



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

ОЛИМПИАДНАЯ РАБОТА

Наименование олимпиады школьников: **«Ломоносов»**

Профиль олимпиады: **Химия**

ФИО участника олимпиады: **Улантимова София Сергеевна**

Класс: **11**

Технический балл: **94**

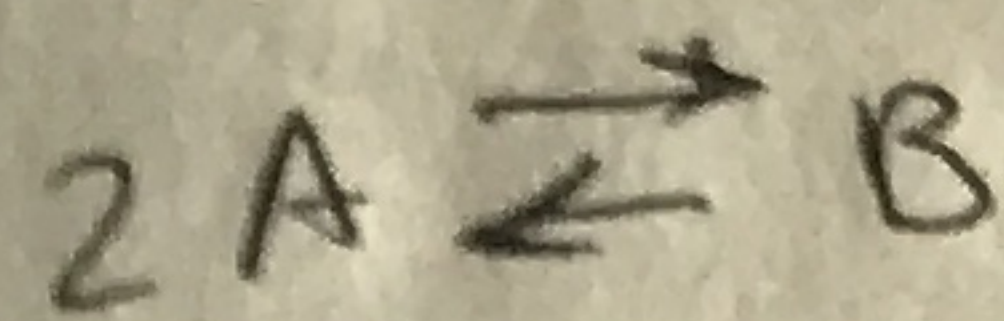
Дата проведения: **27 февраля 2022 года**

1. 86
2. 166
3. 106 неправильная К_{обр}
4. 206
5. 206
6. 206
7. Сумма 946

№3 Вариант 1

$V = 1 \text{ л}$ $T = 303 \text{ K}$

$\frac{n_p(B)}{n(A)} = 1,86$



$P_p = 1 \text{ атм}$

$\frac{n(B)}{n(A)} = \frac{P(B)}{P(A)} = \frac{\chi(B)}{\chi(A)}$

$M_{cp} = 75,9 \text{ г/моль}$

~~$\frac{x-2y}{y} = 1,86 = \frac{x}{y} \cdot 2 \cdot \frac{y}{x-2y} = 1,86$~~

	P_0	ΔP	P_p
A	x	-2y	x-2y
B	0	+y	y
Σ	x	-2y+y=-y	x-y

$\frac{x}{y} = \frac{1}{1,86} + 2 = 2,86$

$\frac{x-2y}{y} = \frac{1}{1,86}$

~~$x = 2,86y$~~

~~$P_p(A) = x-2y = 1,86y - 0,538y$~~

~~$P_p = 2,86y = 1 \text{ атм}$~~

$y = \frac{1}{2,86} \text{ атм} = \frac{101325}{2,86 \cdot 1,538} \text{ Па} = 65881$

~~$35428,322 \text{ Па}$~~

$\chi_A = \frac{1,86y}{2,86y} = 0,65$

$\chi_B = \frac{1,86}{2,86} = 0,65$

$M_{cp} = \frac{M_A \chi_A + M_B \chi_B}{\chi_A + \chi_B}$

$75,9 = 0,65 M_A + 0,65 M_B$

$n_{\Sigma} RT = P_{\Sigma} V$ $n_{\Sigma} = \frac{101325 \cdot 10^{-3}}{8,314 \cdot 303} = 0,04 \text{ моль}$

~~$n_B = \chi_B n_{\Sigma} = 0,026 \text{ моль}$~~

~~$n_A = 0,014 \text{ моль}$~~

~~$M_A = 216,857 - 1,857 M_B$~~

~~$2M_A = M_B$~~

~~$2M_A + 1,857 M_A = 216,857$~~

~~$M_A + 2 \cdot 1,858 M_A = 216,857$~~

~~$3,857 M_A = 216,857$~~

~~$M_A = \frac{216,857}{4,716} = 46$~~

~~$M_A = 56,224$ $M_B = 112,448$~~

~~$A = NO_2$~~

~~$K_p = \frac{k_1}{k_{-1}}$ $k_{-1} = \frac{k_1}{K_p} = \frac{5 \cdot 10^{-3}}{1,86}$~~

~~$B = N_2O_4$~~

~~$K_p = \frac{[B]}{[A]^2} = \frac{1,86}{1^2} = 1,86$~~

$$\frac{33,876 \cdot M(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O})}{M(\text{Na}_2\text{CO}_3) - M(\text{CO}_2) + M(\text{H}_2\text{O})} = m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 0,14 \cdot M(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O})$$

