



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

Вариант 1

Место проведения Москва  
город

**ПИСЬМЕННАЯ РАБОТА**

Олимпиада школьников Ломоносов  
наименование олимпиады

по химии  
профиль олимпиады

Корновой Амины Николаевны  
фамилия, имя, отчество участника (в родительном падеже)

Выход 13:52 Часть  
Возвращение 13:59 Часть

Дата  
«12» марта 2023 года

Подпись участника  
А. Корн

59-72-32-93  
(63.4)

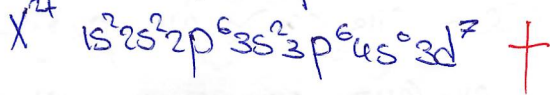
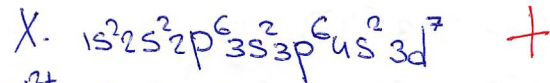
Чистовик.

1.6.

Пусть кол-во неспаренных  $e^-$  -  $n$

$\Rightarrow$  всего  $e^-$ :  $2n \cdot 4 + n = 9n \Rightarrow$  номер в таблице Х кратен 9 и нечетен

X - Co



4.5.



$Q_{реакц} = 6Q(CO_2) + 6Q(H_2O) - 2Q(C_3H_6) = 6 \cdot 393,5 + 6 \cdot 285,8 + 2 \cdot 20,4 = 4116,6 \text{ кДж/моль}$

$Q_{гор} = c_{гор} \cdot t = \frac{75,31 \cdot 3,276(92-23) \cdot 10^3}{18} = 945742,98 \text{ Дж} +$

$\frac{Q_{реакц}}{Q_{гор}} = \frac{2}{3C_3H_6}$

$\frac{4116,6 \cdot 10^3}{945742,98} = \frac{2}{3C_3H_6} \Rightarrow 3C_3H_6 = \frac{2 \cdot 945742,98}{4116,6} = 458,1 \text{ моль} +$

$V(C_3H_6) = \frac{pRT}{P} = \frac{946}{710 \cdot 101,325} \cdot 8,31 \cdot (30+273) = 12,236 \text{ л} +$

5.1.

A -  $C_nH_{2n}O$

$0,6667 = \frac{12n}{12n+2n+16} +$

$n = 4 +$

A -  $C_4H_8O$  ( $CH_3(CH_2)_2-C(=O)-H$ ) +

B -  $CH_3(CH_2)_2-COOH$

D - сложный эфир с формулой  $C_nH_{2x}O_2$

$0,6667 = \frac{12x}{12x+2x+32} +$

$x = 8 +$

C -  $CH_3(CH_2)_2-CH_2-OH$

D -  $CH_3(CH_2)_2-C(=O)-O-CH_2-(CH_2)_2-CH_3$

94

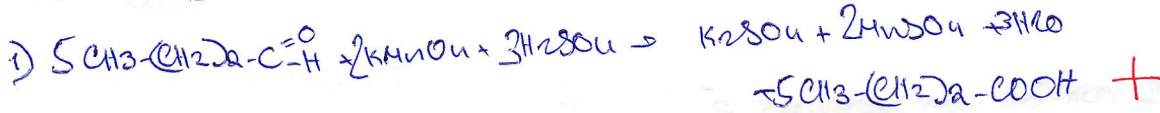
дебелость  
четыре

Возможно  
ошибка

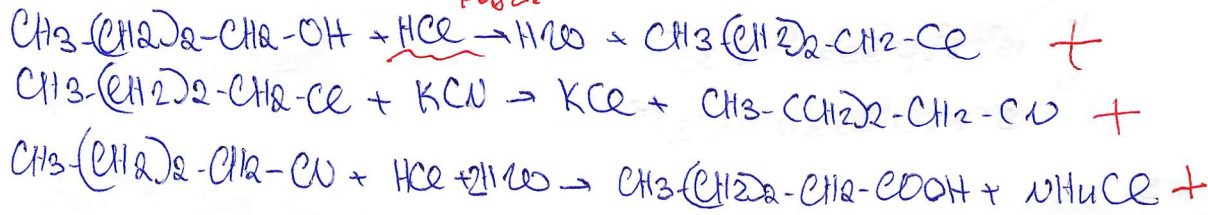
1 2 3 4 5 6 7 8  
6 18 10 12 14 14 16 14 94

