1998/99 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
10. klass

1.   **a)** Element **X** on Li

    b) I   II   IV
       X_2O, YO ja ZO_2
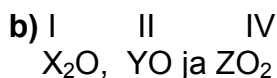
    c) $A_r(Li) = 6,94$; $M_r(Li_2O) = 29,88$

       $\%(Li) = \dfrac{13,88}{29,88} \cdot 100 = 46,45$

       $\%(O) = 100 - 46,45 = 53,55$

      i) $A_r(Y) = 16,0 \cdot \dfrac{46,45\%}{53,55\%} = 13,9 \approx 14$

        Y on lämmastik – **N**

      ii) $A_r(Z) = 2 \cdot 16 \cdot \dfrac{46,45\%}{53,55\%} = 27,8 \approx 28$
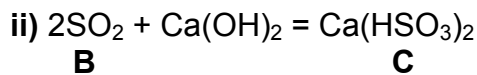
        Z on räni – **Si**

    d) i) $\%(O) = \dfrac{16,0}{29,9} \cdot 100 = 53,5$

      ii) $\%(O) = \dfrac{16,0}{30,0} \cdot 100 = 53,3$

      iii) $\%(O) = \dfrac{32,0}{60,1} \cdot 100 = 53,2$

2.   **a) i)** $S + O_2 = SO_2$
          A   **B**
    ii) $2SO_2 + Ca(OH)_2 = Ca(HSO_3)_2$
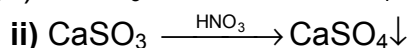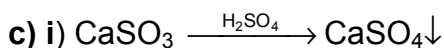   **B**   **C**

    b) i) $M(D) = \dfrac{1}{1} \cdot 6,00 \text{ g} \cdot \dfrac{1}{1,12 \text{ dm}^3} \cdot \dfrac{22,4 \text{ dm}^3}{1 \text{ mol}} = 120 \text{ g/mol}$
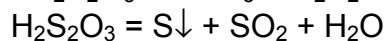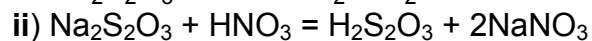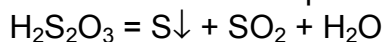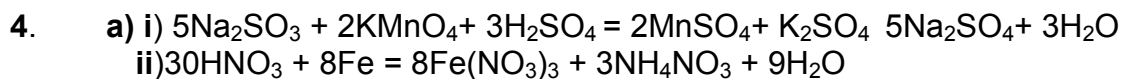
      ii) $CaSO_3$; **iii)** kaltsiumsulfit

    c) i) $CaSO_3 \xrightarrow{\ H_2SO_4\ } CaSO_4\downarrow$
      ii) $CaSO_3 \xrightarrow{\ HNO_3\ } CaSO_4\downarrow$

    d) $Ca(HSO_3)_2 + 2Na_2S = CaSO_3\downarrow + Na_2SO_3 + 2NaHS$
      Sulfiidioon on happelises keskkonnas ebapüsiv.

3.   **a) i)** $Na_2S_2O_3 + HCl = H_2S_2O_3 + 2NaCl$
                      ebapüsiv
         $H_2S_2O_3 = S\downarrow + SO_2 + H_2O$
    ii) $Na_2S_2O_3 + HNO_3 = H_2S_2O_3 + 2NaNO_3$
       $H_2S_2O_3 = S\downarrow + SO_2 + H_2O$

    b) $[Ag(NH_3)_2]Cl + 2HNO_3 = AgCl\downarrow + 2NH_4NO_3$

    c) i) $3Na_2S + 8HNO_3 = 6NaNO_3 + 3S + 2NO\uparrow + 4H_2O$

ehk $Na_2S + 4HNO_3 = 2NaNO_3 + 2NO_2 \uparrow + 2H_2O + S$
ii) $S + 2HNO_3 = H_2SO_4 + 2NO\uparrow$
iii) $Na_2S + 2HCl = 2NaCl + H_2S\uparrow$

4. **a) i)** $5Na_2SO_3 + 2KMnO_4 + 3H_2SO_4 = 2MnSO_4 + K_2SO_4 \ 5Na_2SO_4 + 3H_2O$
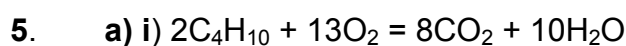**ii)** $30HNO_3 + 8Fe = 8Fe(NO_3)_3 + 3NH_4NO_3 + 9H_2O$
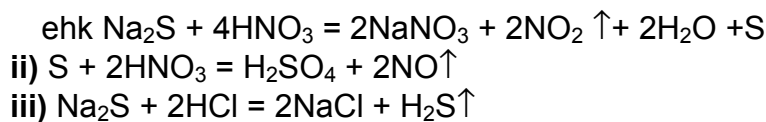
b) $N(\text{rüütel}) = \dfrac{5}{2} \cdot 5{,}00 \text{ cm} \cdot 5{,}00 \text{ cm}^2 \cdot \dfrac{0{,}0127 \text{ mol}}{\text{cm}^3} \cdot \dfrac{1}{0{,}70} \cdot \dfrac{1 \text{ löök}}{0{,}00150 \text{ mol}} =$
$$= 760 \text{ lööki}$$

c) $n(Fe) = 0{,}300 \text{ cm} \cdot 1\underline{0} \text{ cm}^3 \cdot 7{,}8 \text{ g/cm}^3 \cdot \dfrac{1 \text{ mol}}{55{,}9 \text{ g}} = 0{,}419 \text{ mol}$
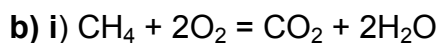
$n(Fe, \text{üks rünnak}) = \dfrac{8}{30} \cdot 3 \cdot 0{,}050 \dfrac{\text{dm}^3}{\text{rünnak}} \cdot 0{,}02 \text{ mol} / \text{dm}^3 \cdot 0{,}60 =$
$$= 0{,}00048 \text{ mol/rünnak}$$

