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(64.5)



МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ имени М.В.ЛОМОНОСОВА

Вариант 2

Место проведения Москва
город

ПИСЬМЕННАЯ РАБОТА

Олимпиада школьников Ломоносов
наименование олимпиады

по химии
профиль олимпиады

Смирновой Светланы Всеволодовны
фамилия, имя, отчество участника (в родительном падеже)

Дата
«12» мая 2023 года

Подпись участника

Смирн

14-99-67-77
(64.5)

1 2 3 4 5 6 7 8
3 6 10 12 14 14 18 18 95

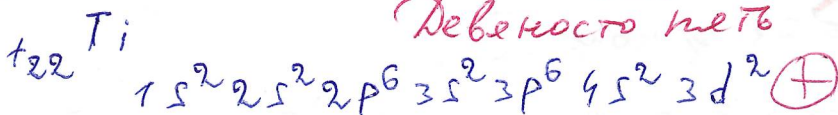
Kaprob

Числовик. 1

95

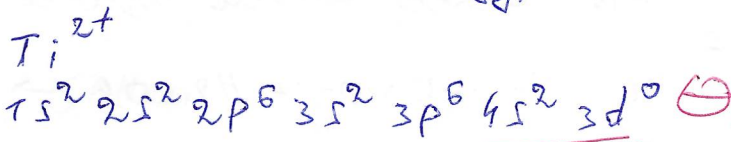
N 1.4

Дефектность нет



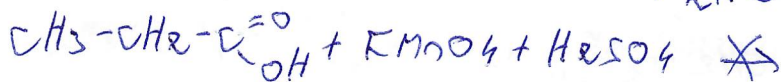
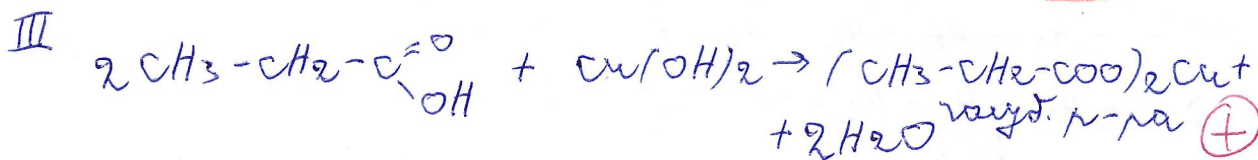
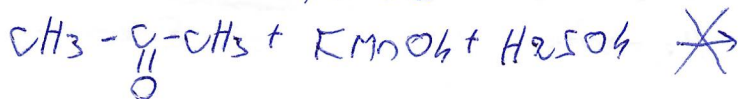
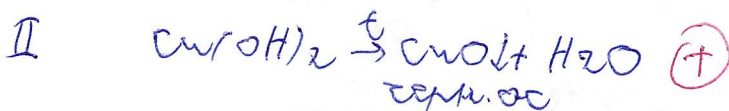
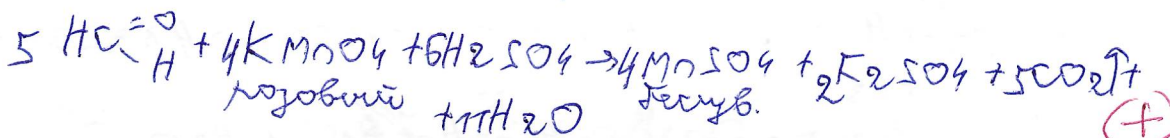
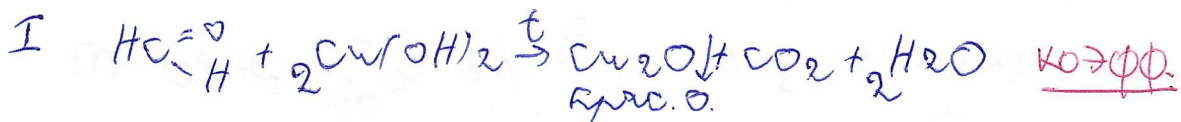
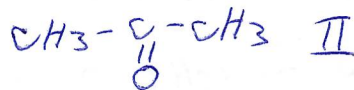
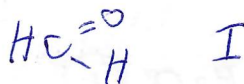
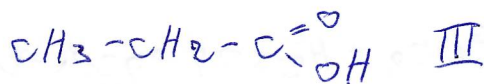
пара пара пара пара пара пара

У Ti 10 пар спаренных e и 2 неспаренных e на d-подуровне.