$$m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 40,332$$

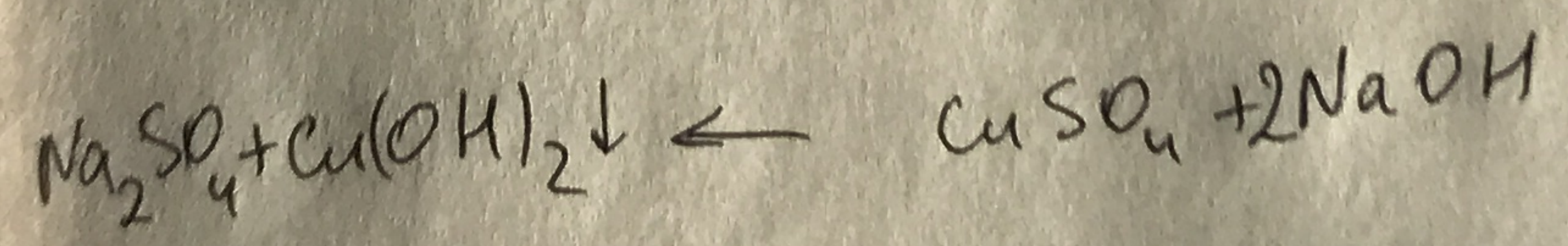
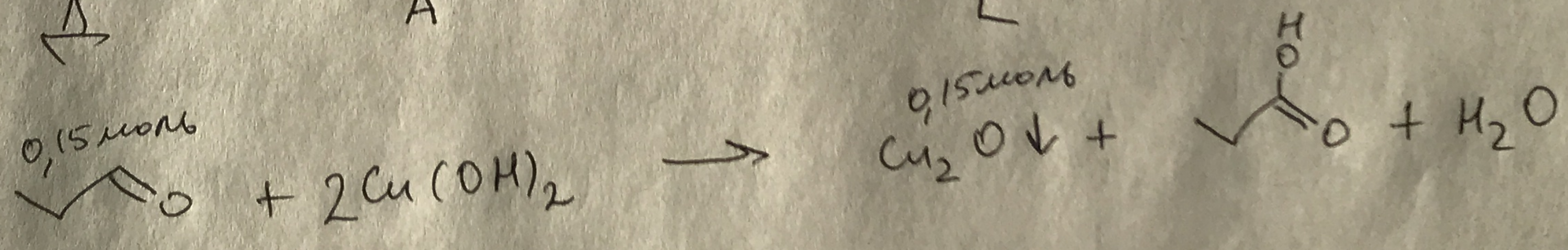
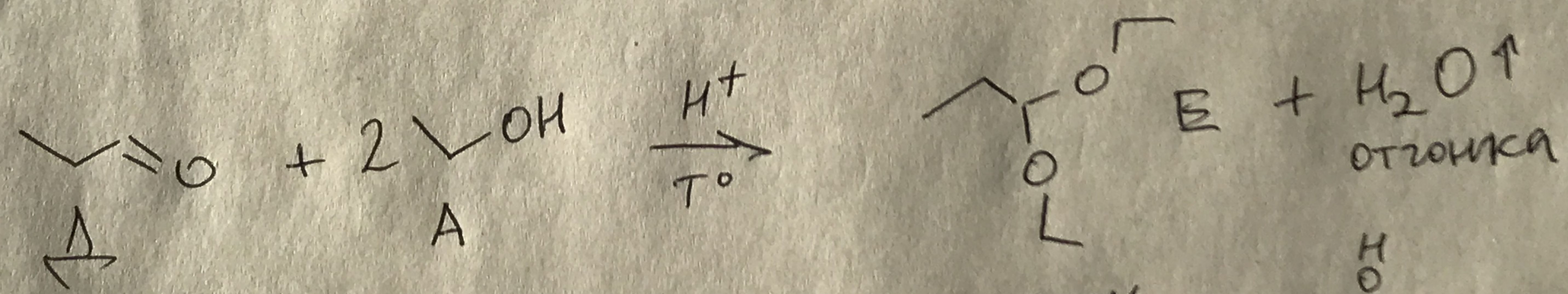
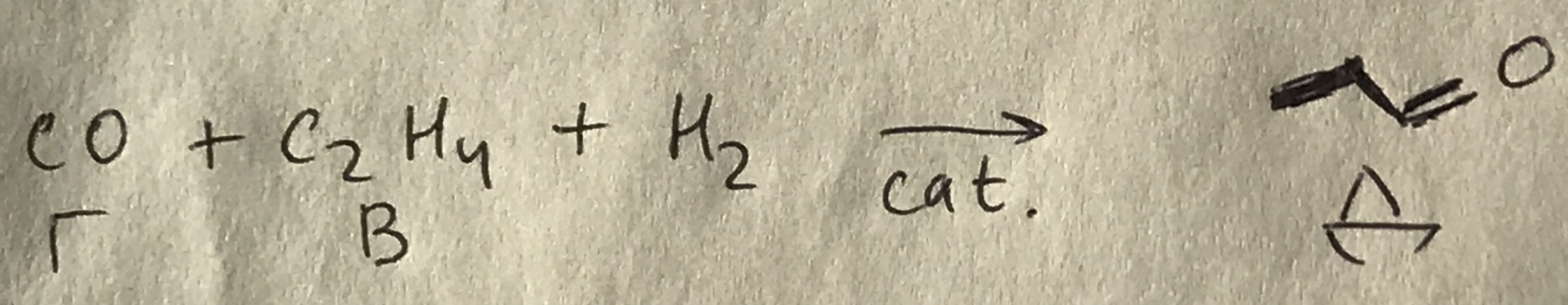
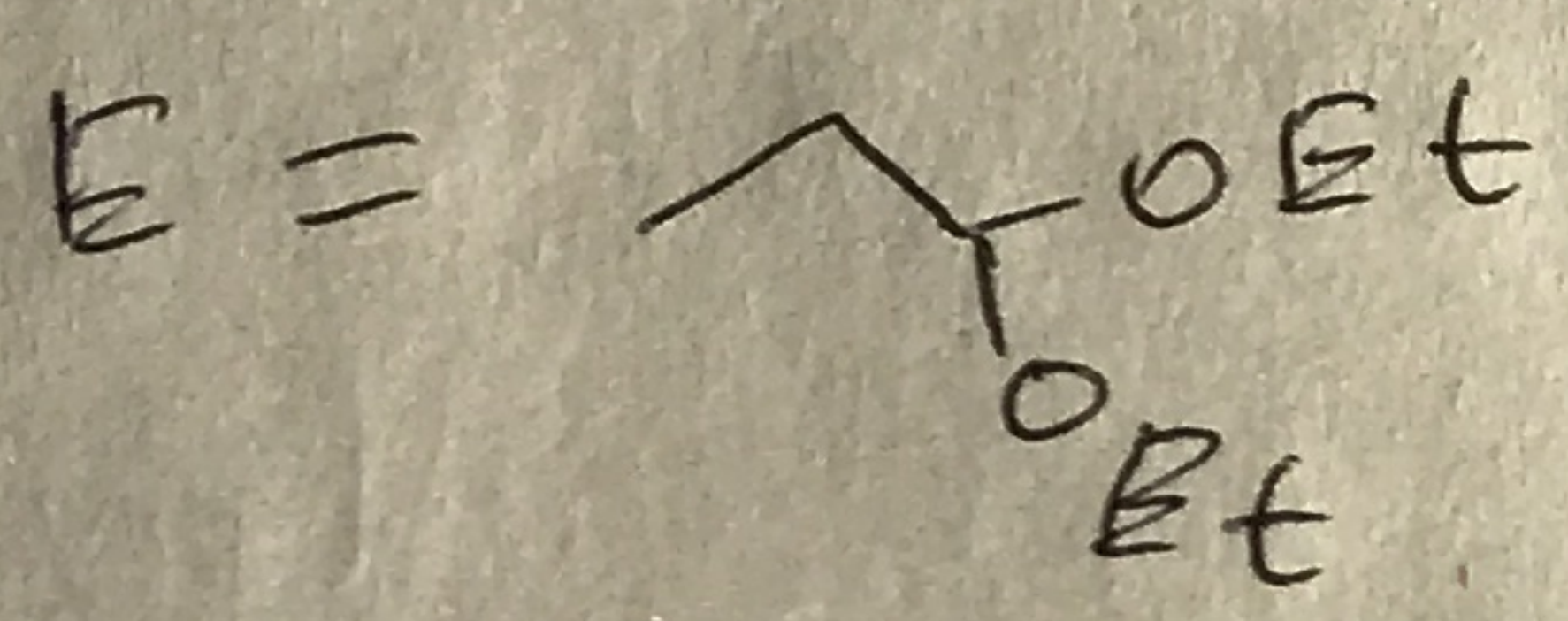
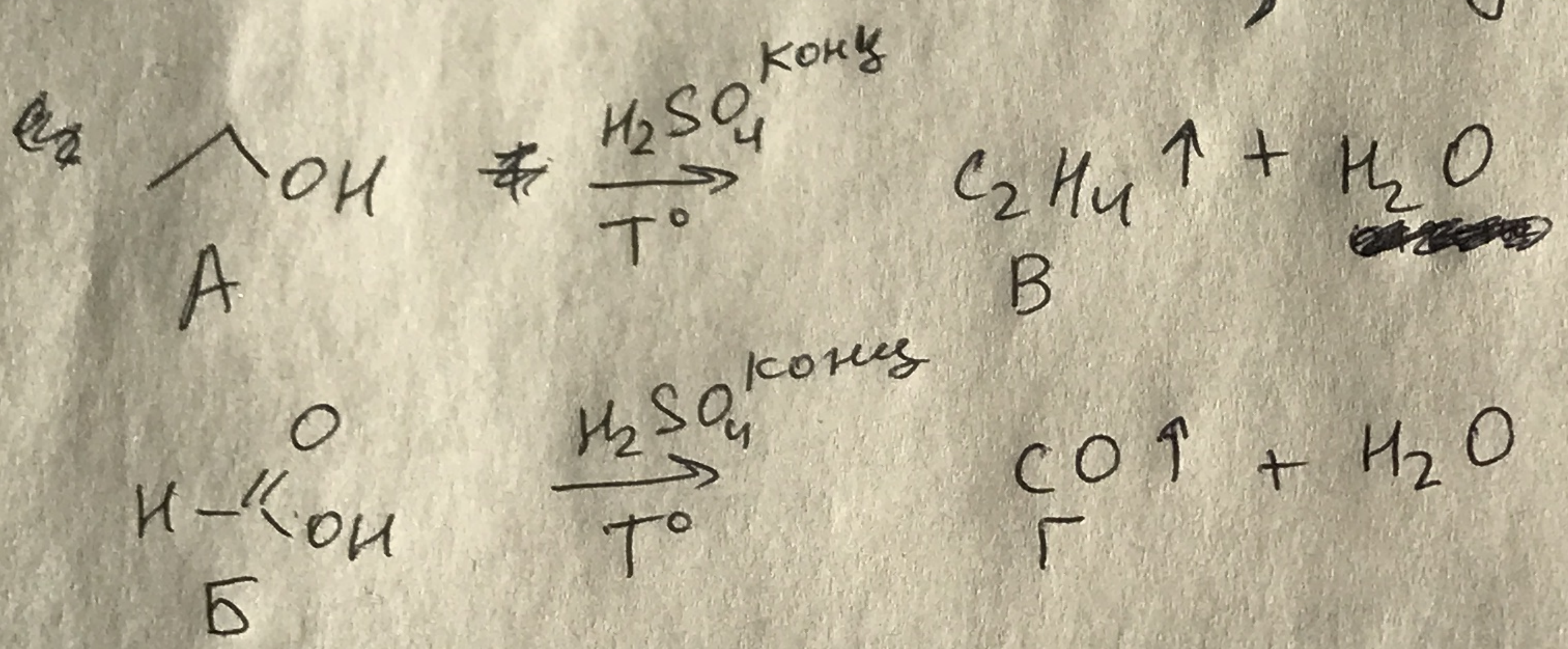
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осадок - Cu_2O - 21,62 - 0,15 моль
 Δ - альдегид
 $M_{\text{ср}} = 0,875 \cdot M(\text{O}_2) = 28 = M(\text{CO}) = M(\text{N}_2)$ - не вьед.
 от H_2SO_4
 $M(\text{C}_2\text{H}_4)$

