



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

## **ОЛИМПИАДНАЯ РАБОТА**

Наименование олимпиады школьников: **«Ломоносов»**

Профиль олимпиады: **Химия**

ФИО участника олимпиады: **Рязанцев Иван Алексеевич**

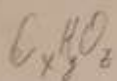
Класс: **11**

Технический балл: **90**

Дата проведения: **27 февраля 2022 года**

10046589 Тюльков И.А.

1. 86
2. 166
3. 166
4. 206
5. 206
6. 106 нет реакции гидроформилирования
7. Сумма 906



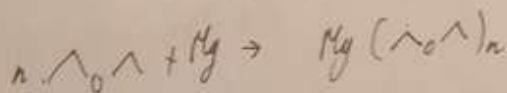
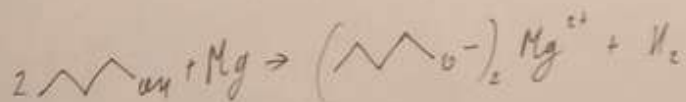
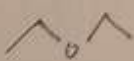
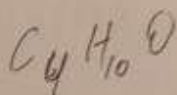
$$6x + y + 8z = 42$$

$$6x + 8z = 32$$

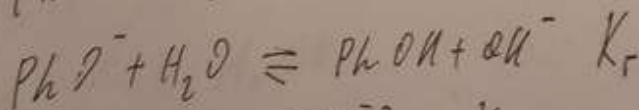
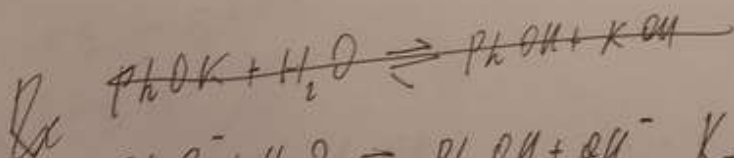
$$y = 10$$

$$x = 4$$

$$z = 1$$



12



$$K_r = \frac{[\text{PhOH}][\text{OH}^-]}{[\text{PhO}^-]} = \frac{K_w}{K_{\text{PhOH}}} = 10^{-4}$$

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

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

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

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

1

$$K_a = \frac{[PhO^-][H^+]}{[PhOH]} = 10^{-4}$$

12 (прод.) 4 КСГОВК

$$[PhOH] = [OH^-]$$

$$C(PhOK) = [PhOH] + [PhO^-] = [OH^-] + \frac{[OH^-]^2}{10^{-4}} = 0,011 M$$

Ответ: 0,011 M.

13

$$pV = nRT$$

$$n = \frac{pV}{RT} = 0,0402 \text{ моль} \quad \left( \frac{p}{RT} \right) \approx p$$

$$x(B) = 0,65$$

$$x(A) = 0,35$$

$$n(B) = 0,026 \text{ моль} \quad (B) = 0,026 M$$

$$n(A) = 0,014 \text{ моль} \quad (A) = 0,014 M$$

$$0,35 M(A) + 0,65 \cdot 2 M(A) = 25,9 \frac{g}{\text{моль}}$$

$$1,65 M(A) = 25,9 \frac{g}{\text{моль}}$$

$$M(A) = 46 \frac{g}{\text{моль}}$$

A - NO<sub>2</sub>, B - N<sub>2</sub>O<sub>4</sub>

$$K = \frac{[B]}{[A]^2} = \frac{k_1}{k_{-1}}$$

$$\frac{0,026}{0,014^2} = \frac{5 \cdot 10^{-3}}{k_{-1}}$$

$$k_{-1} = 3,27 \cdot 10^{-5} \text{ мин}^{-1}$$

Ответ: A - NO<sub>2</sub>; B - N<sub>2</sub>O<sub>4</sub>; k<sub>-1</sub> = 3,27 · 10<sup>-5</sup> мин<sup>-1</sup>

2

$1 = 0,65 \cdot 2 \text{ mol} = 1,3 \text{ mol}$   
 $(A) = 2,5 \cdot \frac{1}{2} \text{ mol}$   
 $= 1,25 \text{ mol}$   
 $1,0 \text{ mol}, B = 1,0 \text{ mol}$

