Supplemental Information 3: Examples of comproportionation-based autocatalytic cycles (interactive version)

Cmp.: Count of **Comp**ACs that are compatible with the common definition of comproportionation, corresponding to Table S1.

Brd. : Count of **br**oa**d**-sense CompACs that affect the element and are only compatible with the rare definition of comproportionation, corresponding to Table S2; note that for a broad-sense CompAC, any element that is involved in an autocatalyst is considered affecred by this broad-sense CompAC.

$_{1}$H Cmp.: 4 Brd.: 26																														$_{2}$He Cmp.: Brd.:
$_{3}$Li Cmp.: Brd.:	$_{4}$Be Cmp.: Brd.:																											**$_{5}$B** Cmp.: 7 Brd.: 4	**$_{6}$C** Cmp.: 8 Brd.: 10	**$_{7}$N** Cmp.: 8 Brd.: 3	**$_{8}$O** Cmp.: 7 Brd.: 31	**$_{9}$F** Cmp.: Brd.: 3	$_{10}$Ne Cmp.: Brd.:
$_{11}$Na Cmp.: Brd.: 6	$_{12}$Mg Cmp.: Brd.:																											**$_{13}$Al** Cmp.: 2 Brd.: 5	**$_{14}$Si** Cmp.: 5 Brd.: 1	**$_{15}$P** Cmp.: 9 Brd.: 3	**$_{16}$S** Cmp.: 11 Brd.: 12	**$_{17}$Cl** Cmp.: 7 Brd.: 5	$_{18}$Ar Cmp.: Brd.:
$_{19}$K Cmp.: Brd.:	**$_{20}$Ca** Cmp.: 1 Brd.: 8															**$_{21}$Sc** Cmp.: 1 Brd.:	**$_{22}$Ti** Cmp.: 2 Brd.:	**$_{23}$V** Cmp.: 9 Brd.:	**$_{24}$Cr** Cmp.: 5 Brd.: 1	**$_{25}$Mn** Cmp.: 14 Brd.:	**$_{26}$Fe** Cmp.: 5 Brd.: 1	**$_{27}$Co** Cmp.: 6 Brd.: 1	**$_{28}$Ni** Cmp.: 7 Brd.:	**$_{29}$Cu** Cmp.: 2 Brd.: 1	**$_{30}$Zn** Cmp.: Brd.: 4	**$_{31}$Ga** Cmp.: 5 Brd.:	**$_{32}$Ge** Cmp.: 2 Brd.:	**$_{33}$As** Cmp.: 8 Brd.: 2	**$_{34}$Se** Cmp.: 8 Brd.: 1	**$_{35}$Br** Cmp.: 6 Brd.: 1	$_{36}$Kr Cmp.: Brd.:
$_{37}$Rb Cmp.: Brd.:	$_{38}$Sr Cmp.: Brd.:															**$_{39}$Y** Cmp.: 1 Brd.:	**$_{40}$Zr** Cmp.: 2 Brd.:	**$_{41}$Nb** Cmp.: 7 Brd.:	**$_{42}$Mo** Cmp.: 3 Brd.:	$_{43}$Tc Cmp.: Brd.:	$_{44}$Ru Cmp.: Brd.:	$_{45}$Rh Cmp.: Brd.:	$_{46}$Pd Cmp.: Brd.:	**$_{47}$Ag** Cmp.: 4 Brd.:	**$_{48}$Cd** Cmp.: 1 Brd.:	$_{49}$In Cmp.: Brd.:	**$_{50}$Sn** Cmp.: 2 Brd.:	$_{51}$Sb Cmp.: Brd.:	**$_{52}$Te** Cmp.: 6 Brd.:	**$_{53}$I** Cmp.: 8 Brd.:	**$_{54}$Xe** Cmp.: 4 Brd.:
$_{55}$Cs Cmp.: Brd.:	**$_{56}$Ba** Cmp.: 1 Brd.:	**$_{57}$La** Cmp.: 1 Brd.:	$_{58}$Ce Cmp.: Brd.:	$_{59}$Pr Cmp.: Brd.:	$_{60}$Nd Cmp.: Brd.:	$_{61}$Pm Cmp.: Brd.:	$_{62}$Sm Cmp.: Brd.:	**$_{63}$Eu** Cmp.: 2 Brd.:	$_{64}$Gd Cmp.: Brd.:	$_{65}$Tb Cmp.: Brd.:	$_{66}$Dy Cmp.: Brd.:	$_{67}$Ho Cmp.: Brd.:	$_{68}$Er Cmp.: Brd.:	$_{69}$Tm Cmp.: Brd.:	$_{70}$Yb Cmp.: Brd.:	$_{71}$Lu Cmp.: Brd.:	$_{72}$Hf Cmp.: Brd.:	**$_{73}$Ta** Cmp.: 2 Brd.:	**$_{74}$W** Cmp.: 3 Brd.:	**$_{75}$Re** Cmp.: 6 Brd.:	$_{76}$Os Cmp.: Brd.:	$_{77}$Ir Cmp.: Brd.:	$_{78}$Pt Cmp.: Brd.:	**$_{79}$Au** Cmp.: 2 Brd.:	**$_{80}$Hg** Cmp.: 6 Brd.:	$_{81}$Tl Cmp.: Brd.:	**$_{82}$Pb** Cmp.: 4 Brd.: 6	$_{83}$Bi Cmp.: Brd.:	$_{84}$Po Cmp.: Brd.:	$_{85}$At Cmp.: Brd.:	$_{86}$Rn Cmp.: Brd.:
$_{87}$Fr Cmp.: Brd.:	$_{88}$Ra Cmp.: Brd.:	$_{89}$Ac Cmp.: Brd.:	**$_{90}$Th** Cmp.: 4 Brd.:	$_{91}$Pa Cmp.: Brd.:	**$_{92}$U** Cmp.: 1 Brd.:	$_{93}$Np Cmp.: Brd.:	$_{94}$Pu Cmp.: Brd.:	$_{95}$Am Cmp.: Brd.:	$_{96}$Cm Cmp.: Brd.:	$_{97}$Bk Cmp.: Brd.:	$_{98}$Cf Cmp.: Brd.:	$_{99}$Es Cmp.: Brd.:	$_{100}$Fm Cmp.: Brd.:	$_{101}$Md Cmp.: Brd.:	$_{102}$No Cmp.: Brd.:	$_{103}$Lr Cmp.: Brd.:	$_{104}$Rf Cmp.: Brd.:	$_{105}$Db Cmp.: Brd.:	$_{106}$Sg Cmp.: Brd.:	$_{107}$Bh Cmp.: Brd.:	$_{108}$Hs Cmp.: Brd.:	$_{109}$Mt Cmp.: Brd.:	$_{110}$Ds Cmp.: Brd.:	$_{111}$Rg Cmp.: Brd.:	$_{112}$Cn Cmp.: Brd.:	$_{113}$Nh Cmp.: Brd.:	$_{114}$Fl Cmp.: Brd.:	$_{115}$Mc Cmp.: Brd.:	$_{116}$Lv Cmp.: Brd.:	$_{117}$Ts Cmp.: Brd.:	$_{118}$Og Cmp.: Brd.:

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$SiHCl_3$ + **HCl** → $SiCl_4$ + $\mathbf{H_2}$ $\mathbf{H_2}$ + Cl_2 → **2 HCl**	(Bade et al., 1996; Patnaik, 2003, p. 210)	Bade et al., p. 175, reaction (6), "*The kinetic favoured $SiHCl_3$, reacts with one molecule HCl to the thermodynamic favoured $SiCl_4$, (comproportionation of hydrogen)*".
NaH + **HCl** → NaCl + $\mathbf{H_2}$ $\mathbf{H_2}$ + Cl_2 → **2 HCl**	(끔 et al., 2003, pp. 10, 301)	
NaH + **HCl** → NaCl + $\mathbf{H_2}$ 2 CuCl + $\mathbf{H_2}$ → 2 Cu + **2 HCl**	(Törndahl et al., 2004; 끔 et al., 2003, p. 10)	Törndahl et al., p. 130, "*In the water-free process, hydrogen reacted directly with CuCl according to an overall formation reaction (3).* *$2CuCl(ads) + H_2(g) \rightarrow 2Cu(s) + 2HCl(g)$ (3)*"
NaH + H_2O → NaOH + $\mathbf{H_2}$ $\mathbf{H_2}$ + 2 Na → **2 NaH**	(Gawley and Hennings, 2006; Hansley and Carlislie, 1945)	Gawley and Hennings, "*Sodium hydride reacts more violently with water than sodium metal*"; Hansley and Carlislie, "*Sodium, under the proper conditions, will rapidly absorb an equivalent of hydrogen to yield a gray-to-white, saltlike crystalline powder according to the equation*"

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Ca + CaF_2 → **2 CaF** **3 CaF** + Sc → **3 Ca** + ScF_3	(Walters et al., 1928; Zmbov and Margrave, 1967)	Walters et al., p. 123, "*In studying the calcium spectra, the sub-halide vapours were invariably obtained by heating a mixture of calcium turnings and a powdered and dehydrated calcium halide salt.*" p. 137, "*Alkaline earth subhalide molecules of the type MX exist in the vapour state at 1000 °C. in equilibrium with the metal and the normal salts.*" Zmbov and Margrave, "*Mono-, di-, and trifluorides of Sc and Y have been identified in the vapors over mixtures of the corresponding metals and CaF_2 in Ta-Knudsen cells at high temperatures.*" p. 3124, Table II.

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$BaCl_2$ + Ba → **2 BaCl** **2 BaCl** + 2 H_2O → **$BaCl_2$** + **$Ba(OH)_2$** + H_2 **$Ba(OH)_2$** + 2 HCl → **$BaCl_2$** + 2 H_2O	(Guntz and Benoit, 1924; 끠 et al., 2003, p. 102)	Guntz and Benoit, p. 720, "*Voici les résultats obtenus à la température de 15°:* *1° Sous-chlorure de baryum:* *$BaCl_2$ sol. + Ba sol. = 2 BaCl sol.*" Guntz and Benoit, p. 714, "*lls sont tous décomposés par l'eau et par les acides étendus endonnant de l'hydrogène, suivant la réaction:* *2 BaCl + 2 H_2O = $BaCl_2$ + $Ba(OH)_2$ + H_2*"

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2 LaI_3 + La → **3 LaI_2** **LaI_2** + ThI_4 → **LaI_3** + ThI_3	(Beck and Schuster, 1993; Ryazanov et al., 2004; Weller et al., 2018, p. 702)	Ryazanov et al., p. 105, "*Lanthandiiodid wurde durch Erhitzen eines gepressten Gemenges von LaI_3 und La im molaren Verhältnis 1:1 bei a) 750 ℃ (1d) und dann 850 ℃ (5d) als violetter Kompaktstoff mit Metallglanz und b) bei 835 ℃ (4 Stunden) und dann 800 ℃ (16 Stunden) als dunkel violett glänzendes Pulver dargestellt.*" Beck and Schuster, p. 691, "*Die Diiodide der Seltenen Erden La-Nd, Gd und Dy wurden aus den Trihalogeniden durcb Synproportionierung mit dem jeweiligen Metall (5-10% Uberschuss) in Ta-Ampullen hergestellt*" pp. 691-692, "*Die Umsetzung der Diiodide der leichteren Seltenen Erden La-Nd und von Gd verlauft als Redox-Reaktion nach AcI_4 + LnI_2 → AcI_3 + LnI_3.*" p. 693, "*Die Reaktionsenthalpien fur die Redoxreaktionen AcI4 + LnI2 → AcI3 + LnI3, Ac: Th, U; Ln = Seltene Erden, lassen sich abschatzen in Analogic zu den Uberlegungen von Johnson zur Stabilitat zweiwertiger Seltenerdhalogenide.*"

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2 $EuCl_3$ + Eu → **3 $EuCl_2$** **2 $EuCl_2$** + Cl_2 → **2 $EuCl_3$**	(Da Silva et al., 2001; Kuznetsov et al., 2001)	Kuznetsov et al., p. 742, "*Wave 1 is observed in the cathodic-anodic region that indicates the appearance in the melt of Eu(II) due to the reaction 2 $EuCl_3$ ⇌ 2 $EuCl_2$ + Cl_2.*" p. 749, "*3.6. The Equilibrium Constant of the Metal-salt Reaction 2 Eu(III) + Eu ⇌ 3 Eu(II)*" Da Silva et al., p. 649, "*We considered the reaction of formation of $EuCl_2$ from Eu and $EuCl_3$*"
Eu_2O_3 + Eu → **3 EuO** **6 EuO** + O_2 → **2 Eu_3O_4** **4 Eu_3O_4** + O_2 → **6 Eu_2O_3**	(Cotton, 2006; Jacob and Rajput, 2016; Weller et al., 2018, p. 702)	Cotton, p. 29, "*Reduction of Eu_2O_3 with Eu above 800 ℃ (comproportionation) gives EuO.*" Jacob and Rajput, Abstract figure, pink and black lines.

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ThO_2 + **Th** → **2 ThO** **ThO** + Si → **Th** + SiO	(Hildenbrand and Murad, 1974; Hoch and Johnston, 1954)	Hildenbrand and Murad, p. 1232, "*High temperature mass spectrometric techniques have been used to study the equilibria (1/2)Th(s) + (1/2)ThO_2(s) = ThO(g), (1); ThO(g) + Si(g) = Th(g) + SiO(g), (2); Th(g) + ThO_2(g) = 2ThO(g), (3).*" Hoch and Johnston, p. 4833, "*The study of the reaction Th(l) + ThO_2(s) ⇌ 2ThO(s) by a high temperature X-ray diffraction technique showed the formation at 2150 °K. of solid ThO.*"
ThI_4 + ThI_2 → **2 ThI_3** **4 ThI_3** → Th + **3 ThI_4**	(Anderson and D'Eye, 1949)	Anderson and D'Eye, p. S244, "*Thorium di- and tri-iodide have now been prepared and found to be deeply coloured compounds, analogous in every respect to the lower zirconium and hafnium iodides. They are formed by reduction of the tetraiodide with varying quantities of metallic thorium at 450-550 °. The tri-iodide is perceptibly volatile; it undergoes reversible dissociation to tetra- and di-iodide at 550-600 °. Above 600 °. both lower iodides disproportionate into the tetraiodide and metallic thorium.*"
ThI_4 + Th → **2 ThI_2** **ThI_2** + UI_4 → **ThI_3** + UI_3 **4 ThI_3** → Th + **3 ThI_4**	(Anderson and D'Eye, 1949; Beck and Schuster, 1993)	Anderson and D'Eye, p. S244, "*Thorium di- and tri-iodide have now been prepared and found to be deeply coloured compounds, analogous in every respect to the lower zirconium and hafnium iodides. They are formed by reduction of the tetraiodide with varying quantities of metallic thorium at 450-550 °. The tri-iodide is perceptibly volatile; it undergoes reversible dissociation to tetra- and di-iodide at 550-600 °. Above 600 °. both lower iodides disproportionate into the tetraiodide and metallic thorium.*" Beck and Schuster, p. 693, "*In diesem Zusammenhang ist die Reaktion von UI_4 mit ThI_2 von Interesse. Unter den von uns gewahlten Bedingungen lauft eine Redox-Reaktion nach (1) ab, bei der die Trihalogenide in ihrem jeweiligen Strukturtyp entstehen ohne Hinweise auf eine Misclikristallbildung.*"
3 ThI_4 + Th → **4 ThI_3** **2 ThI_3** → **ThI_2** + **ThI_4** **ThI_2** + UI_4 → **ThI_3** + UI_3	(Anderson and D'Eye, 1949; Beck and Schuster, 1993)	Anderson and D'Eye, p. S244, "*Thorium di- and tri-iodide have now been prepared and found to be deeply coloured compounds, analogous in every respect to the lower zirconium and hafnium iodides. They are formed by reduction of the tetraiodide with varying quantities of metallic thorium at 450-550 °. The tri-iodide is perceptibly volatile; it undergoes reversible dissociation to tetra- and di-iodide at 550-600 °. Above 600 °. both lower iodides disproportionate into the tetraiodide and metallic thorium.*" Beck and Schuster, p. 693, "*In diesem Zusammenhang ist die Reaktion von UI_4 mit ThI_2 von Interesse. Unter den von uns gewahlten Bedingungen lauft eine Redox-Reaktion nach (1) ab, bei der die Trihalogenide in ihrem jeweiligen Strukturtyp entstehen ohne Hinweise auf eine Misclikristallbildung.*"

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3 UF_4 + U → **4 UF_3** **UF_3** + CaF → **UF_4** + Ca	(Lau and Hildenbrand, 1982; Лидин et al., 2007, p. 591)	Lau and Hildenbrand, p. 2648, Fig. 2, Eq. (4).

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2 $ScCl_3$ + Sc_5Cl_8 → **7 $ScCl_2$** **3 $ScCl_2$** → **2 $ScCl_3$** + Sc	(Corbett, 1981; Poeppelmeier and Corbett, 1978)	Corbett, p. 241, "*Gaseous $ScCl_2$ is thought to be formed by an endothermic reduction of $ScC1_3(g)$ in the hot zone in the sequence $ScCl_3(s) \rightleftharpoons ScCl_3(g)$ (3) followed by $2ScCl_3(g) + Sc(s) \rightleftharpoons 3ScCl_2(g)$ (4) The $ScCl_2$ now diffuses to an intermediate temperature zone where it disproportionates to form a lower phase plus $ScC1_3(g)$, such as $7ScCl_2(g) \rightleftharpoons Sc_5Cl_8(s) + 2ScCl_3(g)$ (5) and the $ScCl_3$ recycles in (4).*" Poeppelmeier and Corbett, Abstract, "*The role the lower valent gas phase species $ScCl_2(g)$ plays in the formation of Sc_5Cl_8 at high temperature is discussed in terms of the postulated transport reaction $Sc_5Cl_8(s) + 2ScCl_3(g) = 7ScCl_2(g)$.*"

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2 YF_3 + Y → **3 YF_2** **YF_2** + CaF → **YF_3** + Ca	(Knight and Wise, 1980; Zmbov and Margrave, 1967)	Knight and Wise, p. 4946, "*YF_2 was generated by the high temperature vaporization reaction between YF_3 powder (Alia Products 99.99%) and Y metal chips (Alfa 99.9%) in a single tantalum effusion cell.*" Zmbov and Margrave, p. 3125, Fig. 4.