В и Г - CO и C_2H_4 Нет указаний, различающих А от Б или В от Г. Пусть А = EtOH ,



Б = HCOOH , тогда В = C_2H_4 , Г = CO .



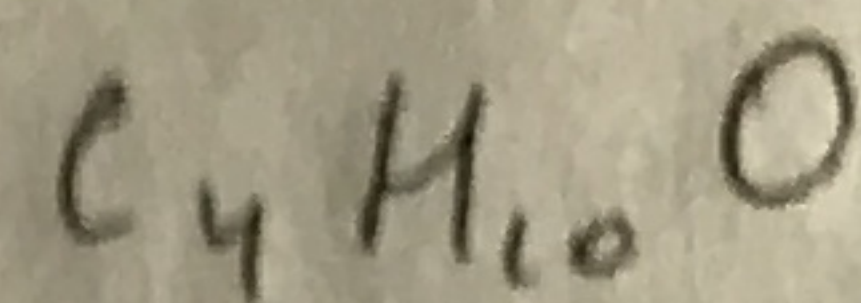
$m(\Delta) = 0,15 \cdot M(\text{C}_3\text{H}_6\text{O}) = 8,71172 \sim 8,72 = m(\Delta)$

№1 Вариант 1

$$\begin{cases} 42e = 6n_c + 1n_H + 8n_{ox} \\ 32 = 6n_c + n_H + 8n_{ox} \end{cases}$$

n_{ox}	1	2	3
n_c	4	2,67	1,33
	цел.	нецел.	нецел.

