

1. Napišite formule slijedećih spojeva, odnosno iona:

- a) Heksaklororodat(III) - ion
- b) Kalijev manganat
- c) Heksaklorostanatna(IV) kiselina
- d) Amonijev željezov(II) sulfat heksahidrat

*Rješenje:*



ostv max

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2. Koje od navedenih vodenih otopina imaju pH > 7 ?

- a)  $\text{NH}_4\text{Cl}(\text{aq})$
- b)  $\text{NaCl}(\text{aq})$
- c)  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{aq})$
- d)  $\text{Na}_2\text{SO}_3(\text{aq})$
- e)  $\text{NaHCO}_3(\text{aq})$
- f)  $\text{Na}_2\text{SO}_4(\text{aq})$
- g)  $\text{NH}_3(\text{aq})$
- h)  $\text{K}_2\text{CO}_3(\text{aq})$

*Rješenje:*

d), e), g), h)

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UKUPNO BODOVA NA STRANICI 1:

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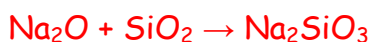
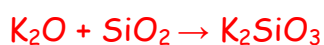
3. Zračni jastuci u automobilima su danas neizostavni dio opreme koja pruža određenu sigurnost prilikom prometnih nezgoda.

Unutar zračnog jastuka nalazi se generator plina punjen sa natrijevim azidom, kalijevim nitratom i kvarcnim pijeskom ( $\text{NaN}_3$ ,  $\text{KNO}_3$  i  $\text{SiO}_2$ ). Prilikom sudara ova smjesa se zapali (eksplodira) električnim impulsom i tada u roku od 40 ms se dogode tri kemijske reakcije pri kojima nastaje elementarni dušik koji napuni zračni jastuk i natrij.

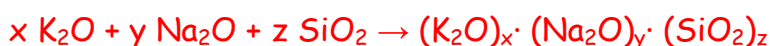
Nastali natrij zatim reagira s kalijevim nitratom pri čemu opet nastaje dušik te kalijev i natrijev oksid, koji odmah reagiraju s kvarcnim pijeskom dajući alkalne silikate (staklo)

Napišite te tri jednadžbe kemijskih reakcija.

**Rješenje:**



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4. Uzorak od 0,7400 g smjese KCl i KBr se otopi u 100 mL vode, otpipetira 25,00 mL i titrira s  $\text{AgNO}_3$ ,  $c = 0,1000 \text{ mol dm}^{-3}$ . Pri titraciji se troši 21,90 ml otopine  $\text{AgNO}_3$ .

Izračunajte masene udjele KCl i KBr u smjesi.

UKUPNO BODOVA NA STRANICI 2:

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**Rješenje:**

$$m(\text{KCl}) + m(\text{KBr}) = 0,7400 \text{ g}$$

$$n(\text{KCl}, \text{KBr}) = \nu(\text{AgNO}_3) \cdot c(\text{AgNO}_3) \cdot \frac{100 \text{ mL}}{25,00 \text{ mL}} =$$

$$= 21,90 \cdot 10^{-3} \text{ dm}^3 \cdot 0,1000 \text{ mol dm}^{-3} \cdot 4 = 8,76 \cdot 10^{-3} \text{ mol}$$

$$n(\text{KCl}) + n(\text{KBr}) = 8,76 \cdot 10^{-3} \text{ mol}$$

$$n(\text{KCl}) = \frac{m(\text{KCl})}{M(\text{KCl})} \quad n(\text{KBr}) = \frac{m(\text{KBr})}{M(\text{KBr})}$$

$$\frac{m(\text{KCl})}{M(\text{KCl})} + \frac{m(\text{KBr})}{M(\text{KBr})} = 8,76 \cdot 10^{-3} \text{ mol}$$

$$m(\text{KCl}) = 0,7400 - m(\text{KBr})$$

$$\frac{0,7400 \text{ g} - m(\text{KBr})}{M(\text{KCl})} + \frac{m(\text{KBr})}{M(\text{KBr})} = 8,76 \cdot 10^{-3} \text{ mol}$$

$$\frac{0,7400 \text{ g} - m(\text{KBr})}{74,55 \text{ g mol}^{-1}} + \frac{m(\text{KBr})}{119 \text{ g mol}^{-1}} = 8,76 \cdot 10^{-3} \text{ mol}$$

$$88,06 \text{ g} - 119 m(\text{KBr}) + 74,55 m(\text{KBr}) = 77,71 \text{ g}$$

$$44,45 m(\text{KBr}) = 10,35 \text{ g}$$

$$m(\text{KBr}) = 0,2328 \text{ g}$$

$$m(\text{KCl}) = 0,7400 \text{ g} - 0,2328 \text{ g}$$

$$m(\text{KCl}) = 0,5072 \text{ g}$$

$$w(\text{KCl}) = \frac{m(\text{KCl})}{m(\text{KCl}, \text{KBr})} = \frac{0,5072}{0,7400} = 0,6854$$

$$w(\text{KBr}) = \frac{0,2328}{0,7400} = 0,3146$$

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5. Kolika masa vodene pare pri 120 °C je potrebna da se 50 kg smjese vode i leda zagrije do 75 °C ? Maseni udio leda u vodi je  $w = 0,40$ .