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Ti + **3 $TiBr_4$** → **4 $TiBr_3$** **2 $TiBr_3$** + 2 HBr → **2 $TiBr_4$** + H_2	(Stebler et al., 1989; Young et al., 1946)	Stebler et al., p. 382, "*B. SYNTHESIS OF $TiBr_3$ $3TiBr_4 + Ti \rightarrow 4TiBr_3$*" Young et al., p. 116, "*The (III)bromide may be satisfactorily produced by the interaction of the (IV)bromide with hydrogen at 750°, provided that the products are chilled to prevent decomposition of the (III)bromide, $2TiBr_3 \rightarrow TiBr_2 + TiBr_4$ and reversal of the reaction of synthesis, $2TiBr_3 + 2HBr \rightarrow H_2 + TiBr_4$*"
$TiBr_2$ + **$TiBr_4$** → **2 $TiBr_3$** **2 $TiBr_3$** + 2 HBr → **2 $TiBr_4$** + H_2	(Stebler et al., 1989; Young et al., 1946)	Stebler et al., p. 377, "*Synthesis and Crystal Growth of $A_3M_2X_9$ (A = Cs, Rb; M = Ti, V, Cr; X = Cl, Br)*" Stebler, p. 378, "*For M =Ti and V the situation is complicated by the competing equilibrium $2MX_3 \rightleftharpoons MX_2 + MX_4$ which is shifted to the right at high temperatures.*" Young et al., p. 116, "*The (III)bromide may be satisfactorily produced by the interaction of the (IV)bromide with hydrogen at 750°, provided that the products are chilled to prevent decomposition of the (III)bromide, $2TiBr_3 \rightarrow TiBr_2 + TiBr_4$ and reversal of the reaction of synthesis, $2TiBr_3 + 2HBr \rightarrow H_2 + TiBr_4$*"

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3 $ZrCl_4$ + Zr → **4 $ZrCl_3$** **2 $ZrCl_3$** + 2 HCl → **2 $ZrCl_4$** + H_2	(Efimov et al., 1987; Лидин et al., 2007, p. 622)	Efimov et al., p. 353, "*The enthalpy change of the resulting reaction: $ZrCl_3(cr)$+ $HCl(sln.\ 17.06H_2O)$ = $ZrCl_4(cr)$ + $0.5H_2(g)$, was found to be ...*" Efimov et al., p. 354, "*$ZrCl_3$ was synthesized by reduction of liquid $ZrCl_4$ with Zr at 773 K and a pressure of 5 MPa.*"
ZrI_4 + ZrI_2 → **2 ZrI_3** **4 ZrI_3** → **3 ZrI_4** + Zr	(Anderson and D'Eye, 1949)	Anderson and D'Eye, pp. S244-245, "*for the work of de Boer and Fast (Z. anorg. Chem., 1930, 187, 177) had shown that in the system of zirconium halides the reversible reactions 3 ZrI_4 + Zr ⇌ 4 ZrI_3 and 2 ZrI_3 ⇌ ZrI_2 + ZrI_4 take place readily at 450-600 °.*"

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V_2O_3 + V → **3 VO** **4 VO** + O_2 → **2 V_2O_3**	(Лидин et al., 2007, p. 599; 马 et al., 2003, p. 413)	
V_2O_5 + V_2O_3 → **4 VO_2** **4 VO_2** + O_2 → **2 V_2O_5**	(Brauer, 1965a, p. 1267; Лидин et al., 2007, p. 598)	Brauer, p. 1267, "*Since the direct reduction of V3O5 does not give a well-defined product, this compound is best prepared by synthesis from V_2O_5 and V_2O_3, suggested a long time ago by Berzelius: V_2O_5 + V_2O_3 = 4VO_2*"
V_2O_5 + **V_2O_3** → **4 VO_2** **2 VO_2** + H_2 → **V_2O_3** + H_2O	(Brauer, 1965a, p. 1267; Spencer and Justice, 1934)	Brauer, p. 1267, "*Since the direct reduction of V3O5 does not give a well-defined product, this compound is best prepared by synthesis from V_2O_5 and V_2O_3, suggested a long time ago by Berzelius: V_2O_5 + V_2O_3 = 4VO_2*" Spencer and Justice, p. 2306, "*The dissociation pressure of vanadium pentoxide has also been studied, and values have been reported for the reactions V_2O_4 + H_2 = V_2O3 + H_2O (3) V_2O_5 + H_2 = V_2O_4 + H_2O (4)*"
V_2O_5 + **V_2O_3** → **4 VO_2** **2 VO_2** + CO → **V_2O_3** + CO_2	(Brauer, 1965a, p. 1267; Spencer and Justice, 1934; 马 et al., 2003, p. 414)	Brauer, p. 1267, "*Since the direct reduction of V3O5 does not give a well-defined product, this compound is best prepared by synthesis from V_2O_5 and V_2O_3, suggested a long time ago by Berzelius: V_2O_5 + V_2O_3 = 4VO_2*" Spencer and Justice, p. 2306, "*This latter work appears to be unsatisfactory and the present investigation, in which the reversible equilibrium V_2O_4 + CO = V_2O_3 + CO2 (5) was studied over the temperature range 750 to 896 ° by a flow method, was undertaken as part of a program of determining the free energy relations of the vanadium oxides.*"

VCl_3 + V → **3 VCl_2** **VCl_2** + 2 HCl → **VCl_3** + H_2	(Лидин et al., 2007, pp. 594, 595)	
2 VCl_3 + **V** → **3 VCl_2** **VCl_2** + H_2 → **V** + 2 HCl	(Лидин et al., 2007, p. 595; 马 et al., 2003, p. 413)	
VCl_4 + V → **4 VCl_3** **2 VCl_3** + Cl_2 → **2 VCl_4**	(Simons and Powell, 1945; Лидин et al., 2007, p. 595)	Simons and Powell, p. 77, "*K_p in mm. for the reaction 2VCl_3(s) + Cl_2 (g) = 2VCl_4 (g) was found to be 1480 at 160 °, 2070 at 170 °, 3000 at 180 °, with a calculated ΔH of 13.8 kcal.*"
3 VCl_4 + **V** → **4 VCl_3** **2 VCl_3** + 3 H_2 → **2 V** + 6 HCl	(Лидин et al., 2007, pp. 594, 595)	
2 V^{3+} + V → **3 V^{2+}** **2 V^{2+}** + H_2O_2 + 2 H^+ → **2 V^{3+}** + 2 H_2O	(Gussone et al., 2020; Rush and Bielski, 1985)	Gussone et al., p. 357, "*Based on this and according to our previous work, vanadium metal reacted by comproportionation with the trivalent vanadium ions (Eq. 1) showing that the potential E_{QRE} is mainly determined by the electrode potential of the V/V^{2+} couple (E(V/V^{2+})). 2V^{3+} + V → 3V^{2+} (1)*" Rush and Bielski, p. 4282, reaction (2).

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$2\ NbCl_3$ + **Nb** → **3 $NbCl_2$** **$NbCl_2$** + H_2 → **Nb** + 2 HCl	(Brauer, 1965b, p. 1296; Schäfer and Kahlenberg, 1960)	Schäfer and Kahlenberg, pp. 323-324, "*Zu diskutieren sind die Gleichgewichte (15) und (16) ... Fur die Reaktion $NbCl_2f + H_2 = Nb + 2\ HCl$ (16) liefert die Rechnung log $Kp._{16\ (at)} = 7{,}087 - 11038/T$ (≈900 °K).*"
$3\ NbCl_5$ + **2 Nb** → **5 $NbCl_3$** **2 $NbCl_3$** + $3\ H_2$ → **2 Nb** + 6 HCl	(Blainey, 1958; Brauer, 1965c, p. 1298)	Blainey, pp. 96, 184, "*This leaves a purified mixture of $CbCl_5$ and $TaCl_5$ gas, and the former is preferentially reduced in hydrogen at 525 °C. (950 °F.) into solid $CbCl_3$, which in turn is reduced to metallic columbium in hydrogen at 625 °C. (1150 °F.).*"
4 $NbCl_5$ + Nb → **5 $NbCl_4$** **2 $NbCl_4$** + Cl_2 → **2 $NbCl_5$**	(Brauer, 1965d, p. 1300; Schäfer and Kahlenberg, 1960)	Schäfer and Kahlenberg, p. 301, "*Die Addition Sigma(1-6)_ΔH liefert schließlich $NbCl_4f$ + ½ Cl_2 = $NbCl_5f$; ΔH_{298} = –24.5 +– 0.2 kcal.*"
4 $NbCl_5$ + Nb → **5 $NbCl_4$** **2 $NbCl_4$** + 2 CCl_4 → **2 $NbCl_5$** + C_2Cl_6	(Brauer, 1965d, p. 1300; Schäfer et al., 1951)	Schäfer et al., p. 262, "*Auch Niobtetrachlorid wird durch Tetrachlorkohlenstoff oxydiert (Vers. 24): $2NbCl_4 + 2CCl_4 = 2NbCl_5 + C_2Cl_6$.*"
2 Nb_2O_5 + Nb → **5 NbO_2** **4 NbO_2** + O_2 → **2 Nb_2O_5**	(Páez Fajardo et al., 2021; Patnaik, 2003, p. 631)	Patnaik, p. 631, "*Similarly, heating the metal powder with pentoxide at 1,100 °C forms bluish-black dioxide: $Nb + 2Nb_2O_5 \rightarrow 5NbO_2$*" Páez Fajardo et al., p. 1418, "*Our previous study shows that bulk NbO_2 oxidizes at temperatures above 400 °C via the following chemical reaction: $4\ NbO_2 + O_2 \rightarrow 2\ Nb_2O_5$*"
Nb_2O_5 + 3 Nb → **5 NbO** **4 NbO** + $3\ O_2$ → **2 Nb_2O_5**	(Kolchin and Sumarokova, 1961; Reed et al., 1995)	Reed et al., p. 108, "*$3Nb + Nb_2O_5 \rightarrow 5NbO$*" Kolchin and Sumarokova, p. 169, "*Samples of the oxide were heated in air at a temperature of 100-300 °C ... Both the oxide and the dioxide were completely oxidized to the pentoxide after 6 hr at 300 °C.*"
NbO_2 + Nb → **2 NbO** **3 NbO** + CO → **2 NbO_2** + NbC	(Kimura et al., 1967; Patnaik, 2003, p. 631)	Patnaik, p. 631, "*Reaction of niobium powder with niobium dioxide in compressed argon at 1,700 °C yields grayish niobium monoxide: $Nb + NbO_2 \rightarrow 2NbO$*" Kimura et al., Abstract, Eq. (2).

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4 $TaCl_5$ + Ta → **5 $TaCl_4$** **$TaCl_4$** + $NbCl_5$ → $NbCl_4$ + **$TaCl_5$**	(Brauer, 1965e, p. 1301; Schäfer and Kahlenberg, 1960)	Schäfer and Kahlenberg, p. 315, Tabelle 6, "*NbCl5g + TaCl4f = TaCl5g + NbCl4f*"
$TaCl_5$ + $TaCl_3$ → **2 $TaCl_4$** **$TaCl_4$** + $NbCl_5$ → $NbCl_4$ + **$TaCl_5$**	(Schäfer and Kahlenberg, 1960; 끙 et al., 2003, p. 421)	Schäfer and Kahlenberg, p. 315, Tabelle 6, "*NbCl5g + TaCl4f = TaCl5g + NbCl4f*"

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$Cr_2O_7^{2-}$ + 6 Cr^{2+} + 14 H^+ → **8 Cr^{3+}** + 7 H_2O **2 Cr^{3+}** + 3 MnO_2 + 2 H_2O → **2 $HCrO_4^-$** + 3 Mn^{2+} + 2 H^+ **2 $HCrO_4^-$ → $Cr_2O_7^{2-}$** + H_2O	(Liang et al., 2021; Szabó et al., 2018; Topich et al., 2004, p. 59; Zintl and Schloffer, 1928)	Zintl and Schloffer, p. 957, "*Dann wird unter potentiornetrischer Kontrolle mit etwas überschüssigem Permanganat oder Bichromat wieder oxydiert und schließlich mit der Chrom(II)-Sulfatlösung titriert.*" Liang et al., pp. 4,6, equations (7)(16). Szabó et al., abstract, "*The forward and backward rate constants for the 2 $HCrO_4^-$ ⇌ $Cr_2O_7^{2-}$ + H_2O reaction were determined at various pH values in concentration jump experiments.*"
2 $CrCl_3$ + Cr → **3 $CrCl_2$** **2 $CrCl_2$** + 2 HCl → **2 $CrCl_3$** + H_2	(Лидин et al., 2007, p. 124; 马 et al., 2003, p. 423)	
2 $CrCl_3$ + Cr → **3 $CrCl_2$** **2 $CrCl_2$** + Cl_2 → **2 $CrCl_3$**	(Hein and Wintner-Hölder, 1931; Лидин et al., 2007, p. 124)	Hein and Wintner-Hölder, p. 318, "*Wird zur Berechnung der Bildungswärme der Reaktion $CrCl_2$ + ½ Cl_2 = $CrCl_3$ die VAN'T HOFF'sche Reaktionsisochore ...*"
$CrCl_2$ + **$CrCl_4$** → **2 $CrCl_3$** **2 $CrCl_3$** + Cl_2 → **2 $CrCl_4$**	(Ogden and Wyatt, 1987)	Ogden and Wyatt, p. 859, "*... and several thermodynamic studies based on vapour pressure measurements have been carried out assuming equilibria of the type (1)-(3). 2 $CrCl_3(s)$ ⇌ 2 $CrCl_2(s)$ + $Cl_2(g)$ (1) 2 $CrCl_3(s,g)$ + $Cl_2(g)$ ⇌ 2 $CrCl_4(g)$ (2) 2 $CrCl_3(s,g)$ ⇌ $CrCl_2(s)$ + $CrCl_4(g)$ (3)* "
$CrCl_2$ + $CrCl_4$ → **2 $CrCl_3$** **2 $CrCl_3$** → **2 $CrCl_2$** + Cl_2	(Ogden and Wyatt, 1987)	Ogden and Wyatt, p. 859, "*... and several thermodynamic studies based on vapour pressure measurements have been carried out assuming equilibria of the type (1)-(3). 2 $CrCl_3(s)$ ⇌ 2 $CrCl_2(s)$ + $Cl_2(g)$ (1) 2 $CrCl_3(s,g)$ + $Cl_2(g)$ ⇌ 2 $CrCl_4(g)$ (2) 2 $CrCl_3(s,g)$ ⇌ $CrCl_2(s)$ + $CrCl_4(g)$ (3)* "

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$Mo_2(HPO_4)_4^{4-}$ + **$Mo_2(HPO_4)_4^{2-}$** → **2 $Mo_2(HPO_4)_4^{3-}$** **2 $Mo_2(HPO_4)_4^{3-}$** + 2 H^+ → **2 $Mo_2(HPO_4)_4^{2-}$** + H_2	(Chang and Nocera, 1987)	Chang and Nocera, p. 4905, Scheme (3) Chang and Nocera, p. 4906, Scheme (4)
$MoCl_3$ + $MoCl_5$ → **2 $MoCl_4$** **2 $MoCl_4$** → **2 $MoCl_3$** + Cl_2	(Couch and Brenner, 1959; McCann III et al., 1970; Schäfer et al., 1967)	Couch and Brenner, p. 187, "*Molybdenum tetrachloride was successfully prepared by direct reaction of pentachloride and trichloride in a sealed tube.*" McCann III et al., p. 185, "*At less than 150 ℃. in vacuo (10^{-5} torr), molybdenum-(IV) chloride undergoes thermal decomposition to molybdenum-(III) chloride and chlorine.*"
$MoBr_2$ + $MoBr_4$ → **2 $MoBr_3$** **2 $MoBr_3$** → **2 $MoBr_2$** + Br_2	(Schmidt et al., 2013)	Schmidt et al., "*The compound decomposes incongruently under formation of solid $MoBr_2$(s) releasing a gas phase of the dominant species $MoBr_4$ and Br_2 in equilibria (11) and (12), see Figure 5.* *$2MoBr_3(s) \rightleftharpoons MoBr_2(s) + MoBr_4(g)$ E11* *$MoBr_3(s) \rightleftharpoons MoBr_2(s) + ½Br_2(g)$ E12* *$MoBr_3(s) + ½Br_2(g) \rightleftharpoons MoBr_4(g)$ E13*"

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2 WCl_6 + $W(CO)_6$ → **3 WCl_4** + 6 CO **WCl_4** + Cl_2 → **WCl_6**	(Dzevitskii and Skorobogatov, 1987; Schrock et al., 1983)	Dzevitskii and Skorobogatov, p. 2375, "*The regeneration of these chlorides must go by the mechnisms (19) and (20): $WCl_4 + Cl_2 \rightarrow WCl_6$ (19) $WOCl_2 + Cl_2 \rightarrow WOCl_4$ (20)*" Schrock et al., p. 2804, "*WCl_4. Solid WCl_6 (99 g, 0.25 mol) and $W(CO)_6$ (44 g, 0.125 mol) were combined in a 500-mL flask equipped with a mechanical stirrer. Dry chlorobenzene (300 mL) was then added. Gas evolution started immediately. (Caution! The CO should be vented to a hood.) The mixture was heated to reflux while being stirred until no more gas evolved (~12 h). The dark green-gray product was filtered off, washed with chlorobenzene, thoroughly rinsed with dichloromethane or pentane, and dried; the yield was virtually quantitative.*"
2 WCl_6 + $W(CO)_6$ → **3 WCl_4** + 6 CO **WCl_4** + 2 H_2S → **WS_2** + 4 HCl **WS_2** + 3 Cl_2 → **WCl_6** + S_2	(Margolin et al., 2008; Modtland, 2018; Schrock et al., 1983)	Schrock et al., p. 2804, "*WCl_4. Solid WCl_6 (99 g, 0.25 mol) and $W(CO)_6$ (44 g, 0.125 mol) were combined in a 500-mL flask equipped with a mechanical stirrer. Dry chlorobenzene (300 mL) was then added. Gas evolution started immediately. (Caution! The CO should be vented to a hood.) The mixture was heated to reflux while being stirred until no more gas evolved (~12 h). The dark green-gray product was filtered off, washed with chlorobenzene, thoroughly rinsed with dichloromethane or pentane, and dried; the yield was virtually quantitative.*" Margolin et al., p. 7, "*WS_2 nanotubes are also obtained in good yields by the reaction of WCl_4 with H_2S in the horizontal reactor at 900 ℃.*" Modtland, p. 72, Table 3.2.
49 WO_3 + 5 W → 3 **$W_{18}O_{49}$** **2 $W_{18}O_{49}$** + 5 O_2 → **36 WO_3**	(Guo et al., 2012; Hein and Herzog, 1965, p. 1422)	Hein and Herzog, p. 1422, "*Very pure W powder and very pure WO_3 are intimately mixed in the prescribed ratio of $WO_{2.72}$ and heated for 6 hours at 800℃ in a small evacuated and sealed quartz tube.*" Guo et al., p. 4766, "*In the temperature range of 500−800 ℃, a slight weight gain occurred for both samples (Figure 6b) because of oxidation of $W_{18}O_{49}$ to WO_3, as described in eq 3. The XRD analysis confirmed that the resultant powders after TG measurement were WO_3.* *$2W_{18}O_{49} + 5O_2 = 36WO_3$ (3)*"