Шировин

5.1 (2 часа)



Способ получения пентановой к-ты:

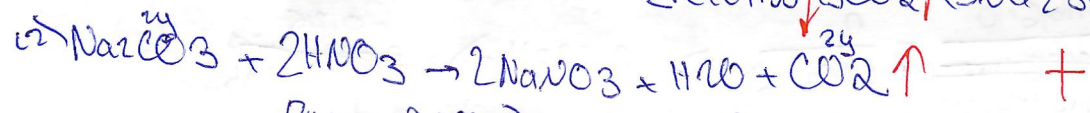
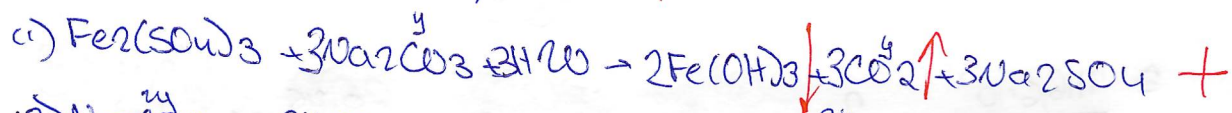


с.з.

$w(\text{BaCO}_3)_{\text{насыщ}} = \frac{21,8}{121,8} = 0,17898 +$

Пусть  $\nu(\text{BaCO}_3 \cdot 10\text{H}_2\text{O})_{\text{исх}} = x$  моль

$0,17898 = \frac{m(\text{BaCO}_3)}{m(\text{H}_2\text{O}) + m(\text{BaCO}_3 \cdot 10\text{H}_2\text{O})_{\text{исх}}} = \frac{106x}{183,7 + 286x} +$   
 $x = 0,6 \text{ моль} +$

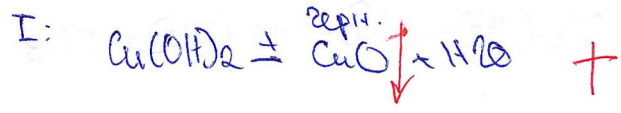
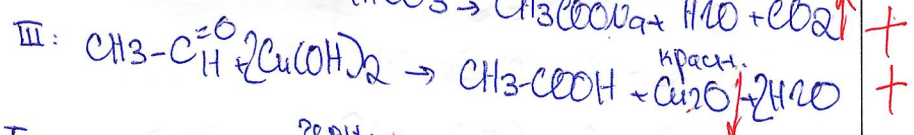
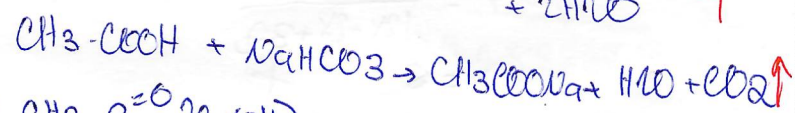
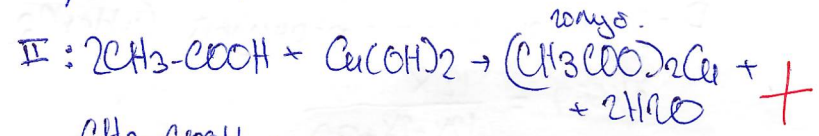


Пусть  $\nu(\text{CO}_2)_2 = 2y \Rightarrow \nu(\text{CO}_2)_1 = y$

$\nu(\text{BaCO}_3)_{\text{исх}} = y + 2y = 3y$   
 $3y = 0,6$   
 $y = 0,2 \text{ моль} +$