$$n_c = \frac{32 - 8n_{ox}}{6} = \frac{16}{3} - \frac{4}{3}n_{ox}$$

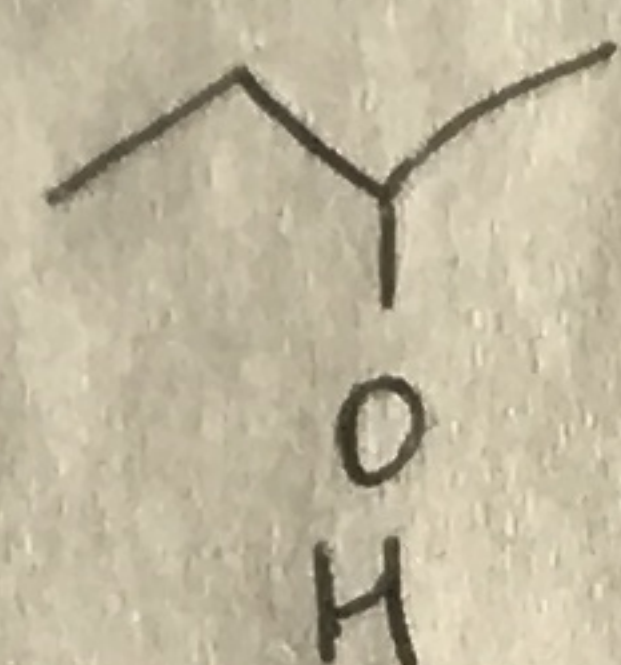
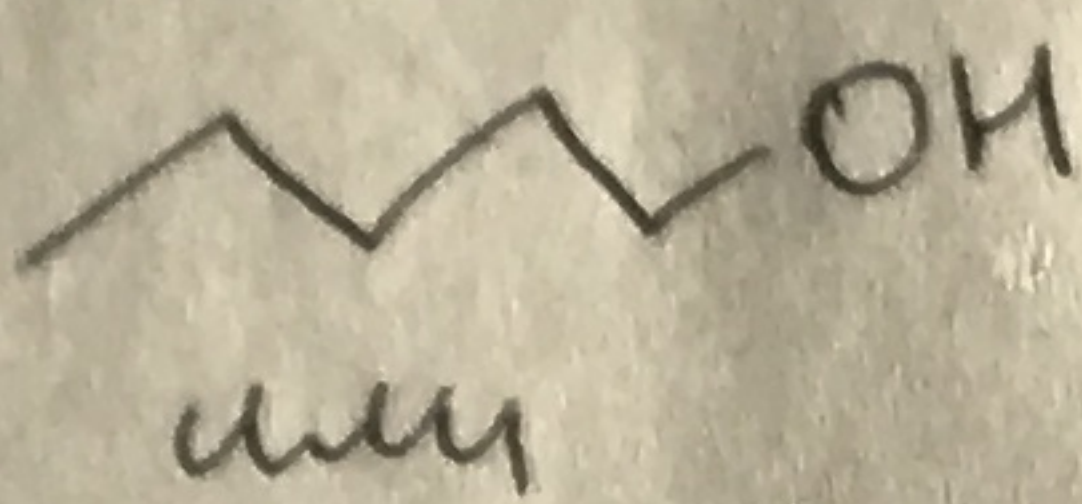
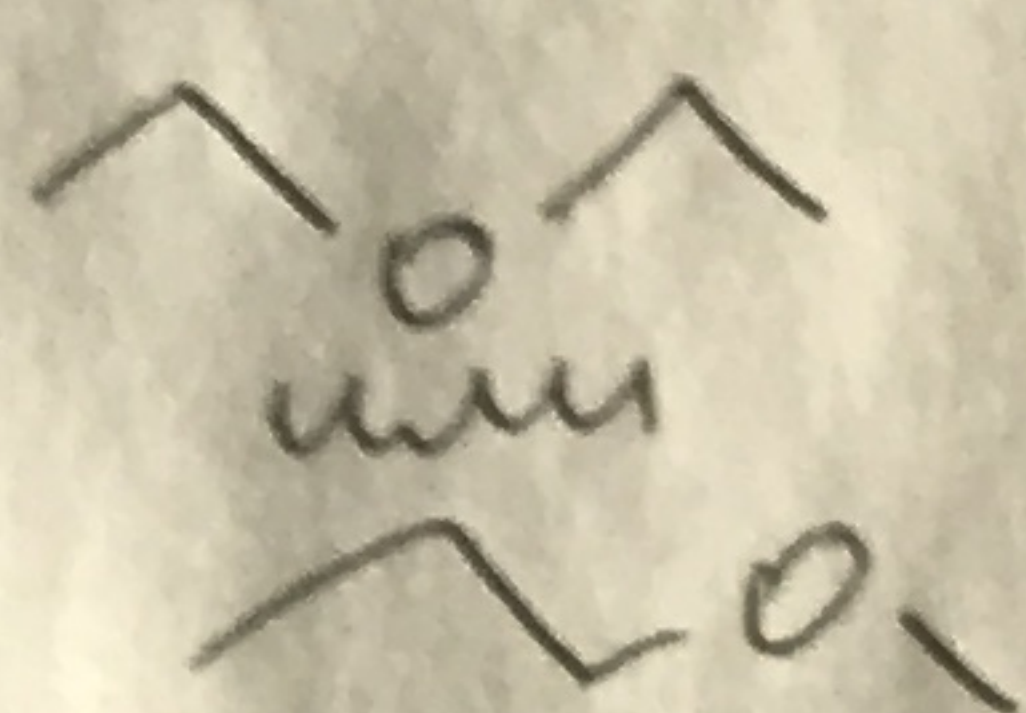
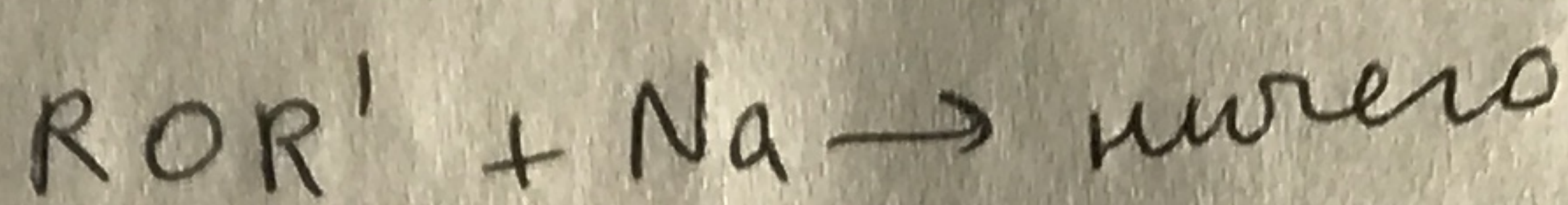
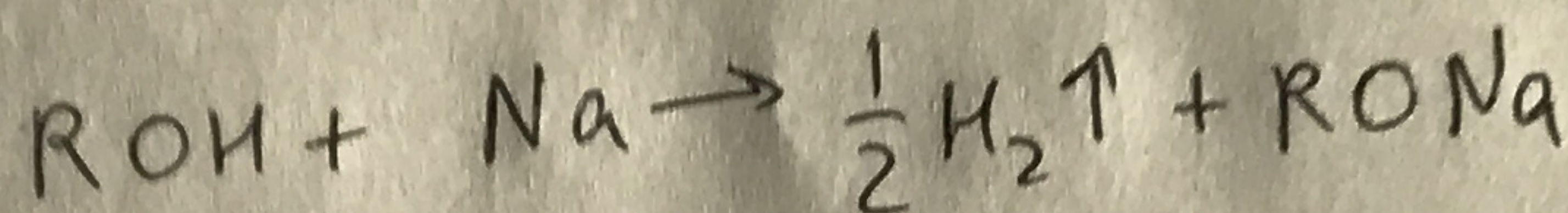