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$2\ KMnO_4 + \mathbf{3\ MnSO_4} + 2\ H_2O \rightarrow \mathbf{5\ MnO_2} + K_2SO_4 + 2\ H_2SO_4$ $\mathbf{2\ MnO_2} + 2\ H_2SO_4 \rightarrow \mathbf{2\ MnSO_4} + O_2 + 2\ H_2O$	(Patnaik, 2003, pp. 553, 554)	Patnaik, p. 553, "*Pure manganese(IV) oxide (precipitate form) may be prepared by reducing permanganate ion with a manganous salt: $2KMnO_4 + 3MnSO_4 + 2H_2O \rightarrow 5MnO_2 + K_2SO_4 + 2H_2SO_4$*" Patnaik, p. 554, "*When heated with concentrated sulfuric acid, manganese(IV) oxide yields manganese(II) sulfate, evolving oxygen: $MnO_2 + H_2SO_4 \rightarrow MnSO_4 + H_2O + ½\ O_2$*"
$2\ MnO_4^- + \mathbf{3\ Mn^{2+}} + 2\ H_2O \rightarrow \mathbf{5\ MnO_2} + 4\ H^+$ $\mathbf{MnO_2} + 2\ Fe^{2+} + 4\ H^+ \rightarrow \mathbf{Mn^{2+}} + 2\ Fe^{3+} + 2\ H_2O$	(Li et al., 2017; Tekin and Bayramoğlu, 1993)	Li et al., p. 1444, "*To prepare spherical MnO_2, a redox reaction was adopted in a liquid phase using sodium permanganate solution and manganese chloride as reactant.*" Tekin and Bayramoğlu, p. 9, "*The reaction of MnO_2 with Fe^{2+} ions in an acidic medium is governed by the equation: $MnO_2 + 2Fe^{2+} + 4H^+ \rightarrow Mn^{2+} + 2Fe^{3+} + 2H_2O$*"
$2\ KMnO_4 + \mathbf{3\ MnSO_4} + 8\ H_2SO_4 \rightarrow \mathbf{5\ Mn(SO_4)_2} + K_2SO_4 + 8\ H_2O$ $\mathbf{Mn(SO_4)_2} + 2\ KI \rightarrow \mathbf{MnSO_4} + K_2SO_4 + I_2$	(Klein, 2016, p. 26; Лидин et al., 2007, p. 246)	
$\mathbf{2\ MnO_4^-} + 3\ Mn^{2+} + 7\ H_2O \rightarrow \mathbf{5\ MnO(OH)_2} + 4\ H^+$ $\mathbf{2\ MnO(OH)_2} + 10\ H^+ + 3\ BiO_3^- \rightarrow \mathbf{2\ MnO_4^-} + 3\ Bi^{3+} + 7\ H_2O$	(曹 and 王, 1982, pp. 305, 313)	
$\mathbf{2\ KMnO_4} + MnO_2 + 4\ KOH \rightarrow \mathbf{3\ K_2MnO_4} + 2\ H_2O$ $\mathbf{2\ K_2MnO_4} + Cl_2 \rightarrow \mathbf{2\ KMnO_4} + 2\ KCl$	(马 et al., 2003, pp. 450, 451)	
$2\ KMnO_4 + \mathbf{MnO_2} + 4\ KOH \rightarrow \mathbf{3\ K_2MnO_4} + 2\ H_2O$ $\mathbf{K_2MnO_4} + Cl_2 \rightarrow \mathbf{MnO_2} + 2\ KCl + O_2$	(马 et al., 2003, pp. 450, 451)	
$K_2MnO_4 + \mathbf{MnSO_4} \rightarrow \mathbf{2\ MnO_2} + K_2SO_4$ $\mathbf{MnO_2} + H_2SO_3 \rightarrow \mathbf{MnSO_4} + H_2O$	(马 et al., 2003, pp. 449, 451)	

$\mathbf{K_2MnO_4} + MnSO_4 \rightarrow \mathbf{2\ MnO_2} + K_2SO_4$ $\mathbf{3\ MnO_2} + KClO_3 + 3\ K_2CO_3 \rightarrow \mathbf{3\ K_2MnO_4} + KCl + 3\ CO_2$	(马 et al., 2003, pp. 450, 451)	
$\mathbf{MnO_4^{2-}} + Mn^{2+} \rightarrow \mathbf{2\ MnO_2}$ $\mathbf{MnO_2} + BiO_3^- + H_2O \rightarrow \mathbf{MnO_4^{2-}} + Bi^{3+} + 2\ OH^-$	(曹 and 王, 1982, pp. 304, 307)	
$\mathbf{MnO_4^{3-}} + MnO_4^- \rightarrow \mathbf{2\ MnO_4^{2-}}$ $\mathbf{2\ MnO_4^{2-}} + HCOO^- + OH^- \rightarrow \mathbf{2\ MnO_4^{3-}} + H_2O + CO_2$	(Kemmitt, 1973, p. 808; Rush and Bielski, 1995)	Kemmitt, p. 808, "The exchange reaction $MnO_4^{3-} + MnO_4^- \rightarrow 2\ MnO_4^{2-}$ is extremely rapid." Rush and Bielski, p. 5833, merge Eq. (7)(8), "*Solutions of hypomanganate(V) were prepared by addition of an excess of sodium formate to manganate(VI) in 10 M NaOH. While formate reduces manganate(VI) quantitatively to hypomanganate at a rate of $k_7 = 0.44 +- 0.08\ M^{-1}s^{-1}$, the latter does not react significantly with formate.*"
$\mathbf{MnO_4^{3-}} + MnO_4^- \rightarrow \mathbf{2\ MnO_4^{2-}}$ $\mathbf{MnO_4^{2-}} + MnO_2 + 4\ OH^- \rightarrow \mathbf{2\ MnO_4^{3-}} + 2\ H_2O$	(Kemmitt, 1973, p. 808; Lux, 1946)	Kemmitt, p. 808, "The exchange reaction $MnO_4^{3-} + MnO_4^- \rightarrow 2\ MnO_4^{2-}$ is extremely rapid." Lux, p. 281, "*Beim Verdünnen oder Erwärmen der Lösung erfolgt Disproportionierung in Manganat(VI) und MnO_2; in stärker alkalischer Lösung besteht das Gleichgewicht: $Na_2MnO_4 + MnO_2 + 4\ NaOH \rightleftharpoons 2\ Na_3MnO_4 + 2\ H_2O$.*"
$\mathbf{MnO_4^{3-}} + MnO_4^- \rightarrow \mathbf{2\ MnO_4^{2-}}$ $\mathbf{2\ MnO_4^{2-}} + SO_3^{2-} + 2\ OH^- \rightarrow \mathbf{2\ MnO_4^{3-}} + SO_4^{2-} + H_2O$	(Kemmitt, 1973, p. 808; Lux, 1946)	Kemmitt, p. 808, "The exchange reaction $MnO_4^{3-} + MnO_4^- \rightarrow 2\ MnO_4^{2-}$ is extremely rapid." Lux, p. 281, "*Die Darstellung von Manganat(V)-hydrat gelingt in einfacher Weise durch Reduktion von Manganat(VII) oder Manganat(VI) mit Na_2SO_3 in stark alkalischer Lösung; auch zahlreiche andere Reduktionsmittel fuhren zur 5-wertigen Stufe des Mangans, sofern man nur in stark alkalisher Lösung und in der Kälte arbeitet.*"
$\mathbf{MnSO_4} + Mn(SO_4)_2 \rightarrow \mathbf{Mn_2(SO_4)_3}$ $\mathbf{Mn_2(SO_4)_3} + HOOC\text{-}COOH \rightarrow \mathbf{2\ MnSO_4} + H_2SO_4 + 2\ CO_2$	(Ramachandran et al., 1984; Selim and Lingane, 1959; 曹 and 王, 1982, p. 317)	Ramachandran et al., p. 379, "*Manganese (III) sulphate was prepared by mixing requisite amounts of manganese (IV) sulphate, sulphuric acid and Mn(II) sulphate and then diluted with water to give the required concentration.*"
$\mathbf{Mn(OH)_2} + H_2MnO_3 \rightarrow \mathbf{Mn_2O_3} + 2\ H_2O$ $\mathbf{2\ Mn_2O_3} + 4\ H_2SO_4 \rightarrow \mathbf{4\ MnSO_4} + O_2 + 4\ H_2O$ $\mathbf{MnSO_4} + 2\ NH_3{\cdot}H_2O \rightarrow \mathbf{Mn(OH)_2} + (NH_4)_2SO_4$	(马 et al., 2003, pp. 446, 448)	

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3 Re_2O_7 + Re → **7 ReO_3** **4 ReO_3** + O_2 → **2 Re_2O_7**	(Melaven et al., 1950; Nechamkin et al., 1950; 끄 et al., 2003, pp. 457, 458)	Melaven et al., p. 189, "*Oxidation of the metal appears to proceed in two steps. The metal first ignites with a red glow.. When this reaction subsides, a deposit of red rhenium(VI) oxide remains. Further oxidation as heating is continued then gives the volatile yellow rhenium(VII) oxide.*" Nechamkin et al., p. 186, "*Rhenium(VI) oxide can be prepared by the incomplete combustion of rhenium in oxygen, but the reaction is hard to control. It can also be obtained by the reduction of rhenium(VII) oxide (1) with rhenium at elevated temperatures and (2) with rhenium(IV) oxide2 at 300°.*"
2 Re_2O_7 + 3 Re → **7 ReO_2** **4 ReO_2** + 3 O_2 → **2 Re_2O_7**	(Glemser, 1965, p. 1480; Melaven et al., 1950; 끄 et al., 2003, pp. 455, 458)	Melaven et al., p. 188, "*Rhenium(VII) oxide can be prepared from the metal or from lower rhenium oxides by direct oxidation in a stream of air or oxygen.*"
Re_2O_7 + ReO_2 → **3 ReO_3** **4 ReO_3** + O_2 → **2 Re_2O_7**	(Melaven et al., 1950; Nechamkin et al., 1950; 끄 et al., 2003, pp. 456, 457)	Melaven et al., p. 189, "*Oxidation of the metal appears to proceed in two steps. The metal first ignites with a red glow.. When this reaction subsides, a deposit of red rhenium(VI) oxide remains. Further oxidation as heating is continued then gives the volatile yellow rhenium(VII) oxide.*" Nechamkin et al., p. 186, "*Rhenium(VI) oxide can be prepared by the incomplete combustion of rhenium in oxygen, but the reaction is hard to control. It can also be obtained by the reduction of rhenium(VII) oxide (1) with rhenium at elevated temperatures and (2) with rhenium(IV) oxide2 at 300°.*"
3 Re_2O_7 + **Re** → **7 ReO_3** **ReO_3** + 3 H_2 → **Re** + 3 H_2O	(Nechamkin et al., 1950; 끄 et al., 2003, pp. 457, 458)	Nechamkin et al., p. 186, "*Rhenium(VI) oxide can be prepared by the incomplete combustion of rhenium in oxygen, but the reaction is hard to control. It can also be obtained by the reduction of rhenium(VII) oxide (1) with rhenium at elevated temperatures and (2) with rhenium(IV) oxide2 at 300°.*"
Re + **2 ReO_3** → **3 ReO_2** Re_2O_7 + **ReO_2** → **3 ReO_3**	(Nechamkin et al., 1950; Лидин et al., 2007, p. 488; 끄 et al., 2003, p. 456)	Nechamkin et al., p. 186, "*Rhenium(VI) oxide can be prepared by the incomplete combustion of rhenium in oxygen, but the reaction is hard to control. It can also be obtained by the reduction of rhenium(VII) oxide (1) with rhenium at elevated temperatures and (2) with rhenium(IV) oxide2 at 300°.*"
2 ReF_6 + **Re** → **3 ReF_4** **ReF_4** → **Re** + 2 F_2	(Лидин et al., 2007, p. 491; 끄 et al., 2003, p. 456)	

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Fe + **2 Fe^{3+}** → **3 Fe^{2+}** **2 Fe^{2+}** + Cl_2 → **2 Fe^{3+}** + 2 Cl^-	(Bühler and Schwarz, 2012; Crabtree and Schaefer, 1966; Thorpe, 1882)	Bühler and Schwarz, *"… Fe <3+> with elemental Fe (in a comproportionation reaction) to Fe <2+>…"* Crabtree and Schaefer, p. 1348, Eq. (1).
Fe + 2 Fe^{3+} → **3 Fe^{2+}** **Fe^{2+}** + Zn → **Fe** + Zn^{2+}	(Bühler and Schwarz, 2012; Horney, 1934; Thorpe, 1882)	Bühler and Schwarz, *"… Fe <3+> with elemental Fe (in a comproportionation reaction) to Fe <2+>…"* Horney, p. 363, "*Let us consider, for example, $FeCl_2$ + Zn → $ZnCl_2$ + Fe.*"
Fe + 2 Fe^{3+} → **3 Fe^{2+}** **Fe^{2+}** + CO_3^{2-} → **$FeCO_3$** **$FeCO_3$** → **FeO** + CO_2 **FeO** + CO → **Fe** + CO_2	(Bühler and Schwarz, 2012; Thorpe, 1882; 끄 et al., 2003, pp. 464, 466, 469)	Bühler and Schwarz, *"… Fe <3+> with elemental Fe (in a comproportionation reaction) to Fe <2+>…"*
Fe_2O_3 + Fe → **3 FeO** **4 FeO** + O_2 → **2 Fe_2O_3**	(끄 et al., 2003, pp. 462, 465)	
Fe_2O_3 + **Fe** → **3 FeO** **FeO** + CO → **Fe** + CO_2	(끄 et al., 2003, pp. 462, 466)	

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$CoSi_2$ + Co → **2 CoSi** **CoSi** + Si → **$CoSi_2$**	(Appelbaum et al., 1985)	Appelbaum et al., p. 1885, "*Similarly, the $CoSi_2$ + Co → 2 CoSi reaction has been known to occur suggesting reversibility of the monosilicide-disilicide transformation.*" Appelbaum et al., p. 1880, "*In view of the above, an attempt has been made to investigate the kinetics of the CoSi + Si → $CoSi_2$ reaction.*"
$CoSi_2$ + Co_2Si → **3 CoSi** **CoSi** + Si → **$CoSi_2$**	(Appelbaum et al., 1985; Cahoon et al., 1984)	Cahoon et al., p. 512, "*FIG. 2 ... (c) growth of CoSi as a result of the reaction of $CoSi_2$ with Co_2Si*" Appelbaum et al., p. 1880, "*In view of the above, an attempt has been made to investigate the kinetics of the CoSi + Si → $CoSi_2$ reaction.*"
$CoSi_2$ + **Co_2Si → 3 CoSi** **CoSi** + Co → **Co_2Si**	(Cahoon et al., 1984; Tu et al., 1982)	Cahoon et al., p. 512, "*FIG. 2 ... (c) growth of CoSi as a result of the reaction of $CoSi_2$ with Co_2Si*" Tu et al., p. 4409, "*... and yet the growth of Co_2Si by the reaction* *CoSi + Co → Co_2Si,* *will gain (–27+24)= –3 Kcal/mole. While the growth of CoSi is much more favorable than Co_2Si, the system chooses to go the other way, i.e., the growth of Co_2Si between CoSi and Co,* *Si/CoSi/Co→Si/CoSi/Co_2Si/Co*"
Co_3O_4 + **Co → 4 CoO** **CoO** + CO → **Co** + CO_2	(Patnaik, 2003, p. 248; Sakka, 1991)	Patnaik, p. 248, "*Cobalt(II) oxide is readily reduced by hydrogen, carbon or carbon monoxide to cobalt*" Sakka, p. 285, "*(1) CoO is produced by the reaction of Co_3O_4 and cobalt metal.*"
Co_3O_4 + Co → **4 CoO** **6 CoO** + O_2 → **2 Co_3O_4**	(Kalmus, 1914; Sakka, 1991; 끠 et al., 2003, p. 480)	Kalmus, p. 116, "*Either the yellow-green or the gray cobalt monoxide oxidizes to Co_3O_4, or to a mixture of Co_3O_4 and Co_6O_7 when heated in the air to any temperature between 385 °C. and 910 °C.*" Sakka, p. 285, "*(1) CoO is produced by the reaction of Co_3O_4 and cobalt metal.*"

Co + 2 $Co(OH)_3$ + 6 CH_3COOH + 6 H_2O → **3 $Co(CH_3COO)_2{\cdot}4H_2O$** **$Co(CH_3COO)_2{\cdot}4H_2O$** → **$Co^{2+}$** + 2 CH_3COO^- + 4 H_2O **Co^{2+}** + 2 BH_4^- + 6 H_2O → **Co** + 2 $B(OH)_3$ + 7 H_2	(Hermann, 1927; Li et al., 2014)	Hermann, "*Freshly precipitated **cobaltic hydroxid** coming, for instance from a filter press and containing 50 p. ct. of **water**, is introduced, together with an amount of **metallic cobalt** powder calculated to form cobaltous oxid from the said hydroxid, and **acetic acid** in slight excess above the amount theoreticall required, into an iron autoclave coated with an acid-proof inner lining. The contents are heated, under stirring to about 120 °C., whereby the pressure in the autoclave is increased to 2.5 to 3.25 atm. After a short time a cobaltous acetate solution has formed which may be easily separated from the undissolved remnants of oxid. Preferably, the acetic acid is, by the addition of water, only diluted to such an extent that, taking into account the water introduced by the moist cobaltic hydroxid, a nearly saturated cobaltous acetate solution is obtained, from which, after filtration, **crystallized cobaltous acetate** separates immediately on cooling-down.*" Li, p. 3762, "*For Ni nanoparticles: $NiCl_2{\cdot}6H_2O$ (0.48 g, 2 mmol) and **NaBH4** (0.15 g, 4 mmol) were mixed and ground in an agate mortar at room temperature. Subsequently, several **drops of water** were slowly added into the mixtures. Accompanied by the release of heat and vapor, the color of mixtures changed from green to black. After grinding for about 30 min, the resulting **solid products** were washed with distilled water and absolute ethanol several times ... For Co nanoparticles: the same procedure was applied as for Ni nanoparticles except that $NiCl_2{\cdot}6H_2O$ was replaced by **$Co(CH_3COO)_2{\cdot}4H_2O$** (0.50 g, 2 mmol) ... The overall solid-state redox reaction can be described by the following equation: $2M^{x+} + 2xBH_4^- + 6xH_2O \rightarrow 2M^0 + 2xB(OH)_3 + 7xH_2$*"