Ответ: Ti

N 2.1



Ответ: $CH_3-CH_2-C(=O)OH$ - III карба

$HC(=O)H$ - I карба

$CH_3-C(=O)-CH_3$ - II карба

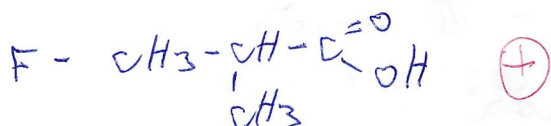
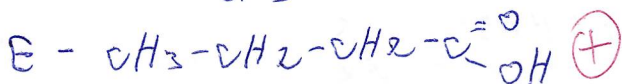
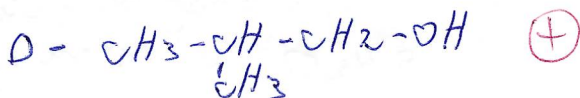
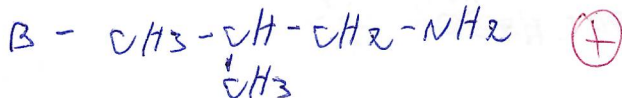
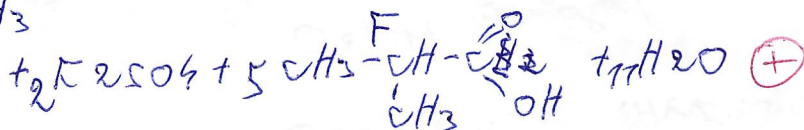
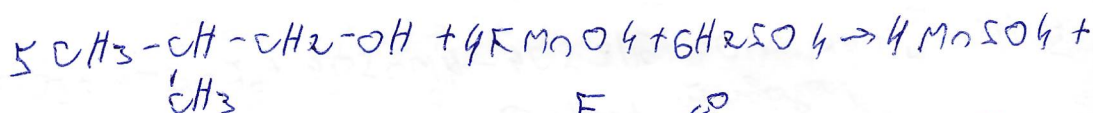
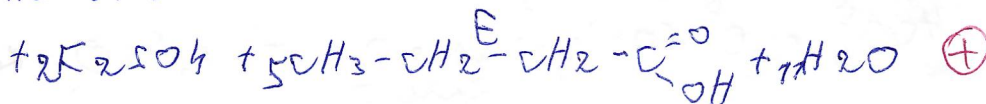
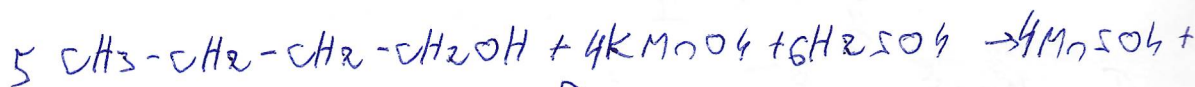
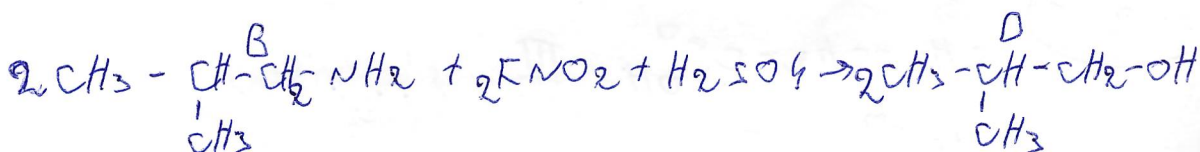
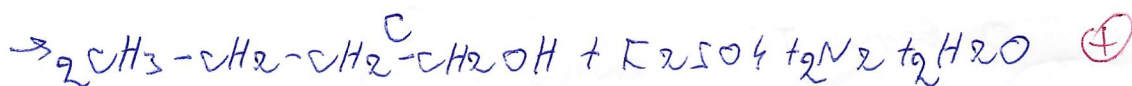
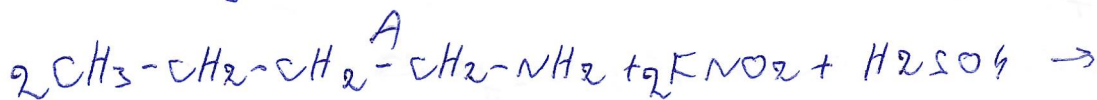
Системик. 9

N 3.6

$$D_{N_2} = 2,607$$

$$M_{cp} = 73 \text{ г/моль} \quad (+)$$

Реакция с нитритной кислотой харак-
терна для аминов, значит ветвь-ва АСВ -
амин. Ветвь-ва С и D - углеводороды, значит
ветвь-ва АСВ после полной углеводородности.



N 4.2

метовик. 3

$T = 288 K$

$T_1 = 24^\circ C$

$m(H_2O) = 1,179 \text{ кг}$

$T_2 = 98^\circ C$

$Q(C_2H_6) = 84,7 \text{ кДж/моль}$

$\rho = 97,3 \text{ кг/л}$

$Q(CO_2) = 393,5$

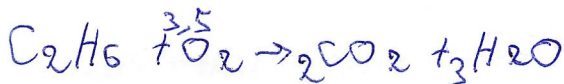
$Q(H_2O) = 285,8$

$c(H_2O) = 75,31 \frac{\text{Дж}}{\text{моль} \cdot K}$

$Q = \nu c (T_2 - T_1)$

$\nu(H_2O) = \frac{1179}{18} = 65,5 \text{ моль} (+)$

$Q = 65,5 \cdot 75,31 \cdot 74 = 365,028 \text{ Дж} = 365,028 \text{ кДж} (+)$



$Q_{сгор}(C_2H_6) = 2Q(CO_2) + 3Q(H_2O) - Q(C_2H_6) =$

$= 2 \cdot 393,5 + 3 \cdot 285,8 - 84,7 = 1559,7 \text{ кДж/моль} (+)$

$\nu(C_2H_6) = \frac{365,028}{1559,7} = 0,234 \text{ моль}$

$V = \frac{\nu RT}{P} = \frac{0,234 \cdot 8,314 \cdot 288}{97,3} = 5,76 \text{ л} (+)$

