



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

## **ОЛИМПИАДНАЯ РАБОТА**

Наименование олимпиады школьников: **«Ломоносов»**

Профиль олимпиады: **Химия**

ФИО участника олимпиады: **Заруднева Ева Валерьевна**

Класс: **11**

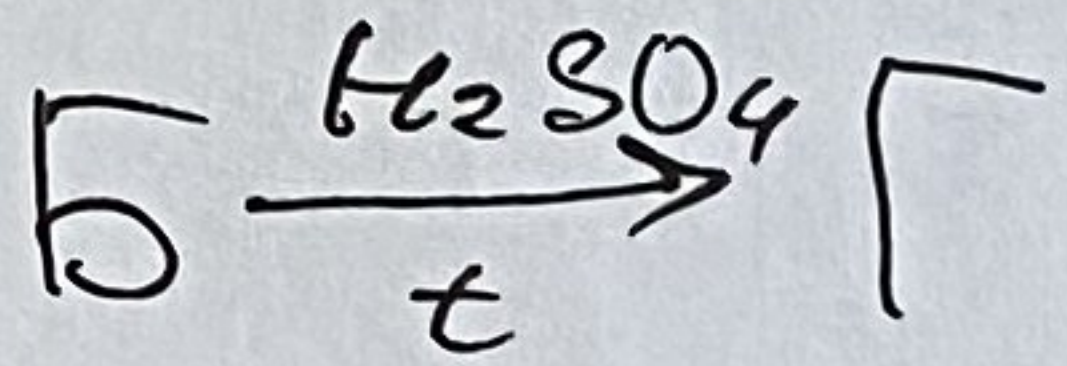
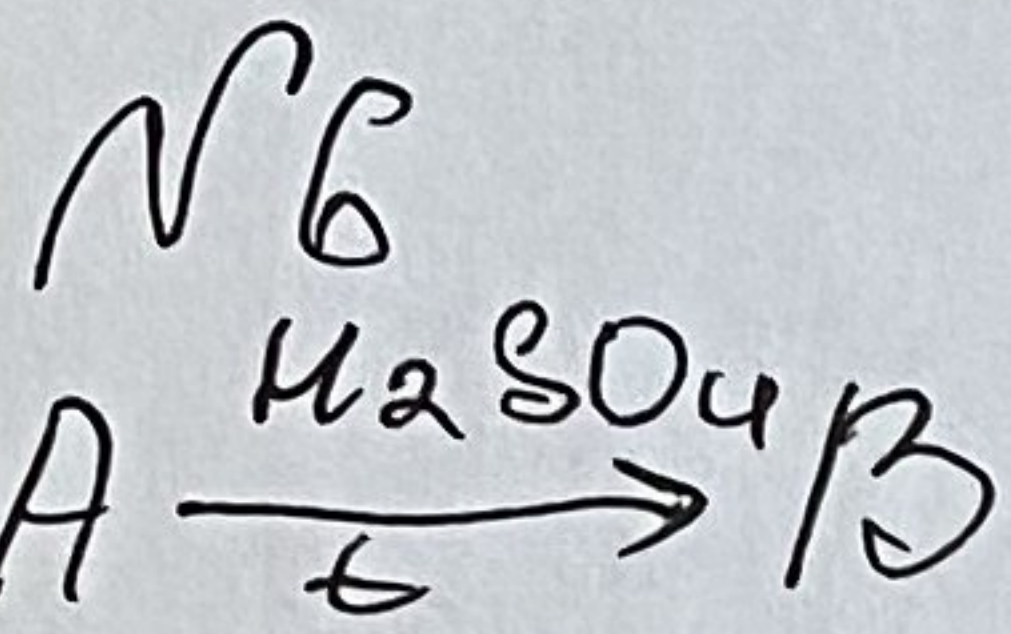
Технический балл: **98**

Дата проведения: **27 февраля 2022 года**

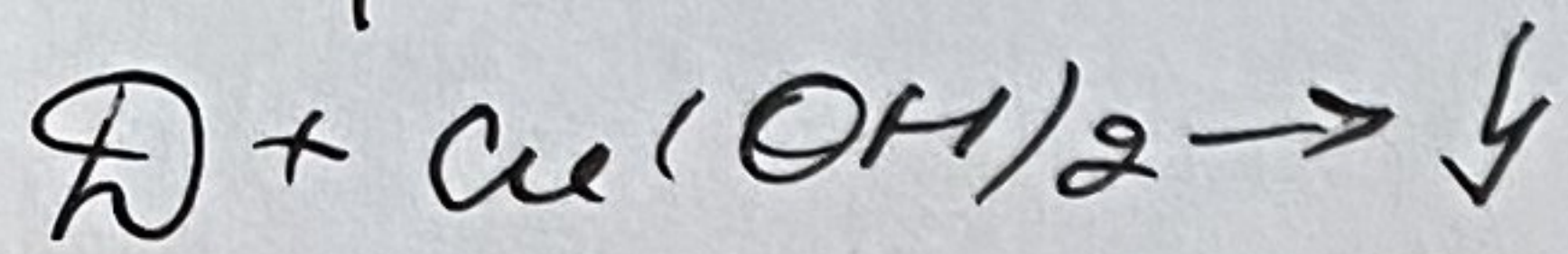
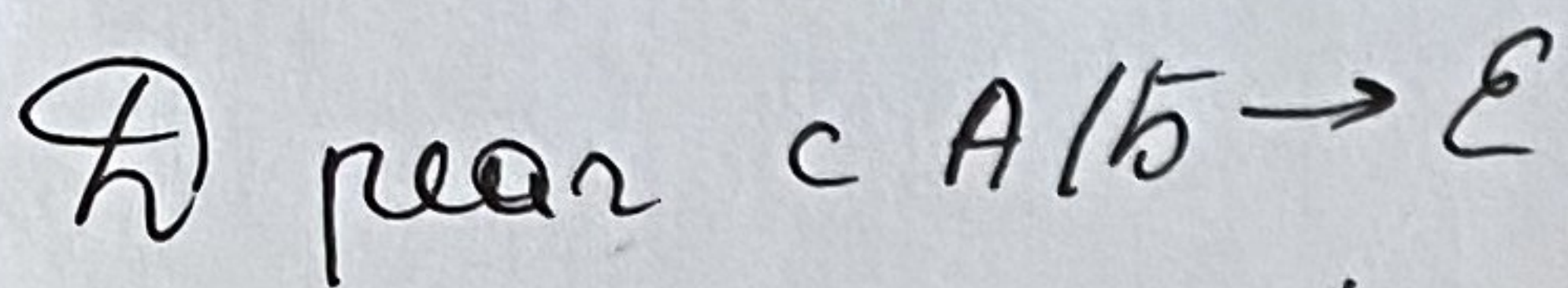
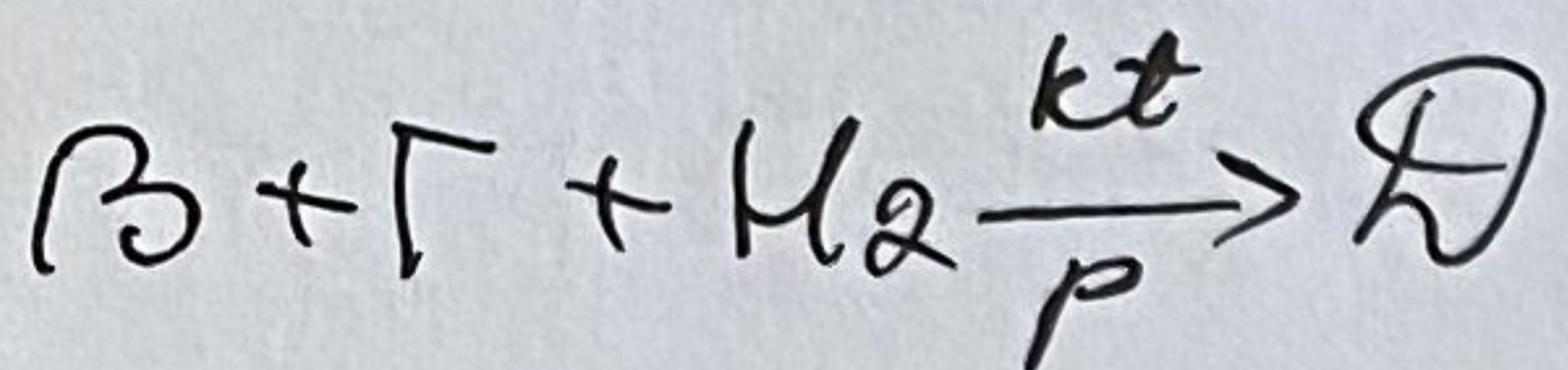
10172231	8	16	16	20	20	18	<b>98</b>	б=неверная мол.масса С
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Осин С.Б.

Менюберк



$$D \text{ no } O_2 = 0,875$$

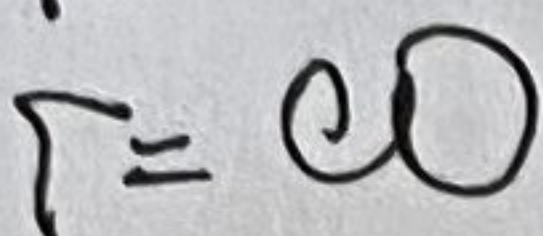
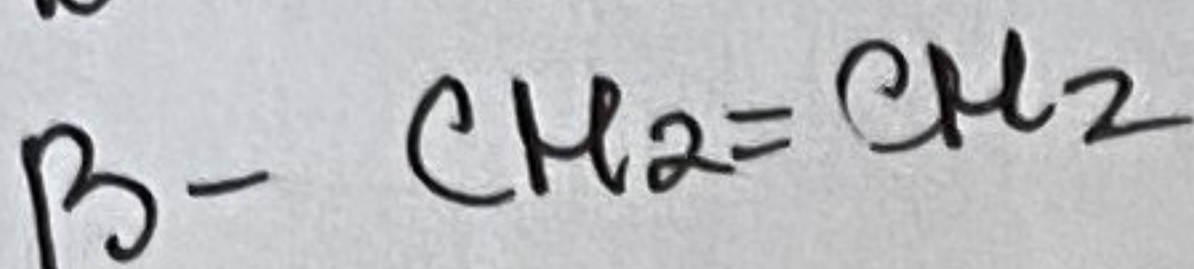
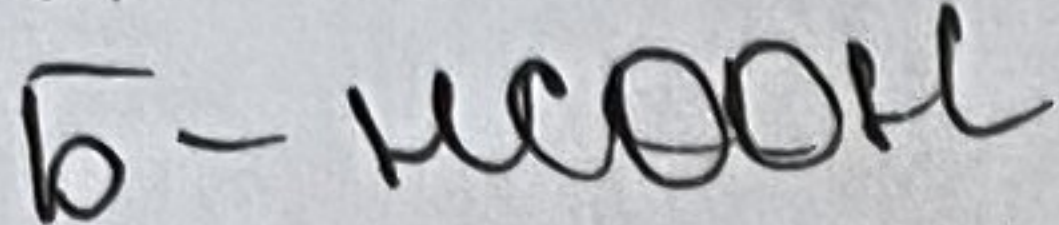
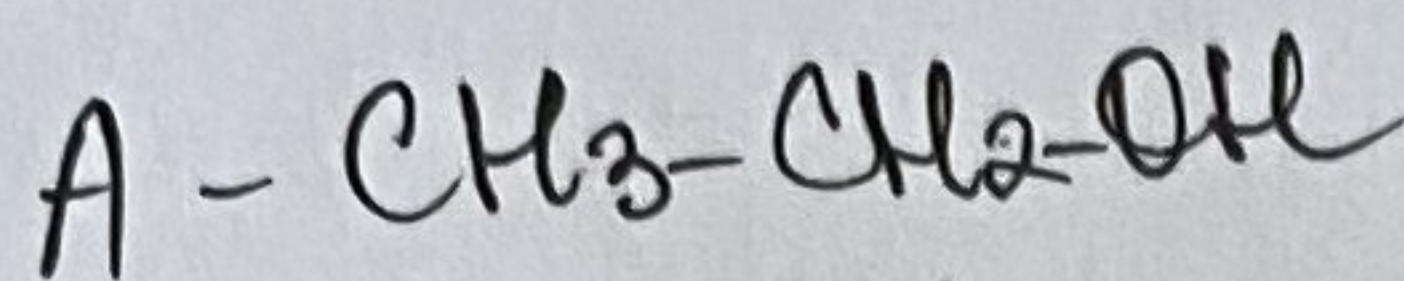