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NiO_2 + **$Ni(OH)_2$ → 2 NiOOH** **2 NiOOH** + Fe + 2 H_2O → $Fe(OH)_2$ + **2 $Ni(OH)_2$**	(Chakkaravarthy et al., 1991; Glemser and Einerhand, 1950)	Chakkaravarthy et al., pp. 29-30, "*Iron at the negative electrode reacts galvanically with the nickel hydroxide at the positive electrode during discharge and charge according to the following reactions* *Fe + 2NiO OH + Fe + 2H_2O → Fe$(OH)_2$ + 2Ni$(OH)_2$ …*" Glemser and Einerhand, pp. 38-39, "*Mit Ni$(OH)_2$ setzt es sich nach NiO_2 + Ni$(OH)_2$ = 2 NiOOH um, das sich auch durch direkte Zersetzung aus $NiO_2{\cdot}xH_2O$ bildet.*"
$NiSi_2$ + Ni_2Si → **3 NiSi** **NiSi** + Si → **$NiSi_2$**	(Cahoon et al., 1984; Wu et al., 2006)	Cahoon et al., p. 511, "*FIG. 1 … (c) reaction between $NiSi_2$ and Ni_2Si to form NiSi at their interface*" Wu et al., p. 1259, "*Therefore, the phase transformation of the Ni-Si coatings during oxidation is summarized as follows:* *$NiSi_2$ → NiSi → Ni_2Si<700 ℃ (5)* *Ni_2Si + Si → NiSi, NiSi + Si → $NiSi_2$, $NiSi_2$ → NiSi → Ni_2Si≥700 ℃ (6)*"
NiS_2 + Ni_3S_2 → **4 NiS** **NiS** + H_2S → **NiS_2** + H_2	(Delafosse et al., 1962; Delafosse and Barret, 1961)	Delafosse et al. 1962, p. 3210, "*Nous avons établi qu'entre 200 et 275 ℃, le processus réactionnel se développe en deux stades avec NiS2 comme phase intermédiare:* *(1) Ni_3S_2 + O_2 → 2NiO + NiS_2,* *(2) NiS_2 + Ni_3S_2 → 4 NiS.*" Delafosse and Barret 1961, pp. 280-281, "*En combinant différentes équations entre elles et en faisant intervenir l'équilibre de dissociation de l'hydrogène sulfuré, (e) H_2S ⇌ H_2 + ½S2 dont on connaît la constante Kp aux températures envisagées, on peut faire apparaître les relations d'équilibres des différents sulfures entre eux:* *… a_4–a_3: et b_4–b_3 NiS + H_2S ⇌ NiS_2 + H_2 (γ)…*"
NiS_2 + **Ni_3S_2 → 4 NiS** **3 NiS** + H_2 → **Ni_3S_2** + H_2S	(Delafosse et al., 1962; Delafosse and Barret, 1961)	Delafosse et al. 1962, p. 3210, "*Nous avons établi qu'entre 200 et 275 ℃, le processus réactionnel se développe en deux stades avec NiS2 comme phase intermédiare:* *(1) Ni_3S_2 + O_2 → 2NiO + NiS_2,* *(2) NiS_2 + Ni_3S_2 → 4 NiS.*" Delafosse and Barret 1961, pp. 280-281, "*En combinant différentes équations entre elles et en faisant intervenir l'équilibre de dissociation de l'hydrogène sulfuré, (e) H_2S ⇌ H_2 + ½S2 dont on connaît la constante Kp aux températures envisagées, on peut faire apparaître les relations d'équilibres des différents sulfures entre eux:* *a_3+e–a_1: et b_3+e–b_1 Ni_3S_2 + H_2S ⇌ NiS + H_2 (α)…*" (Note: the stoichiometry is wrong, a "3" is missing before NiS)

Ni + Ni_2O_3 → **3 NiO** **NiO** + CO → **Ni** + CO_2	(Chien et al., 2011; 马 et al., 2003, p. 494)	Chien et al., p. 153513-1, "*The disproportionation and comproportionation reactions of 3NiO↔Ni+Ni_2O_3 accounted for the RS of NiO_x.*" Chien et al., p. 153513-2, "*In the RESET, the products of the forward reaction became the reactants in the reverse comproportionation reaction,* *Ni + Ni_2O_3 → 3NiO. (2)*"
Ni + **Ni_2O_3 → 3 NiO** **4 NiO** + O_2 → **2 Ni_2O_3**	(Chien et al., 2011; 马 et al., 2003, p. 493)	Chien et al., p. 153513-1, "*The disproportionation and comproportionation reactions of 3NiO↔Ni+Ni_2O_3 accounted for the RS of NiO_x.*" Chien et al., p. 153513-2, "*In the RESET, the products of the forward reaction became the reactants in the reverse comproportionation reaction,* *Ni + Ni_2O_3 → 3NiO. (2)*"
Ni + 2 $Ni(OH)_3$ + 6 CH_3COOH + 6 H_2O → **3 $Ni(CH_3COO)_2{\cdot}4H_2O$** **$Ni(CH_3COO)_2{\cdot}4H_2O$ → 0.86$Ni(CH_3COO)_2{\cdot}$0.14$Ni(OH)_2$** + 0.28 CH_3COOH + 3.72 H_2O **0.86$Ni(CH_3COO)_2{\cdot}$0.14$Ni(OH)_2$ → NiO** + 0.86 CH_3COCH_3 + 0.86 CO_2 + 0.14 H_2O **NiO** + H_2 → **Ni** + H_2O	(De Jesus et al., 2005; Hermann, 1927)	Hermann, "*Freshly precipitated **cobaltic hydroxid** coming, for instance from a filter press and containing 50 p. ct. of **water**, is introduced, together with an amount of **metallic cobalt** powder calculated to form cobaltous oxid from the said hydroxid, and **acetic acid** in slight excess above the amount theoreticall required, into an iron autoclave coated with an acid-proof inner lining. The contents are heated, under stirring to about 120 ℃., whereby the pressure in the autoclave is increased to 2.5 to 3.25 atm. After a short time a cobaltous acetate solution has formed which may be easily separated from the undissolved remnants of oxid. Preferably, the acetic acid is, by the addition of water, only diluted to such an extent that, taking into account the water introduced by the moist cobaltic hydroxid, a nearly saturated cobaltous acetate solution is obtained, from which, after filtration, **crystallized cobaltous acetate** separates immediately on cooling-down … **The process may be applied in an analogous way to nickel salts**.*" De Jesus et al., Eq.(1). De Jesus et al., merge Eq.(7)(8)(11). De Jesus et al., Eq.(10).

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Cu + **Cu^{2+}** → **2 Cu^{+}** **Cu^{+}** + Fe^{3+} → **Cu^{2+}** + Fe^{2+}	(Bjergbakke et al., 1976; Ciavatta et al., 1980; Orth et al., 1989)	Ciavatta et al., p. 593, "*The equilibrium* *Cu^{2+} + Cu(s) ⇌ 2Cu^{+},* *$K_c = [Cu^{+}]^2[Cu^{2+}]^{-1}$ (1)* *has been the subject of several investigations*" Bjergbakke et al., p. 437, "*When mixing the oxygen-free Cu^{+} solution with a solution containing O_2, Fe^{3+}, and Fe^{2+}, the following reactions take place, provided the Fe^{2+} concentration is much higher than the concentration of the other solutes.* *$Cu^{+} + O_2 \rightarrow Cu^{2+} + O_2^{-}$, k_{16},* *$Cu^{+} + Fe^{3+} \rightarrow Fe^{2+} + Cu^{2+}$, k_8,* *$H^{+} + O_2^{-} + Fe^{2+} \rightarrow Fe^{3+} + HO_2^{-}$,* *$H^{+} + HO_2^{-} + 2Fe^{2+} \rightarrow 2Fe^{3+} + 2OH^{-}$.*"
Cu + $CuCl_2$ → **2 CuCl** **2 CuCl** + H_2 → **2 Cu** + 2 HCl	(Patnaik, 2003, p. 261; Törndahl et al., 2004)	Patnaik, p. 261, "*Alternatively, it can be prepared by boiling an acidic solution of copper(II) chloride with copper metal, which on dilution yields white CuCl*" Törndahl et al., p. 130, "*In the water-free process, hydrogen reacted directly with CuCl according to an overall formation reaction (3).* *2CuCl(ads) + H_2(g) → 2Cu(s) + 2HCl(g) (3)*"

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Ag^{2+} + Ag → **2 Ag^{+}** **2 Ag^{+}** + $S_2O_8^{2-}$ → **2 Ag^{2+}** + 2 SO_4^{2-}	(McMillan, 2002; Weller et al., 2018, p. 197; Yu et al., 2014)	Weller et al., p. 197, "*In comproportionation, the reverse of disproportionation, two species with the same element in different oxidation states form a product in which the element is in an intermediate oxidation state. An example is* *$Ag^{2+}(aq) + Ag(s) \rightarrow 2Ag^{+}(aq)$*" Yu, p. 715, combine reactions (1)(2)(3)(5) and $H^+ + OH^- \rightarrow H_2O$. McMillan, p. 66, "*Soluble salts such as nitrate, perchlorate, sulfate, and fluoride yield AgO quantitatively when oxidized with alkaline solutions of sodium or potassium persulfate, i.e.* *$2Ag^+ + S_2O_8^{2-} \rightarrow 2Ag^{2+} + 2SO_4^{2-}$* *$2Ag^{2+} + 4OH^- \rightarrow 2AgO + 2H_2O$*"
Ag^{2+} + **Ag** → **2 Ag^{+}** **Ag^{+}** + Cl^- → **AgCl** **2 AgCl** + H_2 → **2 Ag** + 2 HCl	(Weller et al., 2018, p. 197; 끠 et al., 2003, pp. 358, 362)	Weller et al., p. 197, "*In comproportionation, the reverse of disproportionation, two species with the same element in different oxidation states form a product in which the element is in an intermediate oxidation state. An example is* *$Ag^{2+}(aq) + Ag(s) \rightarrow 2Ag^{+}(aq)$*"
AgF + **$KAgF_4$** → **2 AgF_2** + KF **2 AgF_2** + 2 KF + F_2 → **2 $KAgF_4$**	(Lucier et al., 1998; Shen et al., 1999)	Shen et al., p. 4571, "*Various other attempts were made to synthesize $Ag^{I}Ag^{III}F_4$, all carried out in aHF: (a) AgF + $KAgF_4$; (b) XeF_5AgF_4 + $AgBF_4$; (c) $AgBF_4$ + $KAgF_4$. Reaction (a) gave only $Ag^{II}F_2$ as did reaction (b).*" Lucier et al., p. 102, "*AgF_2 (229.4 mg, 1.57 mmol) and KF (1578.7 mg, 27.2 mmol) in aHF (4.5 g, 220 mmol) with F_2, (~1500 Torr) was agitated (as a brown slurry) at ~20 ℃, without irradiation, for 12 h. Under these conditions, no visible change occurred, nor was F_2 taken up. With only 5 h of irradiation of the static tube, the bright yellow solution color, characteristic of AgF_4^-, was easily seen.*"
AgF + $KAgF_4$ → **2 AgF_2** + KF **2 AgF_2** → **2 AgF** + F_2	(Bailar, 1944; Shen et al., 1999)	Shen et al., p. 4571, "*Various other attempts were made to synthesize $Ag^{I}Ag^{III}F_4$, all carried out in aHF: (a) AgF + $KAgF_4$; (b) XeF_5AgF_4 + $AgBF_4$; (c) $AgBF_4$ + $KAgF_4$. Reaction (a) gave only $Ag^{II}F_2$ as did reaction (b).*" Bailar, p. 524, "*Silver difluoride has been prepared by the action of fluorine on silver and silver salts. It is a dark brown powder, stable at moderate temperature, but decomposed on strong heating to argentous fluoride and fluorine.*"

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$AuCl_3$ + **2 Au** → **3 AuCl** **2 AuCl** → **2 Au** + Cl_2	(Morris, 1918; Patnaik, 2003, p. 324)	Morris, p. 921, "*It was found that the solvent action of auric chloride and hydrochloric acid on metallic gold takes place with the formation of aurous chloride, and further that the aurous chloride may be titrated with potassium permanganate using preventative solution.*" Patnaik, p. 324, "*When heated at 290 ℃, gold(I) chloride decomposes to gold and chlorine gas*"
$AuCl_3$ + 2 Au → **3 AuCl** **AuCl** + Cl_2 → **$AuCl_3$**	(Campbell, 1907; Morris, 1918)	Morris, p. 921, "*It was found that the solvent action of auric chloride and hydrochloric acid on metallic gold takes place with the formation of aurous chloride, and further that the aurous chloride may be titrated with potassium permanganate using preventative solution.*" Campbell, p. 109, "*Dry chlorine and AuCl combine readily at ordinary temperatures to form $AuCl_3$* *$AuCl + Cl_2 = AuCl_3$.*"

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Cd + **$CdSO_4$** → **Cd_2SO_4** **3 Cd_2SO_4** + 2 HNO_3 + 3 H_2SO_4 → **6 $CdSO_4$** + 2 NO + 4 H_2O	(끄 et al., 2003, p. 385)	

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Hg + Hg^{2+} → $\mathbf{Hg_2^{2+}}$ $\mathbf{Hg_2^{2+}}$ + 2 Fe^{2+} → **2 Hg** + 2 Fe^{3+}	(Kozin and Hansen, 2013, p. 80; Raposo et al., 2000)	Kozin and Hansen, p. 80, Eqs. (5.1)(5.2) Raposo et al., p. 51, Reaction (B).
Hg + Hg^{2+} → $\mathbf{Hg_2^{2+}}$ $\mathbf{Hg_2^{2+}}$ + H_2 → **2 Hg** + 2 H^+	(Korinek and Halpern, 1956; Kozin and Hansen, 2013)	Kozin and Hansen, p. 80, Eqs. (5.1)(5.2) Korinek and Halpern, p. 286, Eq. (3).
Hg + $\mathbf{Hg^{2+}}$ → $\mathbf{Hg_2^{2+}}$ $\mathbf{Hg_2^{2+}}$ + 2 Co^{3+} → 2 $\mathbf{Hg^{2+}}$ + 2 Co^{2+}	(Kozin and Hansen, 2013; Rosseinsky and Higginson, 1960)	Kozin and Hansen, p. 80, Eqs. (5.1)(5.2) Rosseinsky and Higginson, p. 31, "*The overall reaction is* $2Co^{III} + Hg^{I}_{2} \rightarrow 2Co^{II} + 2Hg^{II}$ *where* Hg^{I}_{2}*, represents* Hg_2^{2+}*, together with any ion-pairs in which* Hg_2^{2+} *is present.*"
Hg + $\mathbf{Hg^{2+}}$ → $\mathbf{Hg_2^{2+}}$ $\mathbf{Hg_2^{2+}}$ + $S_2O_8^{2-}$ → 2 $\mathbf{Hg^{2+}}$ + 2 SO_4^{2-}	(Kozin and Hansen, 2013; Raghavan, 1973)	Kozin and Hansen, p. 80, Eqs. (5.1)(5.2) Raghavan, p. 12, Eq. (a).
Hg + $HgCl_2$ → $\mathbf{Hg_2Cl_2}$ $\mathbf{Hg_2Cl_2}$ + Fe → 2 **Hg** + $FeCl_2$	(끔 et al., 2003, pp. 389, 391)	
Hg + $\mathbf{HgCl_2}$ → $\mathbf{Hg_2Cl_2}$ $\mathbf{Hg_2Cl_2}$ + Cl_2 → 2 $\mathbf{HgCl_2}$	(끔 et al., 2003, pp. 389, 391)	

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2 B_2O_3 + 2 B → **3 B_2O_2** **B_2O_2** + 2 NH_3 → **2 BN** + 2 H_2O + H_2 **2 BN** + 3 H_2O → **B_2O_3** + 2 NH_3	(Golberg et al., 2003; Inghram et al., 1956; Sommer et al., 1963; Лидин et al., 2007, p. 47)	Sommer et al., p. 89, "*The B_2O_2 vapor was vaporized from a molybdenum Knudsen cell, containing a mixture of solid boron and liquid B_2O_3 heated to temperatures in the range 1450 °to 1500 ℃.*" Golberg et al., p. 8726, Eq. (2).
2 B_2O_3 + **2 B** → **3 B_2O_2** **B_2O_2** + 2 H_2 → **2 B** + 2 H_2O	(Inghram et al., 1956; Sommer et al., 1963; Wang et al., 2008)	Sommer et al., p. 89, "*The B_2O_2 vapor was vaporized from a molybdenum Knudsen cell, containing a mixture of solid boron and liquid B_2O_3 heated to temperatures in the range 1450 °to 1500 ℃.*" Wang et al., p. 3834, Eqs. (1)(2).
7 B_2O_3 + 2 TiB_2 → **9 B_2O_2** + Ti_2O_3 **B_2O_2** + 2 NH_3 → **2 BN** + 2 H_2O + H_2 **2 BN** + 3 H_2O → **B_2O_3** + 2 NH_3	(Einarsrud et al., 1997; Golberg et al., 2003; Лидин et al., 2007, p. 47)	Einarsrud et al., p. 3016, Eq. (2). Golberg et al., p. 8726, Eq. (2).
16 B + **B_2O_3** → **3 B_6O** **9 B_6O** + 4 $CaCO_3$ → 4 CaB_6 + 4 B_4C + **7 B_2O_3**	(Perevislov, 2022)	Perevislov, p. 156, Eq. (1); p. 158, Eq. (9).
16 B + **B_2O_3** → **3 B_6O** **5 B_6O** + 4 CaO → 4 CaB_6 + **3 B_2O_3**	(Perevislov, 2022)	Perevislov, p. 156, Eq. (1); p. 158, Eq. (8).
16 B + **B_2O_3** → **3 B_6O** **B_6O** + 4 O_2 → **3 B_2O_3**	(Perevislov, 2022)	Perevislov, p. 156, Eq. (1); p. 160, Eq. (10).
16 B + B_2O_3 → **3 B_6O** **2 B_6O** → **10 B** + **B_2O_2** **B_2O_2** + 2 H_2 → **2 B** + 2 H_2O	(Perevislov, 2022; Wang et al., 2008)	Perevislov, p. 156, Eq. (1); p. 160, Eq. (2). Wang et al., p. 3834, Eq. (2).