Ответ: $V(C_2H_6) = 5,76 \text{ л}$

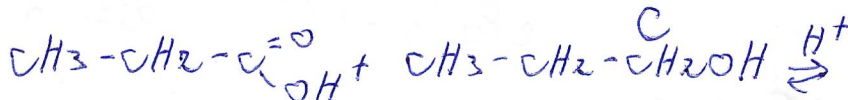
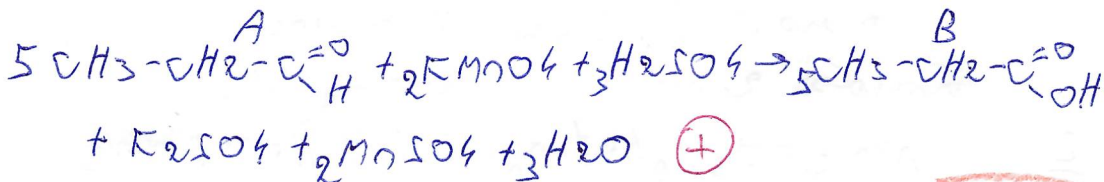
N 5.5

$\omega(H) = 10,35$

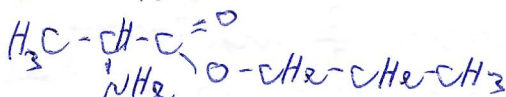
$C_nH_{2n}O$ - формула углеводорода

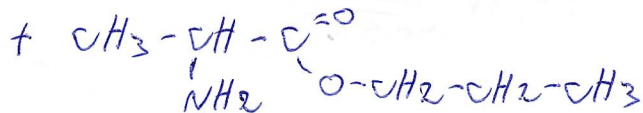
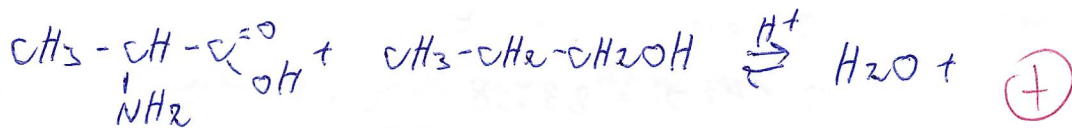
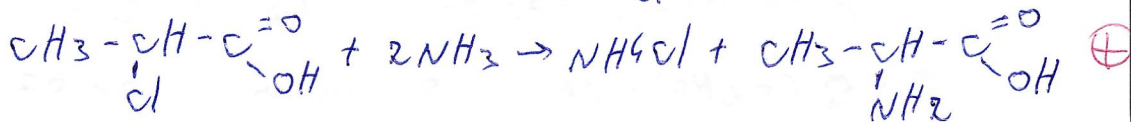
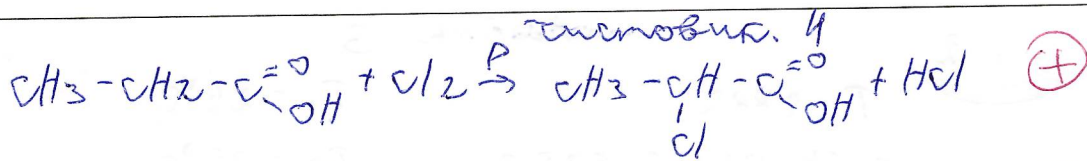
$0,1035 = \frac{2n}{14n + 16}$

$n = 3 (+)$



Тримерное пропилового эфира 2-аминокпропановой к:





N 6.6

$$V(\text{H}_2\text{O}) = 170,2 \text{ мл}$$

$$T = 20^\circ\text{C}$$



$$\rho = 27,8 \text{ г/мл } 100 \text{ г } \text{H}_2\text{O}$$



$$V_{\text{взв}}(\text{Na}_2\text{CO}_3) = 2V_{\text{взв}}(\text{HCl})$$

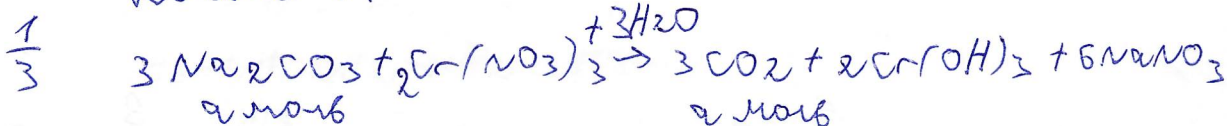
$$\omega(\text{Na}_2\text{CO}_3) = \frac{\rho}{100 + \rho} = \frac{27,8}{127,8} = 0,2179 \text{ масс}$$

$$0,2179 = \frac{m(\text{Na}_2\text{CO}_3)}{m(\text{р-ра})} = \frac{x \cdot 106}{170,2 + x \cdot 286}$$

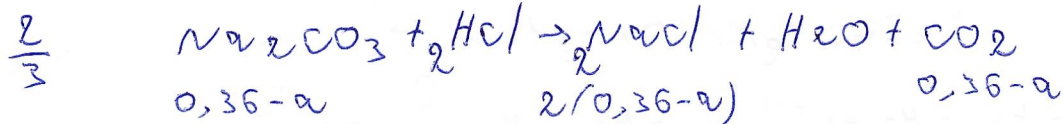
$$x = 0,36 \text{ масс } (+)$$

$$m(\text{р-ра}) = 273,16 \text{ г}$$

Ровня 1:



Ровня 2:



$$0,36 - a = 2a$$

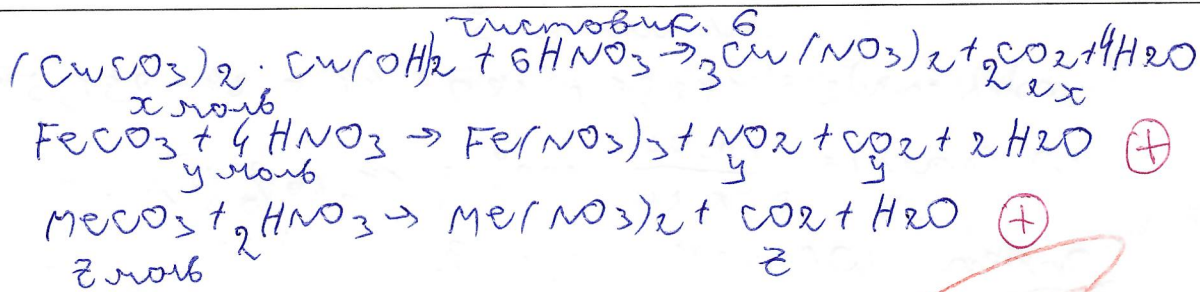
$$3a = 0,36$$

$$a = 0,12 \text{ масс}$$

$$m(\text{NaCl}) = 58,5 \cdot 2 \cdot 0,24 = 28,06 \text{ г } (+)$$

Распор 2 сост $\frac{2}{3}$ первонач. р-ра.

$$m(\text{р-ра})_2 = \frac{2}{3} \cdot 273,16 = 182,1 \text{ г } (+)$$



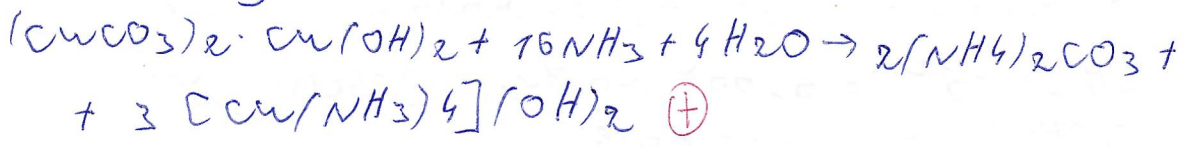
$V(\text{газы}) = \frac{pV}{RT} = 1,2 \text{ моль}$ \oplus

$2x + 2y + z = 1,2 \text{ моль}$ $V(CO_2) = 1,2 - y$

$M_{cp} = \frac{\sum RT}{P} = \frac{1,820 \cdot 8,314 \cdot 298}{101,325} = 44,5 \text{ г/моль}$

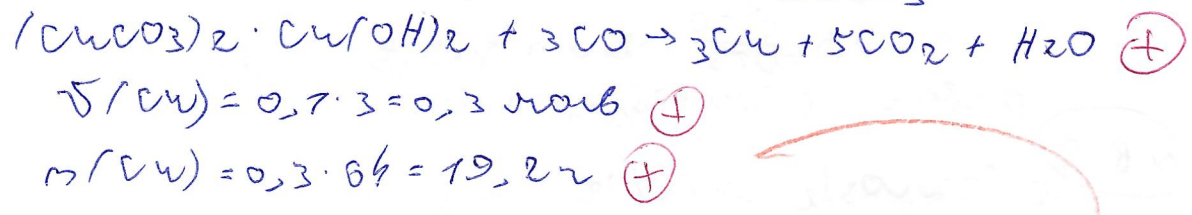
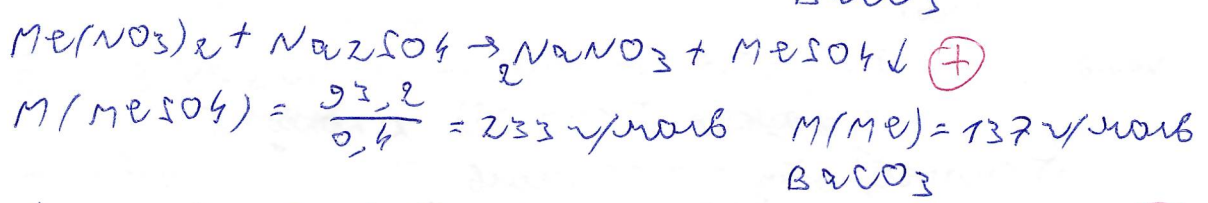
$44,5 = \frac{M_1 V_1 + M_2 V_2}{V_2 + V_1} = \frac{56y + 44(1,2 - y)}{1,2}$

$53,4 = 2y + 52,6$ $m(FeCO_3) = 0,3 \cdot 176 = 52,8 \text{ г}$
 $y = 0,3 \text{ моль}$



$m_{осн} = 173,6 = m(FeCO_3) + m(MnCO_3)$
 $m(MnCO_3) = 78,6 \text{ г}$ $V(\text{азурит}) = 0,1 \text{ моль}$
 $m(\text{азурит}) = 34,6 \text{ г}$ $= x$

$z = 1,2 - 2y - 2x = 1,2 - 0,2 - 0,6 = 0,4 \text{ моль}$
 $M(MnCO_3) = \frac{78,6}{0,4} = 197 \text{ г/моль}$ $M(Mn) = 137 \text{ г/моль}$
 $BaCO_3$



Ответ: $m(Cu) = 19,2 \text{ г}$

Задача 1

N.B.2 $PV = \nu RT$
 $\nu = \frac{PV}{RT}$

$PV = \nu RT$ $\nu = \frac{PV}{RT} = \frac{2973}{8,374 \cdot 298} =$

$M_{ср} = \frac{\nu RT}{P} = \frac{2973}{0,477,57} = 1,2 \text{ моль}$
 $= \frac{1820 \cdot 8,374 \cdot 298}{107,325} =$
 $= \frac{4509,78}{107,325} = 49,5 \text{ г/моль}$