**УЧЕТОВАЯ**

$X - C_x H_{14x+2} O \quad Y - C_y H_{14y+2} O$

$n(C_x H_{14x+2} O) + n(C_y H_{14y+2} O) = \frac{pV}{RT} = 9,3 \text{ mol}$

$M_{\text{op}} = 53 \frac{\text{g}}{\text{mol}}$

$x(X) \cdot (14x + 18) + x(Y) \cdot (14y + 18) = 53$

$x(X) = t \quad x(Y) = 1 - t$

$14tx + 18t + 14y + 18 - 14ty - 18t = 53$

~~$14t(x - y) = 35$~~

~~$14tx + 14y - 14ty = 35$~~

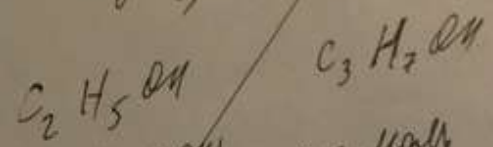
~~$tx - ty + y = 2,5$~~

~~$x = 2; y = 3$~~

~~$2t - 3t + 3 = 2,5$~~

~~$-t = -0,5$~~

~~$t = 0,5$~~



~~$n(C_2 H_5 OH) = 0,2 \text{ mol} \quad m(C_2 H_5 OH) = 9,22$~~

~~$n(C_3 H_7 OH) = 0,1 \text{ mol} \quad m(C_3 H_7 OH) = 6,2$~~

~~$14tx + 18t + 14y + 18 - 14ty - 18t = 53$~~

$tx + y - ty = 2,5; \quad x = 2; y = 3, \quad m.x = u \quad \leftarrow \text{результ}$

$t = 0,5$

$n(C_2 H_5 OH) = 0,15 \text{ mol}$

$n(C_3 H_7 OH) = 0,15 \text{ mol}$

$m(C_2 H_5 OH) = 6,92 \quad m(C_3 H_7 OH) = 9,2$

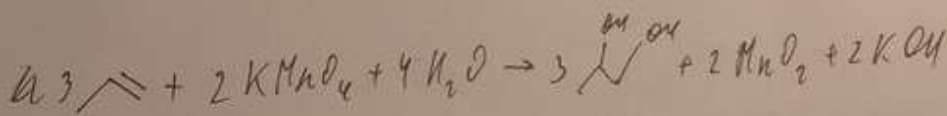
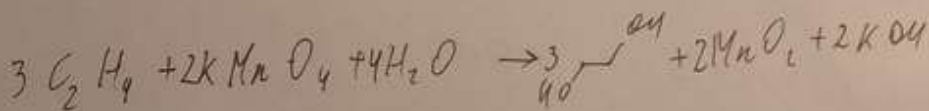
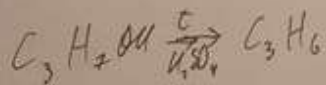
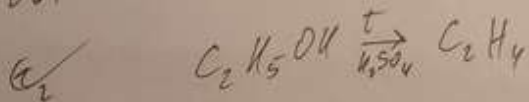
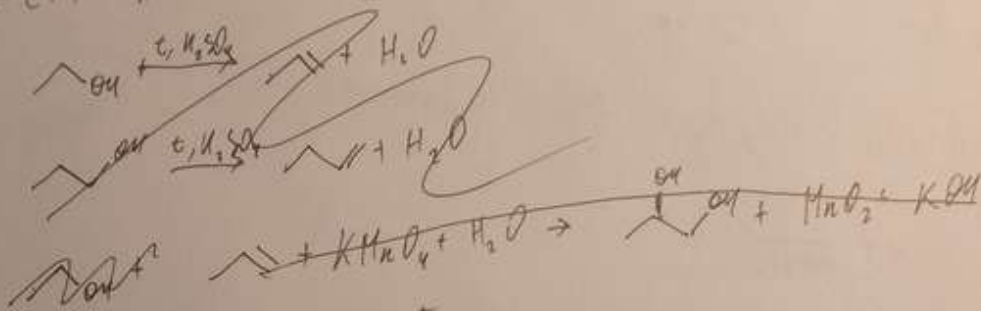
$m(C_2 H_5 OH) = 43,47$   
 $m(C_3 H_7 OH) = 56,67$

**3**

$$K = \frac{[O_2]}{[H_2]} = \frac{K_1}{K_{-1}}$$

14 (продол.)