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$AlCl_3$ + 2 Al → **3 AlCl** **AlCl** + Cl_2 → **$AlCl_2$** + Cl **$AlCl_2$** + Cl_2 → **$AlCl_3$** + Cl	(Gross et al., 1948; Rogowski et al., 1989; Swihart et al., 2003)	Gross et al., p. 206, Eq. (1). Rogowski et al., p. 1119, Eq (3). Swihart et al., p. 94, Table 2, second last row.
2 $AlCl_3$ + Al → **3 $AlCl_2$** **$AlCl_2$** + Cl_2 → **$AlCl_3$** + Cl	(Olah et al., 1988; Swihart et al., 2003)	Olah et al., p. 3231, "*A low-temperature route to aluminum sub-chloride (mixed with other materials) was realized through the reaction of tetraisobutyldialane and HCl at -78 ℃.* *2 $AlCl_3$ + Al ⇌ 3 $AlCl_2$*". Swihart et al., p. 94, Table 2, second last row.

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Ga_2O_3 + 4 Ga → **3 Ga_2O** **Ga_2O** + O_2 → **Ga_2O_3**	(Brukl and Ortner, 1931; Klemm and Schnick, 1936)	Brukl and Ortner, p. 23, "*Diese Reaktionsfähigkeit des Metalls veranlaßte, daß der übliche Weg zur Darstellung niederer Oxyde, die Reduktion durch Wasserstoff, verlassen und von einem innigen Gernenge von III-Oxyd und Metall ausgegangen wurde, entsprechend der Gleichung Ga_2O_3 + 4 Ga → 3 Ga_2O*" Klemm and Schnick, p. 357, "*Als Mittelwert für die Reaktion [Ga_2O] + (O_2) = [Ga_2O_3] erhält man 175 ± 2 kcal*"
Ga_2O_3 + **4 Ga** → **3 Ga_2O** **Ga_2O** + 2 NH_3 → **2 GaN** + H_2O + 2 H_2 **2 GaN** + 3 H_2 → **2 Ga** + 2 NH_3	(Brukl and Ortner, 1931; Imade et al., 2010; L'vov, 2000)	Brukl and Ortner, p. 23, "*Diese Reaktionsfähigkeit des Metalls veranlaßte, daß der übliche Weg zur Darstellung niederer Oxyde, die Reduktion durch Wasserstoff, verlassen und von einem innigen Gernenge von III-Oxyd und Metall ausgegangen wurde, entsprechend der Gleichung Ga_2O_3 + 4 Ga → 3 Ga_2O*" Imade et al., p. 676, Eq. (1). L'vov, p. 89, Eq. (11).
2 Ga + Ga_2S_2 → **2 Ga_2S** **Ga_2S** + H_2 → **2 Ga** + H_2S	(Altamirano et al., 2005; 马 et al., 2003, p. 124)	Altamirano et al., p. 406, Eq. (3).
2 Ga + Ga_2S_2 → **2 Ga_2S** **3 Ga_2S** + 6 HCl → **4 Ga** + 2 $GaCl_3$ + 3 H_2S	(马 et al., 2003, pp. 124, 125)	
Ga + 2 $GaCl_3$ → **3 $GaCl_2$** **2 $GaCl_2$** + 2 NH_3 → **2 GaN** + 4 HCl + H_2 **2 GaN** → **2 Ga** + N_2	(Born and Robertson, 1980; Pan et al., 2002; 曹 and 王, 1982, p. 158)	Born and Robertson, p. 3005, "*The only by-product of the reaction is ammonium chloride or bromide and the reaction involved can be described by 2 $GaCl_2$ + 2 NH_3 = 2 GaN + 4 HCl + H_2*" Pan et al., p. 1818, "*At the reaction temperature of 1150 ℃, the GaN powders are decomposed into a dense, hot vapor of Ga and N_2*"

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$C + \mathbf{CO_2} \rightarrow \mathbf{2\ CO}$ $\mathbf{CO} + FeO \rightarrow Fe + \mathbf{CO_2}$	(Wilson and Bremner, 1948)	Wilson and Bremner, p. 13, Eqs. (2)(4).
$\mathbf{C} + CO_2 \rightarrow \mathbf{2\ CO}$ $\mathbf{CO} + H_2 \rightarrow H_2O + \mathbf{C}$	(Abney and Mansell, 2010; Wilson and Bremner, 1948)	Wilson and Bremner, p. 13, Eq. (4). Abney and Mansell, p. 2, Eq. (3).
$(CN)_2 + \mathbf{2\ CO_2} \rightarrow \mathbf{4\ CO} + N_2$ $\mathbf{CO} + FeO \rightarrow Fe + \mathbf{CO_2}$	(Wilson and Bremner, 1948; 끄 et al., 2003, p. 138)	Wilson and Bremner, p. 13, Eq. (2).
$CaC_2 + \mathbf{CO} \rightarrow CaO + \mathbf{3\ C}$ $\mathbf{C} + Cl_2 + H_2O \rightarrow \mathbf{CO} + 2\ HCl$	(끄 et al., 2003, pp. 85, 135)	
$2\ CaC_2 + \mathbf{CS_2} \rightarrow 2\ CaS + \mathbf{5\ C}$ $\mathbf{C} + 2\ S \rightarrow \mathbf{CS_2}$	(끄 et al., 2003, pp. 84, 135)	
$2\ CaC_2 + \mathbf{CCl_4} \rightarrow 2\ CaCl_2 + \mathbf{5\ C}$ $\mathbf{C} + 2\ Cl_2 \rightarrow \mathbf{CCl_4}$	(끄 et al., 2003, pp. 84, 135)	
$\mathbf{CH_4} + CO_2 \rightarrow \mathbf{2\ CO} + 2\ H_2$ $\mathbf{CO} + 3\ H_2 \rightarrow \mathbf{CH_4} + H_2O$	(Campbell and Goodman, 1982; Wang et al., 1996)	Wang et al., p. 898, Eq. (3). Campbell and Goodman, p. 413, "*The catalytic methanation reaction (3 H_2 + $CO \rightarrow CH_4 + H_2O$) over transition metals (Ni, Fe, Rh and Ru) has, thus, recently been the subject of intense interest from a fundamental, surface scientific point-of-view.*"
$CH_4 + \mathbf{CO_2} \rightarrow \mathbf{2\ CO} + 2\ H_2$ $\mathbf{CO} + FeO \rightarrow \mathbf{CO_2} + Fe$	(Wang et al., 1996; Wilson and Bremner, 1948)	Wang et al., p. 898, Eq. (3). Wilson and Bremner, p. 13, Eq. (2).

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SiO_2 + Si → **2 SiO** **SiO** + CO → **SiO_2** + C	(Mellor, 1925, p. 235)	Mellor, p. 235, "*At the temp. of the electric arc, however, C. Walker's reaction $SiO_2+Si \rightarrow 2SiO$, can be realized ... The reduction can be made with carbon: $SiO_2+C \rightleftharpoons SiO+CO$...*"
SiO_2 + **Si** → **2 SiO** **SiO** + C → **Si** + CO	(Mellor, 1925, p. 235)	Mellor, p. 235, "*At the temp. of the electric arc, however, C. Walker's reaction $SiO_2+Si \rightarrow 2SiO$, can be realized ... and silicon itself can act on carbon monoxide, forming the monoxide: $Si+CO \rightleftharpoons SiO+C$ ...*"
SiO_2 + **Si** → **2 SiO** Mg_2Si + **2 SiO** → **3 Si** + 2 MgO	(Füglein and Schubert, 1999; Mellor, 1925, p. 235)	Mellor, p. 235, "*At the temp. of the electric arc, however, C. Walker's reaction $SiO_2+Si \rightarrow 2SiO$, can be realized*" Füglein and Schubert, p. 866, "*... 600 °C: $Mg_2Si + 2SiO \rightarrow 3Si + 2MgO$...*"
Si + 3 $SiCl_4$ + 2 H_2 → **4 $SiHCl_3$** **$SiHCl_3$** + H_2 → **Si** + 3 HCl	(Breneman and Mui, 1977; Habuka et al., 1996; Simmler, 2000)	Breneman and Mui, p. 2, Eqs. Simmler, p. 619, Eq. (1). Habuka et al., p. 64, Eq. (9).
Si + **3 $SiCl_4$** + 2 H_2 → **4 $SiHCl_3$** **$SiHCl_3$** + Cl_2 → **$SiCl_4$** + HCl	(Schirmeister and Hoffmann, 1992; Simmler, 2000)	Simmler, p. 619, Eq. (1). Schirmeister and Hoffman, p. 69, Abstract.

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$GeCl_4$ + Ge → **2 $GeCl_2$** **$GeCl_2$** + Cl_2 → **$GeCl_4$**	(Patnaik, 2003, pp. 316–317)	
GeO_2 + Ge → **2 GeO** **2 GeO** + O_2 → **2 GeO_2**	(Kita et al., 2009; Law and Meigs, 1957)	Law and Meigs, p. 156, "*The vapor pressure of GeO over mixtures of Ge and GeO_2 corresponding to the reaction Ge + GeO ⇌ 2 GeO(g) is available*"; Eq. (V).

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$\mathbf{Sn^{4+}} + Sn \rightarrow \mathbf{2\ Sn^{2+}}$ $\mathbf{Sn^{2+}} + I_2 \rightarrow 2\ I^- + \mathbf{Sn^{4+}}$	(Awais et al., 2021; Patnaik, 2003, p. 400)	Awais et al., p. 301, Eq. (8).
$Sn^{4+} + \mathbf{Sn} \rightarrow \mathbf{2\ Sn^{2+}}$ $\mathbf{Sn^{2+}} + Fe \rightarrow Fe^{2+} + \mathbf{Sn}$	(Awais et al., 2021; Patnaik, 2003, p. 413)	Awais et al., p. 301, Eq. (8).

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Pb + PbO_2 + 2 H_2SO_4 → **2 $PbSO_4$** + 2 H_2O **$PbSO_4$** + 4 CO → **PbS** + 4 CO_2 **$PbSO_4$** + **PbS** → **2 Pb** + 2 SO_2	(Malinowski, 1987; Malinowski et al., 2004; Varela et al., 1997)	Varela et al., p. 1232, Eq(1). Malinowski et al. 2004, p. 147, Table 2. Eq. (6). Malinowski 1987, p. 329, Eq. (1).
Pb + PbO_2 + 2 H_2SO_4 → **2 $PbSO_4$** + 2 H_2O **$PbSO_4$** + 2 H_2 → **Pb** + SO_2 + 2 H_2O	(Varela et al., 1997; 끄 et al., 2003, p. 183)	Varela et al., p. 1232, Eq(1).
Pb + **PbO_2** + 2 H_2SO_4 → **2 $PbSO_4$** + 2 H_2O **$PbSO_4$** → **PbO_2** + SO_2	(Varela et al., 1997; 끄 et al., 2003, p. 183)	Varela et al., p. 1232, Eq(1).
2 PbO + PbO_2 → **Pb_3O_4** **2 Pb_3O_4** → **6 PbO** + O_2	(끄 et al., 2003, pp. 186, 187)	

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HNO_2 + HNO_3 → **2 NO_2** + H_2O **2 NO_2** + Cu + 2 H^+ → **2 HNO_2** + Cu^{2+}	(Abd El Aal et al., 1992; Evans, 1944)	Abd El Aal et al., p. 369, Eq. (7). Evans, p. 123, "*... must balance the net gain of one molecule by the cycle* *HNO_2 + HNO_3 = $2NO_2$ + H_2O* *$2NO_2$ + $2H^•$ + 2e = $2HNO_2$*"; p. 124, "*...and clearly it must balance the electrical transfer of the anodic reaction* *Cu = $Cu^{••}$ + 2e*"
NH_4NO_3 → 2 H_2O + **N_2O** **N_2O** + H_2SO_4 → **2 NO** + SO_2 + H_2O **2 NO** + O_2 → **2 NO_2** **4 NO_2** + 2 H_2O + O_2 → **4 HNO_3** **HNO_3** + NH_3 → **NH_4NO_3**	(Лидин et al., 2007, pp. 336, 338; 뮤 et al., 2003, pp. 193, 195, 205)	
2 NH_4NO_3 → **2 N_2** + O_2 + 4 H_2O **N_2** + 3 Mg → **Mg_3N_2** **Mg_3N_2** + 6 H_2O → 3 $Mg(OH)_2$ + **2 NH_3** HNO_3 + **NH_3** → **NH_4NO_3**	(Moser and Herzner, 1923; Patnaik, 2003, pp. 40–41, 514)	Moser and Herzner, p. 116, reaction equations.

N_2O_5 + **NO** → **3 NO_2** **2 NO_2** → **2 NO** + O_2	(Patnaik, 2003, p. 650; Wilson and Johnston, 1953)	Wilson and Johnston, p. 5763, "*The rate of the reaction N_2O_5 + NO → $3NO_2$ has been shown by ...*"
N_2O_5 + NO → **3 NO_2** **2 NO_2** + O_3 → **N_2O_5** + O_2	(Patnaik, 2003, p. 684; Wilson and Johnston, 1953)	Wilson and Johnston, p. 5763, "*The rate of the reaction N_2O_5 + NO → $3NO_2$ has been shown by ...*"
NO_2 + NO → **N_2O_3** **N_2O_3** + 2 HNO_3 → **4 NO_2** + H_2O	(뮤 et al., 2003, pp. 204, 206)	
NO_2 + **NO** → **N_2O_3** **N_2O_3** + 2 Hg + H_2SO_4 → **2 NO** + Hg_2SO_4 + H_2O	(뮤 et al., 2003, pp. 204, 206)	
NH_2OH + **HNO_2** → **N_2O** + 2 H_2O **N_2O** + H_2SO_4 → **2 NO** + SO_2 + H_2O **2 NO** + O_2 → **2 NO_2** **NO_2** + **NO** + H_2O → **2 HNO_2**	(Лидин et al., 2007, p. 338; 뮤 et al., 2003, pp. 200, 203, 206)	

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$2\ PH_3 + \mathbf{2\ PCl_3} \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{P_4} + 6\ Cl_2 \rightarrow \mathbf{4\ PCl_3}$	(Patnaik, 2003, p. 705; Rose, 1832)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*"
$\mathbf{2\ PH_3} + 2\ PCl_3 \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{P_4} + 6\ H_2 \rightarrow \mathbf{4\ PH_3}$	(Rose, 1832; 끄 et al., 2003, p. 210)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*"
$\mathbf{2\ PH_3} + 2\ PCl_3 \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{P_4} + 3\ O_2 + 6\ H_2O \rightarrow \mathbf{4\ H_3PO_3}$ $\mathbf{H_3PO_3} + 3\ Zn + 6\ H^+ \rightarrow \mathbf{PH_3} + 3\ Zn^{2+} + 3\ H_2O$	(Rose, 1832; 끄 et al., 2003, pp. 211, 214)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*"
$\mathbf{2\ PH_3} + 2\ PCl_3 \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{2\ P_4} + 3\ Ba(OH)_2 + 6\ H_2O \rightarrow \mathbf{3\ Ba(H_2PO_2)_2} + \mathbf{2\ PH_3}$ $\mathbf{Ba(H_2PO_2)_2} + H_2SO_4 \rightarrow \mathbf{2\ H_3PO_2} + BaSO_4$ $\mathbf{2\ H_3PO_2} \rightarrow \mathbf{PH_3} + H_3PO_4$	(Patnaik, 2003, p. 390; Rose, 1832; Лидин et al., 2007, p. 423)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*"

$\mathbf{2\ PH_3} + 2\ PCl_3 \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{P_4} + 4\ B \rightarrow \mathbf{4\ BP}$ $\mathbf{BP} + NH_3 \rightarrow \mathbf{PH_3} + BN$	(Peret, 1964; Rose, 1832; Vickery, 1959)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*" Peret, p. 44, Eq. (1). Vickery, p. 268, "*A mixture of boron phosphide samples produced by the second reaction was submitted to reaction with dilute ammonia gas and again yielded boron nitride of cubic structure … The reactions involved would appear to be … $BP + NH_3 \rightarrow PH_3 + BN$*"
$\mathbf{2\ PH_3} + 2\ PCl_3 \rightarrow \mathbf{P_4} + 6\ HCl$ $\mathbf{P_4} + 4\ I_2 \rightarrow \mathbf{2\ P_2I_4}$ $\mathbf{13\ P_4} + \mathbf{10\ P_2I_4} + 128\ H_2O \rightarrow \mathbf{40\ PH_4I} + 32\ H_3PO_4$ $\mathbf{PH_4I} \rightarrow \mathbf{PH_3} + HI$	(Klement, 1963, p. 539; Levchuk, 2017, p. 122; Rich, 2007, p. 376; Rose, 1832; Лидин et al., 2007, p. 424)	Rose, p. 307, "*Wird selbstenzündliches Gas in flüssigen Chlorophosphor geleitet, so entsteht zwar im Anfange kein Veränderung, dann aber zeigt sich eine starke Entwicklung von Chlorwasserstoffgas, wobei die Flüssigkeit erst gelb opalisirend wird, und dann gelben Phosphor absetzt, der durch längeres Stehen vorzüglich leicht durch's Sonnenlicht roth wird. Unstreitig würde durch eine noch längere Behandlung des Phosphorchlorürs durch Phosphorwasserstoffgas dasselbe seinen ganzen Chlorgehalt verloren haben.*" Klement, p. 539, "*Diphosphorus tetraiodide … reused for a new batch.*" Levchuk, p. 122, "*In the presence of H_2O (from HI solution) hydrolysis of PH_4I occurs: $PH_4I \rightarrow PH_3 + HI$*"
$PH_3 + \mathbf{3\ PCl_5} \rightarrow \mathbf{4\ PCl_3} + 3\ HCl$ $\mathbf{PCl_3} + Cl_2 \rightarrow \mathbf{PCl_5}$	(끄 et al., 2003, pp. 210, 212)	
$\mathbf{3\ H_3PO_4} + 2\ P + 3\ H_2O \rightarrow \mathbf{5\ H_3PO_3}$ $\mathbf{4\ H_3PO_3} \rightarrow \mathbf{3\ H_3PO_4} + PH_3$	(끄 et al., 2003, pp. 213, 216)	
$\mathbf{3\ PCl_5} + 3\ PH_4I \rightarrow PI_3 + \mathbf{PCl_3} + \mathbf{P_4} + 12\ HCl$ $\mathbf{PCl_3} + Cl_2 \rightarrow \mathbf{PCl_5}$ $\mathbf{P_4} + 10\ Cl_2 \rightarrow \mathbf{4\ PCl_5}$	(Patnaik, 2003, p. 705; 끄 et al., 2003, pp. 210, 212)	