$N(\text{hüdra}) = 0{,}419 \text{ mol} \cdot \dfrac{1 \text{ rünnak}}{0{,}00048 \text{ mol}} = 870 \text{ rünnakut}$

d) Lahingu võitis rüütel. Hüdral jäi võitmiseks 110 vasturünnakut sooritamata

5. **a) i)** $2C_4H_{10} + 13O_2 = 8CO_2 + 10H_2O$
ii) $\Delta H(\text{butaan}) = 21{,}0 \text{ kg} \cdot \dfrac{1000 \text{ g}}{1 \text{ kg}} \cdot \dfrac{1 \text{ mol}}{58{,}1 \text{ g}} \cdot (-2655 \text{ kJ} / \text{mol}) =$
$$= \mathbf{9{,}60 \cdot 10^5 \text{ kJ}}$$
b) i) $CH_4 + 2O_2 = CO_2 + 2H_2O$
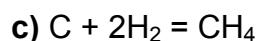**ii)** $n(CH_4) = 9{,}60 \cdot 10^5 \text{ kJ} \cdot \dfrac{1 \text{ mol}}{8{,}02 \cdot 10^2 \text{ kg}} = 1{,}20 \cdot 10^3 \text{ mol}$

$V_M(\text{talvel}) = 22{,}4 \dfrac{\text{dm}^3}{\text{mol}} \cdot \dfrac{253}{273} = 20{,}8 \text{ dm}^3/\text{mol}$

$\mathbf{V(CH_4)} = 1{,}20 \cdot 10^3 \text{ mol} \cdot \dfrac{1}{0{,}990} \cdot 20{,}8 \text{ dm}^3/\text{mol} = \mathbf{25{,}2 \cdot 10^3 \text{ dm}^3}$

iii) $V_M(\text{suvel}) = 22{,}4 \dfrac{\text{dm}^3}{\text{mol}} \cdot \dfrac{293}{273} = 24{,}0 \text{ dm}^3/\text{mol}$
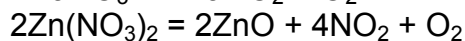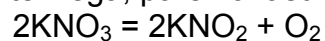
$\mathbf{V(CH_4)} = 1{,}20 \cdot 10^3 \text{ mol} \cdot \dfrac{1}{0{,}990} \cdot 24{,}0 \text{ dm}^3/\text{mol} = \mathbf{29{,}1 \cdot 10^3 \text{ dm}^3}$
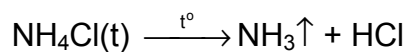
c) $C + 2H_2 = CH_4$
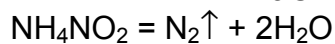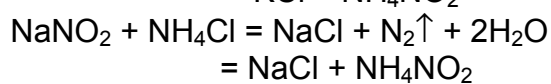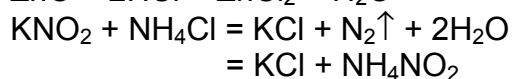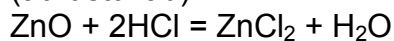$1 \text{ mol} \cdot \Delta H(CH_4, \text{teke}) = 1 \text{ mol} \cdot (-394 \text{ kJ/mol}) + 2 \text{ mol} \cdot (-242 \text{ kJ/mol}) -$
$$-1 \text{ mol} \cdot (-802 \text{ kJ/mol}) = -76 \text{ kJ}$$
$\Delta H(CH_4, \text{teke}) = $ -76 kJ/mol

6. **a)** Pingereas magneesiumist vasakul asuvate metallide nitraadid lagunevad nitritite tekkega, paremal asuvate metallide nitraadid lagunevad oksiidideks.
$2KNO_3 = 2KNO_2 + O_2$
$2NaNO_3 = 2NaNO_2 + O_2$
$2Zn(NO_3)_2 = 2ZnO + 4NO_2 + O_2$

b) Töötlemisel NH_4Cl ja HCl lahuste liiaga ja järgneval kuivaksaurutamisel tekivad metallide kloriidid, eralduvad N_2, H_2O; NH_4Cl laguneb; NH_3, HCl ja H_2O lenduvad (aurustuvad).

$ZnO + 2HCl = ZnCl_2 + H_2O$

$KNO_2 + NH_4Cl = KCl + N_2\uparrow + 2H_2O$

$\qquad\qquad\quad = KCl + NH_4NO_2$

$NaNO_2 + NH_4Cl = NaCl + N_2\uparrow + 2H_2O$

$\qquad\qquad\qquad = NaCl + NH_4NO_2$

$NH_4NO_2 = N_2\uparrow + 2H_2O$

$\qquad NH_4Cl(t) \xrightarrow{\;t^o\;} NH_3\uparrow + HCl$

c) $x + y + z = 1{,}0000$ g

$$\frac{x}{M(KNO_3)} \cdot M(KNO_2) + \frac{y}{M(NaNO_3)} \cdot M(NaNO_2) + \frac{z}{M[Zn(NO_3)_2]} \cdot M(ZnO) =$$

$$= 0{,}7106 \text{ g}$$

$$\frac{x}{M(KNO_3)} \cdot M(KCl) + \frac{y}{M(NaNO_3)} \cdot M(NaCl) + \frac{z}{M[Zn(NO_3)_2]} \cdot M(ZnCl_2) =$$

$$= 0{,}7195$$