4 ИСТОБЧК



$$n(KMnO_4) = \frac{2}{3} (n(C_2H_4) + n(C_3H_6)) = \frac{2}{3} \cdot 0,3 = 0,2 \text{ моль}$$

$$V(KMnO_4) = \frac{n(KMnO_4)}{C(KMnO_4)} = \frac{0,2 \text{ моль} \cdot 1}{2} = 0,1 \text{ л}$$

Ответ: 0,1 л  $\text{CH}_3\text{COOH}$ ;  $\text{CH}_3\text{COOH}$

$$\omega(\text{CH}_3\text{COOH}) = 43,4\%$$

$$\omega(\text{CH}_3\text{COOH}) = 56,6\%$$

$$V(KMnO_4) = 0,1 \text{ л}$$

4

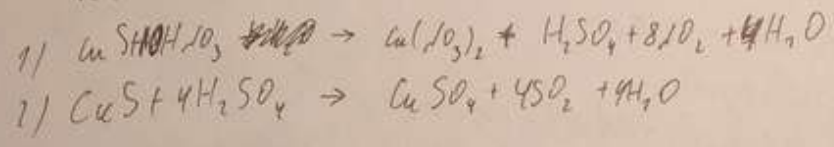
$n(A) = 0,05$   
 $M(A) = 75 \frac{\text{г}}{\text{моль}}$   
 $H(A) = 46 \frac{\text{г}}{\text{моль}}$   
 $A - \text{SO}_2, B - \text{SO}_4$

$K = \frac{\Sigma}{\square}$

15

**ЧУЛТОВУК**

$n(\text{CuS}) = 0,1 \text{ моль}$



1):  $n(\text{HNO}_3) = 1,2 \text{ моль}$

ночь р-на:

$n(\text{SO}_2) = 0,8 \text{ моль} \quad m(\text{SO}_2) = 36,8 \text{ г}$

$n(\text{H}_2\text{SO}_4) = 0,1 \text{ моль}$

$n(\text{HNO}_3) = 0,2 \text{ моль}$

$m_{\text{р-ра}} = 92,8 \text{ г}$

2)  $n(\text{H}_2\text{SO}_4) = 1,127 \text{ моль}$

ночь р-на:

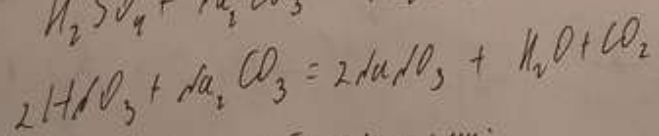
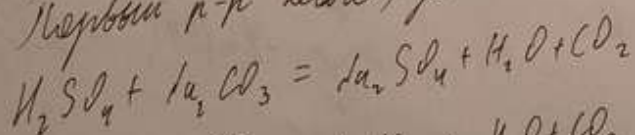
$n(\text{SO}_2) = 0,4 \text{ моль}$

$m(\text{SO}_2) = 25,6 \text{ г}$

$n(\text{H}_2\text{SO}_4) = 1,027 \text{ моль}$

$m_{\text{р-ра}} = 126,7 \text{ г}$

Требуется р-р серки, добавим  $\text{SO}_2 \cdot 10\text{H}_2\text{O}$  вместо  $\text{SO}_2$ .



Для нейтрализации:

$n(\text{SO}_2 \cdot 10\text{H}_2\text{O}) = 0,2 \text{ моль}$

$m(\text{SO}_2 \cdot 10\text{H}_2\text{O}) = 57,2 \text{ г}$

$n(\text{CO}_2) = 0,2 \text{ моль}$

$m(\text{CO}_2) = 8,8 \text{ г}$

$m_{\text{р-ра}} = 141,2$

$\Delta m = m(\text{SO}_2 \cdot 10\text{H}_2\text{O}) - m(\text{CO}_2) = 33,9 \text{ г}$

$n(\text{CO}_2) = n(\text{SO}_2 \cdot 10\text{H}_2\text{O}) < 0,2 \text{ моль}$

$n(\text{SO}_2 \cdot 10\text{H}_2\text{O}) \cdot 242 \frac{\text{г}}{\text{моль}} = 33,9 \text{ г}$

$n(\text{SO}_2 \cdot 10\text{H}_2\text{O}) = 0,14 \text{ моль} < 0,2 \text{ моль}$

**5**

15 (прод.)