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3 H_3AsO_4 + 5 AsH_3 → **8 As** + 12 H_2O **6 As** + 5 $K_2Cr_2O_7$ + 20 H_2SO_4 → **3 As_2O_5** + 5 $Cr_2(SO_4)_3$ + 5 K_2SO_4 + 20 H_2O **As_2O_5** + 3 H_2O → **2 H_3AsO_4**	(Agnew, 1943; Reckleben and Lockemann, 1908; 끄 et al., 2003, p. 229)	Reckleben and Lockemann, p. 122, "*Eine 1/2n-Arsensäurelösung färbte sich bei andauerndem Sehütteln mit Arsenwasserstoff erst gelb, wurde dann dunkler and sehied bald dieke Flocken von Arsen ab. Nach anderthalb Stunden war von den 13% des Arsengehaites allerdings erst 1% absorbiert, bei konzentrierteren Lösungen wurde aber in weit kürzerer Zeit bereits die Hälfte des gesamten Arsens absorbiert.*" Agnew, p. 111, "*...and standard permanganate soh. was run in until the colour became faint pink. The reaction is:* *$3As_2 + 5K_2Cr_2O_7 + 20H_2SO_4 \rightarrow 3As_2O_5 + 5Cr_2(SO_4)_3 + 5K_2SO_4 + 20H_2O$*"
3 H_3AsO_4 + 5 AsH_3 → **8 As** + 12 H_2O **2 As** + 5 Cl_2 + 8 H_2O → **2 H_3AsO_4** + 10 HCl	(Reckleben and Lockemann, 1908; Лидин et al., 2007, p. 27)	Reckleben and Lockemann, p. 122, "*Eine 1/2n-Arsensäurelösung färbte sich bei andauerndem Sehütteln mit Arsenwasserstoff erst gelb, wurde dann dunkler and sehied bald dieke Flocken von Arsen ab. Nach anderthalb Stunden war von den 13% des Arsengehaites allerdings erst 1% absorbiert, bei konzentrierteren Lösungen wurde aber in weit kürzerer Zeit bereits die Hälfte des gesamten Arsens absorbiert.*"
3 H_3AsO_4 + 5 AsH_3 → **8 As** + 12 H_2O **2 As** + 5 NaClO + 3 H_2O → **2 H_3AsO_4** + 5 NaCl	(Gooch and Walker, 1905, pt. II, p. 190; Reckleben and Lockemann, 1908)	Reckleben and Lockemann, p. 122, "*Eine 1/2n-Arsensäurelösung färbte sich bei andauerndem Sehütteln mit Arsenwasserstoff erst gelb, wurde dann dunkler and sehied bald dieke Flocken von Arsen ab. Nach anderthalb Stunden war von den 13% des Arsengehaites allerdings erst 1% absorbiert, bei konzentrierteren Lösungen wurde aber in weit kürzerer Zeit bereits die Hälfte des gesamten Arsens absorbiert.*"

3 H_3AsO_4 + **5 AsH_3** → **8 As** + 12 H_2O **2 As** + 6 HCOONa → **2 AsH_3** + 3 $Na_2C_2O_4$	(Reckleben and Lockemann, 1908; 끄 et al., 2003, p. 220)	Reckleben and Lockemann, p. 122, "*Eine 1/2n-Arsensäurelösung färbte sich bei andauerndem Sehütteln mit Arsenwasserstoff erst gelb, wurde dann dunkler and sehied bald dieke Flocken von Arsen ab. Nach anderthalb Stunden war von den 13% des Arsengehaites allerdings erst 1% absorbiert, bei konzentrierteren Lösungen wurde aber in weit kürzerer Zeit bereits die Hälfte des gesamten Arsens absorbiert.*"
AsH_3 + **$AsCl_3$** → **2 As** + 3 HCl **2 As** + 3 $HgCl_2$ → **2 $AsCl_3$** + 3 Hg	(끄 et al., 2003, pp. 219, 220)	
AsH_3 + $AsCl_3$ → **2 As** + 3 HCl **2 As** + 3 H_2 → **2 AsH_3**	(끄 et al., 2003, p. 219)	
4 AsI_3 + 2 As → **3 As_2I_4** **As_2I_4** + I_2 → **2 AsI_3**	(Лидин et al., 2007, p. 31)	
As_4 + 4 Co_3As_2 → **12 CoAs** **20 CoAs** → **3 As_4** + **4 Co_5As_2** **2 Co_5As_2** → **As_4** + 10 Co	(끄 et al., 2003, p. 479)	

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O_2 + 2 Na_2O → **2 Na_2O_2** **Na_2O_2** + H_2SO_4 → **H_2O_2** + Na_2SO_4 **H_2O_2** + Cl_2 → **O_2** + 2 HCl	(Лидин et al., 2007, p. 416; 끄 et al., 2003, pp. 18, 245)	
H_2O + O_3 → **2 OH** + O_2 **OH** + HCl → **H_2O** + Cl	(Gilles et al., 2000; Sharkey and Smith, 1993)	Gilles et al., p. 8946, merge Eqs. (4)(5). Sharkey and Smith, p. 631, Eq. (1).
H_2O + O_3 → **H_2O_2** + O_2 **H_2O_2** + H_2S → **2 H_2O** + S	(Лидин et al., 2007, p. 413; 끄 et al., 2003, p. 245)	
H_2O + **O_3** → **H_2O_2** + **O_2** **H_2O_2** + Cl_2 → **O_2** + 2 HCl **3 O_2** → **2 O_3**	(Лидин et al., 2007, pp. 413, 416; 끄 et al., 2003, pp. 245, 246)	
OF_2 + **H_2O** → **O_2** + 2 HF **O_2** + 2 H_2 → **2 H_2O**	(끄 et al., 2003, pp. 246, 291)	
2 Na_2O + **O_2** → **2 Na_2O_2** **Na_2O_2** + 2 HCl → 2 NaCl + **H_2O_2** **H_2O_2** + Cl_2 → 2 HCl + **O_2**	(끄 et al., 2003, pp. 18, 245)	
2 Na_2O + O_2 → **2 Na_2O_2** **Na_2O_2** + 2 Na → **2 Na_2O**	(Лидин et al., 2007, p. 349; 끄 et al., 2003, p. 18)	

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2 H_2S + SO_2 → **3 S** + 2 H_2O **S** + H_2 → **H_2S**	(Patnaik, 2003, pp. 380, 381; Steudel, 2003; Uzun et al., 2016)	
SO_2 + 2 H_2S → **3 S** + 2 H_2O **S** + O_2 → **SO_2**	(Patnaik, 2003, p. 892; Steudel, 2003; Uzun et al., 2016)	Patnaik, p. 892, "*Sulfur forms two oxides, sulfur dioxide, SO_2, and the trioxide, SO_3. It burns in oxygen at about 250 ℃ or in air above 260 ℃, forming sulfur dioxide. In excess oxygen the trioxide is obtained.*"
Na_2SO_3 + S → **$Na_2S_2O_3$** **3 $Na_2S_2O_3$** + 6 NaOH → 2 Na_2S + **4 Na_2SO_3** + 3 H_2O	(Lunge, 1883; Patnaik, 2003, p. 892)	Lunge, p. 2915, "*Thiosulfat und Aetznatron zerlegen sich bei 200° nach der Gleichung: 3 $Na_2S_2O_3$ + 6 NaOH = 2 Na_2S + 4 Na_2SO_3 + 3 H_2O.*"
Na_2SO_3 + S → **$Na_2S_2O_3$** **3 $Na_2S_2O_3$** + 4 NaOH + 2 $NaNO_2$ + H_2O → **6 Na_2SO_3** + 2 NH_3	(Lunge, 1883; Patnaik, 2003, p. 892)	Lunge, p. 2915, "*Nitrit wirkt auf Thiosulfat in alkalischer Lösung bei hoher Temperatur wie auf ein Gemenge von Sulfid und Sulfit nach der Gleichung: 3 $Na_2S_2O_3$ + 4 NaHO + 2 $NaNO_2$ + H2O = 6 Na_2SO_3 + 2 NH_3.*"
HOSCN + **SCN^-** + H^+ → **$(SCN)_2$** + H_2O **3 $(SCN)_2$** + 4 H_2O → H_2SO_4 + HCN + **5 SCN^-** + 5H^+	(Nagy et al., 2007; Stedman and Whincup, 1969; Лидин et al., 2007, p. 505)	Nagy et al., p. 286, Eq. (2). Stedman and Whincup, p. 1148, "*In the course of analyses for hydrogen cyanide and thiocyanate ion it is likely that any thiocyanogen would be hydrolysed, and thus not be shown up in the above stoicheiometries. $3(SCN)_2 + 4H_2O \rightarrow H_2SO_4 + HCN + 5SCN^- + 5H^+$*"
HOSCN + **SCN^-** + H^+ → **$(SCN)_2$** + H_2O **$(SCN)_2$** + H_2S → S + **2 SCN^-** + 2 H^+	(Nagy et al., 2007; 뮤 et al., 2003, p. 252)	Nagy et al., p. 286, Eq. (2).
2 H_2SO_4 + S → **3 SO_2** + 2 H_2O **2 SO_2** + O_2 + 2 H_2O → **2 H_2SO_4**	(Hart, 1917; Лидин et al., 2007, p. 513)	
2 H_2SO_4 + **S** → **3 SO_2** + 2 H_2O **SO_2** + 2 CO → **S** + 2 CO_2	(Hart, 1917; Лидин et al., 2007, p. 514)	
CS_2 + **3 SO_3** → COS + **4 SO_2** **SO_2** + 3 Fe_2O_3 → **SO_3** + 2 Fe_3O_4	(뮤 et al., 2003, pp. 144, 262)	
CS_2 + 3 SO_3 → **COS** + **4 SO_2** **2 COS** + C → **CS_2** + 2 CO **2 SO_2** + 2 C → **S_2** + 2 CO_2 **S_2** + C → **CS_2**	(Blackwood and McCarthy, 1973; 뮤 et al., 2003, p. 144)	Blackwood and McCarthy, p. 723, Abstract.
SO_2 + 3 S → **2 S_2O** **S_2O** + O_3 → **2 SO_2**	(Stedman et al., 1974; Лидин et al., 2007, p. 513)	Stedman et al., p. 1250, "*Reactions of S_2O which might be expected in this system were ... $O_3 + S_2O \rightarrow SO_2 + SO_2$ ...*"

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H_2SeO_3 + 2 H_2Se → **3 Se** + 3 H_2O **3 Se** + 4 HNO_3 + H_2O → **3 H_2SeO_3** + 4 NO	(Lingane and Niedrach, 1949; Wei et al., 1994; Wiberg et al., 2001, p. 583)	Lingane and Niedrach, p. 199, Eq. (5). Wei et al., p. 109, Eq. (1). Wiberg et al., p. 583, "*Aqueous solutions of selenous acid are formed when powdered selenium is oxidized by dilute nitric acid: 3 Se + 4 HNO_3 → 3 H_2SeO_3 + 4 NO.*" (Note: this quoted equation is not balanced; H_2O needs to be added since it's "Aqueous".)
H_2SeO_3 + **2 H_2Se** → **3 Se** + 3 H_2O **Se** + H_2 → **H_2Se**	(Lingane and Niedrach, 1949; Patnaik, 2003, p. 378; Wei et al., 1994)	Lingane and Niedrach, p. 199, Eq. (5). Wei et al., p. 109, Eq. (1).
Se + **2 H_2SeO_4** + H_2O → **3 H_2SeO_3** **3 H_2SeO_3** + $HClO_3$ → **3 H_2SeO_4** + HCl	(끄 et al., 2003, pp. 273, 276)	
Se + 2 H_2SeO_4 + H_2O → **3 H_2SeO_3** **H_2SeO_3** + 2 NH_2OH → **Se** + N_2O + 4 H_2O	(끄 et al., 2003, pp. 273, 276)	
Se_2Cl_2 + ZnSe → **3 Se** + $ZnCl_2$ **2 Se** + Cl_2 → **Se_2Cl_2**	(끄 et al., 2003, pp. 272, 274)	
Se_2Cl_2 + **ZnSe** → **3 Se** + $ZnCl_2$ **Se** + Zn → **ZnSe**	(끄 et al., 2003, pp. 272, 274)	
3 Se + $SeCl_4$ → **2 Se_2Cl_2** **Se_2Cl_2** + 2 $FeCl_2$ → **2 Se** + 2 $FeCl_3$	(끄 et al., 2003, pp. 274, 277)	
3 Se + **$SeCl_4$** → **2 Se_2Cl_2** **Se_2Cl_2** + 3 Cl_2 → **2 $SeCl_4$**	(끄 et al., 2003, pp. 274, 277)	

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Te + **$TeCl_4$** → **2 $TeCl_2$** **$TeCl_2$** + Cl_2 → **$TeCl_4$**	(Steudel and Scheschkewitz, 2020, p. 589)	Steudel and Scheschkewitz, p. 589, "*$TeCl_6$ is unknown and $TeCl_2$ exists only in the vapor phase: if $TeCl_4$ or mixtures of Te and $TeCl_4$ are heated the bent molecule $TeCl_2$ can be detected spectroscopically in the gas phase (the same holds for $TeBr_2$):* *$TeCl_4 \rightleftharpoons TeCl_2 + Cl_2$ $\Delta H^\circ = 119$ kJ mol^{-1}* *$Te + TeCl_4 \rightleftharpoons 2\ TeCl_2$*"
2 H_2Te + **TeO_2** → **3 Te** + 2 H_2O **Te** + 2 H_2O → **TeO_2** + 2 H_2	(Лидин et al., 2007, p. 571; 끔 et al., 2003, p. 280)	
2 H_2Te + **$TeCl_4$** → **3 Te** + 4 HCl **Te** + 2 Cl_2 → **$TeCl_4$**	(끔 et al., 2003, pp. 280, 281)	
Te + 2 TeF_6 → **3 TeF_4** **TeF_4** + 2 H_2S → **Te** + 4 HF + 2 S	(Лидин et al., 2007, p. 571; 끔 et al., 2003, p. 284)	
Te + 2 H_2TeO_4 + H_2O → **3 H_2TeO_3** **H_2TeO_3** + 2 SO_2 + H_2O → **Te** + 2 H_2SO_4	(끔 et al., 2003, pp. 283, 285)	
Te + **2 H_2TeO_4** + H_2O → **3 H_2TeO_3** **3 H_2TeO_3** + $K_2Cr_2O_7$ + 4 H_2SO_4 → **3 H_2TeO_4** + $Cr_2(SO_4)_3$ + K_2SO_4 + 4 H_2O	(끔 et al., 2003, pp. 283, 285)	

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HCl + HOCl → **Cl_2** + H_2O **Cl_2** + H_2 → **2 HCl**	(Lister, 1952; Patnaik, 2003, p. 210; 끔 et al., 2003, p. 307)	Lister, p. 879, Abstract.
$HClO_4$ + **7 HCl** → **4 Cl_2** + 4 H_2O **Cl_2** + H_2S → **2 HCl** + S	(끔 et al., 2003, pp. 304, 309)	
$HClO_3$ + **5 HCl** → **3 Cl_2** + 3 H_2O **Cl_2** + 2 HBr → **2 HCl** + Br_2	(끔 et al., 2003, pp. 304, 308)	
Cl_2 + ClF_3 → **3 ClF** **4 ClF** + 2 H_2O → **2 Cl_2** + 4 HF + O_2	(Лидин et al., 2007, pp. 100, 101)	
Cl_2 + **ClF_3** → **3 ClF** **ClF** + F_2 → **ClF_3**	(Лидин et al., 2007, pp. 100, 101)	
$HClO_2$ + $HClO_3$ → **2 ClO_2** + H_2O **2 ClO_2** + H_2O_2 → **2 $HClO_2$** + O_2	(Лидин et al., 2007, pp. 103, 107)	
$HClO_2$ + **$HClO_3$** → **2 ClO_2** + H_2O **6 ClO_2** + 2 H_2O → **4 $HClO_3$** + Cl_2 + O_2	(Лидин et al., 2007, p. 107; 끔 et al., 2003, p. 308)	

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$HBrO_2$ + $HBrO_3$ → **2 $BrO_2^{\bullet}$** + H_2O **$BrO_2^{\bullet}$** + H^+ + Ce^{3+} → **$HBrO_2$** + Ce^{4+}	(Cornish-Bowden and Cárdenas, 2020; Zhabotinsky, 2007)	Cornish-Bowden and Cárdenas, p. 22, Fig. 23. Zhabotinsky, Figure 2.
HBrO + $HBrO_2$ → **Br_2O_2** + H_2O **Br_2O_2** → **2 $BrO^{\bullet}$** **$BrO^{\bullet}$** + H^+ + Ce^{3+} → **HBrO** + Ce^{4+}	(Cornish-Bowden and Cárdenas, 2020)	Cornish-Bowden and Cárdenas, p. 22, Fig. 23.
HBr + HBrO → **Br_2** + H_2O **Br_2** + H_2 → **2 HBr**	(Vidal, 1971; Voegele et al., 2003; 끄 et al., 2003, pp. 312, 316)	Vidal, p. 1360, Title and Abstract, HBr synthesis from H_2 and Br_2. Voegele et al., p. 570, Eq. (4).
HBr + **HBrO** → **Br_2** + H_2O **Br_2** + Cl_2 + 2 H_2O → **2 HBrO** + 2 HCl	(끄 et al., 2003, pp. 310, 313)	
5 HBr + $HBrO_3$ → **3 Br_2** + 3 H_2O **Br_2** + HNO_2 + H_2O → **2 HBr** + HNO_3	(끄 et al., 2003, pp. 310, 313)	
5 HBr + **$HBrO_3$** → **3 Br_2** + 3 H_2O **Br_2** + 5 HOCl + H_2O → **2 $HBrO_3$** + 5 HCl	(끄 et al., 2003, pp. 310, 314)	

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HIO_2 + I^- + H^+ → **2 HOI** **HOI** + $HClO_2$ → **HIO_2** + HOCl	(De Kepper et al., 1990)	De Kepper et al., p. 6530, Table II, C5, C3.
HIO_2 + **I^-** + H^+ → **2 HOI** **HOI** + HSO_3^- → **I^-** + HSO_4^- + H^+	(De Kepper et al., 1990; Morgan, 1954; Rauscher et al., 2011)	De Kepper et al., p. 6530, Table II, C5. Morgan, p. 140, "*This immediately suggests that hypoiodite is the active species ... HIO + SO_3^{2-} → HSO_4^- + I^-*" Rauscher et al., p. 5798, Table 1, line 21.
HIO_2 + **I^-** + H^+ → **2 HOI** **3 HOI** + 3 NaOH → **2 I^-** + IO_3^- + 3 Na^+ + 3 H_2O	(De Kepper et al., 1990; Лидин et al., 2007, p. 218)	De Kepper et al., p. 6530, Table II, C5.
IO_3^- + 5 I^- + 6 H^+ → **3 I_2** + 3 H_2O 5 ClO_2^- + **2 I_2** + 2 H_2O → 5 Cl^- + **4 IO_3^-** + 4 H^+	(De Kepper et al., 1990)	De Kepper et al., p. 6530, Eqs. (14)(12).
IO_3^- + **5 I^-** + 6 H^+ → **3 I_2** + 3 H_2O **I_2** + H_2S → **2 I^-** + 2 H^+ + S	(De Kepper et al., 1990; Patnaik, 2003, p. 381)	De Kepper et al., p. 6530, Eq. (14).
HOI + **I^-** + H^+ → **I_2** + H_2O **I_2** + H_2SO_3 + H_2O → **2 I^-** + 4 H^+ + SO_4^{2-}	(Rauscher et al., 2011; 끄 et al., 2003, p. 320)	Rauscher et al., p. 5798, Table 1, line 12.
HOI + I^- + H^+ → **I_2** + H_2O **I_2** + 2 HOCl → **2 HOI** + Cl_2	(Rauscher et al., 2011; 끄 et al., 2003, p. 320)	Rauscher et al., p. 5798, Table 1, line 12.
HIO_3 + **2 I_2** + 5 HCl → **5 ICl** + 3 H_2O **2 ICl** → **I_2** + Cl_2	(Лидин et al., 2007, p. 214; 끄 et al., 2003, p. 324)	

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XeF_4 + Xe → **2 XeF_2** **XeF_2** + F_2 → **XeF_4**	(Claassen et al., 1962; Weinstock et al., 1966; 끔 et al., 2003, p. 332)	Claassen et al., p. 3593, "*Preliminary studies of the reaction of fluorine or XeF_4 with excess Xe at 400° indicate the existence of a lower fluoride of xenon.*" Weinstock et al., p. 2197, Eq. (13).
XeF_4 + **Xe** → **2 XeF_2** **2 XeF_2** + 2 H_2O → **2 Xe** + O_2 + 4 HF	(Claassen et al., 1962; Stein, 1984; 끔 et al., 2003, p. 332)	Claassen et al., p. 3593, "*Preliminary studies of the reaction of fluorine or XeF_4 with excess Xe at 400° indicate the existence of a lower fluoride of xenon.*" Stein, p. 3670, the second equation.
2 XeF_6 + Xe → **3 XeF_4** **XeF_4** + F_2 → **XeF_6**	(끔 et al., 2003, pp. 332, 334)	
2 XeF_6 + **Xe** → **3 XeF_4** **XeF_4** + 2 H_2 → **Xe** + 4 HF	(Claassen et al., 1962; 끔 et al., 2003, pp. 332, 334)	Claassen et al., p. 3593, Eq. (1).