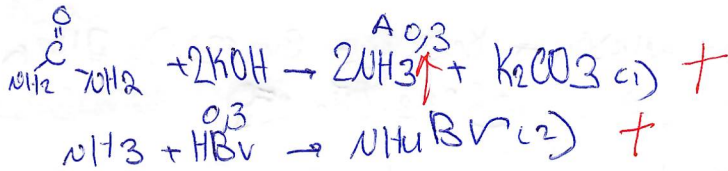
$w(\text{BaCO}_3) = \frac{m(\text{BaCO}_3)}{m(\text{BaCO}_3)_{\text{исх}} + m(\text{HNO}_3) - m(\text{CO}_2)} = \frac{0,2 \cdot 2 \cdot 85}{\frac{0,4 \cdot 106}{0,17898} + 200 - 0,4 \cdot 44} +$   
 $= 0,162 = 16,2 \%$

- 2.6. II -  $\text{CH}_3\text{COOH}$
- III -  $\text{CH}_3\text{C}(\text{O})\text{H}$
- I -  $\text{CH}_3\text{C}(\text{O})\text{CH}_3$



59-72-32-93  
(63.4)

7.2.



$n(\text{HBr}) = 0,309 \text{ моль} +$

$\text{pH} = 1,52$

$-\lg[\text{H}^+] = 1,52$

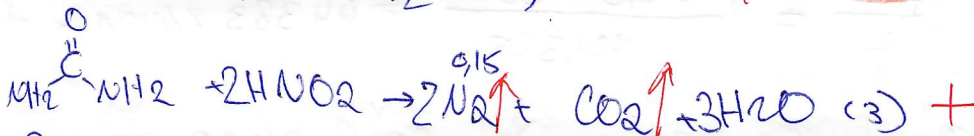
$[\text{H}^+] = 10^{-1,52} = 0,03 \text{ моль/л} +$

$n(\text{H}^+) = 0,03 \cdot 0,3 = 0,009 \text{ моль} +$

$n(\text{HBr})_{\text{пересч}} = 0,009 \text{ моль}$

$n(\text{HBr})_{\text{р}} = 0,309 - 0,009 = 0,3 \text{ моль} +$

$n(\text{NH}_2\text{C}(=\text{O})\text{NH}_2)_1 = \frac{0,3}{2} = 0,15 \text{ моль} +$



$V(\text{N}_2) = \frac{V(\text{A})}{2} \Rightarrow n(\text{N}_2) = \frac{n(\text{A})}{2} = 0,15 \text{ моль}$

не утере  
всегда в шифре  
O<sub>2</sub>!

$n(\text{NH}_2\text{C}(=\text{O})\text{NH}_2)_3 = \frac{0,15}{2} = 0,075 \text{ моль}$

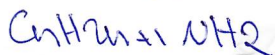
$n(\text{моу})_{\text{исх}} = n(\text{NH}_2\text{C}(=\text{O})\text{NH}_2)_3 + n(\text{NH}_2\text{C}(=\text{O})\text{NH}_2)_1 = 0,225 \text{ моль}$

$C_{\text{моу}} = \frac{n}{V} = \frac{0,225}{0,2} = 1,125 \text{ моль/л}$

3.2.

$M(\text{A} \cdot \text{B}) = 2,107 \cdot 28 = 59 \text{ г/моль} +$

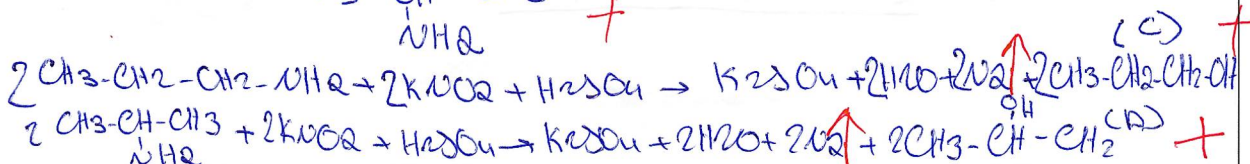
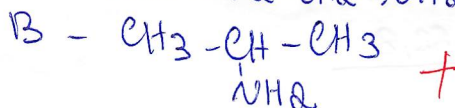
A-B - амины