$x + y + z = 1,2 \text{ моль}$

$\frac{49,5}{7} = \frac{M_1 \nu_1 + M_2 \nu_2}{\nu_1 + \nu_2} = \frac{46y + 44(1,2 - y)}{1,2}$

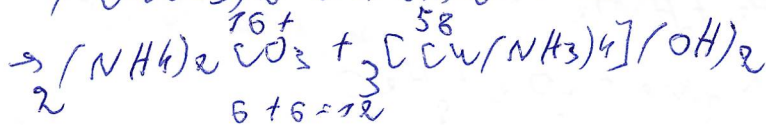
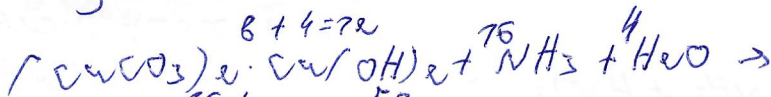
$53,4 = 46y + 52,8 - 44y$

$53,4 = 2y + 52,8$

$2y = 0,6$

$y = 0,3 \text{ моль}$

$m(\text{FeCO}_3) = 34,8 \text{ г}$



$m(\text{осн}) = m(\text{FeCO}_3) + m(\text{MgCO}_3) = 173,6 \text{ г}$
 $34,8 + m(\text{MgCO}_3) = 173,6$

$m(\text{MgCO}_3) = 78,8 \text{ г}$

$\nu(\text{осн}) = 0,7 \text{ моль}$

$m(\text{осн}) = 34,6$

$M(\text{MgCO}_3) = 192 \text{ г/моль}$

$M(\text{Mg}) = 132 \text{ г/моль}$

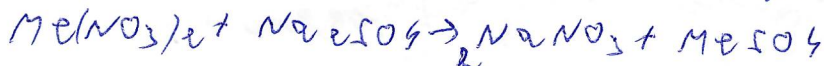


$z = 1,2 - x - y =$

$= 1,2 - 2 \cdot 0,7 - 2 \cdot 0,3 =$

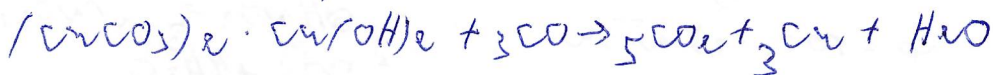
$= 1,2 - 0,2 - 0,6 =$

$= 0,4$



$M(\text{MgSO}_4) = \frac{93,2}{0,4} = 233 \text{ г/моль}$

$M(\text{Mg}) = 132 \text{ г/моль}$ BaCO_3



$\nu(\text{Cu}) = 3 \cdot 0,1 = 0,3 \text{ моль}$

$m(\text{Cu}) = 0,3 \cdot 64 = 19,2 \text{ г}$

Задача 2

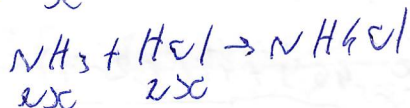
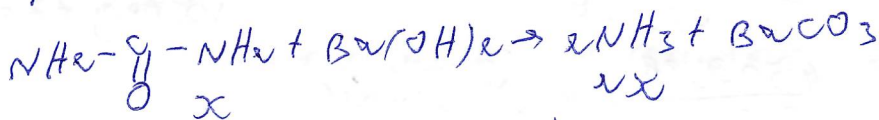
N 7.1

$V(\text{моль}) = 130 \text{ мл}$

$V(\text{HCl}) = 200 \text{ мл}$

$c(\text{HCl}) = 1,005 \text{ моль/л}$

$pH = 2.3$

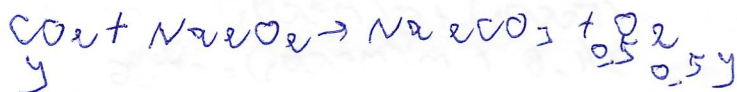
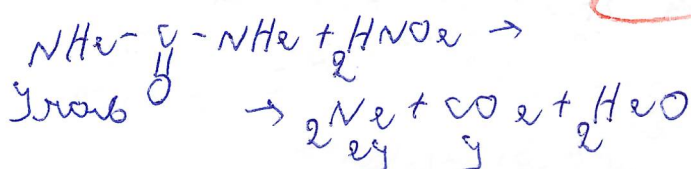


$V(\text{HCl}) = 0,2 \cdot 1,005 = 0,201 \text{ моль}$

$[\text{H}^+] = 10^{-2,3} = 0,005 \text{ моль/л} = c(\text{HCl}) \cdot \alpha$

$V(\text{HCl}) \cdot \alpha = 0,001 \text{ моль}$ $V(\text{HCl})_{\text{прор}} = 0,2 = \text{моль}$