$$m(\text{CaCO}_3 + 10\text{H}_2\text{O}) = 40,042$$

4 УСТОБУК

Проблем:  $\Delta m = 33,92$

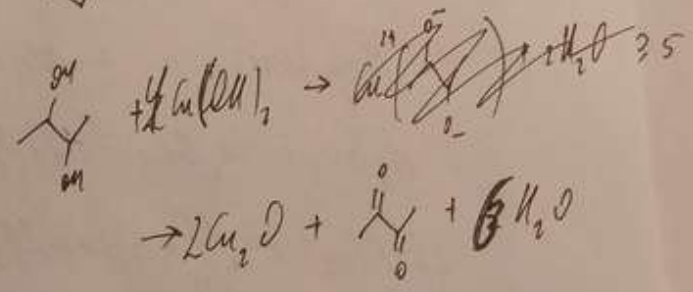
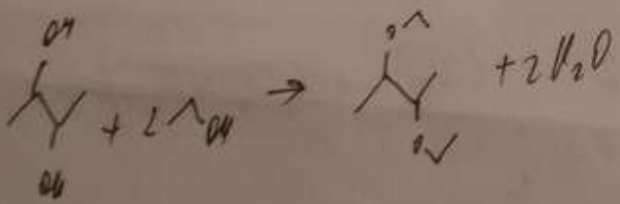
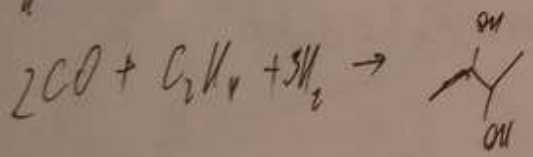
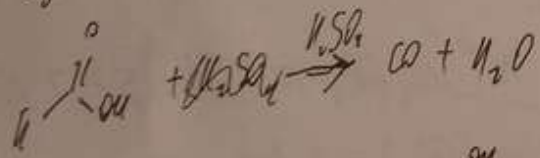
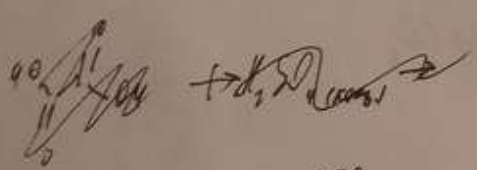
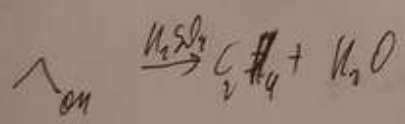
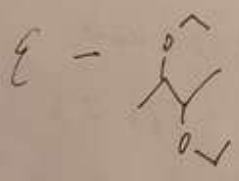
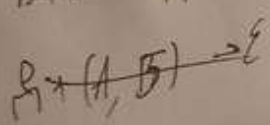
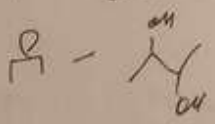
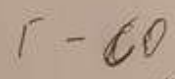
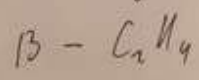
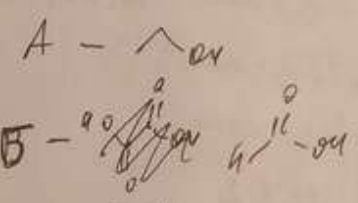
В небуви

$$m(\text{CaCO}_3 \cdot 10\text{H}_2\text{O}) = 40,042$$

4 УСТОБУК

16

~~$M_{\text{Ca}} = 28 \text{ моль}$~~   
 ~~$n(\text{Ca}_2\text{O}) = 0,15 \text{ моль}$~~



$n(\text{Cu}_2\text{O}) = 0,15 \text{ моль}$

$n(\text{CC(O)C}) = 0,075 \text{ моль}$

$m(\text{CC(O)C}) = 6,752$

6

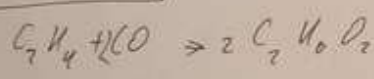
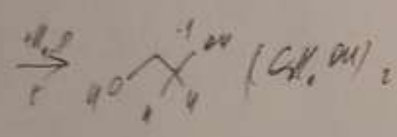


15 (моль)

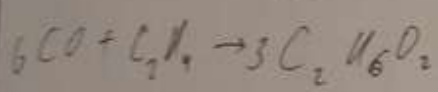
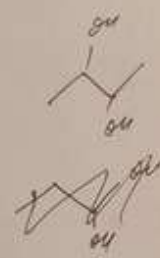
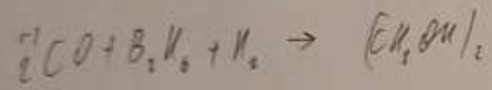
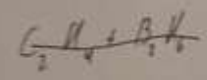
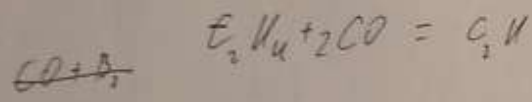
$\dots 10 H_2O = 40,042$