Poznati podaci:  $c_p(\text{H}_2\text{O}, \text{l}) = 4,183 \text{ J K}^{-1} \text{ g}^{-1}$

$c_p(\text{H}_2\text{O}, \text{g}) = 1,866 \text{ J K}^{-1} \text{ g}^{-1}$

$\Delta_s^l h = 333,9 \text{ J g}^{-1}$

$\Delta^g h = 2260 \text{ J g}^{-1}$

Pretpostavite da pri toplinskoj izmjeni nema gubitaka energije!

**Rješenje:**

$$Q_1 = m(\text{H}_2\text{O}, \text{s}) \cdot \Delta_s^l h(\text{H}_2\text{O}, \text{s}) + m(\text{H}_2\text{O}, \text{l}) \cdot c_p(\text{H}_2\text{O}, \text{l}) \cdot \Delta T_1$$

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$$Q_2 = m(\text{H}_2\text{O}, \text{g}) \cdot c_p(\text{H}_2\text{O}, \text{g}) \cdot \Delta T + m(\text{H}_2\text{O}, \text{g}) \cdot \Delta^g h(\text{H}_2\text{O}, \text{g}) + m(\text{H}_2\text{O}, \text{l}) \cdot c_p(\text{H}_2\text{O}, \text{l}) \cdot \Delta T_2$$

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$$m(\text{H}_2\text{O}, \text{s}) = w(\text{H}_2\text{O}, \text{s}) \cdot m(\text{H}_2\text{O}, \text{l}) = 0,40 \cdot 50 = 20 \text{ kg}$$

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$$m(\text{H}_2\text{O}, \text{s}) \cdot \Delta_s^l h(\text{H}_2\text{O}, \text{s}) + m(\text{H}_2\text{O}, \text{l}) \cdot c_p(\text{H}_2\text{O}, \text{l}) \cdot \Delta T_1 = m(\text{H}_2\text{O}, \text{g}) \cdot c_p(\text{H}_2\text{O}, \text{g}) \cdot \Delta T + m(\text{H}_2\text{O}, \text{g}) \cdot \Delta^g h(\text{H}_2\text{O}, \text{g}) + m(\text{H}_2\text{O}, \text{l}) \cdot c_p(\text{H}_2\text{O}, \text{l}) \cdot \Delta T_2$$

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$$20 \text{ kg} \cdot 333,9 \text{ kJ/kg} + 50 \text{ kg} \cdot 4,183 \text{ kJ/K kg} \cdot (348 \text{ K} - 273 \text{ K}) = 2260 \text{ kJ/kg} \cdot m(\text{H}_2\text{O}, \text{g}) + m(\text{H}_2\text{O}, \text{g}) \cdot 1,866 \text{ kJ/K kg} \cdot (393 \text{ K} - 373 \text{ K}) + m(\text{H}_2\text{O}, \text{g}, \text{l}) \cdot 4,183 \text{ kJ/K kg} \cdot (373 \text{ K} - 348 \text{ K})$$

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$$m(\text{H}_2\text{O}, \text{g}) = 22364,25/2401,9 = 9,311 \text{ kg}$$

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6. Treba odrediti formulu otopljenog sumpora u ugljikovom(IV) sulfidu, ako je poznato da otopina koja je dobivena otapanjem 1,603 g sumpora u 100 g ugljikovog(IV) sulfida ima vrelište koje je za 0,15 °C više od vrelišta otapala. Ebulioskopska konstanta ugljikovog(IV) sulfida je 2,42 K kg/mol.

**Rješenje:**

$$\Delta T_e = f \cdot K_e \frac{m_B}{m_A M_B}$$

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$$f = \frac{\Delta T_e m_A M_B}{K_e m_B} =$$

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$$= 0,15 \cdot 100 \cdot 32,06/2,42 \cdot 1000 \cdot 1,603 = 0,124$$

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$$M(S_x) = M(S)/f = 32,06/0,124 = 258,55 \text{ g/mol}$$

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$$x = M(S_x)/M(S) = 258,55/32,06 = 8,06 \approx 8$$

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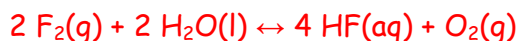
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7. I kalcij i fluor reagiraju s vodom. Napište jednađbe kemijskih reakcija i navedite agregacijska stanja.