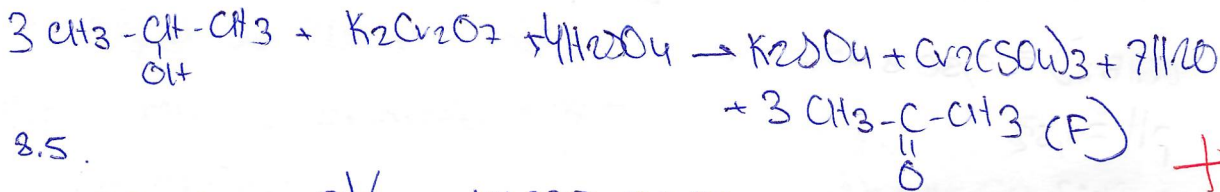
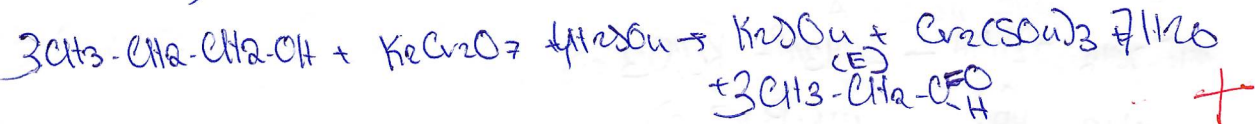
$12n + 2n + 17 = 59$

$14n = 42$

$n = 3$



3.2 (2 часа)



8.5.

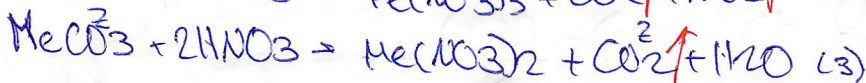
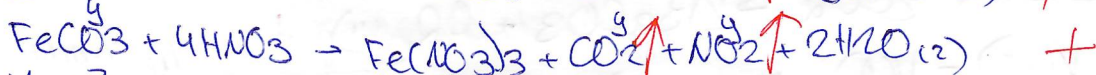
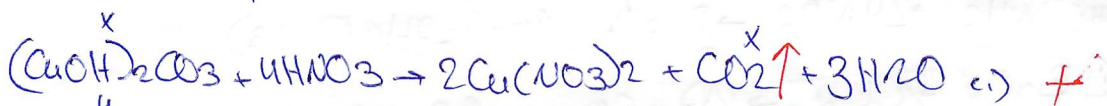
$$V(\text{газа}) = \frac{pV}{RT} = \frac{101,325 \cdot 30,56}{8,31 \cdot (273+25)} = 1,25 \text{ моль}$$

$$pV = \nu RT$$

$$pV = \frac{m}{M} RT$$

$$pM = \rho RT$$

$$M = \frac{\rho RT}{p} = \frac{1,816 \cdot 8,31 \cdot 298}{101,325} = 44,383 \text{ г/моль}$$



Пусть  $\nu((\text{CuOH})_2\text{CO}_3) = x$  моль

$\nu(\text{FeCO}_3) = y$  моль

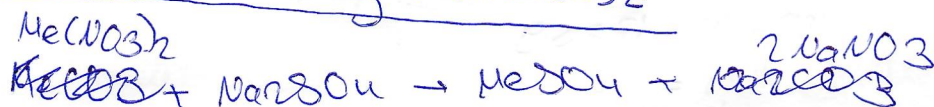
$\nu(\text{MgCO}_3) = z$  моль

$$V(\text{газа}) = \nu(\text{CO}_2)_1 + \nu(\text{CO}_2)_2 + \nu(\text{CO}_2)_3 + \nu(\text{NO}_2)$$

$$\text{I } 1,25 = x + 2y + z$$

$$146,7 = m(\text{FeCO}_3) + m(\text{MgCO}_3) + m((\text{CuOH})_2\text{CO}_3)$$

$$\text{II } 146,7 = 222x + 116y + (160+60)z$$



$$\text{III } m(\text{Mg}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}) = 68,8$$

$$\text{III } (160 + 132) \cdot z = 68,8$$

$$1,25 = x + 2y \quad \text{числовые}$$

Для газа:

~~1,25 = x + 2y~~

$$IV \quad 44x + 44y + 46y + 44z = m(z)$$

$$44x + 44y + 46y + 44z = 44,383 \cdot (x + 2y + z)$$

$$(44x + 44y + 46y + 44z) + 44y = 44,383 \cdot (x + 2y + z)$$

$$2y = (44,383 - 44) \cdot 1,25$$

$$y = 0,24 \text{ моль}$$

Предположим, что Me - Ca, тогда

$$из III \quad z = \frac{68,8}{(40+132)} = 0,4 \text{ моль} +$$

$$из I \quad x = 1,25 - 2y - z = 0,37 \text{ моль} +$$

Подставим в II:

$$146,7 = 222 \cdot 0,37 + 116 \cdot 0,24 + (40+60) \cdot 0,4$$

получается тонгеситово

⇒ предположение верно Me - Ca,  
минерал  $CaCO_3 +$



$$m(Ca) = 0,37 \cdot 63,55 = \underline{\underline{23,51352}} \quad \ominus \text{ всего: малахит!}$$

Серповый  
 $222x + 116y + (Me + 60)z = 146,7$

$$x + 2y + z = 1,25$$

$$44 = 1,25 + 2y = 44,383 \cdot 1,25 \quad y = 0,24$$

$$(Me + 64 + 32 + 36)z = 68,8$$

$$z = \frac{68,8}{Me + 132}$$

$$Ca \quad z = 0,4 \quad x = 0,37$$

$$Sr \quad z = 0,313268372 \quad x = 0,4567$$

$$Ba \quad z = 0,255762 \quad x = 0,514238$$

~~$$(Ca + Sr + Ba)z = 100$$~~

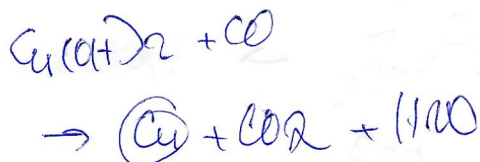
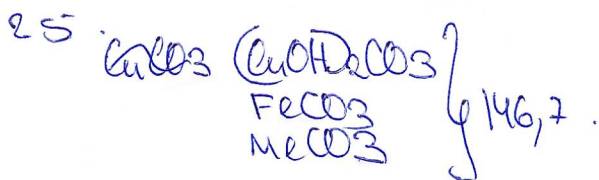
~~$$\rightarrow 2Ca + 2Sr + 2Ba = 100$$~~

Ca<sub>2</sub>

$$69 - 0,4 \cdot 100 = 29$$

$$0,4 \cdot 100 + 116 \cdot 0,24 =$$

Черновик.



$222x + 116y + (Me + 60)z = 146,7$

119,29797

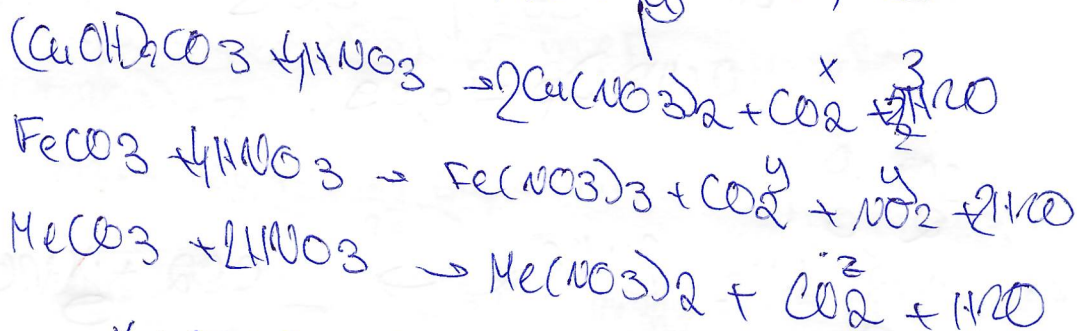
$D(z) = \frac{PV}{RT} = \frac{101,325 \cdot 30,56}{8,31 \cdot 298} = 1,25$