$$42 = 32 - 8n_{ox} + 1n_H + 8n_{ox} = 32 + n_H$$

$$n_H = 10$$

$$\frac{2n_c + 2}{2} = \frac{8+2}{2} = 5 = \frac{n_H}{2} \Rightarrow \text{соед. насыщ.}$$

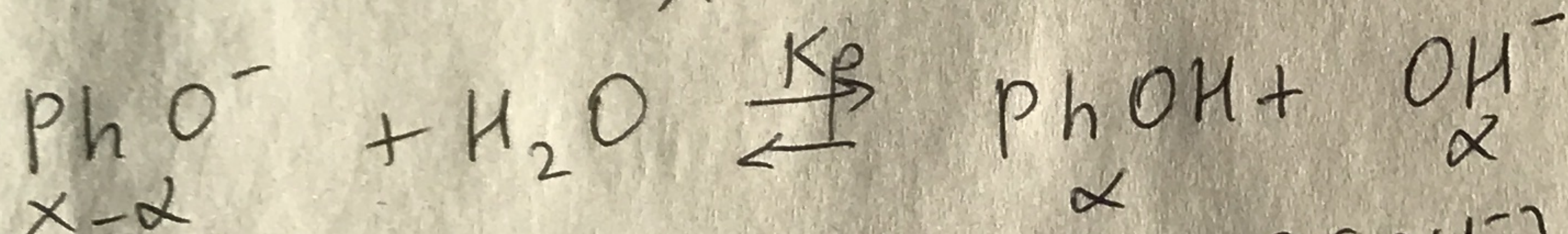
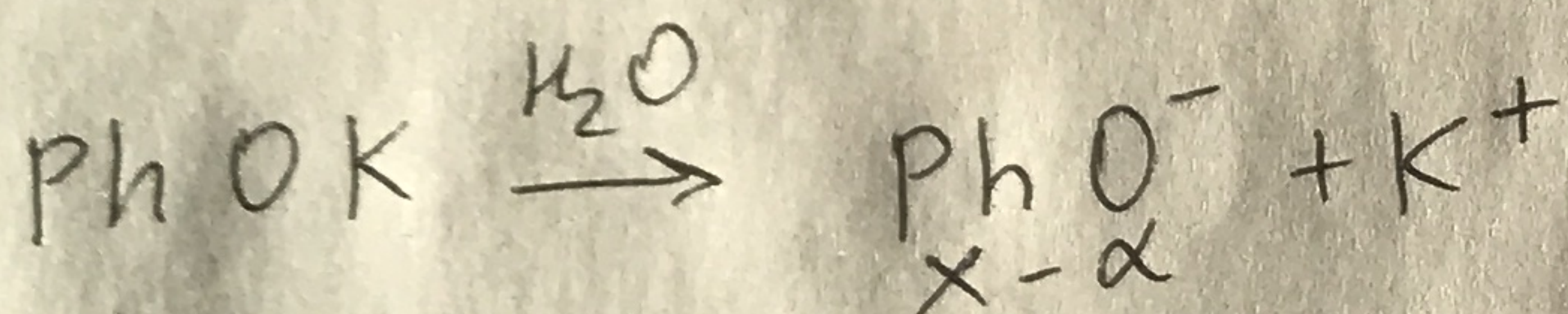
классы: простой эфир и спирт