$$m(\downarrow) = 21,6 \text{ г}$$

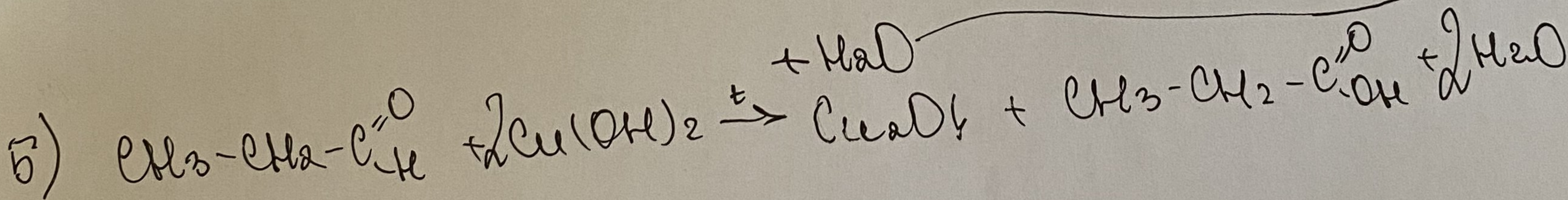
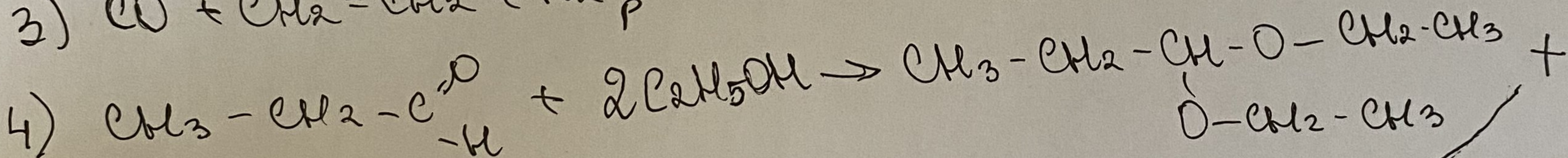
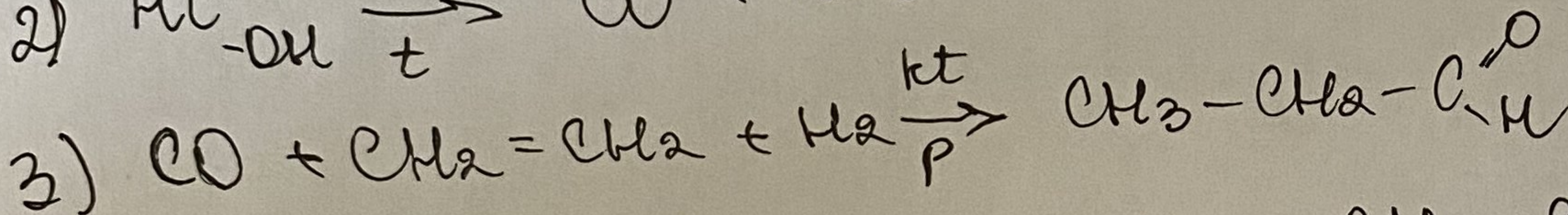
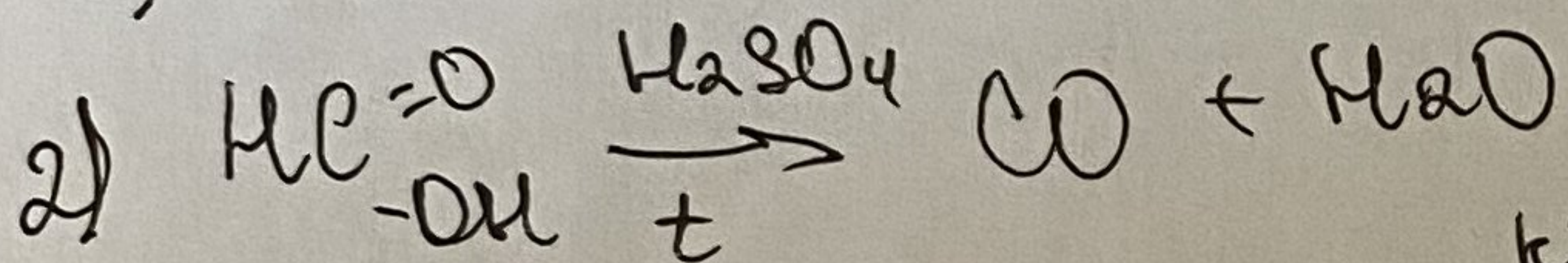
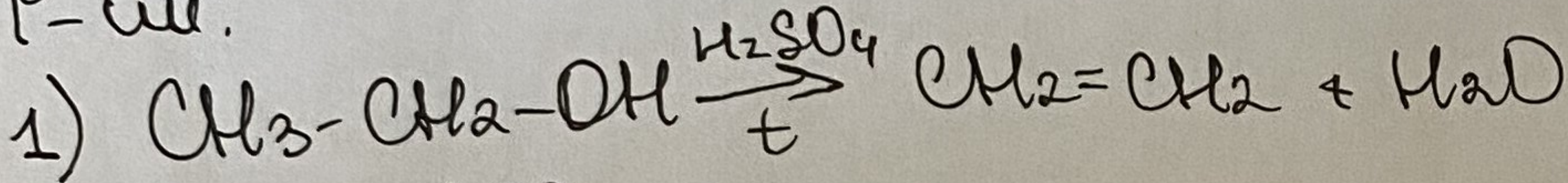
$$D \text{ no } O_2 = \frac{m}{M O_2}$$

$$0,875 = \frac{0,875 \cdot 32}{m} \Rightarrow m = 28 \frac{\text{г}}{\text{моль}}$$

$\downarrow$   
 $C_2H_4, CO, (N_2) \rightarrow$  не подходит по вал.



P-uu:



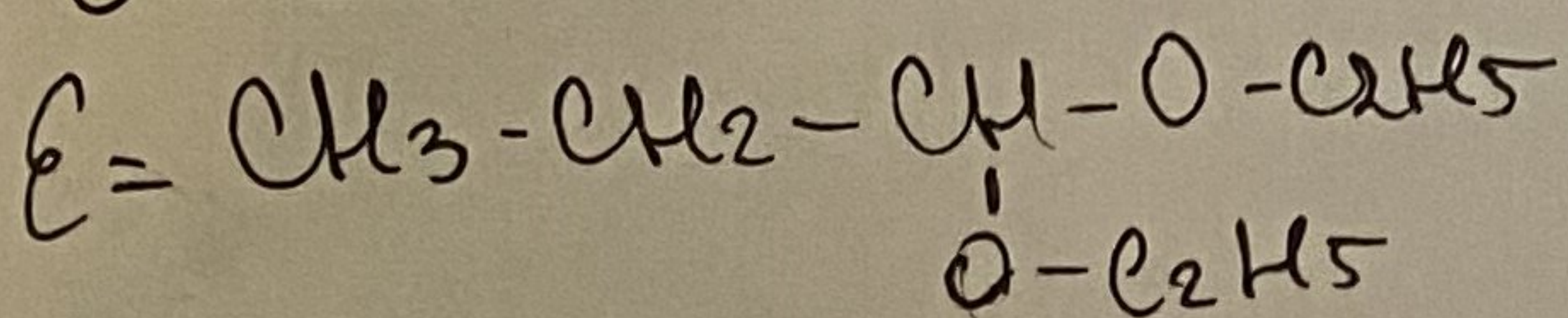
$$m(Cu_2O) = 21,6 \text{ г}$$

$$n(Cu_2O) = \frac{21,6}{160} = 0,135 \text{ моль}$$

$$n(Cu_2O) = n(CH_3-CH_2-COH) = 0,135 \text{ моль}$$

$$m(CH_3CH_2COH) = 0,135 \cdot 58 = 7,82$$

Ответ:  $m(D) = 7,82$ ;  $A = C_2H_5OH$ ;  $B = HCOOH$ ;  $B = C_2H_4$ ;  $\Gamma = CO$ ;  $D = CH_3CH_2COH$ ;



(5)

Учитывая

№5

$$m(\text{CuS}) = 9,6 \text{ г}$$

$$+ m_{\text{пра}}(\text{HNO}_3) = 120 \text{ г}$$

$$\omega(\text{HNO}_3) = 63\%$$

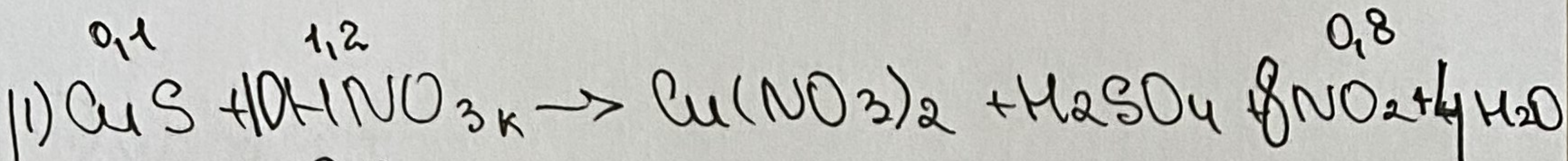
$$m(\text{CuS}) = 9,6 \text{ г}$$

$$+ m_{\text{пра}}(\text{H}_2\text{SO}_4) = 142,7 \text{ г}$$

$$\omega(\text{H}_2\text{SO}_4) = 98\%$$

$$\Delta m_{\text{проб}} - ?$$

$$m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) - ?$$



$$n(\text{CuS}) = \frac{9,6}{96} = 0,1 \text{ моль}$$

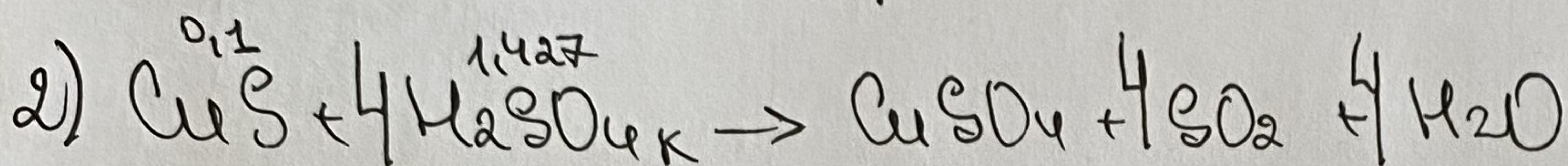
$$m_{\text{вва}}(\text{HNO}_3) = 120 \cdot 0,63 = 75,6 \text{ г}$$

$$n(\text{HNO}_3) = \frac{75,6}{63} = 1,2 \text{ моль}$$

$$n(\text{HNO}_3) > n(\text{CuS}) \quad n(\text{NO}_2) = 8n(\text{CuS}) = 0,8 \text{ моль}$$

