

2007/2008 õ.a. keemiaolümpiaadi lõppvooru ülesannete lahendused

9. klass

1. a) **Hapet tuleb kallata vette**, sest vastasel juhul võib lahuse keema minemisel hape välja puitsida.

$$b) M = \frac{134 \text{ mg}}{\text{dm}^3} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} \cdot \frac{1 \text{ g}}{1000 \text{ mg}} = 3,00 \text{ g/mol}$$

Sellisele molaarmassile vastavad gaasid: ^3He , ^3H , HD. ^3H ehk tritium (T) pole toatemperatuuril stabiilne, kuna ühineb T_2 -ks ning on ka radioaktiivne.

^3He , HD

c) O_2 (nt) < CO_2 (nt) < H_2O (tahke) < H_2O (vedel, nt) < NaCl < Hg

d) Al: +13|2|8|3) Br: +35|2|8|18|7)
 S^{2-} : +16|2|8|8) Cd^{2+} : +48|2|8|18|18)

$$e) m(\text{Na}_2\text{SO}_4) = \frac{3}{7} \cdot 5,3 \text{ g} \cdot \frac{1 \text{ mol}}{44 \text{ g}} \cdot \frac{142 \text{ g}}{1 \text{ mol}} = 7,3 \text{ g}$$

2. a) Kuna **A** tekib veega reageerimisel, siis on tegemist hüdroksiidiga $\text{X}(\text{OH})_n$
 $\text{X} + n\text{H}_2\text{O} = \text{X}(\text{OH})_n + n/2\text{H}_2\uparrow$

$$M(\text{X}) = \frac{1}{1} \cdot \frac{8,0 \text{ g}}{0,2 \text{ mol}} = 40 \text{ g/mol} \quad \text{X} - \text{Ca, kaltsium}$$

A – $\text{Ca}(\text{OH})_2$, kaltsiumhüdroksiid

$$b) m = \frac{1}{1} \cdot 1,5 \text{ g} \cdot \frac{1 \text{ mol}}{40 \text{ g}} \cdot \frac{74 \text{ g}}{1 \text{ mol}} = 2,8 \text{ g}$$

c) i) $\text{Ca} + 2\text{H}_2\text{O} = \text{Ca}(\text{OH})_2 + \text{H}_2\uparrow$

ii) $2\text{Ca} + \text{O}_2 = 2\text{CaO}$

$\text{CaO} + 3\text{C} \xrightarrow{t} \text{CaC}_2 + \text{CO}\uparrow$

$\text{CaC}_2 + 2\text{H}_2\text{O} = \text{Ca}(\text{OH})_2 + \text{C}_2\text{H}_2\uparrow$

iii) $\text{Ca}(\text{OH})_2 + \text{Cl}_2 = \text{CaOCl}_2 + \text{H}_2\text{O}$

3. a) 1. kiht (kolvi põhjas): tahke kruus
 2. kiht: vedel $\text{Ca}(\text{HCO}_3)_2$ ja metanooli vesilahus
 3. kiht: vedel tolupeen
 4. kiht: gaas vesinik

b) i) Kõigepealt lendub vesinik.

ii) Kolvist kallatakse kogu vedelik jaotuslehtrisse. Kolvi põhja jääb kruus. Jaotuslehtrist vedeliku välja laskmisel eraldub $\text{Ca}(\text{HCO}_3)_2$ ja metanooli vesilahus, seejärel tolupeen.

iii) $\text{Ca}(\text{HCO}_3)_2$ ja metanooli vesilahusest eraldub destilleerimisel kõigepealt metanool ja siis vesi, kolvi põhja jääb sool.

