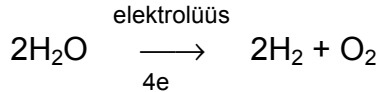
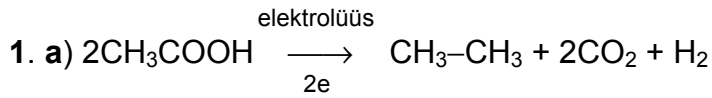
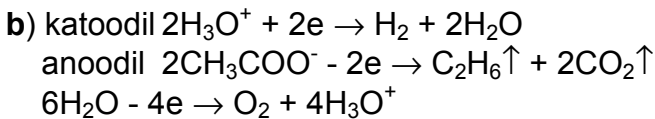


1997/98. õa keemiaolümpiaadi vabariikliku vooru ülesannete lahendused
12. klass



$$M(\text{C}_2\text{H}_6 \cdot 2\text{CO}_2 \cdot \text{H}_2) = (1 \text{ mol} \cdot 30,0 \text{ g/mol} + 2 \text{ mol} \cdot 44,0 \text{ g/mol} + 1 \text{ mol} \cdot 2,02 \text{ g/mol}) \cdot \frac{1}{4 \text{ mol}} = 30,0 \text{ g/mol}$$

$$M(2\text{H}_2 \cdot 1\text{O}_2) = (2 \text{ mol} \cdot 2,02 \text{ g/mol} + 1 \text{ mol} \cdot 32,0 \text{ g/mol}) \cdot \frac{1}{3 \text{ mol}} = 12,0 \text{ g/mol}$$



c) $n(\text{gaasid}) = \frac{761}{760} \text{ atm} \cdot 40,0 \text{ dm}^3 \cdot \frac{1 \text{ mol} \cdot \text{K}}{0,082 \text{ atm} \cdot \text{dm}^3} \cdot \frac{1}{298 \text{ K}} = 1,64 \text{ mol}$

d) $M(\text{gaasid}) = 29,0 \text{ g/mol} \cdot 0,476 = 13,8 \text{ g/mol}$

Olgu veest tekkinud gaasisegu moolide arv x , siis äädikhapest tekkinud gaasisegu moolide arv on $1,64 \text{ mol} - x$

$$x \cdot 12,0 \text{ g/mol} + (1,64 \text{ mol} - x) \cdot 30,0 \text{ g/mol} = 1,64 \text{ mol} \cdot 13,8 \text{ g/mol}$$

$$12,0x \text{ g/mol} + 49,2 \text{ g} - 30,0x \text{ g/mol} = 22,6 \text{ g}$$

$$18x \text{ g/mol} = 26,6 \text{ g}$$

$$x = 26,6 \text{ g} \cdot \frac{1 \text{ mol}}{18 \text{ g}} = \approx 1,48 \text{ mol}$$

$$1,64 \text{ mol} - x \Rightarrow 1,64 \text{ mol} - 1,48 \text{ mol} = 0,16 \text{ mol}$$

$$n(\text{CH}_3\text{COOH}) = \frac{2}{4} \cdot 0,16 \text{ mol} = 0,080 \text{ mol}$$

$$n(\text{H}_2\text{O}) = \frac{2}{3} \cdot 1,48 \text{ mol} = 0,987 \text{ mol}$$

e) $Q(\text{CH}_3\text{COOH}) = \frac{2}{2} \cdot 0,080 \text{ mol} \cdot \frac{1 \text{ F}}{\text{mol}} = 0,080 \text{ F}$

$$Q(\text{H}_2\text{O}) = \frac{4}{2} \cdot 0,987 \text{ mol} \cdot \frac{1 \text{ F}}{\text{mol}} = 1,97 \text{ F}$$

$$\Sigma[Q(\text{CH}_3\text{COOH}) + Q(\text{H}_2\text{O})] = 0,080 \text{ F} + 1,97 \text{ F} = 2,05 \text{ F}$$

$$U = 0,393 \text{ kWh} \cdot \frac{1000 \text{ A} \cdot \text{V}}{1 \text{ kW}} \cdot \frac{3600 \text{ s}}{\text{h}} \cdot \frac{1}{2,05 \text{ F}} \cdot 0,85 \cdot \frac{1 \text{ F}}{96485 \text{ A} \cdot \text{s}} =$$

$$= 6,08 \text{ V} \approx 6,1 \text{ V}$$

$$2. \text{ a) } M^{25^{\circ}\text{C}}(\text{gaasid}) = 0,499 \text{ g} \cdot 22,4 \text{ dm}^3 / \text{mol} \cdot \frac{298}{273} \cdot \frac{1}{0,230 \text{ dm}^3} = 53,0 \text{ g / mol}$$

$$M^{0^{\circ}\text{C}}(\text{gaasid}) = 0,0497 \text{ g} \cdot 22,4 \text{ dm}^3 / \text{mol} \cdot \frac{1}{0,024 \text{ dm}^3} = 46,4 \text{ g / mol}$$

Gaaside segu molaarmass saab väheneda ainult ühe gaasi kondenseerumise tõttu.