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$Ca(HCO_3)_2$ + H^+ + HSO_3^- → **$2\ H_2CO_3$** + $CaSO_3$ $CaCO_3$ + **H_2CO_3** → **$Ca(HCO_3)_2$**	(Saleem, 1972)	Saleem, p. 172, Eqs. (7)(6).
$Ca(HCO_3)_2$ + CaO → **$2\ CaCO_3$** + H_2O **$CaCO_3$** + H_2CO_3 → **$Ca(HCO_3)_2$**	(Patnaik, 2003, p. 526; Saleem, 1972)	Saleem, p. 172, Eqs. (6).
$Ca(OH)_2$ + H_2CO_3 → $CaCO_3$ + **$2\ H_2O$** CaO + **H_2O** → **$Ca(OH)_2$**	(马 et al., 2003, p. 90)	
$Ca_3(PO_4)_2$ + 4 H_3PO_4 → **$3\ Ca(H_2PO_4)_2$** **$Ca(H_2PO_4)_2$** + 2 $CaCO_3$ → **$Ca_3(PO_4)_2$** + 2 CO_2 + 2 H_2O	(马 et al., 2003, pp. 88, 89)	
$Ca_3(PO_4)_2$ + **$4\ H_3PO_4$** → **$3\ Ca(H_2PO_4)_2$** **$Ca(H_2PO_4)_2$** + 2 HCl → $CaCl_2$ + **$2\ H_3PO_4$**	(马 et al., 2003, p. 88)	
Na_2S + H_2S → **$2\ NaHS$** **NaHS** + NaOH → **Na_2S** + H_2O	(Reátegui-Romero et al., 2019; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5)(7).
Na_2S + **H_2S** → **$2\ NaHS$** **NaHS** + HCl → **H_2S** + NaCl	(Madsen et al., 2014; Reátegui-Romero et al., 2019; Rule, 1911; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5) Rule, p. 560, "*The substance obtained by this method possesses a light buff tint, is extremely deliquescent, and when freshly prepared dissolves in hydrochloric acid to a clear solution with violent evolution of hydrogen sulphide.*"
Na_2CO_3 + H_2CO_3 → **$2\ NaHCO_3$** **$NaHCO_3$** + NaOH → **Na_2CO_3** + H_2O	(马 et al., 2003, pp. 11, 12)	
Na_2O + H_2O → **$2\ NaOH$** **$2\ NaOH$** + 2 Na → **$2\ Na_2O$** + H_2	(Dönges, 1963, p. 976; 马 et al., 2003, p. 18)	Dönges, p. 976, Eq. (II).
5 NaN_3 + **$NaNO_3$** → **$3\ Na_2O$** + 8 N_2 **Na_2O** + H_2O → 2 **NaOH** **NaOH** + HNO_3 → **$NaNO_3$** + H_2O	(Dönges, 1963, p. 975; 马 et al., 2003, pp. 18, 19)	Dönges, p. 975, Eq. (I).
ZnS + **$2\ ZnO$** → **$3\ Zn$** + SO_2 **Zn** + 2 H_2O → **$Zn(OH)_2$** + H_2 **$Zn(OH)_2$** → **ZnO** + H_2O	(Guntz, 1926; Patnaik, 2003, p. 989; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction:* *ZnS + 2ZnO = 3Zn + SO_2*" Philpott et al., p. 4," *In DI water zinc reacts with water to form zinc hydroxide (Zn + 2 H_2O → $Zn(OH)_2$ + H_2).*"
4 ZnO + **$ZnCl_2$** + **$5\ H_2O$** → **$Zn_5(OH)_8Cl_2{\cdot}H_2O$** **$Zn_5(OH)_8Cl_2{\cdot}H_2O$** + 8 HCl → **$5\ ZnCl_2$** + **$9\ H_2O$**	(Smičáková et al., 2017; Tanaka et al., 2007)	Tanaka et al., p. 2062, "*Preparation of ZHC particles was carried out in aqueous media as follows. The synthetic ZnO particles (16.0 mmol) were added into 50 ml of 0-2.0 mol dm3 $ZnCl_2$ solutions in a sealed polypropyrene vessel or a stainless-steel autoclave and they were aged at 6–140 ℃ for 48 h without stirring*" "*These facts allow us to infer that the ZnO particles are hydrolyzed in $ZnCl_2$ solutions to recrystallize as ZHC by the following reactions:* *ZnO + H_2O → Zn^{2+} + $2OH^-$,* *$5Zn^{2+}$ + $8OH^-$ + $2Cl^-$ + H_2O → $Zn_5(OH)_8Cl_2{\cdot}H_2O$*" Smičáková et al., p. 1869, Eq. (2).
$6\ NaAlO_2$ + $Al_2(SO_4)_3$ + 12 H_2O → 3 Na_2SO_4 + **$8\ Al(OH)_3$** **$Al(OH)_3$** + NaOH → **$NaAlO_2$** + 2 H_2O	(Patnaik, 2003, p. 869; 万 et al., 2018)	万et al., p. 4842, "*体系中发生的反应方程式如下* *$6NaAlO_2$ + $Al_2(SO_4)_3$ + $12H_2O$ → $3Na_2SO_4$ + $8Al(OH)_3$ (拟薄水铝石) (2)*"
$AsCl_3$ + As_2O_3 → **$3\ AsOCl$** **AsOCl** + HCl → **$As(OH)Cl_2$** **$As(OH)Cl_2$** + HCl → **$AsCl_3$** + H_2O	(Efremov et al., 2002; Wiberg et al., 2001, p. 747)	Wiberg et al., p. 747, "*As_2O_3 and $AsCl_3$ comproportionate to give arsenic oxygen chloride: As_2O_3 + $AsCl_3$ → 3 AsOCl.*" Efremov et al., p. 844, "*… this band can be assigned to predominantly stretching vibrations of the 'isolated' multiple bonds AsO in AsOCl, which forms by the reactions … $As(OH)Cl_2$ ⇌ AsOCl + HCl*"; p. 843, "*…hydrolysis proceeds according to the scheme: $AsCl_3$ + H_2O ⇌ $As(OH)Cl_2$ + HCl*"
$H_2S_2O_7$ + H_2O → **$2\ H_2SO_4$** **H_2SO_4** + SO_3 → **$H_2S_2O_7$**	(马 et al., 2003, pp. 266, 268)	
$H_2Cr_2O_7$ + H_2O → **$2\ H_2CrO_4$** **H_2CrO_4** + CrO_3 → **$H_2Cr_2O_7$**	(马 et al., 2003, p. 427)	
$5\ B_2H_6$ + 2 BBr_3 → **$6\ B_2H_5Br$** **B_2H_5Br** + $(CH_3)_2SbH$ → **B_2H_6** + $(CH_3)_2SbBr$	(Burg and Grant, 1959; Schlesinger and Burg, 1931)	Schlesinger and Burg, p. 4322, "*A similar experiment …*" Burg and Grant, p.3, "*Its vapor density …*"
6 AlN + **$Al_2(SO_4)_3$** + 24 H_2O → **$8\ Al(OH)_3$** + 3 $(NH_4)_2SO_4$ **$2\ Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(马 et al., 2003, pp. 117, 120)	
6 AlN + $Al_2(SO_4)_3$ + 24 H_2O → **$8\ Al(OH)_3$** + 3 $(NH_4)_2SO_4$ **$2\ Al(OH)_3$** → **Al_2O_3** + 3 H_2O **Al_2O_3** + 3 C + N_2 → **$2\ AlN$** + 3 CO	(马 et al., 2003, pp. 117, 118)	
$Al_2(SO_4)_3$ + 2 Na_3AlF_6 → **$4\ AlF_3$** + 3 Na_2SO_4 **AlF_3** + 3 H_2O → **$Al(OH)_3$** + 3 HF **$2\ Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(Лидин et al., 2007, p. 19; 马 et al., 2003, p. 120)	
$AlCl_3$ + 3 $LiAlH_4$ → **$4\ AlH_3$** + 3 LiCl **$2\ AlH_3$** + 2 BCl_3 → **$2\ AlCl_3$** + B_2H_6	(Zuckerman and Hagen, 1991, p. 14; 马 et al., 2003, p. 122)	Zuckerman and Hagen, p. 14, Eq. (a).
CO + H_2 + $CaCN_2$ → CaO + **$2\ HCN$** **HCN** + H_2O → **CO** + NH_3	(Dedman and Owen, 1961; 马 et al., 2003, p. 138)	Dedman and Owen, p. 681, "*…and suggests that hydrogen cyanide is produced by the reaction of carbon monoxide and hydrogen with calcium cyanamide:* *CO + H_2 + $CaCN_2$ → CaO + 2 HCN*"
$Pb(CH_3)_3(C_2H_5)$ + $Pb(CH_3)(C_2H_5)_3$ → **$2\ Pb(CH_3)_2(C_2H_5)_2$** $Pb(CH_3)_4$ + **$Pb(CH_3)_2(C_2H_5)_2$** → **$2\ Pb(CH_3)_3(C_2H_5)$**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (141) (142).
$Pb(CH_3)_3(C_2H_5)$ + **$Pb(CH_3)(C_2H_5)_3$** → **$2\ Pb(CH_3)_2(C_2H_5)_2$** $Pb(C_2H_5)_4$ + **$Pb(CH_3)_2(C_2H_5)_2$** → **$2\ Pb(CH_3)(C_2H_5)_3$**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (142) (143).
$5\ H_3PO_4$ + $POCl_3$ → **$3\ H_4P_2O_7$** + 3 HCl **$H_4P_2O_7$** + H_2O → **$2\ H_3PO_4$**	(Лидин et al., 2007, p. 436; 马 et al., 2003, p. 217)	
$2\ HF$ + SiF_4 → **H_2SiF_6** **H_2SiF_6** + 4 H_2O → **$6\ HF$** + H_4SiO_4	(曹 and 王, 1982, pp. 106, 108)	

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Na_2S + H_2S → **2 NaHS** **NaHS** + NaOH → **Na_2S** + H_2O	(Reátegui-Romero et al., 2019; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5)(7).
Na_2S + **H_2S** → **2 NaHS** **NaHS** + HCl → **H_2S** + NaCl	(Madsen et al., 2014; Reátegui-Romero et al., 2019; Rule, 1911; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5) Rule, p. 560, "*The substance obtained by this method possesses a light buff tint, is extremely deliquescent, and when freshly prepared dissolves in hydrochloric acid to a clear solution with violent evolution of hydrogen sulphide.*"
Na_2CO_3 + H_2CO_3 → **2 $NaHCO_3$** **$NaHCO_3$** + NaOH → **Na_2CO_3** + H_2O	(马 et al., 2003, pp. 11, 12)	
Na_2O + H_2O → **2 NaOH** **2 NaOH** + 2 Na → **2 Na_2O** + H_2	(Dönges, 1963, p. 976; 马 et al., 2003, p. 18)	Dönges, p. 976, Eq. (II).
5 NaN_3 + **$NaNO_3$** → **3 Na_2O** + 8 N_2 **Na_2O** + H_2O → 2 **NaOH** **NaOH** + HNO_3 → **$NaNO_3$** + H_2O	(Dönges, 1963, p. 975; 马 et al., 2003, pp. 18, 19)	Dönges, p. 975, Eq. (I).
6 $NaAlO_2$ + $Al_2(SO_4)_3$ + 12 H_2O → 3 Na_2SO_4 + **8 $Al(OH)_3$** **$Al(OH)_3$** + NaOH → **$NaAlO_2$** + 2 H_2O	(Patnaik, 2003, p. 869; 万 et al., 2018)	万et al., p. 4842, "*体系中发生的反应方程式如下* *$6NaAlO_2 + Al_2(SO_4)_3 + 12H_2O \rightarrow 3Na_2SO_4 + 8Al(OH)_3$ (拟薄水铝石) (2)*"

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$\mathbf{Ca(HCO_3)_2} + H^+ + HSO_3^- \rightarrow \mathbf{2\ H_2CO_3} + CaSO_3$ $CaCO_3 + \mathbf{H_2CO_3} \rightarrow \mathbf{Ca(HCO_3)_2}$	(Saleem, 1972)	Saleem, p. 172, Eqs. (7)(6).
$\mathbf{Ca(HCO_3)_2} + CaO \rightarrow \mathbf{2\ CaCO_3} + H_2O$ $\mathbf{CaCO_3} + H_2CO_3 \rightarrow \mathbf{Ca(HCO_3)_2}$	(Patnaik, 2003, p. 526; Saleem, 1972)	Saleem, p. 172, Eqs. (6).
$Ca(HCO_3)_2 + \mathbf{CaO} \rightarrow \mathbf{2\ CaCO_3} + H_2O$ $\mathbf{CaCO_3} \rightarrow \mathbf{CaO} + CO_2$	(Patnaik, 2003, pp. 526, 862)	
$2\ CaO + \mathbf{CaC_2} \rightarrow \mathbf{3\ Ca} + 2\ CO$ $\mathbf{Ca} + 2\ C \rightarrow \mathbf{CaC_2}$	(Hick et al., 2009; Li et al., 2012)	Li et al., p. 10743, Eq. (4); p. 10742, Eq. (3).
$\mathbf{2\ CaO} + CaC_2 \rightarrow \mathbf{3\ Ca} + 2\ CO$ $\mathbf{2\ Ca} + O_2 \rightarrow \mathbf{2\ CaO}$	(Li et al., 2012; Pilling and Bedworth, 1923)	Li et al., p. 10743, Eq. (4). Pilling and Bedworth, p. 577, "*Calcium is attacked by … unaffected by the oxide thickness.*"
$\mathbf{Ca(OH)_2} + H_2CO_3 \rightarrow CaCO_3 + \mathbf{2\ H_2O}$ $CaO + \mathbf{H_2O} \rightarrow \mathbf{Ca(OH)_2}$	(끄 et al., 2003, p. 90)	
$\mathbf{Ca_3(PO_4)_2} + 4\ H_3PO_4 \rightarrow \mathbf{3\ Ca(H_2PO_4)_2}$ $\mathbf{Ca(H_2PO_4)_2} + 2\ CaCO_3 \rightarrow \mathbf{Ca_3(PO_4)_2} + 2\ CO_2 + 2\ H_2O$	(끄 et al., 2003, pp. 88, 89)	
$Ca_3(PO_4)_2 + \mathbf{4\ H_3PO_4} \rightarrow \mathbf{3\ Ca(H_2PO_4)_2}$ $\mathbf{Ca(H_2PO_4)_2} + 2\ HCl \rightarrow CaCl_2 + \mathbf{2\ H_3PO_4}$	(끄 et al., 2003, p. 88)	

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$\mathbf{H_2Cr_2O_7} + H_2O \rightarrow \mathbf{2\ H_2CrO_4}$ $\mathbf{H_2CrO_4} + CrO_3 \rightarrow \mathbf{H_2Cr_2O_7}$	(끄 et al., 2003, p. 427)	

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FeS_2 + **Fe** → **2 FeS** **FeS** + C + CaO → **Fe** + CO + CaS	(曹 and 王, 1982, pp. 324, 334)	

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2 CoO + $Co(CN)_2$ → **3 Co** + 2 CO + N_2 **Co** + H_2O → **CoO** + H_2	(끔 et al., 2003, pp. 477, 480)	

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Cu_2S + **2 CuO** → SO_2 + **4 Cu** **2 Cu** + 2 NO → N_2 + **2 CuO**	(Patnaik, 2003, p. 643; 马 et al., 2003, p. 339)	

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2 ZnO + ZnS + 3 Se → **3 ZnSe** + SO_2 **2 ZnSe** + 3 O_2 → **2 ZnO** + 2 SeO_2	(Georgobiani et al., 2005; Wagenknecht and Juza, 1965, p. 1078)	Georgobiani et al., p. 607, the Eq. Wagenknecht and Juza, p. 1078, "*II. ZnSe may be prepare … according to …*"
ZnS + **2 ZnO** → **3 Zn** + SO_2 **Zn** + 2 H_2O → **$Zn(OH)_2$** + H_2 **$Zn(OH)_2$** → **ZnO** + H_2O	(Guntz, 1926; Patnaik, 2003, p. 989; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction:* *$ZnS + 2ZnO = 3Zn + SO_2$*" Philpott et al., p. 4," *In DI water zinc reacts with water to form zinc hydroxide ($Zn + 2\ H_2O \rightarrow Zn(OH)_2 + H_2$).*"
ZnS + 2 ZnO → **3 Zn** + SO_2 **Zn** + 2 HCl → **$ZnCl_2$** + H_2 **$ZnCl_2$** + H_2S → **ZnS** + 2 HCl	(Guntz, 1926; Patnaik, 2003, p. 994; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction:* *$ZnS + 2ZnO = 3Zn + SO_2$*" Philpott et al., p. 4,"*… as detailed in the following chemical reactions: $Zn(OH)_2 + 2\ HCl \rightarrow ZnCl_2 + 2\ H_2O$ and $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$.*" Patnaik, p. 994, "*Also, zinc sulfide may be prepared in the laboratory by passing hydrogen sulfide through an aqueous solution of a soluble zinc salt, such as zinc chloride or zinc nitrate.*"
4 ZnO + **$ZnCl_2$** + **5 H_2O** → **$Zn_5(OH)_8Cl_2{\cdot}H_2O$** **$Zn_5(OH)_8Cl_2{\cdot}H_2O$** + 8 HCl → **5 $ZnCl_2$** + **9 H_2O**	(Sminčáková et al., 2017; Tanaka et al., 2007)	Tanaka et al., p. 2062, "*Preparation of ZHC particles was carried out in aqueous media as follows. The synthetic ZnO particles (16.0 mmol) were added into 50 ml of 0-2.0 mol dm3 $ZnCl_2$ solutions in a sealed polypropyrene vessel or a stainless-steel autoclave and they were aged at 6–140 ℃ for 48 h without stirring*" "*These facts allow us to infer that the ZnO particles are hydrolyzed in $ZnCl_2$ solutions to recrystallize as ZHC by the following reactions:* *$ZnO + H_2O \rightarrow Zn^{2+} + 2OH^-$,* *$5Zn^{2+} + 8OH^- + 2Cl^- + H_2O \rightarrow Zn_5(OH)_8Cl_2{\cdot}H_2O$*" Sminčáková et al., p. 1869, Eq. (2).

