

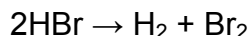
**Prirodno-matematički fakultet**  
**Društvo matematičara i fizičara Crne Gore**

**OLIMPIJADA ZNANJA 2016.**

**Rješenja zadataka iz HEMIJE**  
**za II razred srednje škole**

**1.** Na nekoj temperaturi konstanta disocijacije bromovodonika na elemente u njihovom najstabilnijem stanju iznosi 4. Sve komponente sistema su u gasovitom stanju. Koliko procenata prvobitno prisutnog bromovodonika disosuje na ovoj temperaturi?

**Rješenje:**



$$[\text{HBr}] = c - \omega \cdot c \quad [\text{H}_2] = [\text{Br}_2] = \frac{1}{2} \cdot \omega \cdot c \quad \dots\dots\dots 2 \text{ boda}$$

$$K = \frac{[\text{H}_2][\text{Br}_2]}{[\text{HBr}]^2} \quad \dots\dots\dots 2 \text{ boda}$$

$$K = \frac{(1/2 \cdot \omega \cdot c)^2}{(c - \omega c)^2} = \frac{1/4 \cdot \omega^2 \cdot c^2}{c^2 \cdot (1 - \omega)^2} = \frac{1/4 \cdot \omega^2}{1 - 2 \cdot \omega + \omega^2} = 4 \quad \dots\dots\dots 2 \text{ boda}$$

$$\omega = 0.80 = 80\% \quad \dots\dots\dots 2 \text{ boda}$$

**ukupno: 8 bodova**

**2.** U koliko grama vode treba rastvoriti 10 g  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  da bi se dobio rastvor u kome je maseni udio natrijum-sulfata  $\omega = 0.05$ ?

$\text{Ar}(\text{Na})=23$ ;  $\text{Ar}(\text{S})=32$ ,  $\text{Ar}(\text{O})=16$ ;  $\text{Ar}(\text{H})=1$ .

**Rješenje:**

$$\text{Mr}(\text{Na}_2\text{SO}_4)=142 \quad \text{Mr}(\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O})=322$$

$$\omega = \frac{m(\text{Na}_2\text{SO}_4)}{m(\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}) + m(\text{H}_2\text{O})} \quad \dots\dots\dots 2 \text{ boda}$$

$$m(\text{Na}_2\text{SO}_4) = \frac{m(\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}) \cdot \text{Mr}(\text{Na}_2\text{SO}_4)}{\text{Mr}(\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O})} = 4.41\text{g} \quad \dots\dots\dots 2 \text{ boda}$$

$$0.05 = \frac{4.41\text{g}}{10\text{g} + m(\text{H}_2\text{O})} \quad \dots\dots\dots 2 \text{ boda}$$

$$m(\text{H}_2\text{O})=78.2\text{g}$$

..... 2 boda

ukupno: **8 bodova**

**3.** Koje od navedenih soli grade vodene rastvore koji reaguju bazno:

a)  $(\text{NH}_4)_2\text{SO}_4$  b)  $\text{CH}_3\text{COONH}_4$  c)  $\text{CaCO}_3$  d)  $\text{NaNO}_2$  e)  $\text{KHCO}_3$

$$K_a(\text{NH}_4^+)=5 \cdot 10^{-10} \quad K_a(\text{CH}_3\text{COONH}_4)=2 \cdot 10^{-5}$$

**Rješenje:**

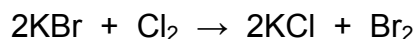
d) i e)

2 x 3 = **6 bodova**

**4.** Smješa kalijum-hlorida i kalijum-bromida mase 3.595 g zagrijavana je sa hlorom, tako da je u smješi cjelokupan kalijum-bromid prešao u kalijum-hlorid. Ukupna masa kalijum-hlorida poslije reakcije je iznosila 3.129 g. Izračunati masu kalijum-bromida u smjesi.  $A_r(\text{K})=39$ ;  $A_r(\text{Cl})=35.5$ ;  $A_r(\text{Br})=80$ .