**4 ЕРНОВУК**

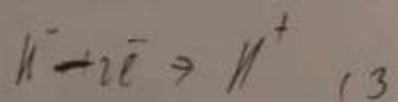
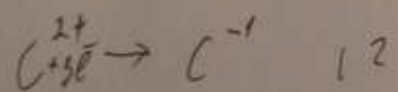
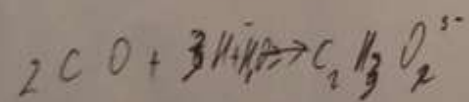
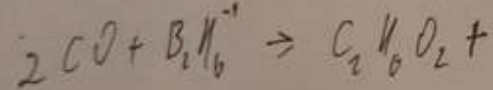
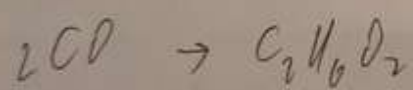
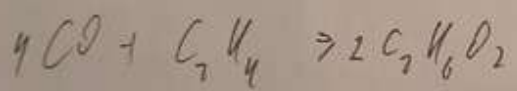
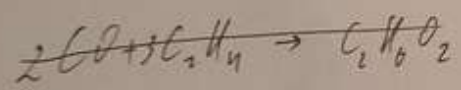
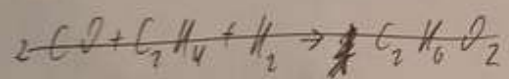
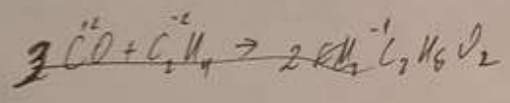
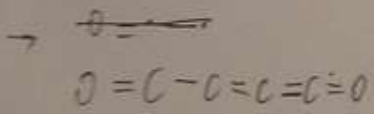
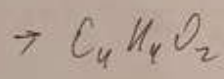
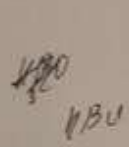
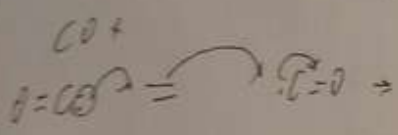
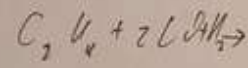
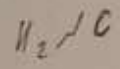
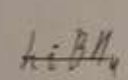
- $C_2H_4$
- $B_2H_6$
- $CO$
- $H_2$



$C_4$

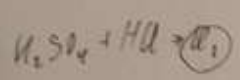
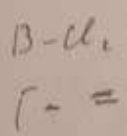
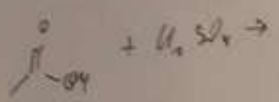


$C_2H_6O_2$

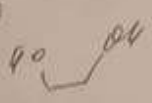
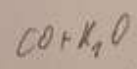
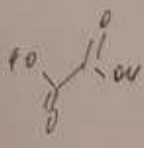
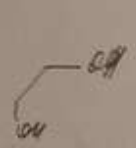
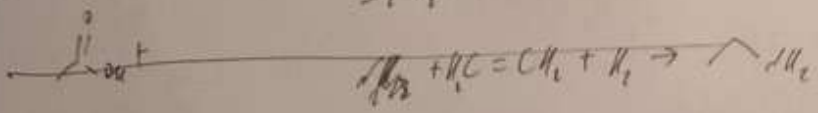
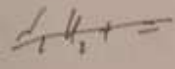


**7**

ЧЕЛОВЕК



4.95

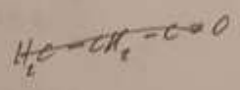
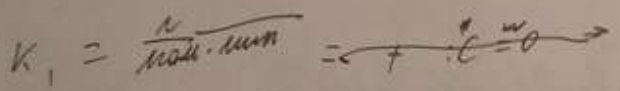


28+8

C2H4O2

C2H6O2

$\frac{\text{моль}}{\text{л} \cdot \text{мин}} K_1 \cdot \frac{\text{моль}^2}{\text{л}^2} = K_2 \cdot \frac{\text{моль}}{\text{л}} \cdot \text{CO} + \text{C}_2\text{H}_4$



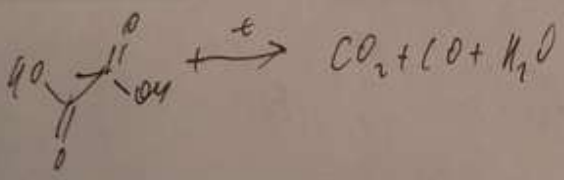
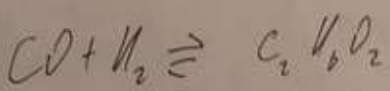
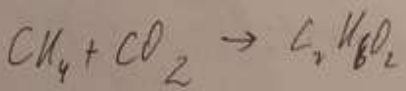
$\frac{\text{моль}}{\text{л} \cdot \text{мин}} = K_{-1} \cdot \frac{\text{моль}}{\text{л}} \cdot \text{CH}_3\text{COOH}$

= +



$K_{-1} = \frac{1}{\text{мин}}$

18+



C2H4O2