$M_{CO_2} = PV = \frac{m}{M}$

$M \cdot p = pRT$

$M = \frac{pRT}{p} = 44,383$

x=20,37



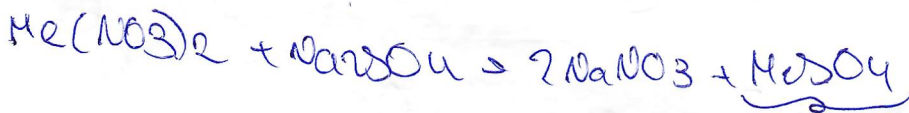
$x + 2y + z = 1,25$

$44x + 44y + 46y + 44z = 44,383(x + 2y + z)$

$1,25 \cdot 44 + 2y = 55,47875$

$y = 0,514538$

24  
0,514538



$z \cdot (Me + 32 + 64 + 2 \cdot 18) = z \cdot 68,8$

$z(Me + 132) = 68,8$

$z = \frac{68,8}{Me + 132}$

$z = 0,255$

$22x + (Me + 60)z = 118,86 \quad z = 0,4$

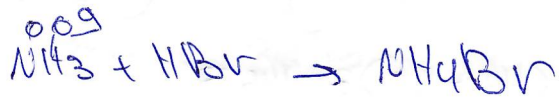
46,2447

$22x + \frac{(Me + 60) \cdot 68,8}{132 + Me} = 118,86$

50,4



Урновел.



$$2(\text{NH}_3) = 2(\text{HBr}) = 0,309$$

$$\text{pH} = 1,52$$

$$-\lg \{H^+\} = 1,52$$

$$\{H^+\} = 10^{-1,52} = 0,03$$

$$0(\text{HBr})_p = 0,09$$



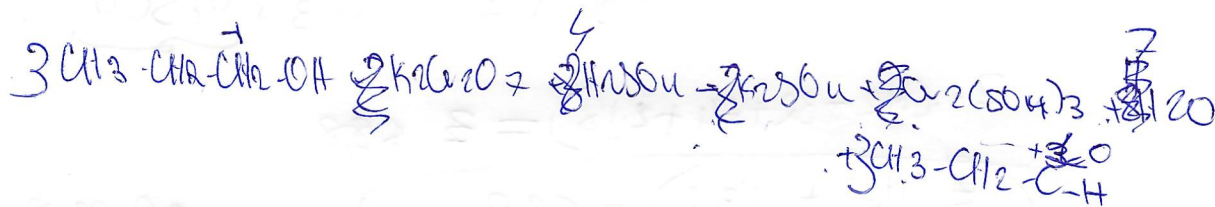
$$0(\text{HNO}_2) = 0,09$$

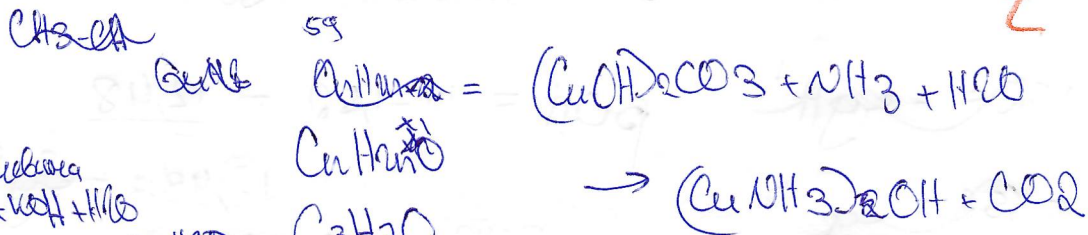
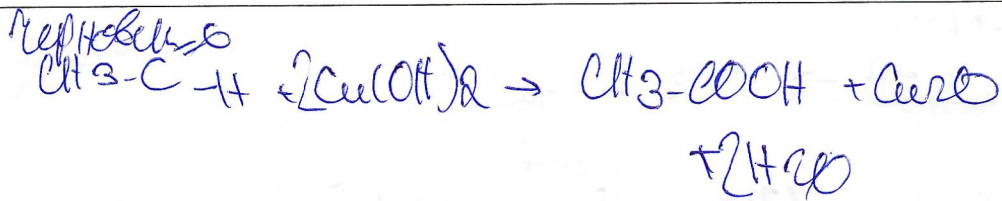
$$C = \frac{0,09}{0,2} = 0,45$$



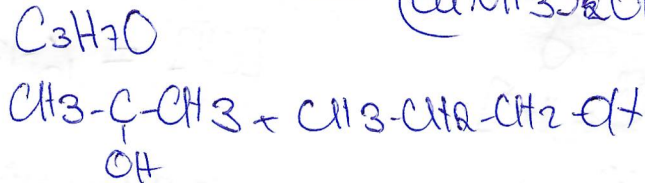
3.2  $n=59$

$\text{O}_2$





Молекулярная  
 $+ \text{KOH} + \text{HClO}$   
 Мольная часть  $\text{C}_3\text{H}_7\text{O}$



94,65888

Б.С.