$\text{HNO}_3$  - в избытке, расчет по недостатку

$$m_{\text{пра}} \text{ концы} = 9,6 + 120 - (0,8 \cdot 46) = 92,8 \text{ г}$$



$$n(\text{CuS}) = \frac{9,6}{96} = 0,1 \text{ моль}$$

$$m_{\text{вва}}(\text{H}_2\text{SO}_4) = 142,7 \cdot 0,98 = 139,85 \text{ г}$$

$$n(\text{H}_2\text{SO}_4) = \frac{139,85}{98} = 1,427$$

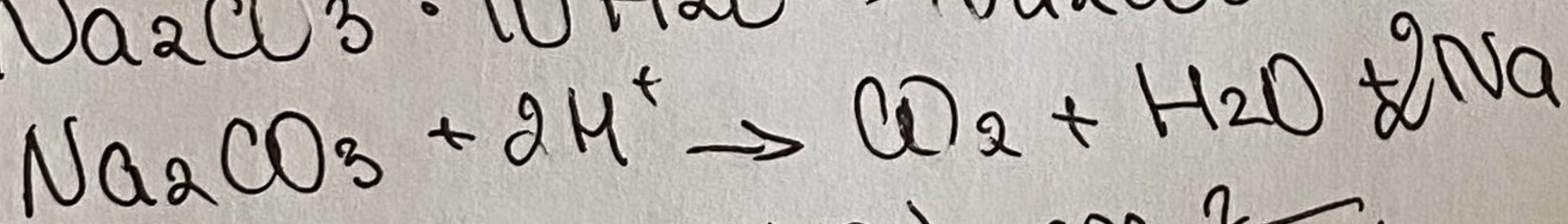
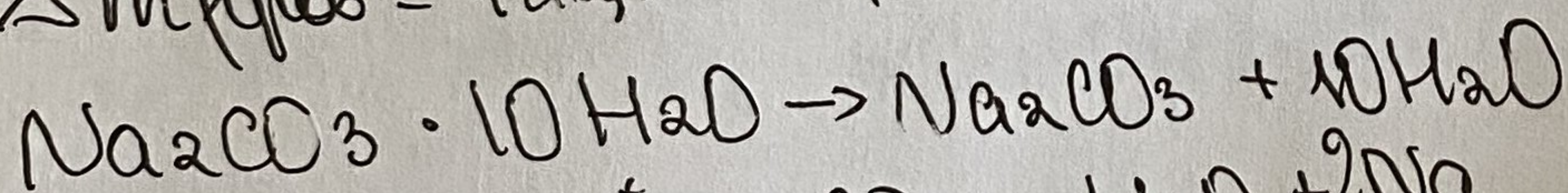
$$n(\text{H}_2\text{SO}_4) > n(\text{CuS})$$

$\text{H}_2\text{SO}_4$  - в избытке  
расчет по недостатку

$$n(\text{SO}_2) = 4n(\text{CuS}) = 0,4 \text{ моль}$$

$$m_{\text{пра}} \text{ кон} = m(\text{CuS}) + m_{\text{пра}}(\text{H}_2\text{SO}_4) - m(\text{SO}_2) = 9,6 + 142,7 - (0,4 \cdot 64) = 126,7 \text{ г}$$

$$\Delta m_{\text{проб}} = 126,7 - 92,8 = 33,9 \text{ г}$$



$$M(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 286 \frac{\text{г}}{\text{моль}}$$

Если взять 1 моль, то  $m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 286 \text{ г}$ , но  $\text{CO}_2 \uparrow$

$$\Rightarrow m(\text{соли}) = 242 \text{ г}$$

$$1 \text{ моль (соли)} = 242 \text{ г}$$

$$x \text{ моль (соли)} = 33,9$$

$$x = 0,14$$

$$m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 0,14 \cdot 286 = 40 \text{ г (в первый стакан)}$$

$$\text{Ответ: } \Delta m_{\text{проб}} = 33,9 \text{ г}; m(\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}) = 40 \text{ г - в перв. стакан}$$

Ученик

N4

t = 180°C T = 453K

перв. организм. синтез

m смеси = 15,9 г

V смеси = 11,15 л

p = 1 атм = 101,325 кПа

c(KMnO4) = 0,4 моль

V(KMnO4) - ?

pV = nRT

n смеси =  $\frac{pV}{RT} = \frac{101,325 \cdot 11,15}{8,314 \cdot 453} = 0,3 \text{ моль}$

M смеси =  $\frac{15,9}{0,3} = 53 \frac{\text{г}}{\text{моль}}$

Итого n1 + n2 = 0,3

n1 = x

n2 = 0,3 - x

Mср =  $\frac{n_1 \cdot M_1 + n_2 \cdot M_2}{n_1 + n_2}$

53 =  $\frac{x \cdot 46 + (0,3 - x) \cdot 60}{x + 0,3 - x}$

53 · 0,3 = 46x + 18 - 60x

15,9 - 18 = -14x

-2,1 = -14x

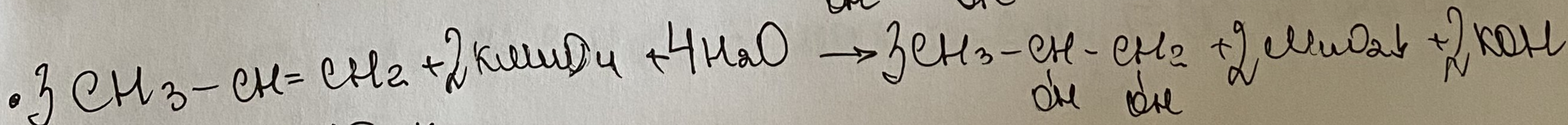
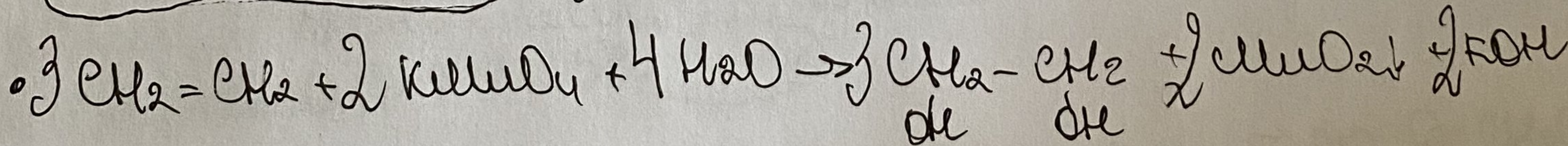
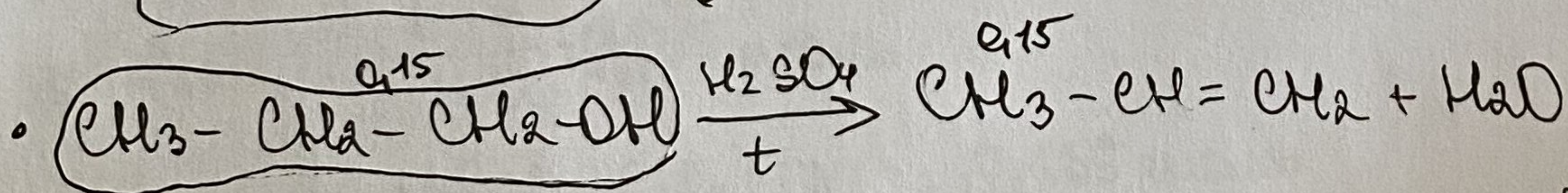
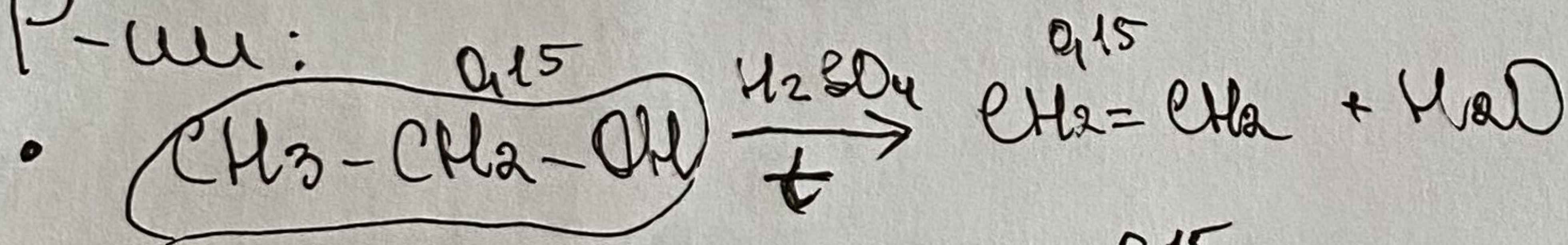
x = 0,15 = n(C2)

0,3 - x = 0,15 = n(C3)

w(C2) =  $\frac{m(C_2) \cdot 100\%}{m(C_2) + m(C_3)} = \frac{0,15 \cdot 46 \cdot 100\%}{0,15 \cdot 46 + 0,15 \cdot 60} = \frac{6,9 \cdot 100\%}{6,9 + 9} = \frac{6,9}{15,9} \cdot 100\% = 43,4\%$

w(C3) = 100 - 43,4 = 56,6%

P-ум:



$\frac{0,15}{3} = \frac{x}{2} \Rightarrow x = 0,1$

n(KMnO4)C2 = 0,1 моль

n(KMnO4)C3 = 0,1 моль

n(KMnO4)C2 и C3 = 0,2 моль

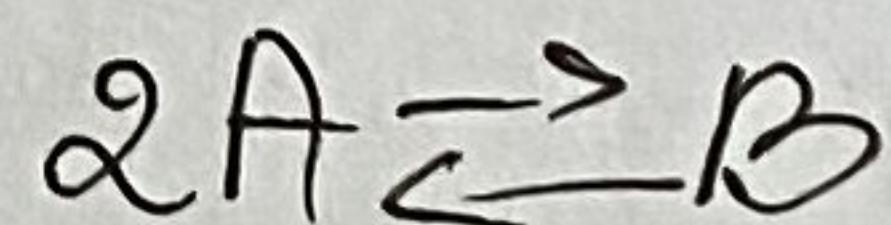
V(KMnO4) смеси =  $\frac{n \text{ смеси}}{c} = \frac{0,2}{0,4} = 0,5 \text{ л}$   
c(KMnO4) = 0,4  $\frac{\text{моль}}{\text{л}}$

Ответ: w(C2) = 43,4%; w(C3) = 56,6%; V(KMnO4)см = 0,5 л

(4)

Менювик

№3



$$V = 1 \text{ л}$$

$$t = 30^\circ\text{C} \quad T = 30 + 273 = 303 \text{ K}$$

$$B:A = 1,86:1$$

$$p = 1 \text{ атм} = 101,325 \text{ кПа}$$

$$M_{\text{сред}} = 45,9 \frac{\text{г}}{\text{моль}}$$

$$k_{\text{ср}} = 5 \cdot 10^{-3} \frac{\text{ч}}{\text{моль} \cdot \text{мин}}$$

$$pV = nRT$$

$$n_{\text{сред}} = \frac{pV}{RT} = \frac{101,325 \cdot 1}{8,314 \cdot 303} = 0,04 \text{ моль}$$

$$\text{Пусть } n_A + n_B = 0,04$$

$$\frac{n_B}{n_A} = 1,86$$

$$n_B = 1,86 n_A$$

$$1,86 n_A + n_A = 0,04$$

$$2,86 n_A = 0,04$$

$$n_A = 0,014 \text{ моль}$$

$$n_B = 0,04 - 0,014 = 0,026 \text{ моль}$$

$$B = 2A \\ M_B = 2M_A$$

$$M_{\text{ср}} = \frac{M_A n_A + M_B n_B}{n_A + n_B} = \frac{M_A \cdot n_A + 0,026 \cdot 2 M_A}{0,04}$$