$x = 0,1 \text{ моль} - V(\text{моль}) \cdot n$



$2,5y = 0,2 \cdot 2$

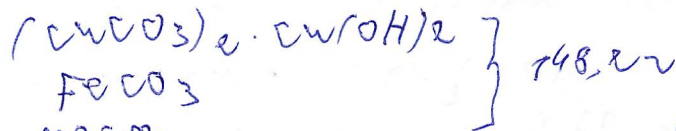
$2,5y = 0,4$

$y = 0,16 \text{ моль} - V(\text{моль}) \cdot n$

$V(\text{моль}) = 0,16 \text{ моль}$

$c(\text{моль}) = 2 \text{ моль/л}$

N 8.2



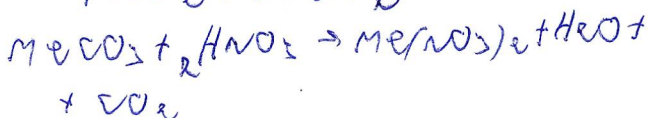
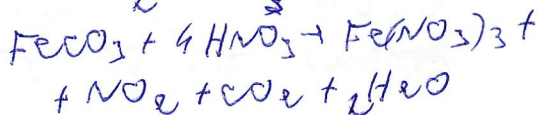
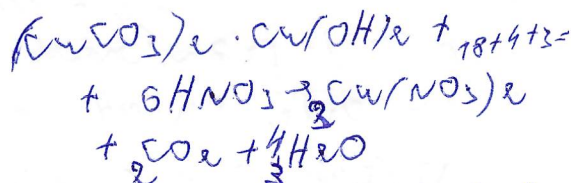
$8 + 18 = 26$

$S(\text{мг}) = 1,820 \text{ г/л}$

$V = 20,34 \text{ л}$

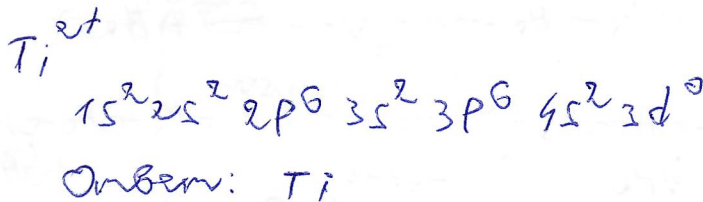
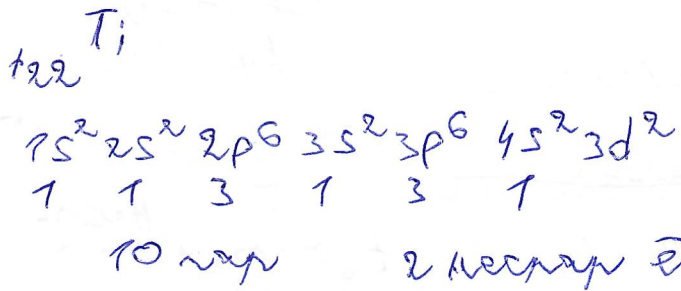
$p = 107,325 \text{ кПа}$

$T = 298 \text{ K}$

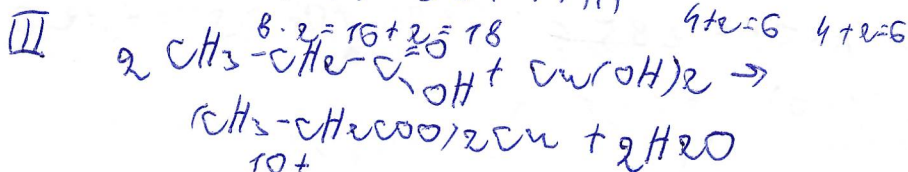
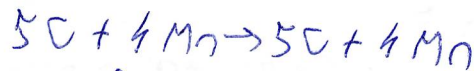
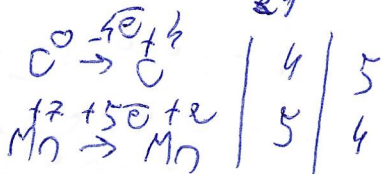
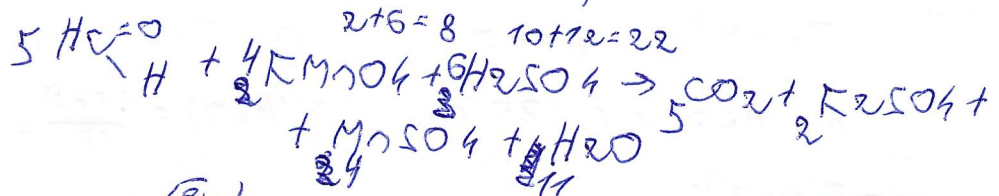
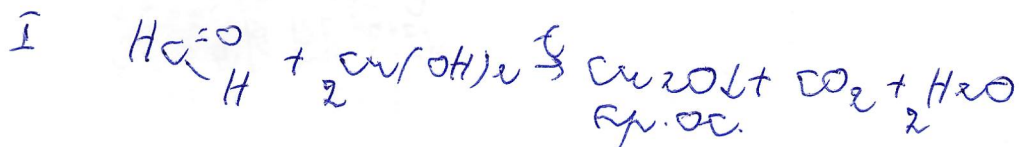
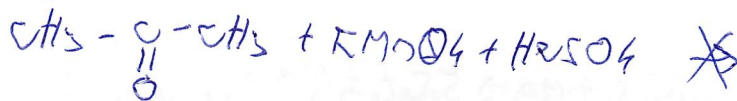
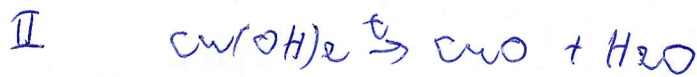
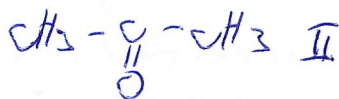
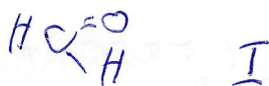
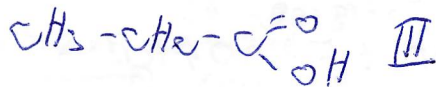