c) $\text{Ca}(\text{HCO}_3)_2$ laguneb vee välja keetmisel

$\text{Ca}(\text{HCO}_3)_2 \xrightarrow{t} \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2\uparrow$

$$4. a) m = 10,0 \text{ m}^3 \cdot \frac{1000 \text{ dm}^3}{1 \text{ m}^3} \cdot \frac{1,03 \text{ kg}}{1 \text{ dm}^3} \cdot \frac{35 \text{ g}}{1 \text{ kg}} \cdot \frac{1 \text{ kg}}{1000 \text{ g}} = 360,5 \text{ kg} = 361 \text{ kg}$$

$$b) m(\text{Cl}^-) = 360,5 \text{ kg} \cdot 0,553 = 199,4 \text{ kg} = 199 \text{ kg}$$

$$m(\text{Na}^+) = 110,3 \text{ kg} \approx 110 \text{ kg} \quad m(\text{SO}_4^{2-}) = 28,1 \text{ kg} \approx 28 \text{ kg}$$

$$m(\text{Mg}^{2+}) = 13,3 \text{ kg} \approx 13 \text{ kg} \quad m(\text{Ca}^{2+}) = 4,3 \text{ kg} \quad m(\text{K}^+) = 4,0 \text{ kg}$$

$$m(\text{ioonid}) = (199,4 + 110,3 + 28,1 + 13,3 + 4,3 + 4,0) \text{ kg} = 359,4 \text{ kg}$$

$$c) m(\text{KCl}) = 4,0 \text{ kg} \cdot \frac{1 \text{ kmol}}{39,1 \text{ kg}} \cdot \frac{74,6 \text{ kg}}{1 \text{ kmol}} = 7,6 \text{ kg}$$

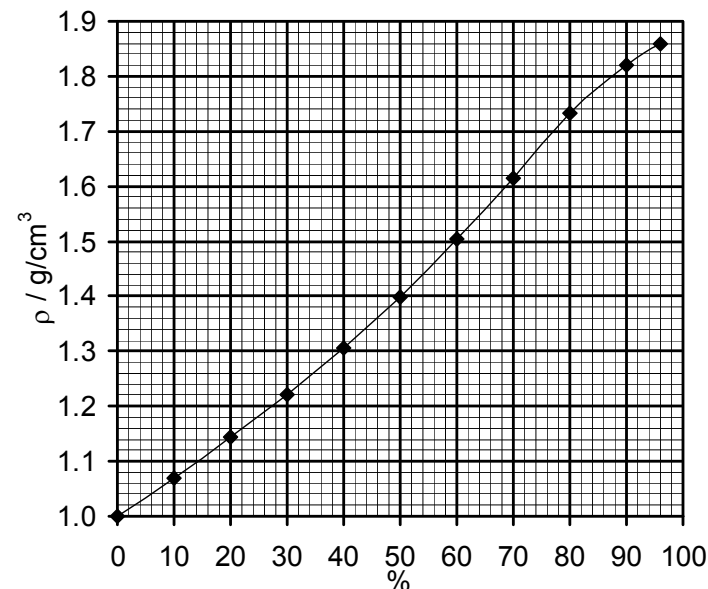
$$m(\text{CaCl}_2) = 4,3 \text{ kg} \cdot \frac{1 \text{ kmol}}{40,1 \text{ kg}} \cdot \frac{111 \text{ kg}}{1 \text{ kmol}} = 11,9 \text{ kg} = 12 \text{ kg}$$

$$m(\text{MgCl}_2) = 13,3 \text{ kg} \cdot \frac{1 \text{ kmol}}{24,3 \text{ kg}} \cdot \frac{95,2 \text{ kg}}{1 \text{ kmol}} = 52,1 \text{ kg} \approx 52 \text{ kg}$$

$$m(\text{Na}_2\text{SO}_4) = 28,1 \text{ kg} \cdot \frac{1 \text{ kmol}}{96,1 \text{ kg}} \cdot \frac{142 \text{ kg}}{1 \text{ kmol}} = 41,5 \text{ kg} \approx 42 \text{ kg}$$

$$m(\text{NaCl}) = [359,4 - (7,6 + 11,9 + 52,1 + 41,5)] \text{ kg} = 246,1 \text{ kg} = 246 \text{ kg}$$