**Rješenje:**

$$M_r(\text{KBr})=119 \quad M_r(\text{KCl})=74.5$$



..... 2 boda

$m_1(\text{KCl})$  – masa KCl u početnoj smjesi;  $m_2(\text{KCl})$  – masa KCl nastala iz KBr u početnoj smjesi:  $m_1(\text{KCl}) + m(\text{KBr}) = 3.595\text{g}$

$$\text{nakon reakcije: } m_1(\text{KCl}) + m_2(\text{KCl}) = 3.129\text{g}$$

..... 2 boda

Iz reakcije slijedi:  $M(\text{KBr}) : M(\text{KCl}) = m(\text{KBr}) : m_2(\text{KCl})$

$$m_2(\text{KCl}) = M(\text{KCl})/M(\text{KBr}) \cdot m(\text{KBr}) = 0.626 \cdot m(\text{KBr}) \quad \text{..... 2 boda}$$

$$m_1(\text{KCl}) + m(\text{KBr}) = 3.595\text{g}$$

$$m_1(\text{KCl}) + 0.626 \cdot m(\text{KBr}) = 3.129\text{g}$$

..... 2 boda

nakon sređivanja:

$$m(\text{KBr})=1.25\text{g}$$

..... 2 boda

ukupno: **10 bodova**

**5.** Napisati formule anhidrida sledećih kiselina: a)  $\text{H}_4\text{P}_2\text{O}_7$ , b)  $\text{HClO}_2$ , c)  $\text{H}_3\text{AsO}_4$

**Rješenje:**

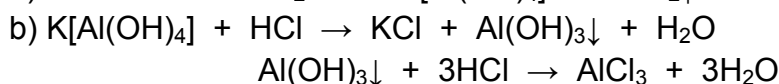
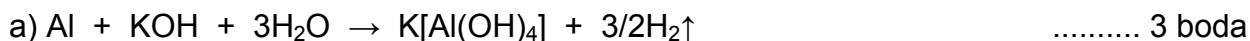
a)  $\text{P}_4\text{O}_{10}$  ili  $\text{P}_2\text{O}_5$ , b)  $\text{Cl}_2\text{O}_3$ , c)  $\text{As}_2\text{O}_5$

3 x 2 = **6 bodova**

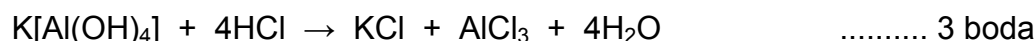
**6.** U 30%-tni rastvor kalijum-hidroksida rastvoren je elementarni aluminijum. U nastali rastvor polako je dodata 20%-na hlorovodonična kiselina.

- a) Napisati hemijsku jednačinu rastvaranja elementarnog aluminijuma u alkaliji;  
 b) Napisati jednačinu reakcije koja se odvija pri dodavanju viška kiseline u dobijeni alkalni rastvor.

**Rješenje:**



ili



ukupno: **6 bodova**

**7.** Katjon kobalta ima naelektrisanje +2 i 25 elektrona. Napisati elektronsku konfiguraciju atoma kobalta i odrediti u kojoj grupi i u kojoj periodu se nalazi kobalt u periodnom sistemu?

**Rješenje:**



9. grupa i 4. perioda ..... 3 boda

ukupno: **6 bodova**

**8.** Neki uzorak mangan-oksida mase 542.3 g ima odnos broja atoma Mn:O 1.00 : 1.42 i sastoji se od  $\text{Mn}_2\text{O}_3$  i MnO. Kolika je masa  $\text{Mn}_2\text{O}_3$  u uzorku?  
 $\text{Ar}(\text{Mn})=55$ ;  $\text{Ar}(\text{O})=16$ .

**Rješenje:**

u  $\text{Mr}(\text{Mn}_2\text{O}_3)$  ima 2 mol atoma Mn i 3 mol atoma O  
 a u  $\text{m}(\text{Mn}_2\text{O}_3)$  ima  $x_1$  mol atoma Mn i  $y_1$  mol atoma O ..... 2 boda

$$N(\text{Mn} / \text{Mn}_2\text{O}_3) = \frac{2 \cdot m(\text{Mn}_2\text{O}_3)}{\text{Mr}(\text{Mn}_2\text{O}_3)}$$

$$N(\text{O} / \text{Mn}_2\text{O}_3) = \frac{3 \cdot m(\text{Mn}_2\text{O}_3)}{\text{Mr}(\text{Mn}_2\text{O}_3)}$$

..... 2 boda

u  $\text{Mr}(\text{MnO})$  ima 1 mol atoma Mn i 1 mol atoma O  
 a u  $\text{m}(\text{MnO})$  ima  $x_2$  mol atoma Mn i  $y_2$  mol atoma O

$$N(\text{Mn} / \text{MnO}) = \frac{m(\text{MnO})}{Mr(\text{MnO})}$$

$$N(\text{O} / \text{MnO}) = \frac{m(\text{MnO})}{Mr(\text{MnO})}$$

..... 2 boda

$$N(\text{Mn}) = N(\text{Mn iz Mn}_2\text{O}_3) + N(\text{Mn iz MnO})$$

$$N(\text{O}) = N(\text{O iz Mn}_2\text{O}_3) + N(\text{O iz MnO})$$

$$N(\text{Mn}) = \frac{2 \cdot m(\text{Mn}_2\text{O}_3)}{Mr(\text{Mn}_2\text{O}_3)} + \frac{m(\text{MnO})}{Mr(\text{MnO})}$$

$$N(\text{O}) = \frac{3 \cdot m(\text{Mn}_2\text{O}_3)}{Mr(\text{Mn}_2\text{O}_3)} + \frac{m(\text{MnO})}{Mr(\text{MnO})}$$