Германий: 3

N 1.4



N 2.1

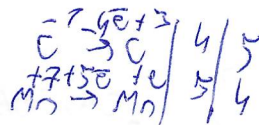
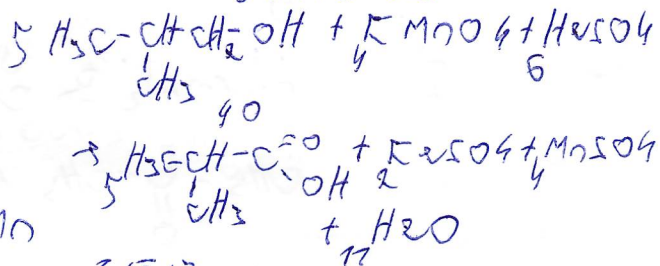
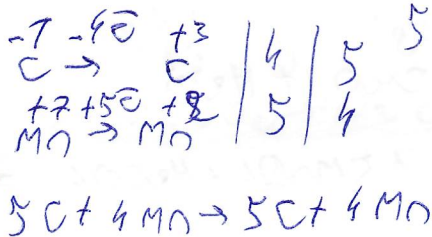
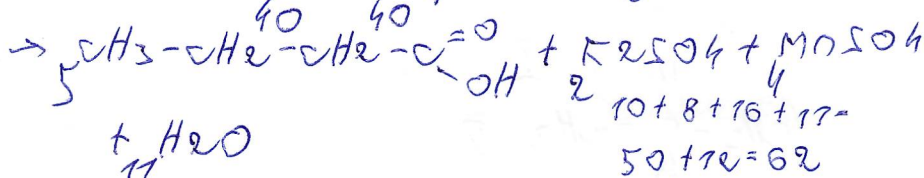
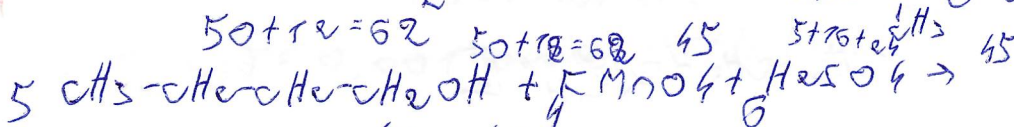
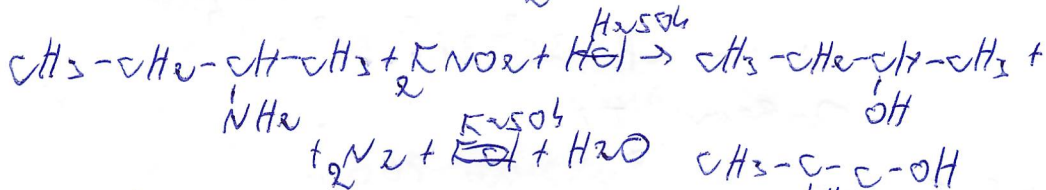
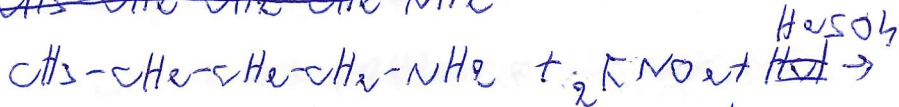


Черновик. 4

N3.6

$$D_{N_2} = 2,607$$

$$M_{ср} = 73 \text{ г/моль}$$



N4.2

$$T = 75^\circ\text{C} = 288\text{K}$$

$$Q = \nu C (T_2 - T_1)$$

$$m(\text{H}_2\text{O}) = 1,779 \text{ кг}$$

$$\nu(\text{H}_2\text{O}) = \frac{1779}{78} = 65,5 \text{ моль}$$

$$T_1 = 24$$

$$T_2 = 98$$

$$Q = 65,5 \cdot 75,37 \cdot 74 =$$

$$= 365026 =$$

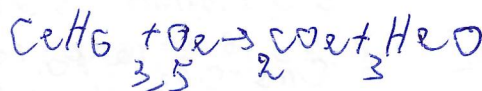
$$= 365,028 \text{ кДж}$$

$$Q(\text{C}_2\text{H}_6) = 89,7$$

$$Q(\text{CO}_2) = 393,5$$

$$Q(\text{H}_2\text{O}) = 285,6$$

$$C(\text{H}_2\text{O}) = 75,37$$



термовик. 5

$$Q_{\text{сгор}}(\text{C}_2\text{H}_6) = 2Q(\text{CO}_2) + 3Q(\text{H}_2\text{O}) - Q(\text{C}_2\text{H}_6) =$$

$$= 2 \cdot 393,5 + 3 \cdot 285,8 - 84,7 =$$

$$= 787 + 857,4 - 84,7 = 1559,7 \text{ кДж/моль}$$

$$V(\text{C}_2\text{H}_6) = \frac{365,028}{1559,7} = 0,234 \text{ моль}$$

$$PV = \nu RT$$

$$V = \frac{\nu RT}{P} = \frac{0,234 \cdot 8,314 \cdot 288}{97,3} = 5,76 \text{ л}$$