**Rješenje:**



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8. Za konduktometrijsku titraciju otpipetirano je 25,00 mL uzorka koji sadrži kloridne ione. Uzorak se titrira otopinom  $\text{AgNO}_3$ ,  $c = 0,5015 \text{ mol dm}^{-3}$ , pri čemu je mjerena vodljivost u ovisnosti o volumenu dodanog titranda. Podaci titracije prikazani su u tablici:

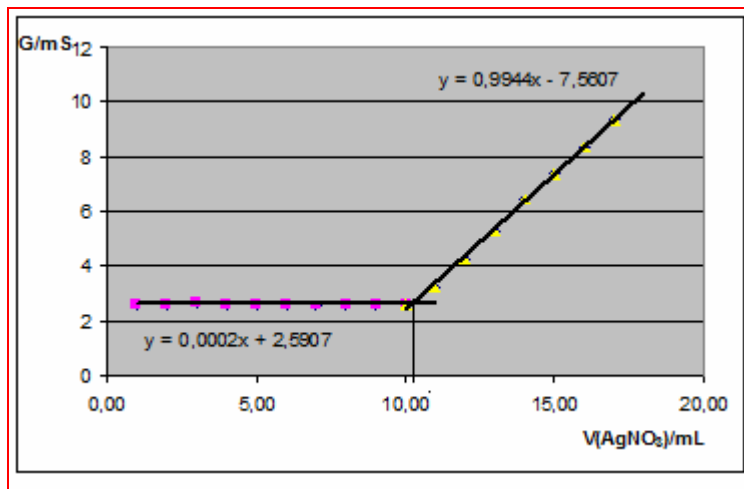
Vodljivost G/mS	Volumen titranda V( $\text{AgNO}_3$ )/mL
2,59	1,00
2,57	2,00
2,64	3,00
2,59	4,00
2,61	5,00
2,57	6,00
2,53	7,00
2,60	8,00
2,61	9,00
2,61	10,00
3,20	11,00
4,25	12,00
5,30	13,00
6,45	14,00
7,40	15,00
8,35	16,00
9,35	17,00

Grafički prikažite ovisnost vodljivosti o volumenu dodanog titranda i izračunajte množinsku koncentraciju kloridnih iona u uzorku.

**Rješenje:**

UKUPNO BODOVA NA STRANICI 5:

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$$V_e = 10,21 \text{ mL}$$

$$V_1 \cdot c_1 = V_2 \cdot c_2$$

$$10,21 \text{ mL} \cdot 0,5015 \text{ mmol/mL} = 25,00 \text{ mL} \cdot c_2$$

$$c_2 = 10,21 \text{ mL} \cdot 0,5015 \text{ mmol/mL} / 25,00 \text{ mL}$$

$$c_2 = 0,2048 \text{ mol dm}^{-3}$$

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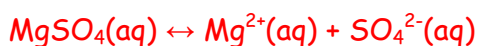
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9. Izračunajte stupanj disocijacije,  $\alpha$ , magnezijevog sulfata  $c = 0,01 \text{ mol dm}^{-3}$  pri  $25^\circ \text{C}$ . Pri toj temperaturi vrijednost konstante ravnoteže disocijacije je,  $K_c = 6,3 \cdot 10^{-3} \text{ mol dm}^{-3}$ .

**Rješenje:**

UKUPNO BODOVA NA STRANICI 6:

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$$\alpha = \frac{c_{\text{dis}}}{c_{\text{uk}}}$$

$$c_{\text{dis}} = [\text{Mg}^{2+}, \text{aq}] = [\text{SO}_4^{2-}, \text{aq}]$$

$$\alpha = \frac{[\text{Mg}^{2+}, \text{aq}]}{[\text{MgSO}_4]_{\text{uk}}} = \frac{[\text{SO}_4^{2-}, \text{aq}]}{[\text{MgSO}_4]_{\text{uk}}}$$

$$[\text{Mg}^{2+}, \text{aq}] = [\text{SO}_4^{2-}, \text{aq}] = \alpha \cdot [\text{MgSO}_4]_{\text{uk}}$$

$$[\text{MgSO}_4]_{\text{uk}} = [\text{MgSO}_4, \text{aq}] + [\text{Mg}^{2+}, \text{aq}] =$$