$$45,9 \cdot 0,04 = 0,066 \text{ г/л}$$

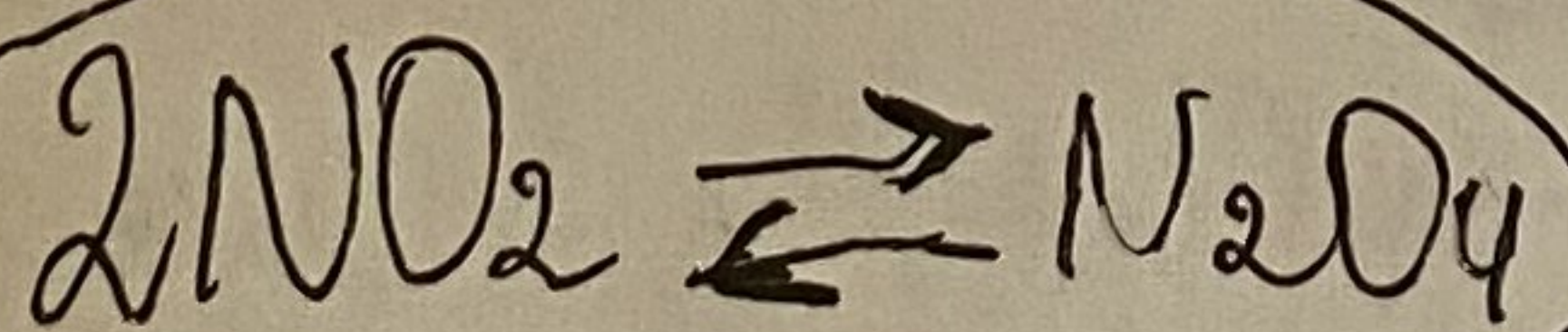
$$3,036 = 0,066 M_A$$

$$M_A = 46 \frac{\text{г}}{\text{моль}}$$

$$M_B = 92 \frac{\text{г}}{\text{моль}}$$

$$M(\text{NO}_2) = 46 \frac{\text{г}}{\text{моль}}$$

$$M(\text{N}_2\text{O}_4) = 92 \frac{\text{г}}{\text{моль}}$$



$$K_{\text{равн}} = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

$$C_A = \frac{0,014}{1} = 0,014 \frac{\text{моль}}{\text{л}}$$

$$C_B = \frac{0,026}{1} = 0,026 \frac{\text{моль}}{\text{л}}$$

$$K_{\text{равн}} = \frac{0,026}{(0,014)^2} = 132,65$$

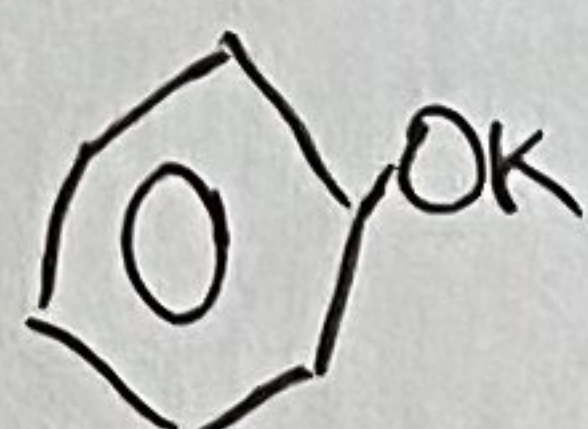
$$K_{\text{ср}} = \frac{5 \cdot 10^{-3}}{132,65} = 3,77 \cdot 10^{-5} \text{ мин}^{-1}$$

3

Объем:  $A = \text{NO}_2$ ;  $B = \text{N}_2\text{O}_4$ ;  $K_{\text{ср}} = 3,77 \cdot 10^{-5} \text{ мин}^{-1}$

Учебник

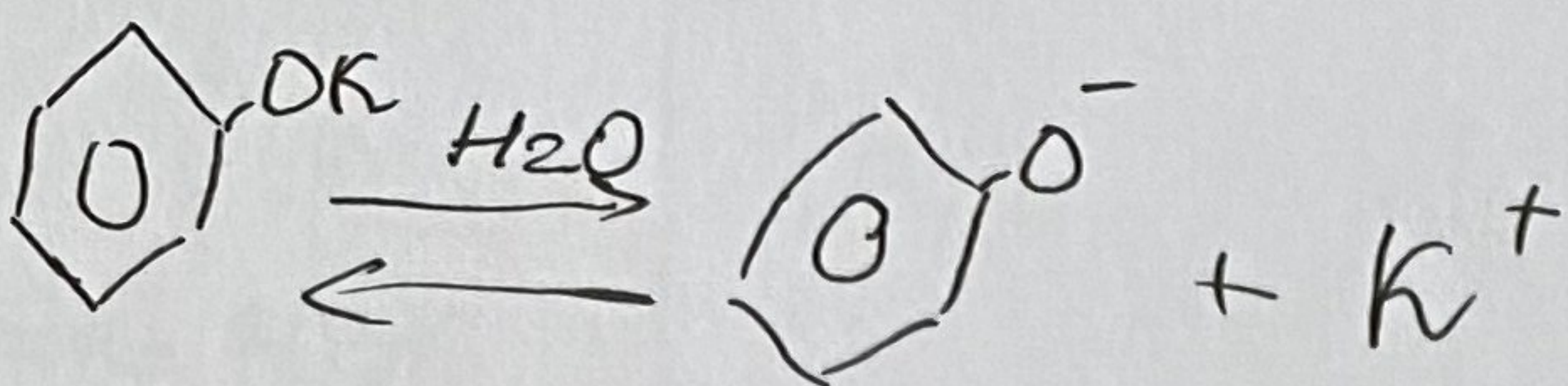
№2



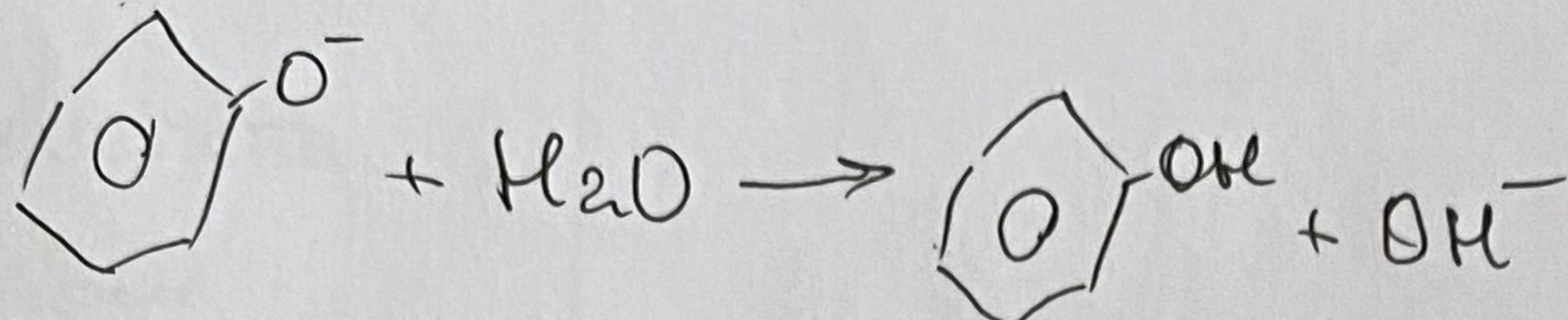
pH=11

$K_{\text{гидр}} = 10^{-10}$

$c(\text{C}_6\text{H}_5\text{OK})$ ?

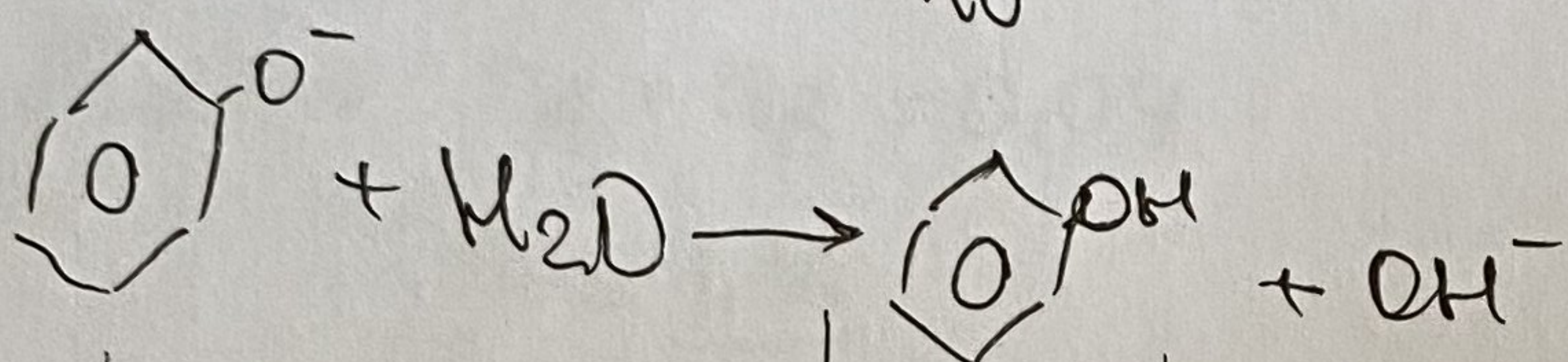


Где  $\text{C}_6\text{H}_5 = \text{Ph}$



$$K_{\text{гидр}} = \frac{[\text{PhOH}][\text{OH}^-][\text{H}^+]}{[\text{PhO}^-][\text{H}^+]} = \frac{K_w}{K_{\text{гидр}}}$$

$$K_{\text{гидр}} = \frac{10^{-14}}{10^{-10}} = 10^{-4}$$



было	C	0	0
гидр	X	X	X
остав	C-X	X	X

$$\frac{X^2}{C-X} = \frac{(10^{-3})^2}{C-10^{-3}} = 10^{-4}$$

$$C = 0,011 \frac{\text{моль}}{\text{л}}$$

$$\text{pH} = -\lg[\text{H}^+]$$

$$K_w = [\text{OH}^-][\text{H}^+]$$

$$11 = -\lg[\text{H}^+]$$

$$10^{-11} = [\text{H}^+]$$

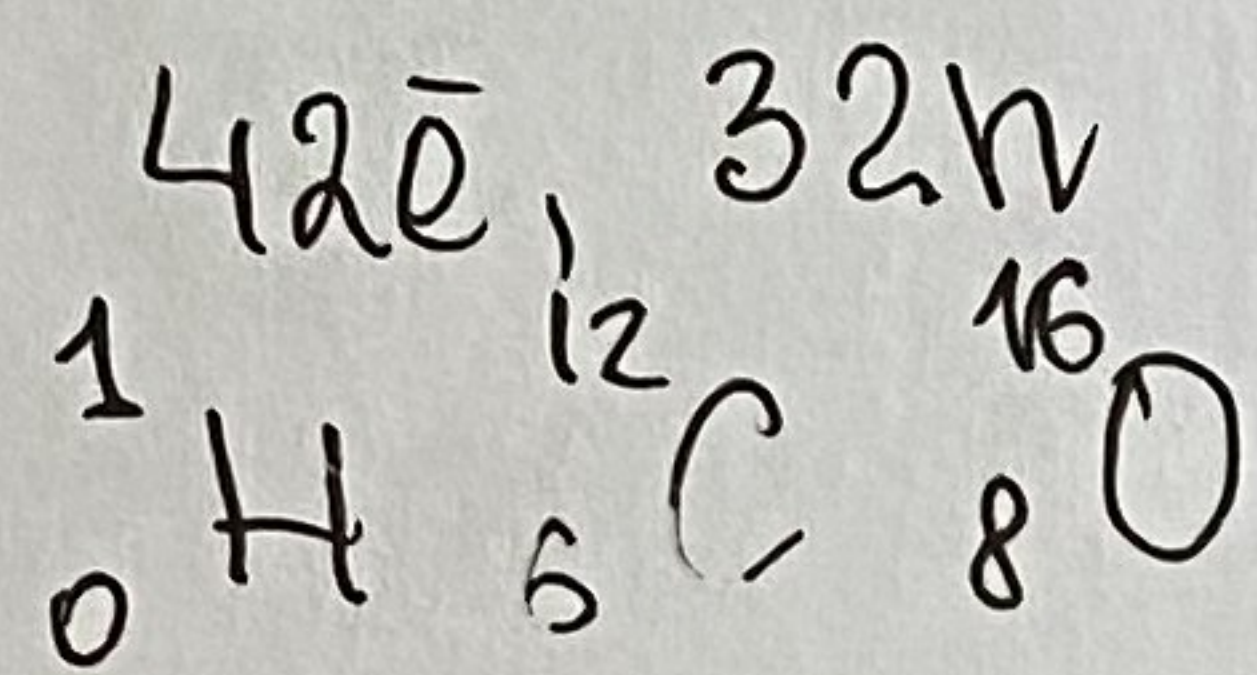
$$[\text{OH}^-] = \frac{10^{-14}}{10^{-11}} = 10^{-3}$$

$$C = 0,011 \frac{\text{моль}}{\text{л}}$$

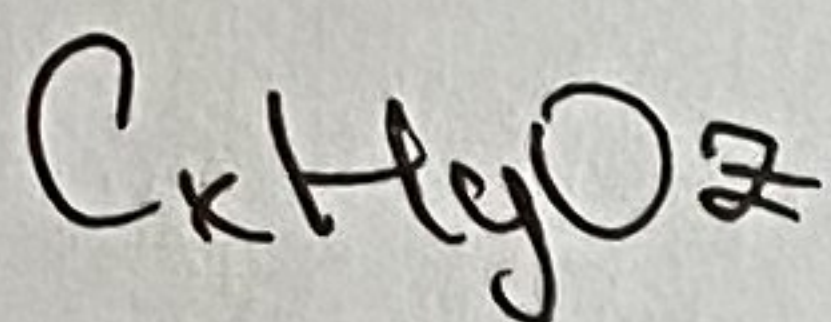
Ответ:  $C = 0,011 \frac{\text{моль}}{\text{л}}$

Мисловка

№1



2 разных масса  
кислот. мол.

