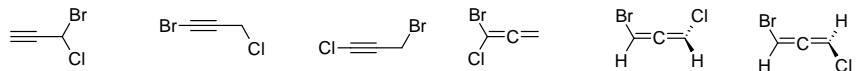
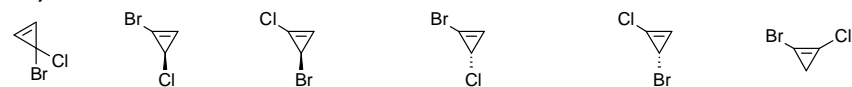


2012/2013 õ.a. keemiaolümpiaadi lõppvooru ülesannete lahendused

10. klass

1. a)



(12*0,5)

b)

Kuna süsivesinik koosneb ainult vesiniku ja süsiniku aatomitest aatomitest, kusjuures küllastatud süsivesinikus on maksimaalselt (C_nH_{2n+2}) $2x+2$ vesiniku aatomit, võime koostada järgnevad võrrandisüsteemi:

$$12x + y = 104$$

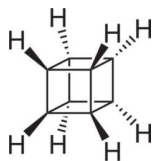
$$y \leq 2x + 2$$

$$104 - 12x \leq 2x + 2$$

$$102 \leq 14x$$

$$x \geq 7,3$$

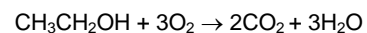
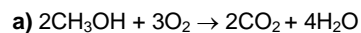
Seega peab olema süsivesinikus täpselt 8 süsinikku, kuna 9 puhul läheb molaarmass juba liiga suureks ning 7 puhul ei saa olla piisavalt vesinikke, et molaarmass täis tuleks.



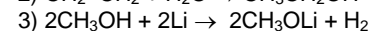
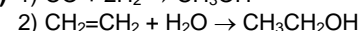
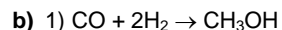
Kolme sümmeetriatasandi olemasolu näitab, et tegu on kõrge sümmeetriaastmega kujuga ning sobib näiteks kuubi taoline struktuur nagu „kubaan“.

(4)

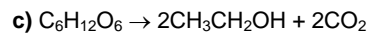
2.



(2*1)

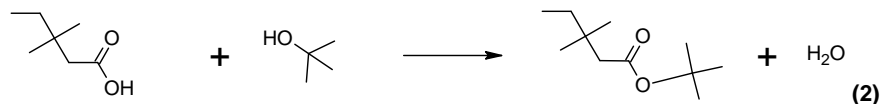


(3*1)



(1)

d) (1,1-dimetüül)etüül-3,3-dimetüülpentanaat, (2-metüülprop-2-üül)-3,3-dimetüülpentanaat või tertbutüül-3,3-dimetüülpentanaat



(2)

3.

a)

A – NO – lämmastikmonooksiid

B – NO₂ – lämmastikdioksiid

C – N₂O₅ – dilämmastikpentaoksiid

D – N₂O₃ – dilämmastiktrioksiid

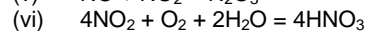
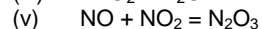
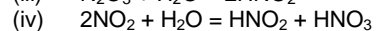
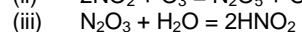
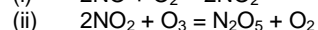
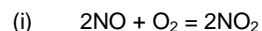
E – HNO₂ – lämmastikhappe

F – HNO₃ – lämmastikhape

G – N₂O – dilämmastikmonooksiid

(7*0,5)

b)



(6*1)

4. a) i) A = Ca, kaltsium

B = CaO, kaltsiumoksiid

C = CaCO₃, kaltsiumkarbonaat

D = Ca(OH)₂, kaltsiumhüdrosiid

E₂ = Cl₂, kloor

F = Ca(OCl)₂, kaltsiumhüpoklorit

G = CaCl₂, kaltsiumkloriid

H = HCl, vesinikkloriidhape

(8*0,5)

ii) B – kustutamata lubi

D – kustutatud lubi

H – soolhape

(3*0,5)

- b) 1) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2\uparrow$
 2) $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
 3) $2\text{Ca(OH)}_2 + 2\text{Cl}_2 \rightarrow \text{Ca(OCl)}_2 + \text{CaCl}_2 + 2\text{H}_2\text{O}$
 4) $\text{Ca(OCl)}_2 + 4\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{Cl}_2$

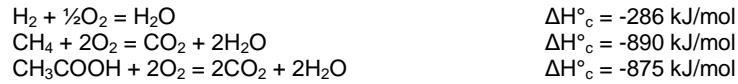
(4*)

5. a) oksüdeerijad ja redutseerijad:

- i) $\text{CO}_2 + 4\text{H}_2 = \text{CH}_4 + 2\text{H}_2\text{O}$
 ii) $\text{CH}_3\text{COOH} = \text{CH}_4 + \text{CO}_2$ (disproportsioneerumisreaktsioon)