№2

$$pH = 11$$

$$c(PhOK) = ? = x. K_{гис} = \frac{[PhO^-][H^+]}{[PhOH]} = 10^{-10}$$



$$c(OH^-) = \frac{10^{-14}}{10^{-11}} = 10^{-3}$$

$$[OH^-] = 10^{-3} = \alpha. K_p = \frac{[PhOH][OH^-]}{[PhO^-]} = \frac{[PhOH] \cdot 10^{-3}}{[H^+][PhO^-]} = \frac{10^{-14}}{K_{гис}}$$

$$K_p = \frac{10^{-14}}{10^{-10}} = 10^{-4}$$

$$10^{-4} = \frac{\alpha \cdot 10^{-3} \cdot \alpha}{x - \alpha}$$

~~$$10^{-4} x - 10^{-4} \alpha = 10^{-3} \alpha$$~~
~~$$10^{-4} x = \alpha (10^{-3} + 10^{-4})$$~~

$$\frac{10^{-3} \cdot 2}{x - 10^{-3}} = 10^{-4}$$

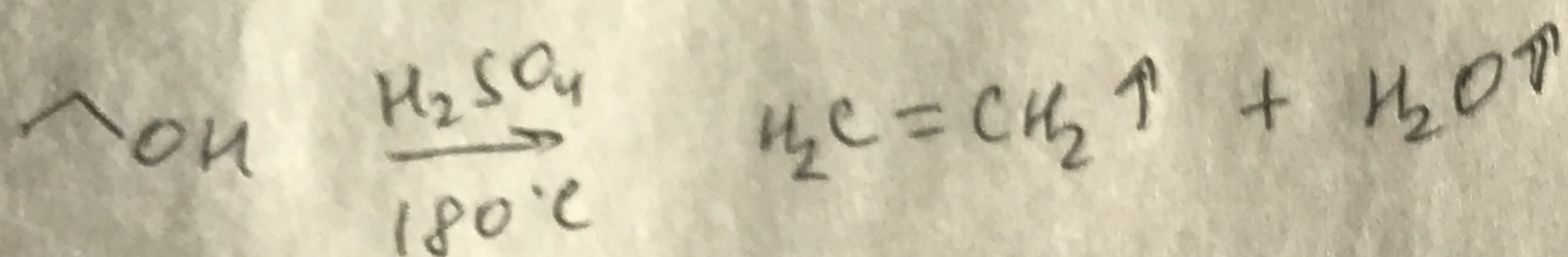
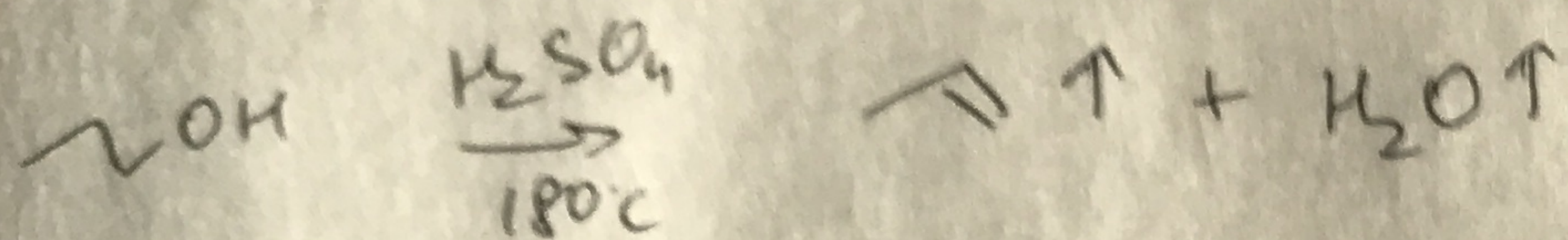
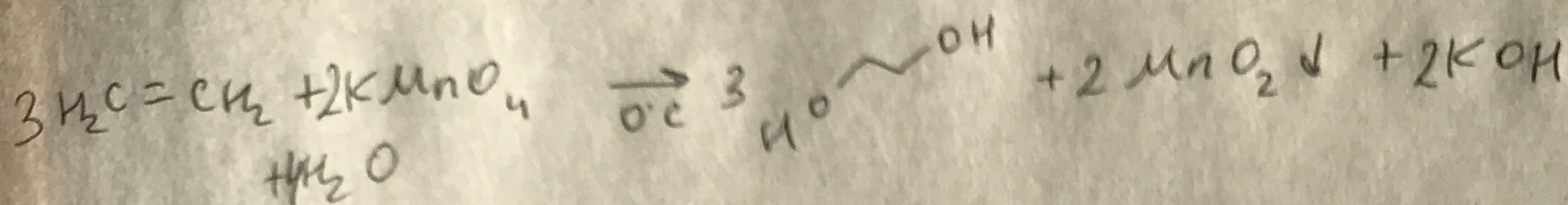
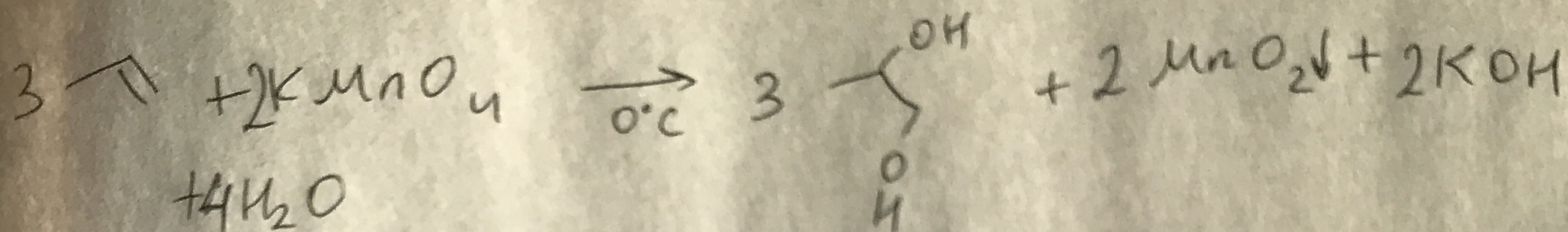
$$10^{-6} = 10^{-4} x - 10^{-7}$$

$$x = (10^{-6} + 10^{-7}) \cdot \frac{1}{10^{-4}}$$

$$x = 11 \cdot 10^{-6} \cdot 10^4 = 1,1 \cdot 10^{-2}$$

Ответ: $c(PhOK) = 0,011 M$.