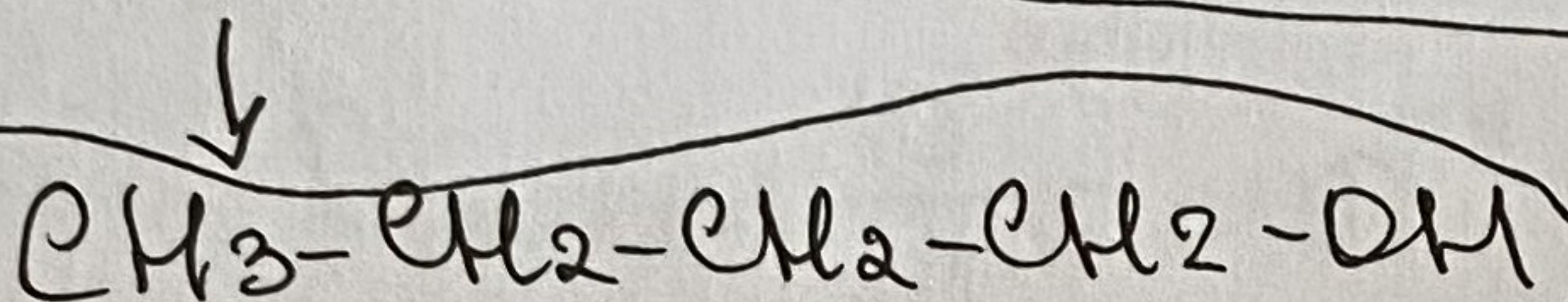
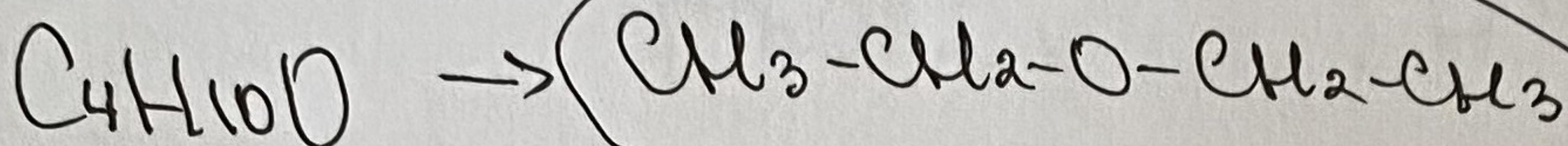


$$6x + 8z = 32$$

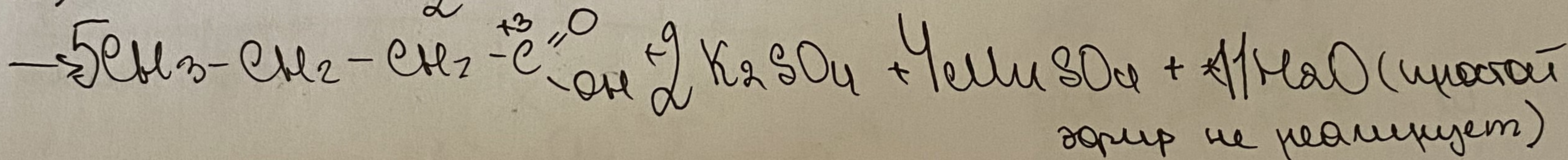
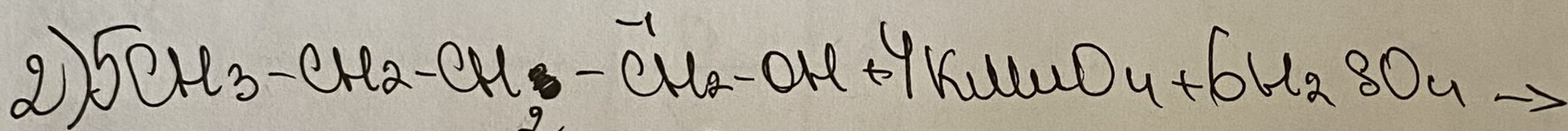
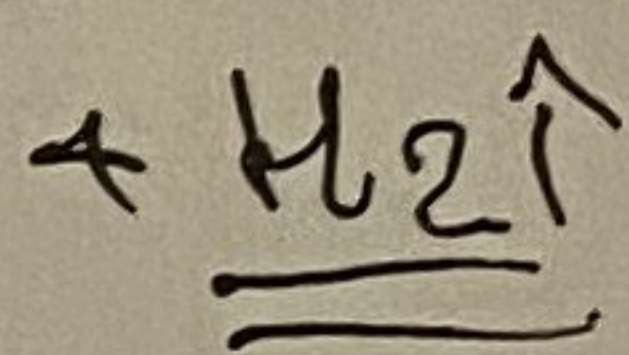
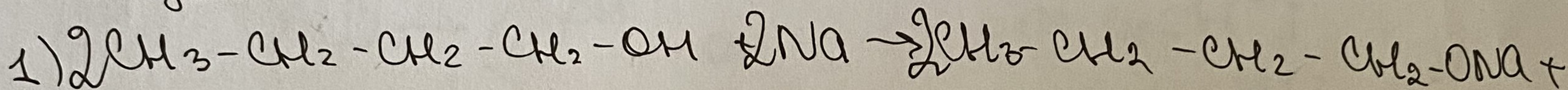
$$z = 1$$

$$x = 4$$

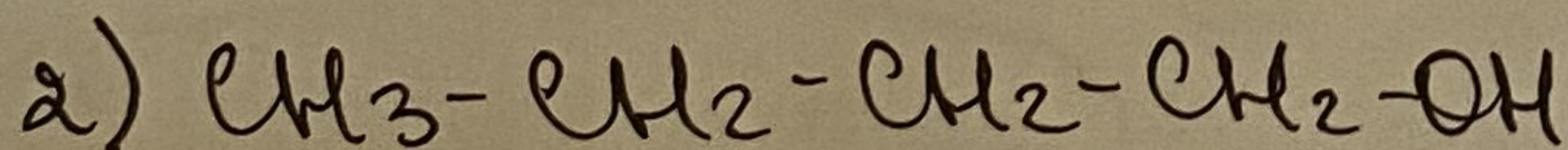
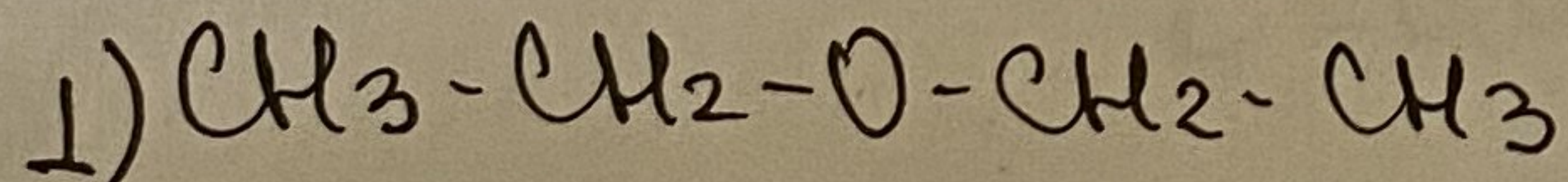
$$y = 42 - 32 = 10$$



Реакции:



Вла:

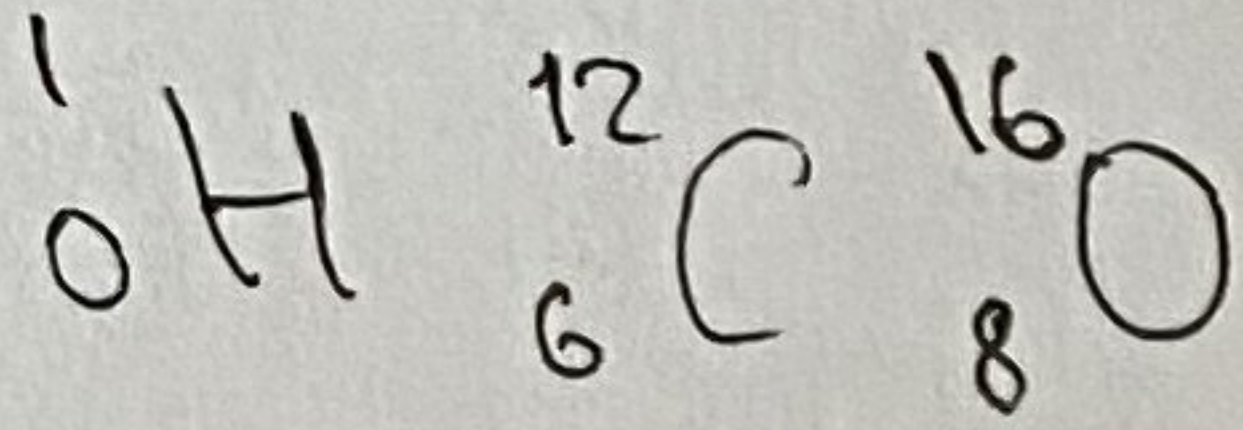




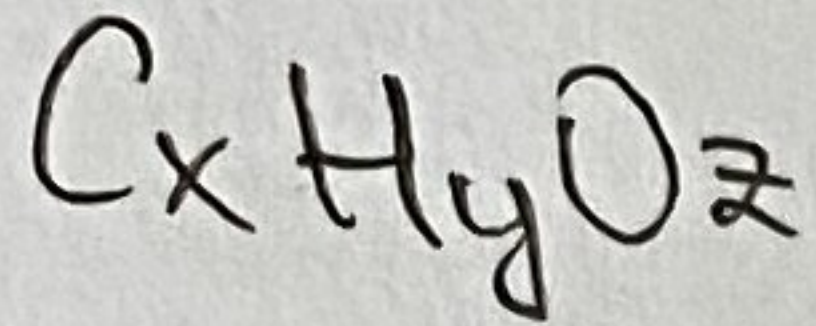
~~Черновик~~ Черновик

N1.