$0(\text{CuCO}_3 \cdot \text{CuOH})_2 - x$   
 $0(\text{FeCO}_3) - y$   
 $0(\text{MeCO}_3) - z$

$\text{Cu}$   
 $\rho_V = \rho RT$   
 $\rho_V = \frac{m}{M} RT$

$\rho_M = \rho RT$   
 $M = \frac{\rho RT}{\rho}$

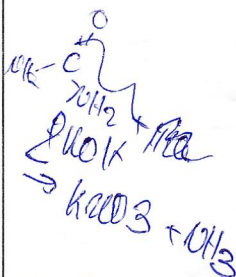
$222x + 116y + (\text{Me} + 60)z = 146,7$

$x + y + z = 1,25$

$44x + 44y + 46y + 44z = 1,25 \cdot 44,383$

$M = 44,383$

$D = \frac{\rho_V}{\rho} = 1,25$



$44 \cdot 1,25 + 46y = 1,25 \cdot 44,383$

$44,75 + 2y = 1,25$

$z = 2y = 1,25 \cdot 0,383$

$y = 0,24$

$44x + y + z$

$46y = 1,25 \cdot 44,383$

$\text{MeSO}_4$

$y = 0,01$

$(\text{Me} + 60)z = 0,3058$

$0,01 \cdot 116 + (\text{Me} + 60)z = 69$

$(\text{Me} + 96)z = 68,8$

$67,84 = \text{Me} \cdot z + 60 \cdot z$

$z = 0,9244$

$\text{Me} \cdot z + 132z = 68,8$

$0,96 = 72z$

$68,8 \cdot 132 = 9096$   
 $9096 / 72 = 126,333$

$0,96 / 72 = 0,01333$

$30,465$

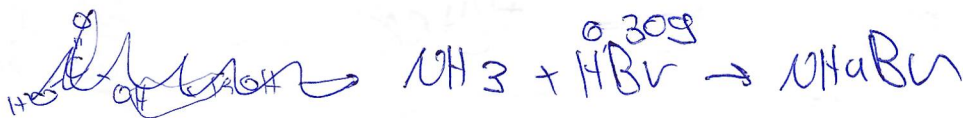
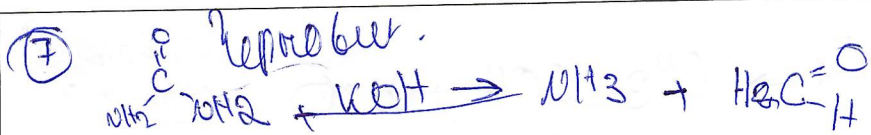
$802,8$

$\text{Me} = \frac{(67,84 - 60 \cdot \frac{0,96}{72})}{0,96} z = \frac{0,96}{72}$

$27,64 = 72z$

$z = 0,383888$

$\text{Me} = 6$



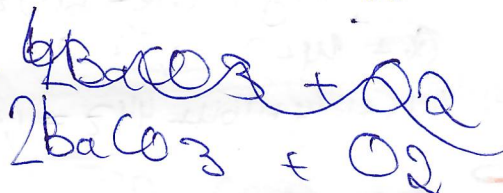
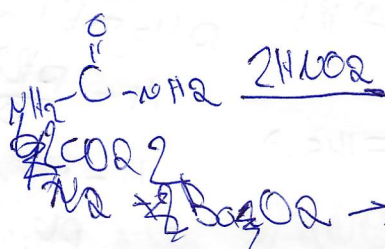
$1,52 = -\lg K^+$

$-1,52 = \lg K^+$

$10^{-1,52} = K^+$

$[H^+] = 0,03$

$[OH^-]$



25.