..... 2 boda

uz uslov  $N(\text{Mn})/N(\text{O})=1/1.42$  i uz smjenu:  $m(\text{Mn}_2\text{O}_3) + m(\text{MnO}) = 542.3\text{g}$

dobija se:  $m(\text{Mn}_2\text{O}_3)=463\text{g}$

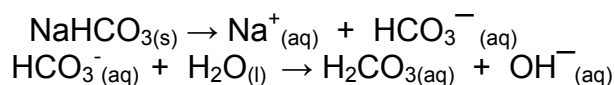
..... 2 boda

ukupno: **10 bodova**

**9.** U  $250\text{ cm}^3$  vodenog rastvora nalazi se rastvoreno  $10.0\text{ g}$  natrijum-hidrogenkarbonata. Koliko iznosi pH rastvora?  $K_{a1}(\text{H}_2\text{CO}_3) = 4.5 \cdot 10^{-7} \text{ moldm}^{-3}$ .

$\text{Ar}(\text{Na})=23$ ;  $\text{Ar}(\text{C})=12$ ;  $\text{Ar}(\text{O})=16$ ;  $\text{Ar}(\text{H})=1$ .

**Rješenje:**



..... 2 boda

$$M(\text{NaHCO}_3)=84$$

$$n(\text{NaHCO}_3) = n(\text{HCO}_3^-) = n / V = 0.119\text{mol}$$

$$c(\text{HCO}_3^-) = n / V = 0.476 \text{ moldm}^{-3}$$

..... 2 boda

$$K_b = K_w / K_{a1} = 2.22 \cdot 10^{-7} \text{ moldm}^{-3}$$

..... 2 boda

$$c(\text{H}_2\text{CO}_3) = c(\text{OH}^-) = x$$

$$K_b = \frac{c(\text{H}_2\text{CO}_3) \cdot c(\text{OH}^-)}{c(\text{HCO}_3^-)} = \frac{x^2}{c(\text{HCO}_3^-)} = 2.22 \cdot 10^{-7} \text{ moldm}^{-3}$$

$$x = \sqrt{K_b \cdot c(\text{HCO}_3^-)} = \sqrt{2.22 \cdot 10^{-7} \cdot 0.476}$$

..... 2 boda

$$x = c(\text{OH}^-) = 3.25 \cdot 10^{-4} \text{ moldm}^{-3}$$

$$\text{pOH} = 3.48$$

$$\text{pH} = 10.52$$

..... 2 boda

ukupno: **10 bodova**

**10.** Za neutralizaciju 0.2012 g neke diprotonske kiseline troši se 10.20 cm<sup>3</sup> rastvora NaOH. 15.30 cm<sup>3</sup> istog rastvora NaOH neutrališe 10.00 cm<sup>3</sup> rastvora H<sub>2</sub>SO<sub>4</sub>, koncentracije 0.2 moldm<sup>-3</sup>. Izračunati relativnu molekulsku masu nepoznate kiseline.

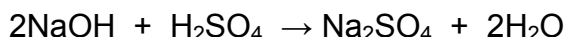
**Rješenje:**



$$n(\text{H}_2\text{A}) : n(\text{NaOH}) = 1 : 2$$

$$n(\text{H}_2\text{A}) = \frac{1}{2} \cdot n(\text{NaOH}) = \frac{1}{2} \cdot c(\text{NaOH}) \cdot V(\text{NaOH}) \quad \text{..... 2 boda}$$

c(NaOH) ćemo izračunati iz reakcije sa sumpornom kiselinom



$$n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) = 2 : 1$$

$$n(\text{NaOH}) = 2 \cdot n(\text{H}_2\text{SO}_4) \text{ odnosno}$$

$$c(\text{NaOH}) \cdot V(\text{NaOH}) = 2 \cdot c(\text{H}_2\text{SO}_4) \cdot V(\text{H}_2\text{SO}_4)$$

$$c(\text{NaOH}) = \frac{2 \cdot c(\text{H}_2\text{SO}_4) \cdot V(\text{H}_2\text{SO}_4)}{V(\text{NaOH})} = \frac{2 \cdot 0.2 \cdot 10.0}{15.3}$$