42e, 32a

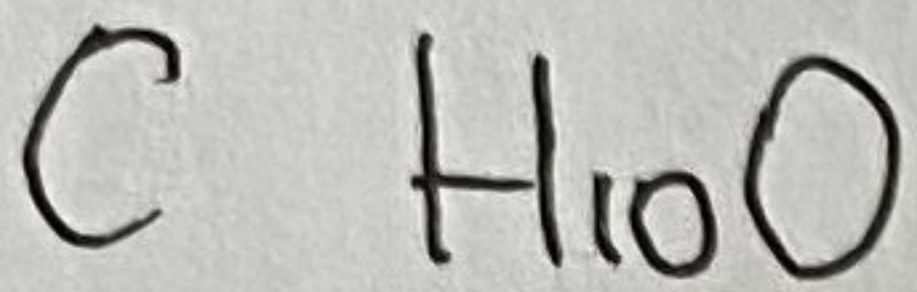


2 разных класса  
различить



$$6x + 8z = 32$$

$$y = 42 - 32 = 10$$



$$C = \frac{N}{D}$$

$$V = \frac{N}{D}$$

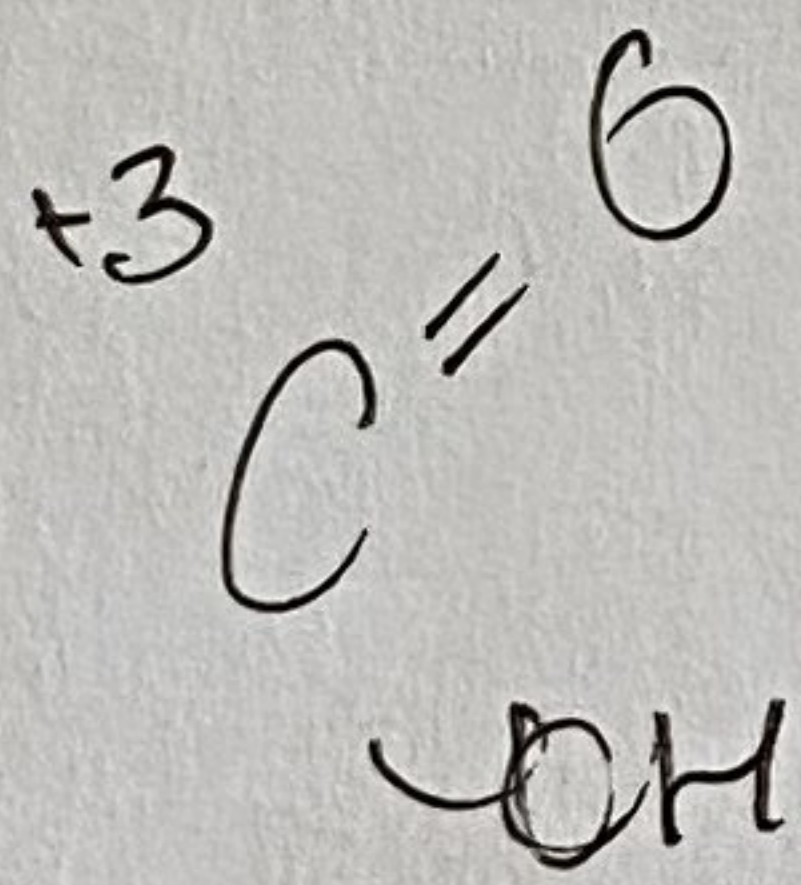
10B

10+2

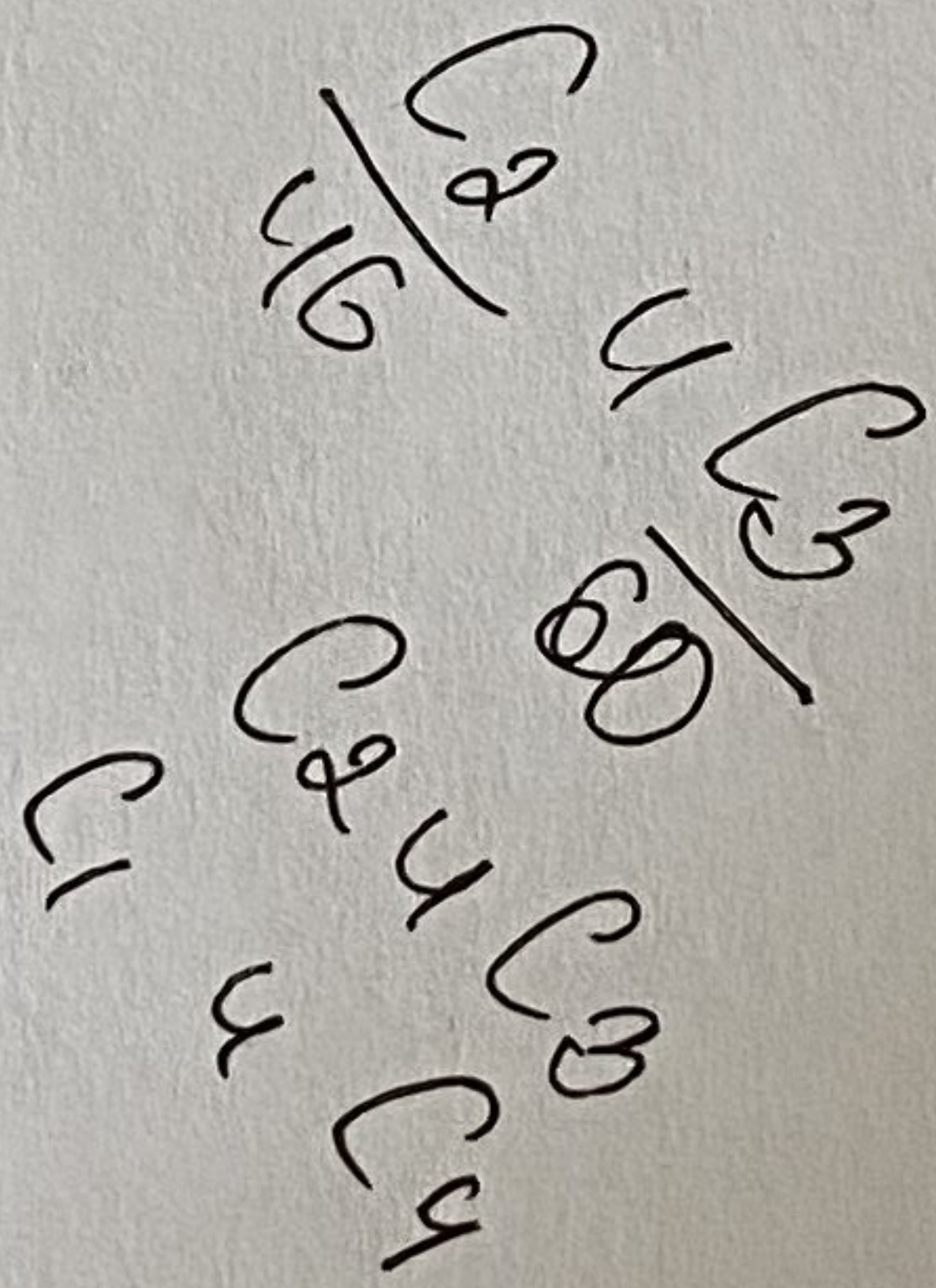
H<sub>2</sub>O

6+10

$$196 \cdot 10^{-4}$$

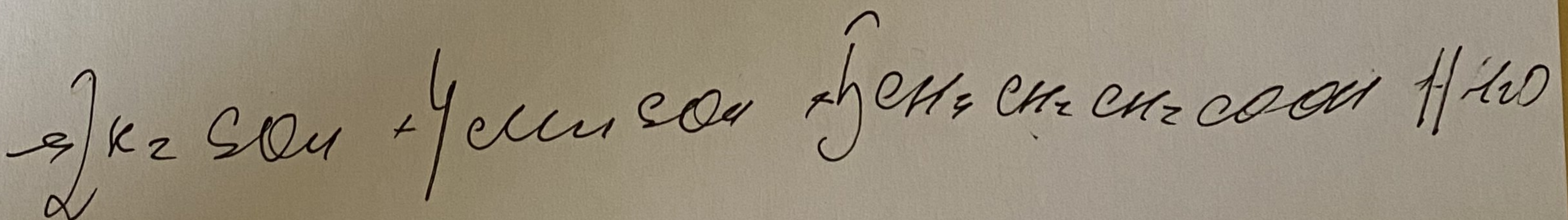
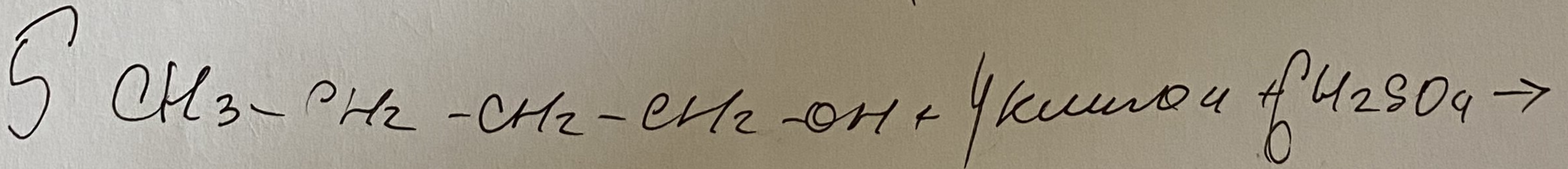
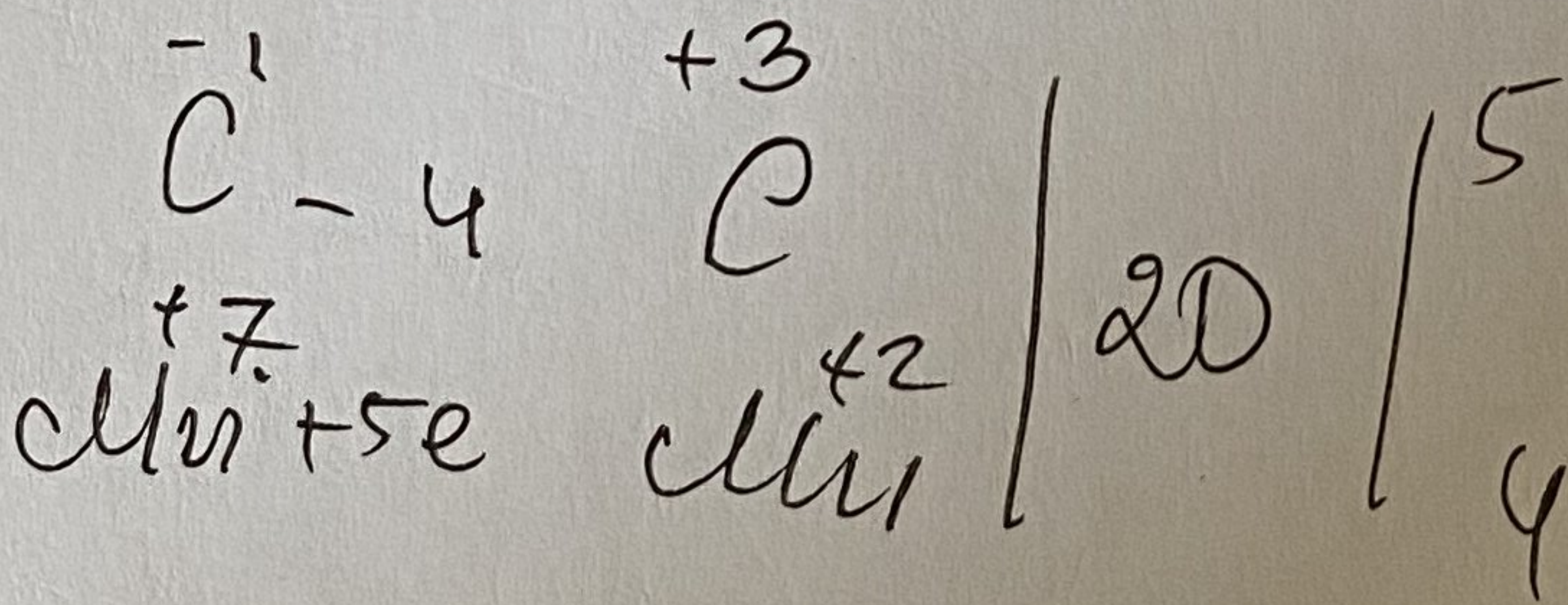