①



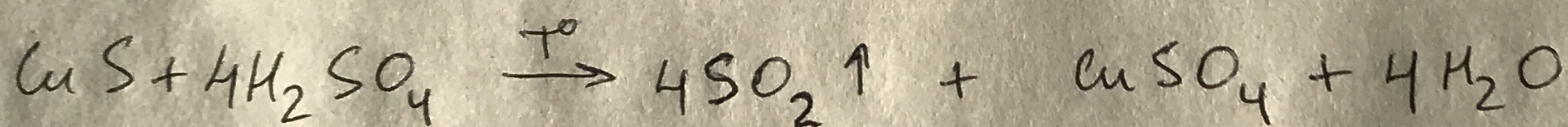
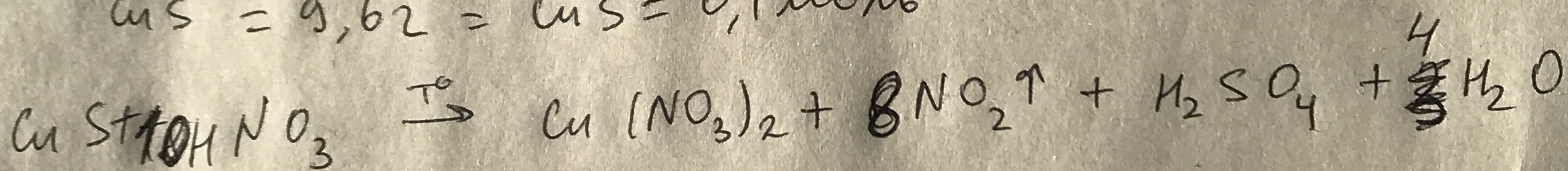
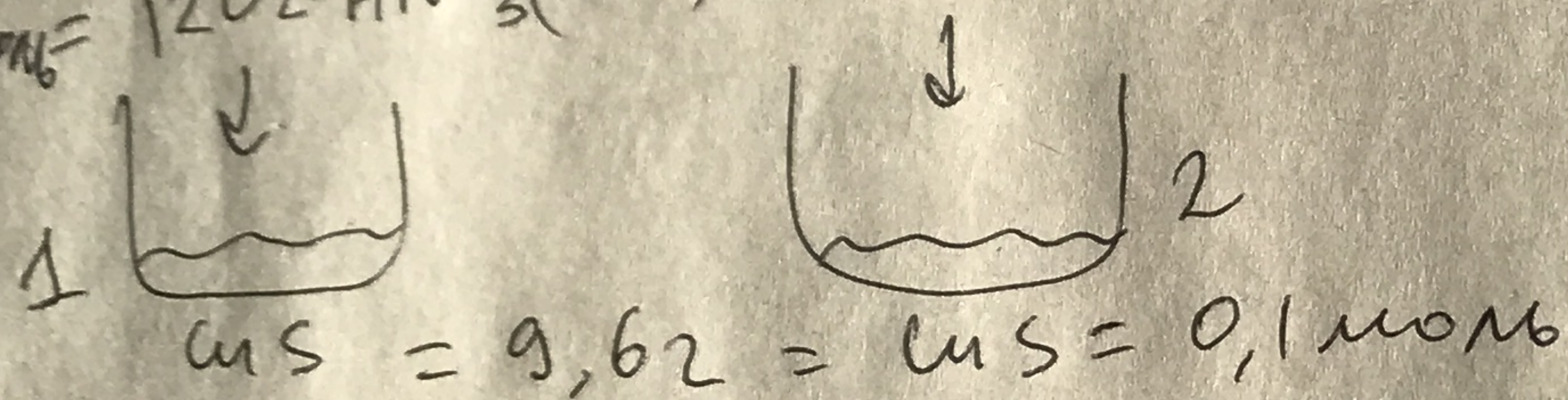
2 моль KMnO_4 на 3 моль алкенов

$$\frac{2}{3} = \frac{x}{0,3} \quad x = 0,2 \text{ моль}$$

$$V = \frac{n}{c} = \frac{0,2}{0,4} = 0,5 \text{ л} = V(\text{KMnO}_4)$$

№5

$$1,2 \text{ моль} = 120\text{г} - \text{HNO}_3(63\%) \quad 142,72 - \text{H}_2\text{SO}_4(98\%) = 1,426 \text{ моль}$$



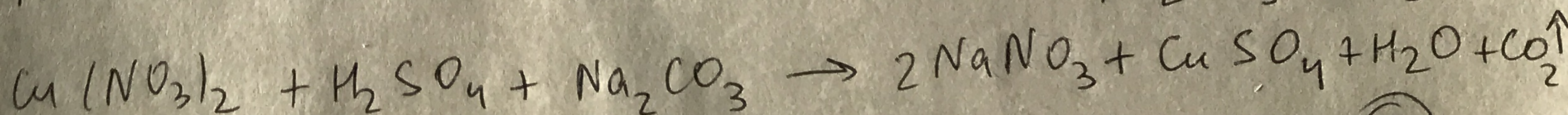
$$n(\text{NO}_2 \uparrow) = 8n(\text{CuS}) = 0,8 \quad m(\text{NO}_2) = 0,8 \cdot M(\text{NO}_2) = 36,82$$

$$m_K(1) = 120 + 9,6 - 36,8 = 92,82$$

$$n(\text{SO}_2 \uparrow) = 4n(\text{CuS}) = 0,4 \quad m(\text{SO}_2) = 0,4 \cdot M(\text{SO}_2) = 25,6242$$

$$m_K(2) = 142,7 + 9,6 - 25,6242 = 126,6762$$

$$m_K(2) - m_K(1) = \Delta m_{1-2} = 33,8762 \text{ г. помещаем в 1 ст. Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O:}$$



$$m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} - \text{CO}_2 \uparrow) = \Delta m = 33,8762$$

(4)