Järelikult madalama keemistemperatuuriga gaasi G' molaarmass on

$$M(G') = \approx 46,4 \text{ g/mol}$$

$$0,5 \cdot [M(G') + M(G'')] = 53,0 \text{ g/mol}$$

$$M(G'') = 53,0 \text{ g / mol} \cdot \frac{1}{0,5} - 46,4 \text{ g / mol} \approx 59,6 \text{ g / mol}$$

b) Et C, H ja O molaarmassid on väga lähedased täisarvudele, siis ümardame gaasi G' molaarmassi 46,0 g/mol.

Võrrandit $12x + 14y + 16z = 46,0$ rahuldab süsiniku moolide arv 1 ja 2, siis on vesiniku (y) ja hapniku (z) moolide arv järgmine:

x	y	z	M(g/mol)	Valem
2	6	1	46	$\text{C}_2\text{H}_6\text{O} \rightarrow \text{CH}_3\text{OCH}_3$ või $\text{C}_2\text{H}_5\text{OH}$
1	2	2	46	$\text{CH}_2\text{O}_2 \rightarrow \text{HCOOH}$

Tingimust rahuldab ainult dimetüüleeter – metoksumetaan, sest etüülalkohol ja metaanhape on normaaltingimustel vedelas olekus ja nad on keemiliselt aktiivsed.

G'' on $\text{CH}_3\text{OC}_2\text{H}_5$ (metüületüüleeter e. metoksetaan)

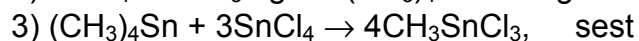
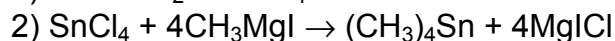
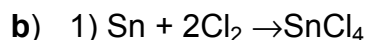
$$M(\text{CH}_3\text{OC}_2\text{H}_5) = 60,0 \text{ g/mol}$$

c) Eetrid on kergesti lenduvad ühendid $t_{\text{keem}}(\text{CH}_3\text{OC}_2\text{H}_5) = 7,6^{\circ}\text{C}$, mistõttu teda leidub gaasifaasis (n.t.) märgatavas hulgas.

3. a) Kui metall reageerib klooriga ja annab tetraalküülühendi, siis peab tema oksüdatsiooniaste ühendites olema +IV.

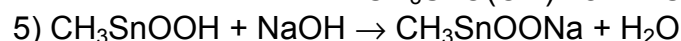
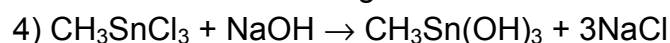
$$M(A) = 4 \cdot 35,5 \text{ g / mol} \cdot \frac{45,5}{54,5} = 118,55 \text{ g / mol} \approx 119 \text{ g / mol}$$

A on Sn (tina)



$$n[(\text{CH}_3)_4\text{Sn}] = 1 \text{ g} \cdot \frac{1 \text{ mol}}{179 \text{ g}} = 0,0056 \text{ mol}$$

$$n(\text{SnCl}_4) = 4,4 \text{ g} \cdot \frac{1 \text{ mol}}{260 \text{ g}} = 0,017 \text{ mol, millest tuleneb moolide suhe 3:1}$$



c) A - Sn (tina); B - SnCl₄ (tina(IV)kloriid), C - (CH₃)₄Sn (tetrametüültina), D - CH₃SnCl₃ (metüültina(IV)kloriid), E - CH₃SnOOH (metüültinaoksühüdrosiid).

4. a) CuO (vask(II)oksiid); CO₂ (süsihappegaas ehk süsinikdioksiid); H₂O (vesi ehk vesinikoksiid).

$$\text{b) } m^1(\text{gaas}) = 3,51 \text{ dm}^3 \cdot 0,798 \text{ g/dm}^3 = 2,80 \text{ g}$$

$$m^2(\text{gaas}) = 3,38 \text{ dm}^3 \cdot 0,910 \text{ g/dm}^3 = 3,08 \text{ g}$$

$$n^1(\text{gaas}) = 3,51 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3 \cdot 473 / 273} = 0,0904 \text{ mol}$$

$$n^2(\text{gaas}) = 3,38 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} \cdot \frac{273}{473} = 0,0871 \text{ mol}$$

$$\text{c) } m(\text{MeO}) = 10,00 \text{ g} - 2,80 \text{ g} = 7,20 \text{ g}$$

$$M(\text{MeO}) = 7,20 \text{ g} \cdot \frac{1}{0,0904 \text{ mol}} = 79,6 \text{ g/mol}$$

$$M(\text{Me}) = 79,6 \text{ g/mol} - 16,0 \text{ g/mol} = 63,6 \text{ g/mol}$$

Metalli oksiidiks on CuO

$$\text{Kontrolliks: } m(\text{MeO}) = 10,00 \text{ g} - 3,08 \text{ g} = 6,92 \text{ g}$$

$$M(\text{MeO}) = 6,92 \text{ g} \cdot \frac{1}{0,0871 \text{ mol}} = 79,5 \text{ g/mol}$$

$$\text{d) } M(\text{gaasid I}) = 2,80 \text{ g} \cdot \frac{1}{0,0904 \text{ mol}} = \approx 31 \text{ g/mol}$$