OH



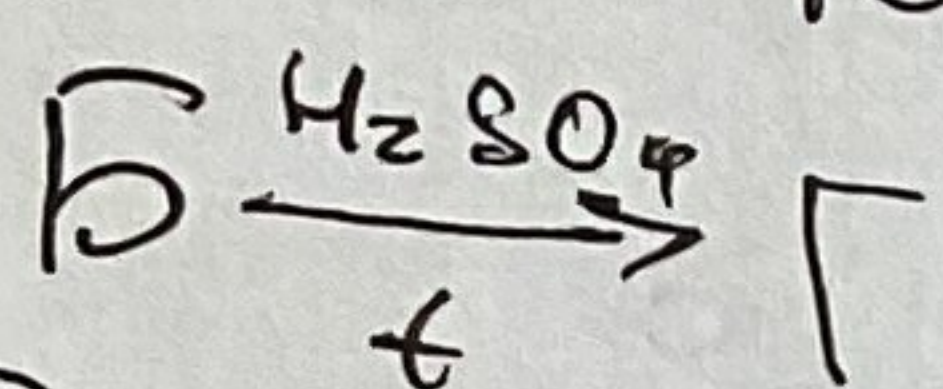
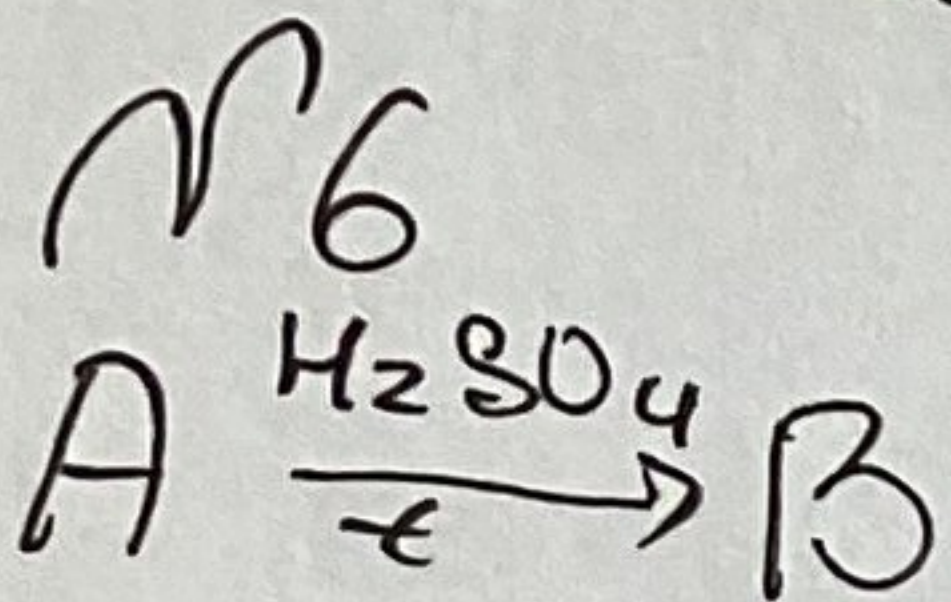
4+8

5+3

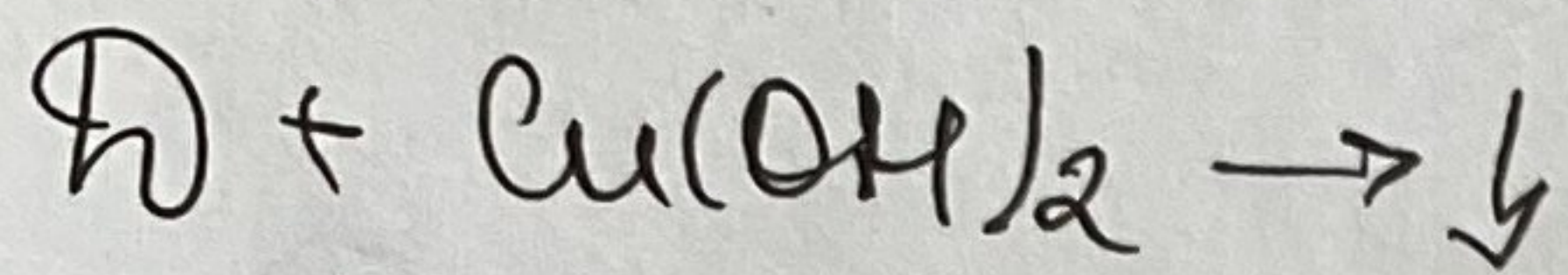
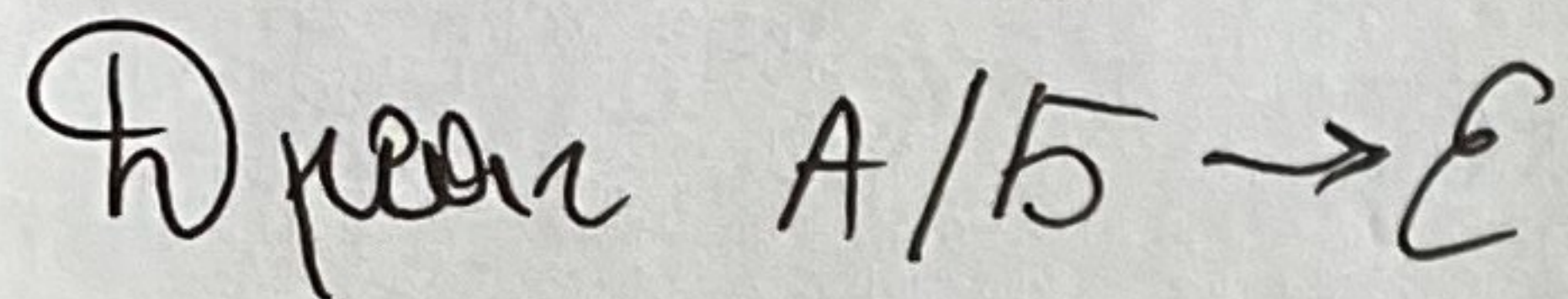
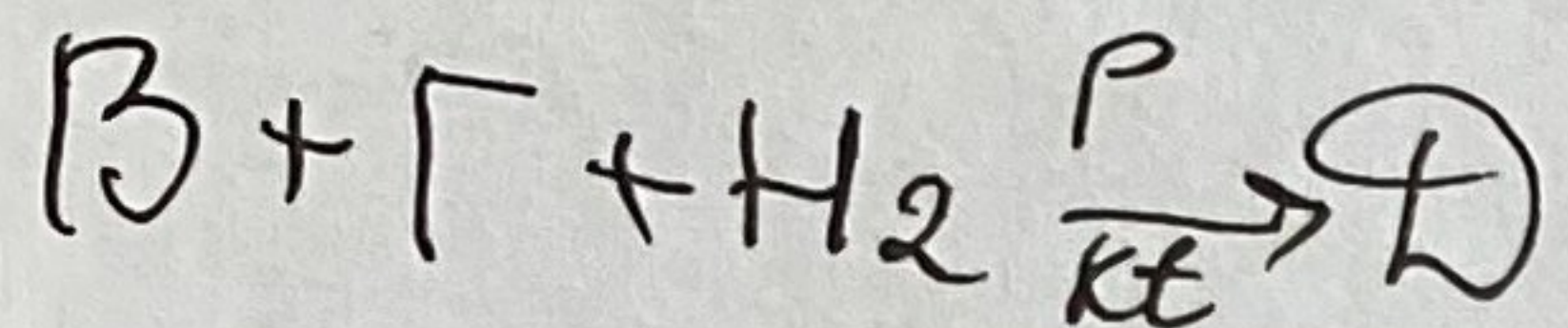


2

~~Задача~~ Упробит



$D_{H_2O} = 0,875$



$m(\downarrow) = 21,62$

$D_{H_2O} = \frac{m}{m_{H_2O}}$

$m_{\text{acetone}} = D_{H_2O} \cdot m_{H_2O} = 0,875 \cdot 32 = 28 \frac{2}{100} \text{ г}$

$\downarrow$   
 $CaH_4, CO, N_2$   
 (не подходит по чис.)

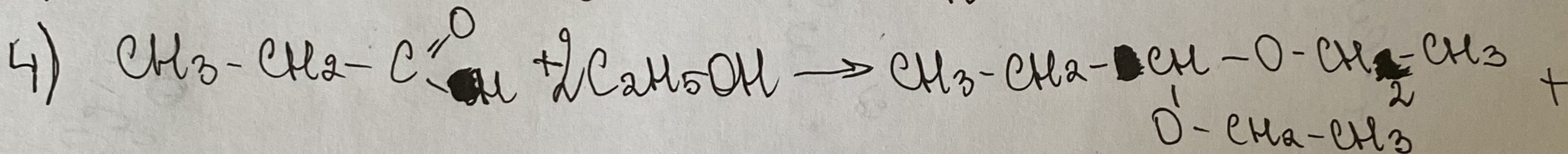
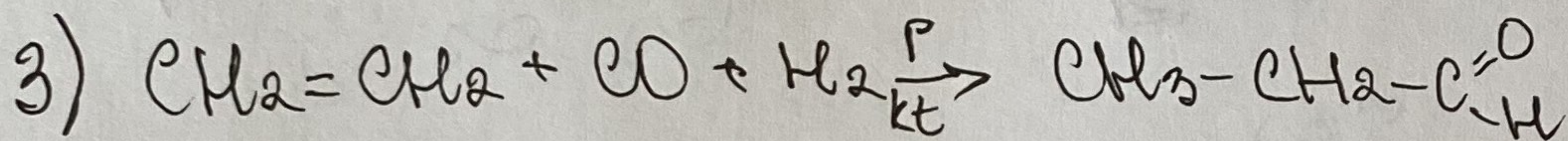
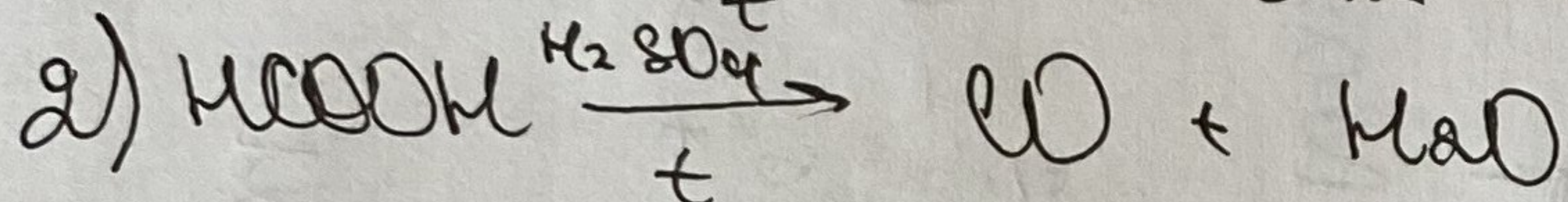
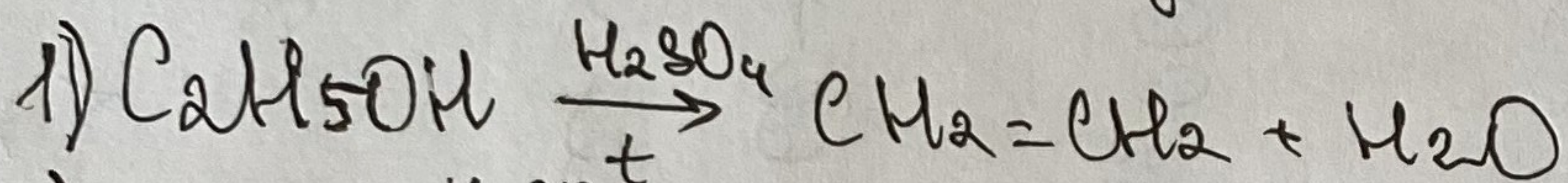
A -  $CaH_5OH$

