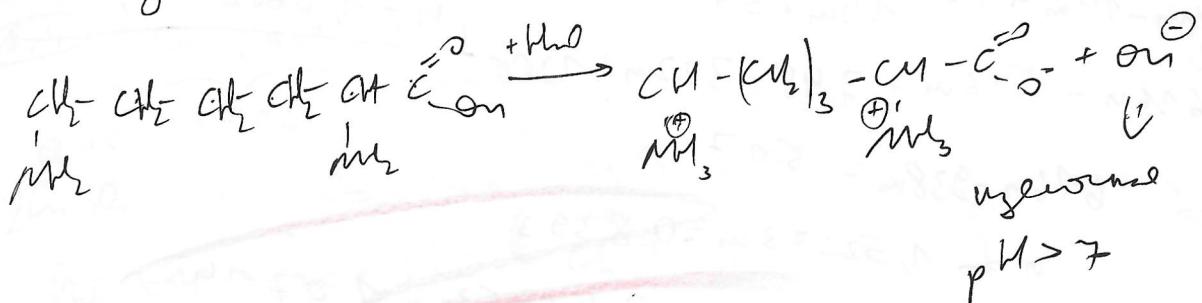
ЧЕРНОВИК



2 - нуклеофильное



3 - окисл.



2.1 $\text{CO}, \text{CO}_2 \quad D(\mu_2) = 21,2 \Rightarrow M = 42,42/\text{моль}$

$$42,4 = \frac{28x + 44y}{x + y}$$

$$36y = 14,4x$$

$$y = 9x$$



~~$\frac{10x}{x+2} = 1,5$~~

~~$\frac{10x}{2} = 1,5$~~

$$\frac{10x}{10x + 2} = \frac{1}{1,5}$$

$$15x = 10x + 2$$

$$2 = 5x$$

имп 5 из 5

$$M(\text{моль}) = \frac{308x + 176x}{11x + 4x} = 32,27$$

$$D(\mu_2) = \underline{\underline{15,135}}$$