Qualitative inorganic analysis

SCHEME FOR THE SEPARATION OF THE CATIONS

ORIGINAL SOLUTION

Pb^{2+}, Ag^{+}, Hg_2^{2+}, Hg^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, As^{5+}, Sb^{3+}, Sb^{5+}, Sn^{2+}, Sn^{4+}, Fe^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

NaOH, heating → NH_3 sharp smelling gas

HCl (3 mol/L)

I

PRECIPITATE

$PbCl_2$	AgCl	Hg_2Cl_2
white ppt.	white ppt.	white ppt.

H_2O (100 °C)

AgCl, Hg_2Cl_2 (white ppt.) → NH_3 (conc.)

- $HgNH_2Cl + Hg^0$ — black precipitate
- $Ag(NH_3)_2^{+}$ → HNO_3 (conc.) → AgCl, white precipitate

Pb^{2+} → $K_2Cr_2O_7$ → $PbCrO_4$, yelow precipitate

SOLUTION

Hg^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, As^{5+}, Sb^{3+}, Sb^{5+}, Sn^{2+}, Sn^{4+}, Fe^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

H_2S (in acidic medium)

II

PRECIPITATE

HgS	Bi_2S_3	CuS	CdS	As_2S_3	As_2S_5	Sb_2S_3	Sb_2S_5	SnS	SnS_2
black ppt.	brown ppt.	black ppt.	yelow ppt.	yelow ppt.	yelow ppt.	orange ppt.	orange ppt.	smeđi talog	yelow ppt.

KOH (3 mol/L)

II a subgroup

HgS	Bi_2S_3	CuS	CdS
black ppt.	brown ppt.	black ppt.	yelow ppt.

HNO_3 (3 mol/L)

- $Hg(NO_3)_2 \cdot 2HgS$, black ppt. → $HNO_3 + HCl$ (1:3), $SnCl_2$ → $Hg_2Cl_2 + Hg^0$, grey precipitate
- Bi^{3+}, Cu^{2+}, Cd^{2+} → NH_3 (conc.)
  - $Bi(OH)_3$, white ppt. → SnO_2^{2-} → Bi^0, brown precipitate
  - $Cu(NH_3)_4^{2+}$, $Cd(NH_3)_4^{2+}$
    - HAc + $Fe(CN)_6^{4-}$ → $Cu_2Fe(CN)_6$, reddish brown ppt.
    - KCN + H_2S → CdS, yelow precipitate

II b subgroup

AsS_4^{3-}, AsO_2^{-}, SnS_3^{2-}, SnO_3^{2-}, SbS_4^{3-}, SbO_2^{-}

HCl (6 mol/L)

As_2S_3	As_2S_5	SnS	SnS_2	Sb_2S_3	Sb_2S_5
yelow ppt.	yelow ppt.	smeđi talog	yelow ppt.	orange ppt.	orange ppt.

HCl (conc.)

As_2S_3	As_2S_5
yelow ppt.	yelow ppt.

HNO_3 (conc.) + NaAc + $AgNO_3$ → Ag_3AsO_4, chocolate brown p.

Sb^{3+}, Sn^{2+}

- $NaNO_2$ + rhodamine B → Sb-rhodamine, purple solution
- HCl + $HgCl_2$ → Sn^{4+}, grey ppt. Hg_2Cl_2

SOLUTION

Fe^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

NH_4Cl + NH_4OH

III

PRECIPITATE

$Fe(OH)_3$	$Cr(OH)_3$	$Al(OH)_3$
brown ppt.	grey-green p.	white ppt.

NaOH (6 mol/L) + H_2O_2 (3 %)

- $Fe(OH)_3$, brown ppt. → HNO_3 (6 mol/L) + H_2O_2 (3 %) → NH_4SCN → $Fe(SCN)^{2+}$, blood red solution
- CrO_4^{2-}, $Al(OH)_4^{-}$ → HAc + $Pb(Ac)_2$ → $PbCrO_4$, yelow precipitate
  - NH_4Cl → $Al(OH)_3$, white precipitate

SOLUTION

Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

H_2S (in basic medium)

IV

PRECIPITATE

CoS	NiS	MnS	ZnS
black ppt.	black ppt.	pink ppt.	white ppt.

HCl (0.5 mol/L)

CoS	NiS
black ppt.	black ppt.

HNO_3 (conc.) → Co^{2+}, Ni^{2+}

- NH_4SCN + amyl alcohol → $Co(SCN)_4^{2-}$, deep blue solution
- NH_3 (3 mol/L) + dimethylglyoxime → Ni-dimethylglyoxime, red precipitate

Mn^{2+}, Zn^{2+} → NaOH (6 mol/L) + H_2O_2 (3 %)

- MnO_2, brown ppt. → HNO_3 + $NaBiO_3$ → MnO_4^{-}, purple solution
- $Zn(OH)_3^{-}$ → H_2S → ZnS, white precipitate

SOLUTION

Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

$(NH_4)_2PO_4$ (0.5 mol/L) + NH_3 (conc.)