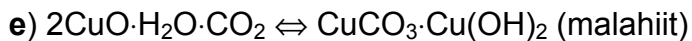
Lagunemisel tekkivate ainete hulgad suhtuvad alati nagu täisarvud. Keskmise molaarmassi 31 g/mol annavad H₂O ja CO₂ hulkade suhe 1:1

$$(18 \text{ g/mol} + 44 \text{ g/mol}) \cdot \frac{1}{2} = 31 \text{ g/mol}$$

$$M(\text{gaasid II}) = 3,08 \text{ g} \cdot \frac{1}{0,0871 \text{ mol}} = 35,4 \text{ g/mol}, \text{ millele vastab H}_2\text{O ja CO}_2$$

hulkade suhe 1:2

$$(18 \text{ g/mol} + 2 \cdot 44 \text{ g/mol}) \cdot \frac{1}{3} = 35,3 \text{ g/mol}$$



$$\text{5. a) } n(\text{X}) = -46,32 \text{ kJ} \cdot \frac{1 \text{ mol}}{-926,4 \text{ kJ}} = 0,05000 \text{ mol}$$

$$M(\text{X}) = 3,00 \text{ g} \cdot \frac{1}{0,05 \text{ mol}} = 60,0 \text{ g/mol}$$

$$\text{Seega } 12 \text{ g/mol} \cdot n(\text{C}) + 1 \text{ g/mol} \cdot n(\text{H}) + 16 \text{ g/mol} \cdot n(\text{O}) = 60,0 \text{ g/mol}$$

$$\text{b) } -926,4 \text{ kJ/mol} \cdot 1 \text{ mol} = -393,5 \text{ kJ/mol} \cdot n(\text{C}) -$$

$$-(-241,8 \text{ kJ}) / \text{mol} \cdot \frac{n(\text{H})}{2} - (-344,2 \text{ kJ}) / \text{mol} \cdot 1 \text{ mol}$$

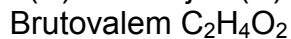
c) $12 \cdot n(\text{C}) + 1 \cdot n(\text{H}) + 16 \cdot n(\text{O}) = 60$

$n(\text{O}) \leq 3$

$n(\text{O}) = 3$ mol ei sobi, sest $60 - 48 = 12n(\text{C})$, mistõttu $n(\text{H}) = 0$

$n(\text{O}) = 2$ mol, siis $60 - 32 = 12n(\text{C}) + n(\text{H})$, millest

$n(\text{C}) = 2$ mol ja $n(\text{H}) = 4$ mol.

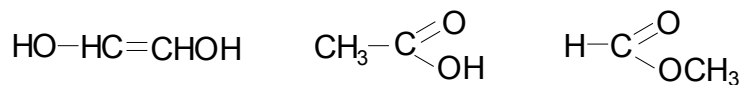


$n(\text{O}) = 1$ mol ei sobi.

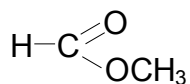
Kontroll:

$-393,5 \text{ kJ/mol} \cdot 2 \text{ mol} - 241,8 \text{ kJ/mol} \cdot 2 \text{ mol} - 344,2 \text{ kJ/mol} \cdot 1 \text{ mol} = -926,4 \text{ kJ}$

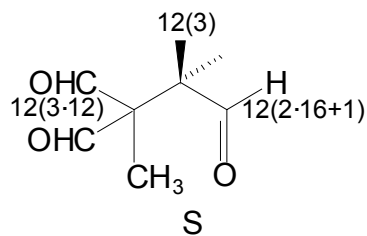
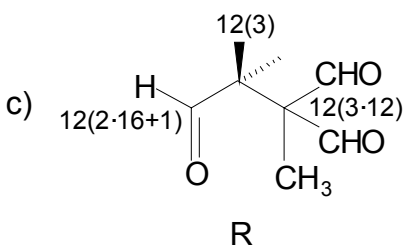
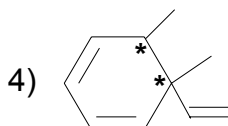
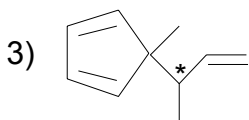
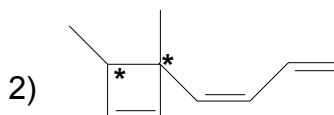
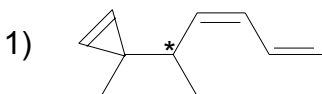
d)



e) Ülesande tingimustele vastab ainult metüülformiaat ehk metüülmetanaat



6. a,b)



3-2-formüül-2,3-dimetüülbutaandiaal