B -  $CaH_4$

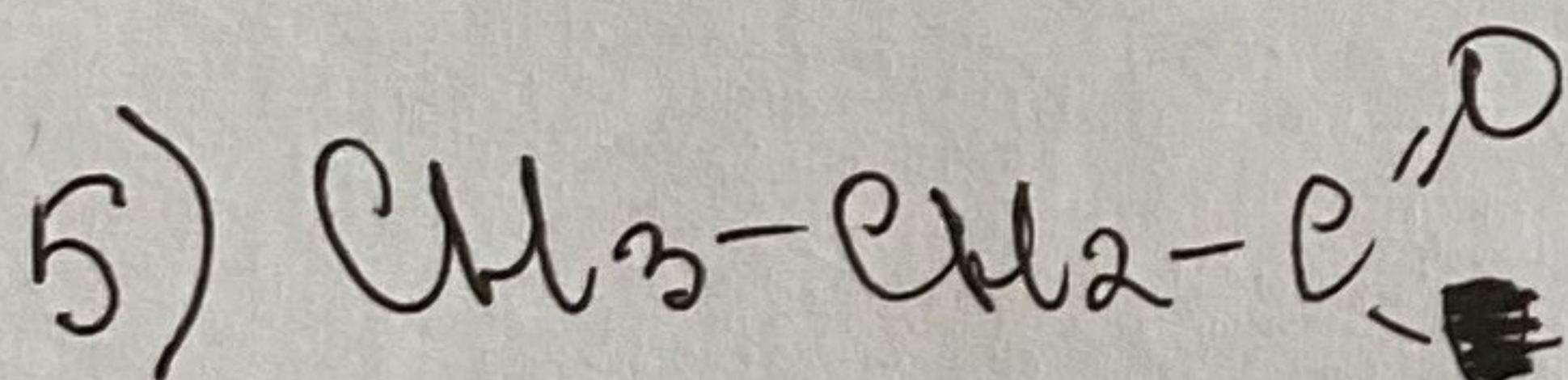
Б -  $HCOOH$

Г -  $CO$

Реакции:



+  $H_2O$



$\frac{21,6}{100} = 0,135$

$36 + 16 + 6$

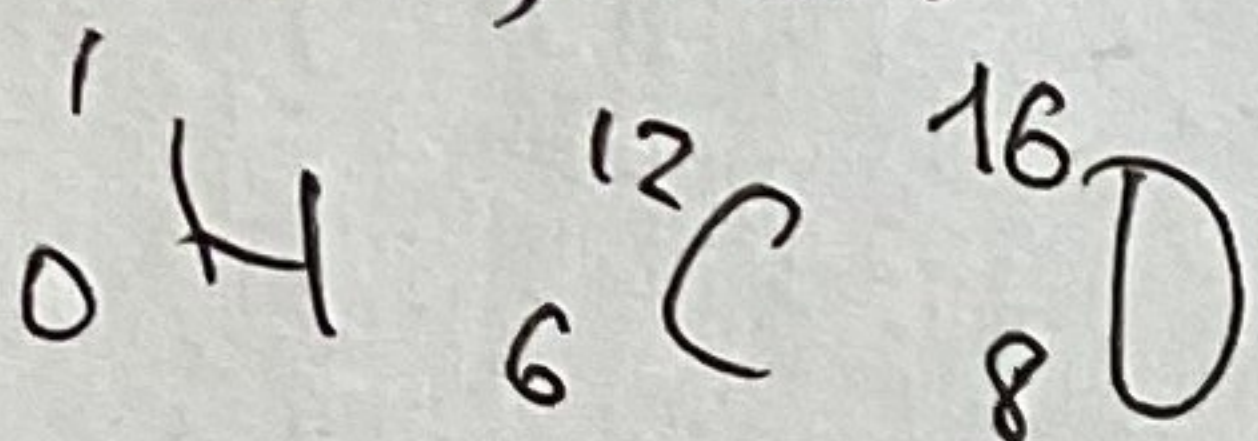
7,83

2

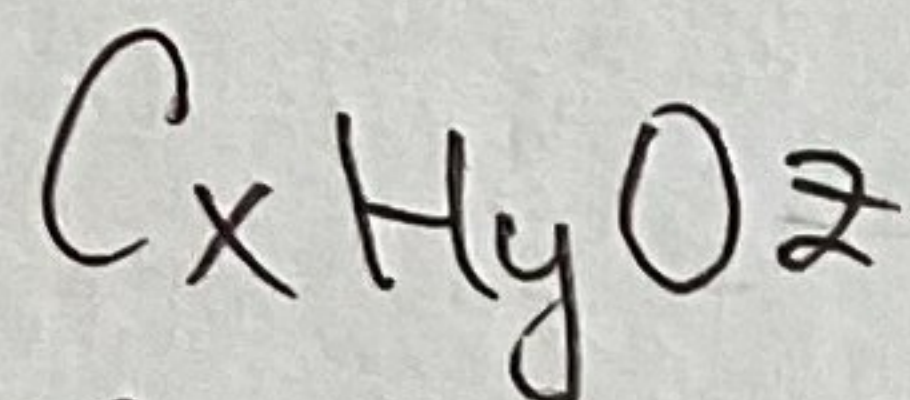
~~Сиреневый~~ Сиреневый

N<sub>1</sub>

$$42\bar{e}, 32n$$



2 разных класса  
кислород. сог. смес.

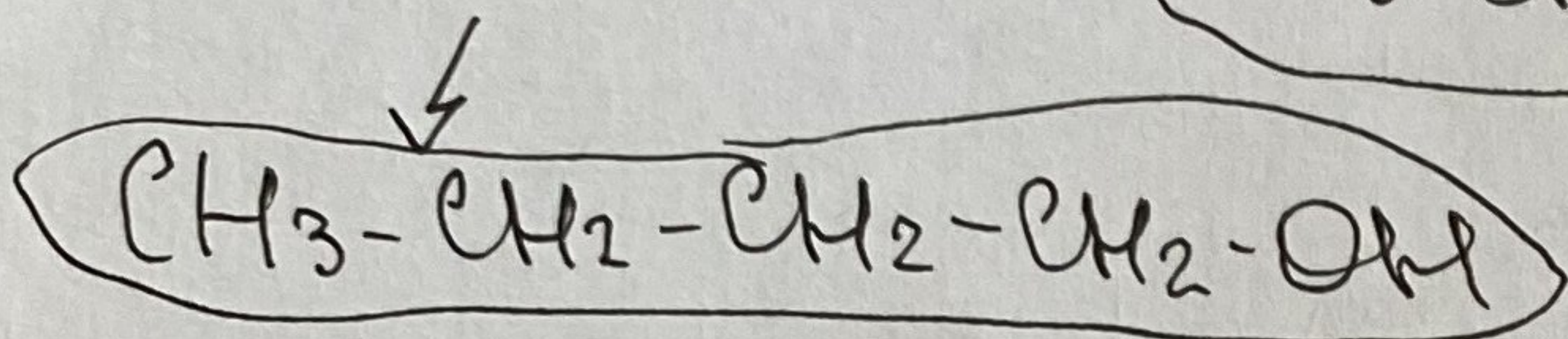
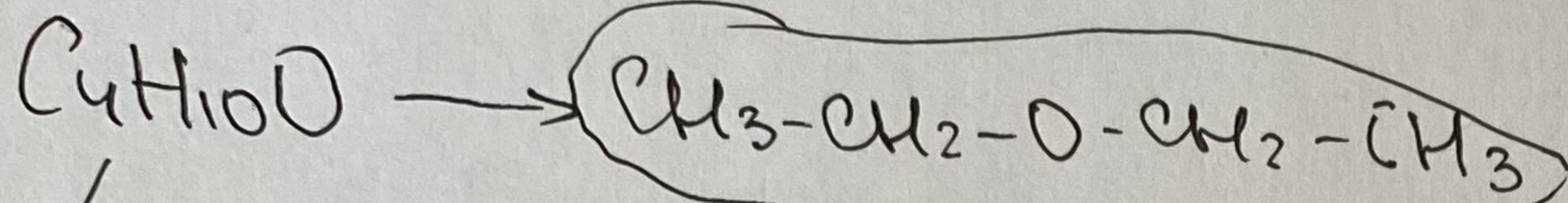


$$6x + 8z = 32$$

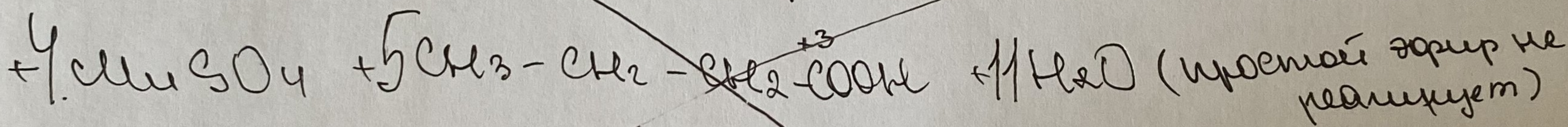
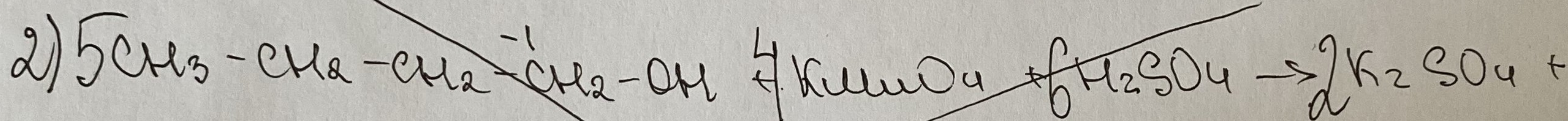
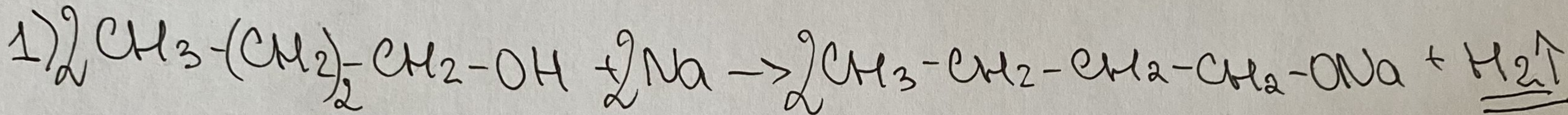
$$y = 42 - 32 = 10$$

$$z = 1$$

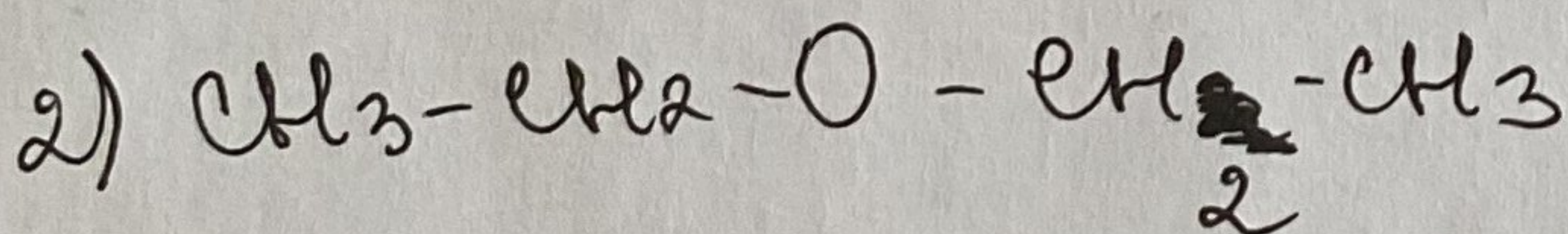
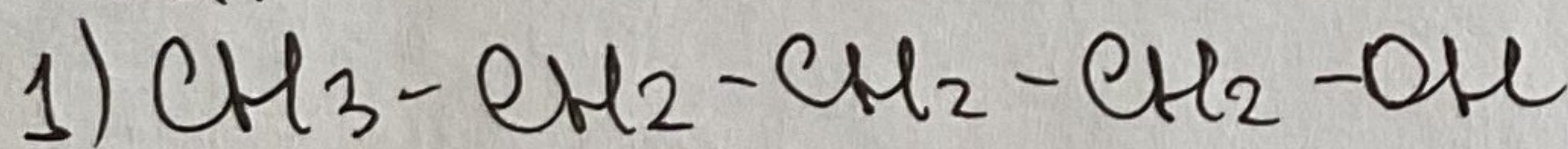
$$x = 4$$



Реакции:



В-ва:



①