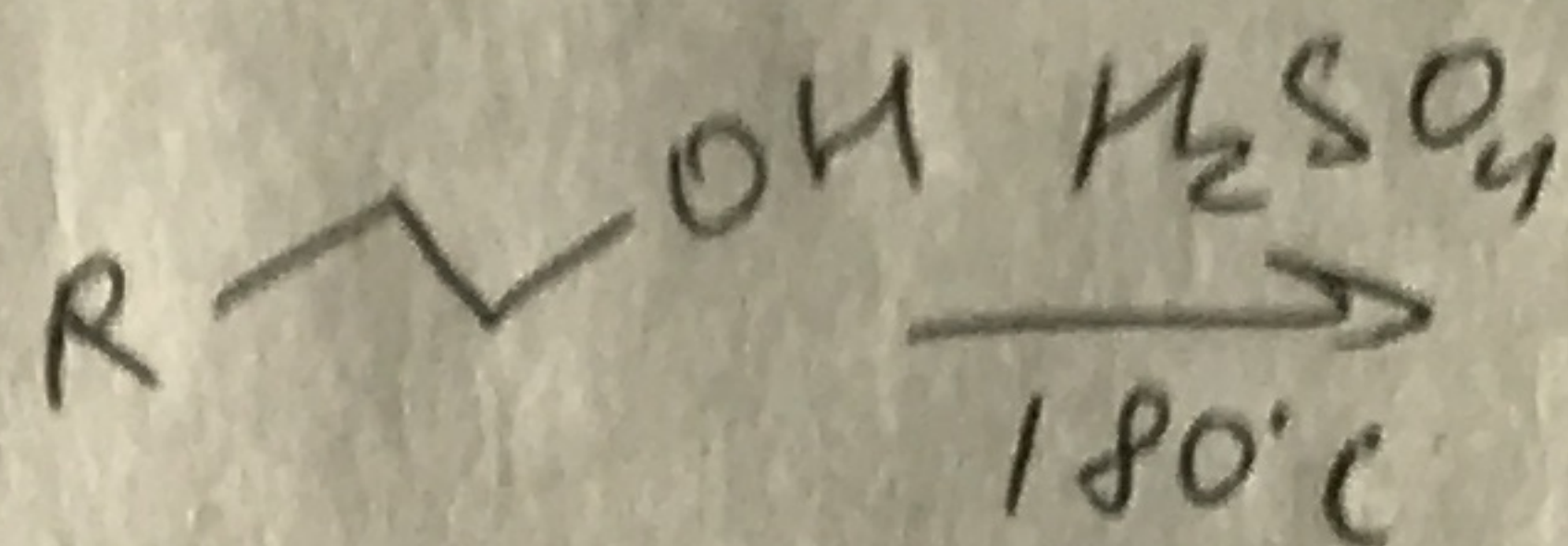
$$v_1 = k_1 A^2 \quad v_{-1} = k_{-1} B$$

$$\frac{v_1}{v_{-1}} = K_p = \frac{B}{A^2} = \frac{k_1 A^2}{k_{-1} B}$$

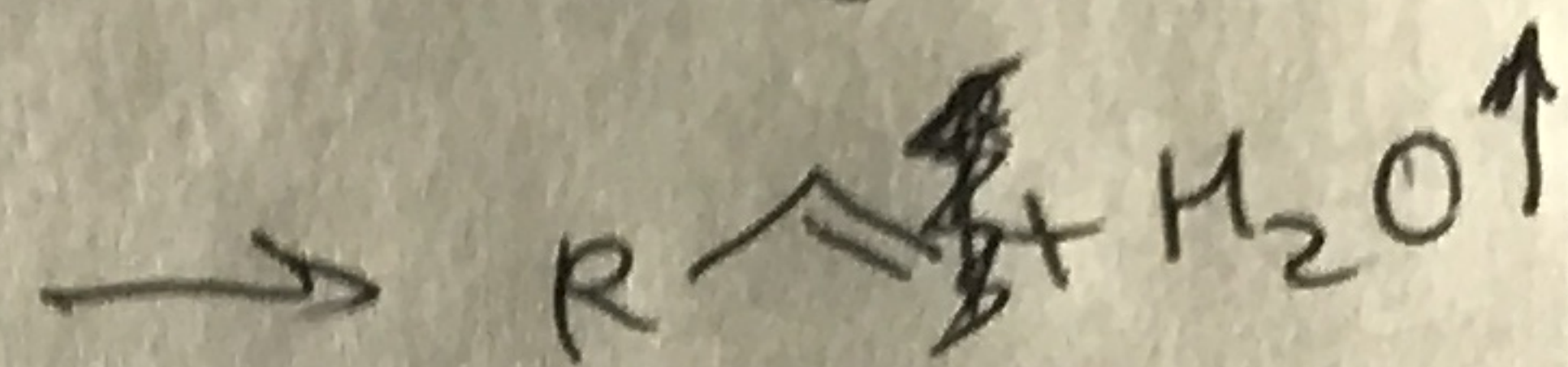
$$k_{-1} = \frac{k_1 A^2}{B^2} = \frac{5 \cdot 10^{-3} \cdot 1^4}{1,86^2} = 1,445 \cdot 10^{-3} \text{ мин}^{-1}$$

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$$m(C_n H_{2n+2}O + C_m H_{2m+2}O) = 15,92$$



$$V(p) = 11,15 \text{ л} \quad (T = 453 \text{ К}, P = 101325 \text{ Па})$$



$$n = \frac{pV}{RT} = \frac{101325 \cdot 0,01115}{8,314 \cdot 453} = 0,3 \text{ моль} = n_n$$

$$(12,011n + (2n+2) \cdot 1,008 + 15,999) n_n +$$

$$+ (12,011m + (2m+2) \cdot 1,008 + 15,999) n_m = 15,9$$

$$14,027 n \cdot n_n + 18,015 n_n + 14,027 n_m \cdot m + 18,015 n_m = 15,9$$

$$18,015 (n_n + n_m) = 15,9$$

$$M(CH_3OH) = 32,042 \text{ г/моль}$$

$$M(C_2H_5OH) = 46,069 \text{ г/моль}$$

$$M(R-CH_2OH) = 60,096 \text{ г/моль}$$

$$M_{cp} = 53 = \frac{15,9}{0,3}$$

Если смесь EtOH и PrⁿOH:

$$60,096 \chi_{Pr} + 46,069 \chi_{Et} = 53$$

$$\chi_{Pr} = 1 - \chi_{Et}$$

$$60,096 - \chi_{Et}(60,096 - 46,069) = 53$$

$$7,096 = 14,027 \chi_{Et} \quad \chi_{Et} = 0,5 = \chi_{Pr}$$

$$w(EtOH) = \frac{0,3 \cdot 0,5 \cdot M(EtOH)}{15,9} = 43,44\%$$

$$w(PrⁿOH) = 56,6\%$$

0,4 M KMnO₄

(3)