V

PRECIPITATE

$Ba_3(PO_4)_2$	$Sr_3(PO_4)_2$	$Ca_3(PO_4)_2$	$MgNH_4PO_4$
white ppt.	white ppt.	white ppt.	white ppt.

CH_3COOH (conc.) + K_2CrO_4

- $BaCrO_4$, yelow precipitate
- Sr^{2+}, Ca^{2+}, Mg^{2+} → NH_3 (conc.)

$Sr_3(PO_4)_2$	$Ca_3(PO_4)_2$	$MgNH_4PO_4$
white ppt.	white ppt.	white ppt.

CH_3COOH (conc.) + $(NH_4)_2SO_4$

- $SrSO_4$, white precipitate
- Ca^{2+}, Mg^{2+} → $(NH_4)_2C_2O_4$
  - CaC_2O_4, white precipitate
  - Mg^{2+} → NaOH + quinalizarine → Mg-quinalizarine, blue solution

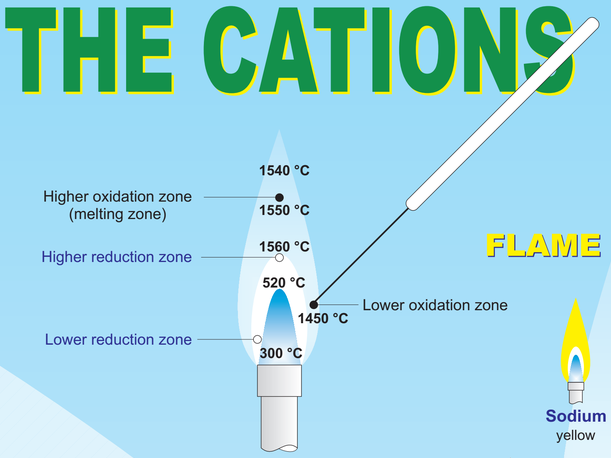
SOLUTION

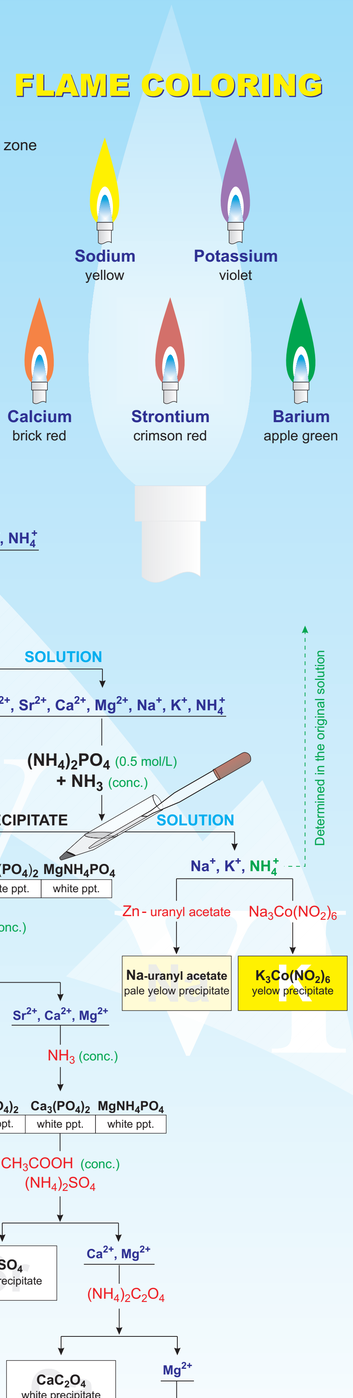
Na^{+}, K^{+}, NH_4^{+}

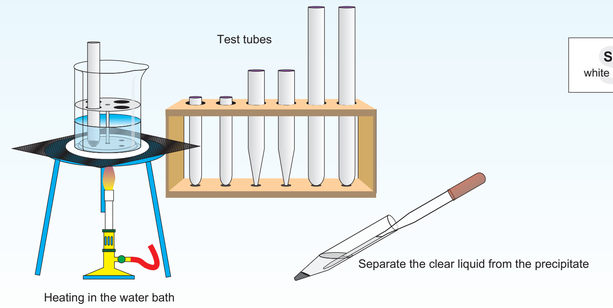
- Zn - uranyl acetate → Na-uranyl acetate, pale yelow precipitate
- $Na_3Co(NO_2)_6$ → $K_3Co(NO_2)_6$, yelow precipitate

Determined in the original solution

FLAME COLORING







PERIODIC TABLE OF THE ELEMENTS

1 IA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.0079	2 IIA																2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)					

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