5. a)



$$b) m(\text{H}_2\text{SO}_4 \text{ lahus}) = 450 \text{ cm}^3 \cdot \frac{1,399 \text{ g}}{1 \text{ cm}^3} = 629,55 \text{ g}$$

$$m(\text{H}_2\text{SO}_4) = 629,55 \text{ g} \cdot 0,5 = 314,78 \text{ g}$$

$$m(96\% \text{ H}_2\text{SO}_4) = 314,78 \text{ g} \cdot \frac{1}{0,96} = 327,89 \text{ g}$$

$$V(96\% \text{H}_2\text{SO}_4) = 327,89 \text{ g} \cdot \frac{1 \text{ cm}^3}{1,86 \text{ g}} = 176,3 \text{ cm}^3$$

$$V(\text{H}_2\text{O}) = (629,55 - 327,89) \text{ g} \cdot \frac{1 \text{ cm}^3}{0,999 \text{ g}} = 302,0 \text{ cm}^3$$

c) i) $\rho(36\% \text{H}_2\text{SO}_4) = 1,27 \text{ g/cm}^3$

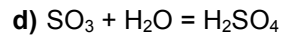
ii)
$$\begin{cases} 0,36 \cdot m(36\% \text{H}_2\text{SO}_4) + 0,96 \cdot m(96\% \text{H}_2\text{SO}_4) = 314,78 \text{ g} \\ m(36\% \text{H}_2\text{SO}_4) + m(96\% \text{H}_2\text{SO}_4) = 629,55 \text{ g} \end{cases}$$

$$m(36\% \text{H}_2\text{SO}_4) = 629,55 \text{ g} - m(96\% \text{H}_2\text{SO}_4)$$

$$0,36 \cdot (629,55 \text{ g} - m(96\% \text{H}_2\text{SO}_4)) + 0,96 \cdot m(96\% \text{H}_2\text{SO}_4) = 314,78 \text{ g}$$

$$m(96\% \text{H}_2\text{SO}_4) = 146,90 \text{ g}$$

$$m(36\% \text{H}_2\text{SO}_4) = 629,55 \text{ g} - 146,90 \text{ g} = 482,6 \text{ g}$$



$$V(\text{SO}_3) = \frac{1}{1} \cdot 314,78 \text{ g} \cdot \frac{1 \text{ mol}}{98,078 \text{ g}} \cdot \frac{22,41 \text{ dm}^3}{1 \text{ mol}} = 71,92 \text{ dm}^3$$

6. a) **A** – H_2O_2 , vesinikperoksiid

D – KOH , kaaliumhüdroksiid

B – I_2 , jood

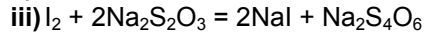
E – NaI , naatriumjodiid

$$N(\text{Na}) = \frac{270,2 \cdot 0,17}{22,99} = 2,00$$

$$N(\text{O}) = \frac{270,2 \cdot 0,355}{16,00} = 6,00$$

$$N(\text{S}) = \frac{270,2 \cdot 0,475}{32,06} = 4,00$$

F – $\text{Na}_2\text{S}_4\text{O}_6$, naatriumtiosulfaat



c) $n(\text{D}) = n(\text{HCl}) = 14,3 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{0,526 \text{ mol}}{1 \text{ dm}^3} = 0,00752 \text{ mol}$

$$n(\text{A, katse (I)}) = \frac{1}{2} n(\text{D}) = \frac{1}{2} \cdot 0,00752 \text{ mol} = 0,00376 \text{ mol}$$

d) $n(\text{B}) = \frac{1}{2} n(\text{Na}_2\text{S}_2\text{O}_3) = \frac{1}{2} \cdot 16,0 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{0,472 \text{ mol}}{1 \text{ dm}^3} = 0,00378 \text{ mol}$

$$n(\text{A, katse (II)}) = n(\text{B}) = 0,00378 \text{ mol}$$

e) Aine **A** hulk on suurem katse **(II)** andmete kohaselt.

$$n(\text{A, üld}) = 2n(\text{A, katse (II)}) = 2 \cdot 0,00378 \text{ mol} = 0,00756 \text{ mol}$$

$$\%(\text{A}) = 0,00756 \text{ mol} \cdot 34,01 \frac{\text{g}}{\text{mol}} \cdot \frac{1}{5,10 \text{ g}} \cdot 100 = 5,04$$