$222x + 116y + (144 + 12 + 48)z = 145,7$

$\rho(z) = \frac{pV}{M} = \frac{101,325 \cdot 30,56}{8,31 \cdot (273 + 25)} = 1,25$

$pV = nRT$

$pV = \frac{m}{M} RT$

$M = \frac{pRT}{\rho}$

$M = \frac{pRT}{\rho} = 44,382g = \frac{1,016 \cdot 8,31 \cdot 298}{101,325} = 44,382g$

$x + 2y + z = 1,25$

$44x + 44y + 46y + 44z = 1,25 \cdot 44,382g$

Черновик

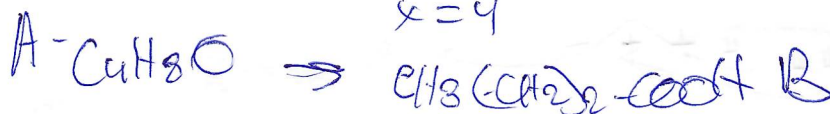
⑤  $n = 18x$

54,81172



$4x = 16$

$x = 4$

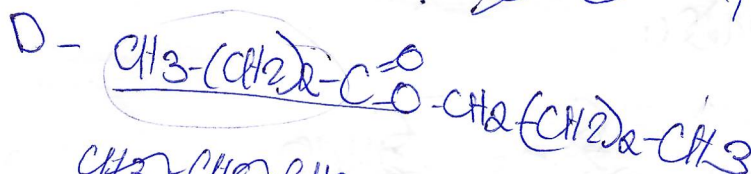


$KNO_2$   
 $HNO_2$

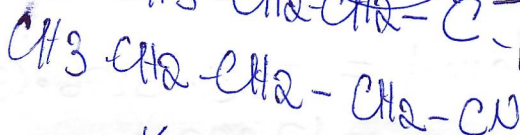
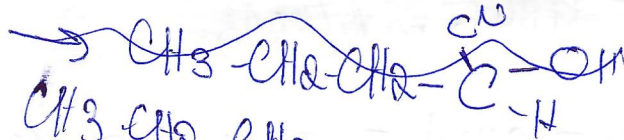
$0,6667 = \frac{12 \cdot x}{12 \cdot x + 2x + 32}$

$14x \cdot 0,6667 + 21,3344 = 12x$

$(19 \cdot 0,6667 - 12)x = 21,3344 - 2,6667x$

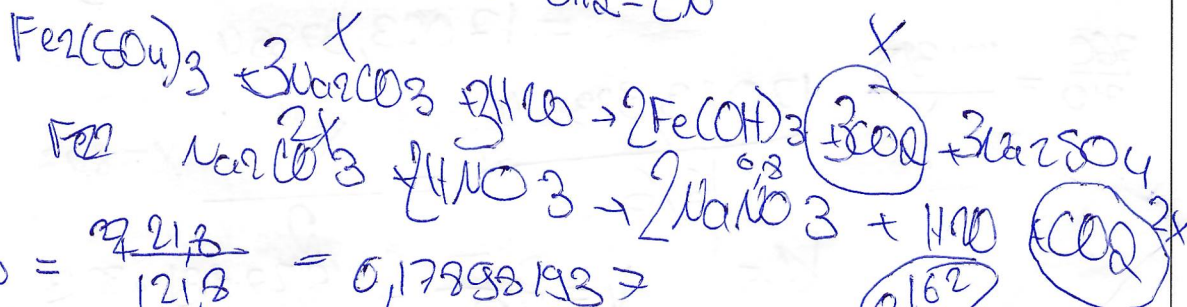


$x = 8$



2,6667x

⑥



$w = \frac{218}{121,8} = 0,178981937$

$\frac{0,178981937}{100} = \frac{106x}{1837 + 286x}$

$w(NaNO_2) = \frac{68}{419,295} \cdot 3x = 0,6$   
 $x = 0,2$

$32,87898 + 51,1883415x = 106x$

$32,87898 = 54,3x$   
 $x = 0,6$