$$c(\text{NaOH}) = 0.2614 \text{ moldm}^{-3} \quad \text{..... 2 boda}$$

vratimo se izrazu za izračunavanje broja mola nepoznate kiseline

$$n(\text{H}_2\text{A}) = \frac{1}{2} \cdot c(\text{NaOH}) \cdot V(\text{NaOH})$$

$$n(\text{H}_2\text{A}) = \frac{1}{2} \cdot 0.2614 \text{ moldm}^{-3} \cdot 10.20 \cdot 10^{-3} \text{ dm}^3$$

$$n(\text{H}_2\text{A}) = 1.33 \cdot 10^{-3} \text{ mol}$$

$$n(\text{H}_2\text{A}) = m(\text{H}_2\text{A}) / M_r(\text{H}_2\text{A}) \quad \text{..... 2 boda}$$

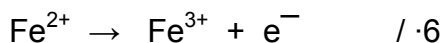
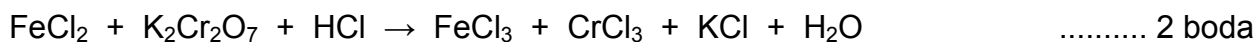
$$M_r(\text{H}_2\text{A}) = m(\text{H}_2\text{A}) / n(\text{H}_2\text{A}) = 0.2012 / 1.33 \cdot 10^{-3}$$

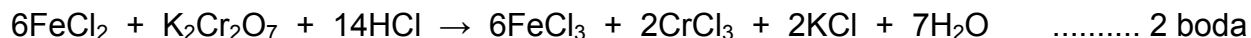
$$M_r(\text{H}_2\text{A}) = 151.28 \quad \text{..... 2 boda}$$

ukupno: **10 bodova**

**11.** Koliko grama gvožđe(II)-hlorida reaguje sa 2.94 g kalijum-dihromata u prisustvu hlorovodonične kiseline ako oksidacioni brojevi gvožđa i hroma u nastalim jedinjenjima iznose +3? Ar(Fe)=56; Ar(Cl)=35.5; Ar(K)=39; Ar(Cr)=52.

**Rješenje:**





$$6 \cdot M(\text{FeCl}_2) : M(\text{K}_2\text{Cr}_2\text{O}_7) = m(\text{FeCl}_2) : m(\text{K}_2\text{Cr}_2\text{O}_7)$$

$$M(\text{FeCl}_2)=127 \quad M(\text{K}_2\text{Cr}_2\text{O}_7)=294$$

$$m(\text{FeCl}_2) = \frac{6 \cdot Mr(\text{FeCl}_2) \cdot m(\text{K}_2\text{Cr}_2\text{O}_7)}{Mr(\text{K}_2\text{Cr}_2\text{O}_7)} \quad \text{..... 2 boda}$$

$$m(\text{FeCl}_2)=7.62\text{g} \quad \text{..... 2 boda}$$

ukupno: **10 bodova**

**12.** Koliko puta će se smanjiti stepen disocijacije  $\text{CH}_3\text{COOH}$  u rastvoru koncentracije  $0.05 \text{ mol dm}^{-3}$  ako se u  $100 \text{ cm}^3$  rastvora doda  $0.082 \text{ g}$  bezvodnog  $\text{CH}_3\text{COONa}$ ?  
 $K(\text{CH}_3\text{COOH}) = 1.8 \cdot 10^{-5}$   $\text{Ar}(\text{Na})=23$ ;  $\text{Ar}(\text{C})=12$ ;  $\text{Ar}(\text{O})=16$ ;  $\text{Ar}(\text{H})=1$ .

**Rješenje:**

$$\alpha_1 = \sqrt{\frac{K_a}{c}} = \sqrt{\frac{1.8 \cdot 10^{-5}}{0.05}} = 0.019 \quad \text{..... 2 boda}$$

$$\alpha_1 = 1.9\%$$

poslije dodavanja  $\text{CH}_3\text{COONa}$

$$K_a = \frac{c(\text{H}^+) \cdot c(\text{CH}_3\text{COO}^-)}{c(\text{CH}_3\text{COONa})}$$

$$c(\text{CH}_3\text{COONa}) = \frac{m}{Mr \cdot V} = 0.01 \text{ mol dm}^{-3} \quad \text{..... 2 boda}$$

..... 2 boda

$$c(\text{H}^+) = \frac{K_a \cdot c(\text{kiseline})}{c(\text{solu})} = 9 \cdot 10^{-5}$$

$$\alpha_2 = \frac{c(\text{H}^+)}{c(\text{kiseline})} = 0.0018 \quad \text{..... 2 boda}$$

$$\frac{\alpha_1}{\alpha_2} = \frac{1.9\%}{0.18\%} \approx 10 \text{ puta}$$

..... 2 boda

ukupno: **10 bodova**