№ 5.5

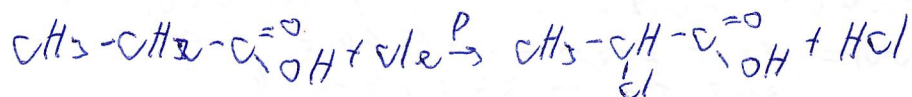
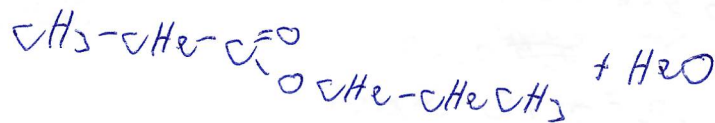
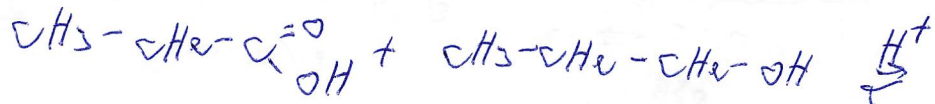
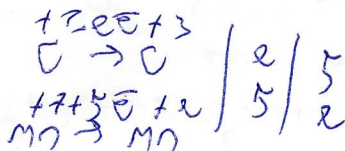
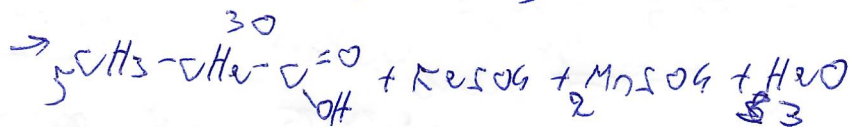
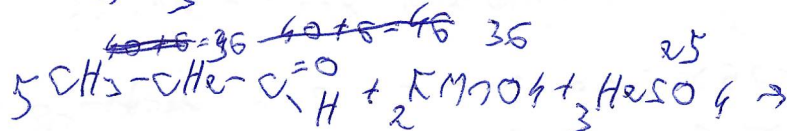
$$\omega(\text{H}) = 10,35 \quad \text{содерж. O}$$

$$\frac{0,1035}{1} = \frac{2n}{14n + 16}$$

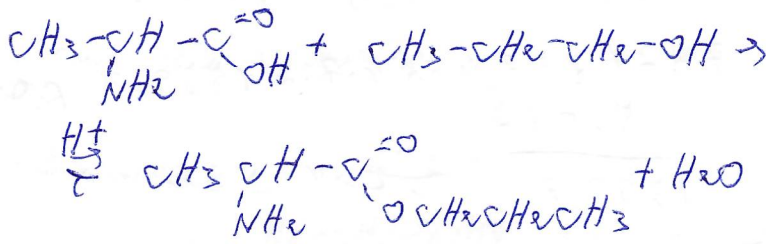
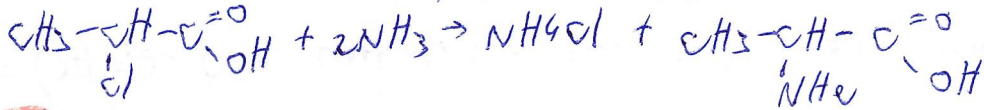
$$2n = 1,449n + 1,656$$

$$0,557n = 1,656$$

$$n = 3$$



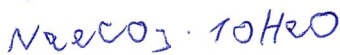
термовик. 6



N6.6

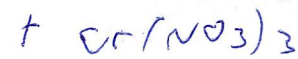
$$V(\text{H}_2\text{O}) = 170,2 \text{ мл}$$

$$T = 20^\circ\text{C}$$



$$V_2 = 2V_1$$

$$S = 27,8 \text{ мВ } 100 \sim \text{H}_2\text{O}$$



$$\omega = \frac{S}{S + 100} = \frac{27,8}{127,8} = 0,2179 \text{ масс}$$

$$\omega(\text{Na}_2\text{CO}_3) = \frac{m(\text{Na}_2\text{CO}_3)}{m(\text{H}_2\text{O})} = \frac{x \cdot 106}{170,2 + x \cdot 286} = \frac{0,2179}{1}$$

$$106x = 19,7 + 51,2x$$

$$54,8x = 19,7$$

$$x = 0,359 \text{ масс}$$

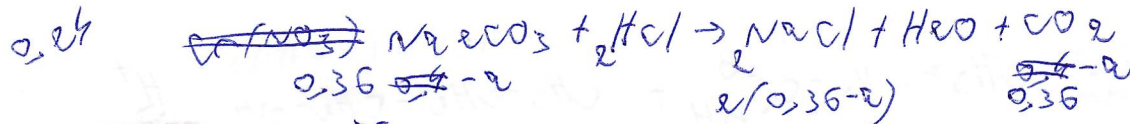
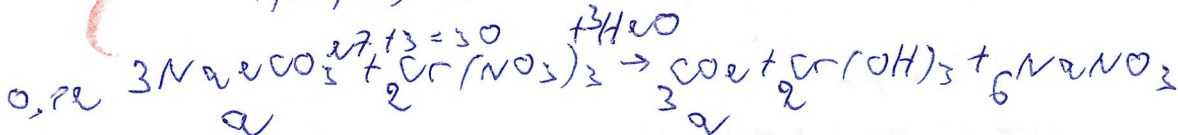
$$m(\text{H}_2\text{O}) = 170,2 + 51,2x$$

$$106x = 19,726 + 51,19x$$

$$54,81x = 19,726$$

$$x = 0,359$$

$$x = 0,356$$



$$0,36 - x = 2x$$

$$3x = 0,36$$

$$x = 0,12 \text{ масс}$$

$$m(\text{NaCl}) = 58,5 \cdot 2 \cdot 0,24 = 28,08 \text{ г}$$

Расчет 2 масс $\frac{2}{3}$ перв. н-ра

$$m(\text{H}_2\text{O}) = 170,2 \text{ г}$$

$$\omega(\text{NaCl}) = 17,16\%$$

$$m(\text{H}_2\text{O}) = 170,2 + 120 - 0,24 \cdot 44 = 251,54$$