(3)

b) Arvutame põlemisentalpia kaudu (kuna vesiniku põlemisel tekib ühest moolist vesinikust üks mool vett, on vee tekkeentalpia võrdne vesiniku põlemisentalpiaga).



reaktsioon i: $\Delta H^\circ = 4 \cdot (-286 \text{ kJ/mol}) - (-890 \text{ kJ/mol}) = -254 \text{ kJ/mol}$
 reaktsioon ii: $\Delta H^\circ = -875 \text{ kJ/mol} - (-890 \text{ kJ/mol}) = 15 \text{ kJ/mol}$

(4)

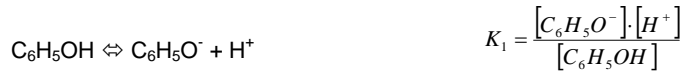
c) $\text{CH}_4 + 2\text{O}_2 = \text{CO}_2 + 2\text{H}_2\text{O}$
 $n = 101325 \text{ Pa} \cdot 0,200 \text{ m}^3 / (8,314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 298 \text{ K}) = 8,18 \text{ mol metaani}$
 $\Delta H = 8,18 \text{ mol} \cdot (-890 \text{ kJ/mol}) = -7280 \text{ kJ}$

(3)

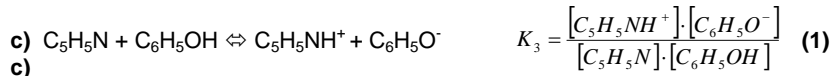
d) Kuna metanoolis on süsinik rohkem oksüdeeritud olekus kui metaanis ning süsinike arvud on võrdsed, eraldub metanooli põlemisel väiksem soojushulk (gaasilise metanooli põlemisentalpia on -764 kJ/mol).

(1)

6. a)



(2)



$$K_3 = \frac{[\text{C}_5\text{H}_5\text{NH}^+] \cdot [\text{C}_6\text{H}_5\text{O}^-]}{[\text{C}_5\text{H}_5\text{N}] \cdot [\text{C}_6\text{H}_5\text{OH}]} \cdot \frac{[\text{H}^+]}{[\text{H}^+]} = \frac{[\text{C}_5\text{H}_5\text{NH}^+]}{[\text{C}_5\text{H}_5\text{N}] \cdot [\text{H}^+]} \cdot \frac{[\text{C}_6\text{H}_5\text{O}^-] \cdot [\text{H}^+]}{[\text{C}_6\text{H}_5\text{OH}]} = K_2 \cdot K_1 = 1,95 \cdot 10^{-19} \quad (1)$$

d) $n(\text{fenool}) = m(\text{fenool}) / M(\text{fenool}) = 9,4 \text{ g} / 94 \text{ g/mol} = 0,1 \text{ mol}$
 $c(\text{fenool}) = n/V = 0,1 \text{ M}$

Oletame, et fenooli dissotsiatsioonil tekib x (ühikuga M) H^+ iooni. $[\text{H}^+] = x$
 $[\text{C}_6\text{H}_5\text{OH}] = 0,1 - x$ ning $[\text{C}_6\text{H}_5\text{O}^-] = [\text{H}^+] = x$, seega

$$K_1 = \frac{[\text{C}_6\text{H}_5\text{O}^-] \cdot [\text{H}^+]}{[\text{C}_6\text{H}_5\text{OH}]} = \frac{x \cdot x}{0,1 - x} = 1,3 \cdot 10^{-10}$$

$$x^2 + 1,3 \cdot 10^{-10} \cdot x - 1,3 \cdot 10^{-11} = 0$$

$$x = 3,6 \cdot 10^{-6}$$

$$\text{pH} = -\log[\text{H}^+] = 5,44$$

(4)

e) Pärast lahuste kokkusegamist:

$c(\text{fenool}) = c(\text{püridiin}) = 0,05 \text{ M}$
 Reaktsiooni stöhhiomeetriast: $[\text{C}_5\text{H}_5\text{NH}^+] = [\text{C}_6\text{H}_5\text{O}^-] = x$ ning

$$[\text{C}_5\text{H}_5\text{N}] = [\text{C}_6\text{H}_5\text{OH}] = 0,05 - x$$

$$K_3 = \frac{[\text{C}_5\text{H}_5\text{NH}^+] \cdot [\text{C}_6\text{H}_5\text{O}^-]}{[\text{C}_5\text{H}_5\text{N}] \cdot [\text{C}_6\text{H}_5\text{OH}]} = \frac{x \cdot x}{(0,05 - x) \cdot (0,05 - x)} = 1,95 \cdot 10^{-19}$$

$$x^2 = 1,95 \cdot 10^{-19} \cdot x^2 - 1,95 \cdot 10^{-20} \cdot x + 4,875 \cdot 10^{-22}$$

$$x = 2,21 \cdot 10^{-11} \text{ M}$$

(3)