$$= [\text{MgSO}_4, \text{aq}] + [\text{SO}_4^{2-}, \text{aq}]$$

$$[\text{MgSO}_4, \text{aq}] = [\text{MgSO}_4]_{\text{uk}} - [\text{Mg}^{2+}, \text{aq}] =$$

$$= [\text{MgSO}_4]_{\text{uk}} - [\text{SO}_4^{2-}, \text{aq}]$$

$$[\text{MgSO}_4, \text{aq}] = (1 - \alpha)[\text{MgSO}_4]_{\text{uk}}$$

$$K_c = \frac{[\text{MgSO}_4, \text{aq}][\text{SO}_4^{2-}, \text{aq}]}{[\text{MgSO}_4, \text{aq}]}$$

$$K_c = \frac{\alpha \cdot c_{\text{uk}} \cdot \alpha \cdot c_{\text{uk}}}{(1 - \alpha) \cdot c_{\text{uk}}} = \frac{\alpha^2 \cdot c_{\text{uk}}}{1 - \alpha}$$

$$c_{\text{uk}} \cdot \alpha^2 + K_c \cdot \alpha - K_c = 0$$

$$\alpha = \frac{-K_c + \sqrt{K_c^2 + 4K_c c_{\text{uk}}}}{2c_{\text{uk}}}$$

$$\alpha = \frac{-6,3 \cdot 10^{-3} + \sqrt{(6,3 \cdot 10^{-3})^2 + 4 \cdot 6,3 \cdot 10^{-3} \cdot 0,01}}{2 \cdot 0,01} =$$

$$= 0,54 \quad (54\%)$$

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10. Kolika je promjena standardne slobodne energije standardnog članka bakar – cink?

$$E^\circ(\text{Cu}^{2+}/\text{Cu}) = 0,34 \text{ V}$$

$$E^\circ(\text{Zn}^{2+}/\text{Zn}) = -0,76 \text{ V}$$

UKUPNO BODOVA NA STRANICI 7:

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**Rješenje:**

$$E^\circ (\text{čl.}) = E^\circ (\text{Cu}^{2+}/\text{Cu}) - E^\circ (\text{Zn}^{2+}/\text{Zn}) =$$

$$= 0,34 \text{ V} - (-0,76) = 1,10 \text{ V}$$

$$\Delta G^\circ = -z \cdot F \cdot E^\circ$$

$$\Delta G^\circ = -2 \cdot 96500 \text{ C/mol} \cdot 1,10 \text{ V} =$$

$$= -212300 \text{ C V/mol} =$$

$$= -212300 \text{ J/mol} = -212,3 \text{ kJ/mol}$$

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- 11.** Koliki je pH otopine ako se pomješa 150,0 mL otopine NaCl,  $c = 1,1 \text{ mol dm}^{-3}$ ; 200,0 mL otopine HCl,  $c = 2,5 \text{ mol dm}^{-3}$ ; 250,0 mL otopine KCl,  $c = 2,2 \text{ mol dm}^{-3}$ ; 200,0 mL otopine KOH,  $c = 1 \text{ mol dm}^{-3}$ ; 200,0 mL otopine NaOH,  $c = 1,5 \text{ mol dm}^{-3}$ ; 300,0 mL otopine  $\text{HNO}_3$ ,  $c = 2,5 \text{ mol dm}^{-3}$  i 250,0 mL  $\text{H}_2\text{O}$ ?

**Rješenje:**

$$V = 250,0 \text{ mL} + 300,0 \text{ mL} + 200,0 \text{ mL} + 200,0 \text{ mL} + 250,0 \text{ mL} + 200,0 \text{ mL} + 150,0 \text{ mL} = 1550,0 \text{ mL}$$

$$n(\text{H}^+) = 0,2 \cdot 2,5 + 0,3 \cdot 2,5 = 0,50 + 0,75 = 1,25 \text{ mol}$$

$$n(\text{OH}^-) = 0,2 \cdot 1,5 + 0,2 \cdot 1 = 0,30 + 0,20 = 0,50 \text{ mol}$$

$$n(\text{H}^+, \text{konačno}) = 1,25 \text{ mol} - 0,50 \text{ mol} = 0,75 \text{ mol}$$

$$c(\text{H}^+) = n/V =$$

$$= 0,75 \text{ mol} / 1,550 \text{ dm}^3 = 0,484 \text{ mol dm}^{-3}$$

$$\text{pH} = -\log c(\text{H}^+) = 0,315$$

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**Ukupni bodovi**





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UKUPNO BODOVA NA STRANICI 8:

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