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5 B_2H_6 + 2 BBr_3 → **6 B_2H_5Br** **B_2H_5Br** + $(CH_3)_2SbH$ → **B_2H_6** + $(CH_3)_2SbBr$	(Burg and Grant, 1959; Schlesinger and Burg, 1931)	Schlesinger and Burg, p. 4322, "*A similar experiment …*" Burg and Grant, p.3, "*Its vapor density …*"
B_4C + **BO** → **5 B** + CO **B** + N_2O → **BO** + N_2	(Hanner and Gole, 1980; Yoon and Jha, 1996)	Yoon and Jha, p. 613, Table VI. Hanner and Gole, p. 5027, Eq. (2); p. 5029, FIG. 6.
B_4C + BO → **5 B** + CO **4 B** + C → **B_4C**	(Yoon and Jha, 1996; Лидин et al., 2007, p. 42)	Yoon and Jha, p. 613, Table VI.
B_2O_3 + 2 KBH_4 → **4 B** + 2 KOH + H_2O + 2 H_2 **4 B** + 3 O_2 → **2 B_2O_3**	(Wang et al., 2013; 끄 et al., 2003, p. 107)	Wang et al., p. 2019, Eq. (2).

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6 $NaAlO_2$ + $Al_2(SO_4)_3$ + 12 H_2O → 3 Na_2SO_4 + **8 $Al(OH)_3$** **$Al(OH)_3$** + NaOH → **$NaAlO_2$** + 2 H_2O	(Patnaik, 2003, p. 869; 万 et al., 2018)	万et al., p. 4842, “*体系中发生的反应方程式如下* *$6NaAlO_2 + Al_2(SO_4)_3 + 12H_2O \rightarrow 3Na_2SO_4 + 8Al(OH)_3$ (拟薄水铝石) (2)*”
6 AlN + **$Al_2(SO_4)_3$** + 24 H_2O → **8 $Al(OH)_3$** + 3 $(NH_4)_2SO_4$ **2 $Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(马 et al., 2003, pp. 117, 120)	
6 AlN + $Al_2(SO_4)_3$ + 24 H_2O → **8 $Al(OH)_3$** + 3 $(NH_4)_2SO_4$ **2 $Al(OH)_3$** → **Al_2O_3** + 3 H_2O **Al_2O_3** + 3 C + N_2 → **2 AlN** + 3 CO	(马 et al., 2003, pp. 117, 118)	
$Al_2(SO_4)_3$ + 2 Na_3AlF_6 → **4 AlF_3** + 3 Na_2SO_4 **AlF_3** + 3 H_2O → **$Al(OH)_3$** + 3 HF **2 $Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(Лидин et al., 2007, p. 19; 马 et al., 2003, p. 120)	
$AlCl_3$ + 3 $LiAlH_4$ → **4 AlH_3** + 3 LiCl **2 AlH_3** + 2 BCl_3 → **2 $AlCl_3$** + B_2H_6	(Zuckerman and Hagen, 1991, p. 14; 马 et al., 2003, p. 122)	Zuckerman and Hagen, p. 14, Eq. (a).

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$Ca(HCO_3)_2$ + H^+ + HSO_3^- → **2 H_2CO_3** + $CaSO_3$ $CaCO_3$ + **H_2CO_3** → **$Ca(HCO_3)_2$**	(Saleem, 1972)	Saleem, p. 172, Eqs. (7)(6).
$Ca(HCO_3)_2$ + CaO → **2 $CaCO_3$** + H_2O **$CaCO_3$** + H_2CO_3 → **$Ca(HCO_3)_2$**	(Patnaik, 2003, p. 526; Saleem, 1972)	Saleem, p. 172, Eqs. (6).
$Ca(HCO_3)_2$ + **CaO** → **2 $CaCO_3$** + H_2O **$CaCO_3$** → **CaO** + CO_2	(Patnaik, 2003, pp. 526, 862)	
2 CaO + **CaC_2** → **3 Ca** + 2 CO **Ca** + 2 C → **CaC_2**	(Hick et al., 2009; Li et al., 2012)	Li et al., p. 10743, Eq. (4); p. 10742, Eq. (3).
Na_2CO_3 + H_2CO_3 → **2 $NaHCO_3$** **$NaHCO_3$** + NaOH → **Na_2CO_3** + H_2O	(끄 et al., 2003, pp. 11, 12)	
B_4C + BO → **5 B** + CO **4 B** + C → **B_4C**	(Yoon and Jha, 1996; Лидин et al., 2007, p. 42)	Yoon and Jha, p. 613, Table VI.
CO_2 + CS_2 + 4 Cu → **2 CO** + 2 Cu_2S **CO** + FeO → Fe + **CO_2**	(Wilson and Bremner, 1948; 끄 et al., 2003, p. 142)	Wilson and Bremner, p. 13, Eq. (2).
CO + H_2 + $CaCN_2$ → CaO + **2 HCN** **HCN** + H_2O → **CO** + NH_3	(Dedman and Owen, 1961; 끄 et al., 2003, p. 138)	Dedman and Owen, p. 681, "*...and suggests that hydrogen cyanide is produced by the reaction of carbon monoxide and hydrogen with calcium cyanamide:* *$CO + H_2 + CaCN_2 \rightarrow CaO + 2\ HCN$*"
$Pb(CH_3)_3(C_2H_5)$ + $Pb(CH_3)(C_2H_5)_3$ → **2 $Pb(CH_3)_2(C_2H_5)_2$** $Pb(CH_3)_4$ + **$Pb(CH_3)_2(C_2H_5)_2$** → **2 $Pb(CH_3)_3(C_2H_5)$**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (141) (142).
$Pb(CH_3)_3(C_2H_5)$ + **$Pb(CH_3)(C_2H_5)_3$** → **2 $Pb(CH_3)_2(C_2H_5)_2$** $Pb(C_2H_5)_4$ + **$Pb(CH_3)_2(C_2H_5)_2$** → **2 $Pb(CH_3)(C_2H_5)_3$**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (142) (143).

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2 HF + SiF_4 → **H_2SiF_6** **H_2SiF_6** + 4 H_2O → **6 HF** + H_4SiO_4	(曹 and 王, 1982, pp. 106, 108)	

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PbS + 3 $PbSO_4$ → **4 PbO** + 4 SO_2 **PbO** + H_2S → **PbS** + H_2O	(Sadovnikov et al., 2011; 马 et al., 2003, p. 180)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction 3PbSO$_4$ + PbS = 4PbO + 4SO$_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction Pb + ½O2 = PbO.*"
PbS + **3 PbSO$_4$** → **4 PbO** + 4 SO_2 **PbO** + SO_3 → **PbSO$_4$**	(Sadovnikov et al., 2011; 马 et al., 2003, p. 181)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction 3PbSO$_4$ + PbS = 4PbO + 4SO$_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction Pb + ½O2 = PbO.*"
PbS + 2 PbO → **3 Pb** + SO_2 **Pb** + H_2S → **PbS** + H_2	(Лидин et al., 2007, p. 448; 马 et al., 2003, p. 177)	
PbS + **2 PbO** → **3 Pb** + SO_2 **2 Pb** + O_2 → **2 PbO**	(Лидин et al., 2007, p. 448; 马 et al., 2003, p. 176)	
Pb(CH$_3$)$_3$(C$_2$H$_5$) + Pb(CH$_3$)(C$_2$H$_5$)$_3$ → **2 Pb(CH$_3$)$_2$(C$_2$H$_5$)$_2$** Pb(CH$_3$)$_4$ + **Pb(CH$_3$)$_2$(C$_2$H$_5$)$_2$** → **2 Pb(CH$_3$)$_3$(C$_2$H$_5$)**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (141) (142).
Pb(CH$_3$)$_3$(C$_2$H$_5$) + **Pb(CH$_3$)(C$_2$H$_5$)$_3$** → **2 Pb(CH$_3$)$_2$(C$_2$H$_5$)$_2$** Pb(C$_2$H$_5$)$_4$ + **Pb(CH$_3$)$_2$(C$_2$H$_5$)$_2$** → **2 Pb(CH$_3$)(C$_2$H$_5$)$_3$**	(Moedritzer, 1968)	Moedritzer, p. 248, Eqs. (142) (143).

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$5\ NaN_3 + \mathbf{NaNO_3} \rightarrow \mathbf{3\ Na_2O} + 8\ N_2$ $\mathbf{Na_2O} + H_2O \rightarrow 2\ \mathbf{NaOH}$ $\mathbf{NaOH} + HNO_3 \rightarrow \mathbf{NaNO_3} + H_2O$	(Dönges, 1963, p. 975; 끄 et al., 2003, pp. 18, 19)	Dönges, p. 975, Eq. (I).
$\mathbf{6\ AlN} + Al_2(SO_4)_3 + 24\ H_2O \rightarrow \mathbf{8\ Al(OH)_3} + 3\ (NH_4)_2SO_4$ $\mathbf{2\ Al(OH)_3} \rightarrow \mathbf{Al_2O_3} + 3\ H_2O$ $\mathbf{Al_2O_3} + 3\ C + N_2 \rightarrow \mathbf{2\ AlN} + 3\ CO$	(끄 et al., 2003, pp. 117, 118)	
$\mathbf{CO} + H_2 + CaCN_2 \rightarrow CaO + \mathbf{2\ HCN}$ $\mathbf{HCN} + H_2O \rightarrow \mathbf{CO} + NH_3$	(Dedman and Owen, 1961; 끄 et al., 2003, p. 138)	Dedman and Owen, p. 681, "*...and suggests that hydrogen cyanide is produced by the reaction of carbon monoxide and hydrogen with calcium cyanamide:* $CO + H_2 + CaCN_2 \rightarrow CaO + 2\ HCN$"

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$Ca_3(PO_4)_2$ + 4 H_3PO_4 → **3 $Ca(H_2PO_4)_2$** **$Ca(H_2PO_4)_2$** + 2 $CaCO_3$ → **$Ca_3(PO_4)_2$** + 2 CO_2 + 2 H_2O	(끄 et al., 2003, pp. 88, 89)	
$Ca_3(PO_4)_2$ + **4 H_3PO_4** → **3 $Ca(H_2PO_4)_2$** **$Ca(H_2PO_4)_2$** + 2 HCl → $CaCl_2$ + **2 H_3PO_4**	(끄 et al., 2003, p. 88)	
5 H_3PO_4 + $POCl_3$ → **3 $H_4P_2O_7$** + 3 HCl **$H_4P_2O_7$** + H_2O → **2 H_3PO_4**	(Лидин et al., 2007, p. 436; 끄 et al., 2003, p. 217)	

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3 AsS_2^- + AsO_3^{3-} + 6 H^+ → **2 As_2S_3** + 3 H_2O **As_2S_3** + HS^- + NH_3 → **2 AsS_2^-** + NH_4^+	(Rich, 2007, p. 388)	Rich, p. 388, "*The thioarsenites react with acids, forming As2S3: … 3 AsS_2^- + AsO_3^{3-} + 6 H_3O^+ → 2 As_2S_3 + 9 H_2O*" "*Alkali sulfides dissolve the sulfides, e.g.:* *As_2S_3 + HS^- + NH_3 → 2 AsS_2^- + NH_4^+*"
$AsCl_3$ + As_2O_3 → **3 AsOCl** **AsOCl** + HCl → **As(OH)Cl_2** **As(OH)Cl_2** + HCl → **$AsCl_3$** + H_2O	(Efremov et al., 2002; Wiberg et al., 2001, p. 747)	Wiberg et al., p. 747, "*As_2O_3 and $AsCl_3$ comproportionate to give arsenic oxygen chloride: As_2O_3 + $AsCl_3$ → 3 AsOCl.*" Efremov et al., p. 844, "*… this band can be assigned to predominantly stretching vibrations of the 'isolated' multiple bonds AsO in AsOCl, which forms by the reactions … As(OH)Cl_2 ⇌ AsOCl + HCl*"; p. 843, "*…hydrolysis proceeds according to the scheme: $AsCl_3$ + H_2O ⇌ As(OH)Cl_2 + HCl*"

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$O_2SCl_2 + \mathbf{O_2SF_2} \rightarrow \mathbf{2\ O_2SFCl}$ $\mathbf{O_2SFCl} + KSO_2F \rightarrow \mathbf{O_2SF_2} + KCl + SO_2$	(Greenwood and Earnshaw, 1997, p. 694; Schmidt and Siebert, 1973, p. 849; Seel et al., 1967)	Greenwood and Earnshaw, p. 694, "*Fluorination yields $O2_sF_2$ (also prepared by $SO_2 + F_2$) and comproportionation of this with O_2SCl_2 and O_2SBr_2 yield the corresponding O_2SFX species.*" Seel et al., p. 111, the second equation.
$\mathbf{Ca(HCO_3)_2} + H^+ + HSO_3^- \rightarrow \mathbf{2\ H_2CO_3} + CaSO_3$ $CaCO_3 + \mathbf{H_2CO_3} \rightarrow \mathbf{Ca(HCO_3)_2}$	(Saleem, 1972)	Saleem, p. 172, Eqs. (7)(6).
$\mathbf{Ca(HCO_3)_2} + CaO \rightarrow \mathbf{2\ CaCO_3} + H_2O$ $\mathbf{CaCO_3} + H_2CO_3 \rightarrow \mathbf{Ca(HCO_3)_2}$	(Patnaik, 2003, p. 526; Saleem, 1972)	Saleem, p. 172, Eqs. (6).
$Ca(HCO_3)_2 + \mathbf{CaO} \rightarrow \mathbf{2\ CaCO_3} + H_2O$ $\mathbf{CaCO_3} \rightarrow \mathbf{CaO} + CO_2$	(Patnaik, 2003, pp. 526, 862)	
$\mathbf{2\ CaO} + CaC_2 \rightarrow \mathbf{3\ Ca} + 2\ CO$ $\mathbf{2\ Ca} + O_2 \rightarrow \mathbf{2\ CaO}$	(Li et al., 2012; Pilling and Bedworth, 1923)	Li et al., p. 10743, Eq. (4). Pilling and Bedworth, p. 577, "*Calcium is attacked by … unaffected by the oxide thickness.*"
$\mathbf{Ca(OH)_2} + H_2CO_3 \rightarrow CaCO_3 + \mathbf{2\ H_2O}$ $CaO + \mathbf{H_2O} \rightarrow \mathbf{Ca(OH)_2}$	(马 et al., 2003, p. 90)	
$\mathbf{Ca_3(PO_4)_2} + 4\ H_3PO_4 \rightarrow \mathbf{3\ Ca(H_2PO_4)_2}$ $\mathbf{Ca(H_2PO_4)_2} + 2\ CaCO_3 \rightarrow \mathbf{Ca_3(PO_4)_2} + 2\ CO_2 + 2\ H_2O$	(马 et al., 2003, pp. 88, 89)	
$Ca_3(PO_4)_2 + \mathbf{4\ H_3PO_4} \rightarrow \mathbf{3\ Ca(H_2PO_4)_2}$ $\mathbf{Ca(H_2PO_4)_2} + 2\ HCl \rightarrow CaCl_2 + \mathbf{2\ H_3PO_4}$	(马 et al., 2003, p. 88)	
$\mathbf{Na_2CO_3} + H_2CO_3 \rightarrow \mathbf{2\ NaHCO_3}$ $\mathbf{NaHCO_3} + NaOH \rightarrow \mathbf{Na_2CO_3} + H_2O$	(马 et al., 2003, pp. 11, 12)	
$\mathbf{Na_2O} + H_2O \rightarrow \mathbf{2\ NaOH}$ $\mathbf{2\ NaOH} + 2\ Na \rightarrow \mathbf{2\ Na_2O} + H_2$	(Dönges, 1963, p. 976; 马 et al., 2003, p. 18)	Dönges, p. 976, Eq. (II).
$5\ NaN_3 + \mathbf{NaNO_3} \rightarrow \mathbf{3\ Na_2O} + 8\ N_2$ $\mathbf{Na_2O} + H_2O \rightarrow 2\ \mathbf{NaOH}$ $\mathbf{NaOH} + HNO_3 \rightarrow \mathbf{NaNO_3} + H_2O$	(Dönges, 1963, p. 975; 马 et al., 2003, pp. 18, 19)	Dönges, p. 975, Eq. (I).
$\mathbf{2\ ZnO} + ZnS + 3\ Se \rightarrow \mathbf{3\ ZnSe} + SO_2$ $\mathbf{2\ ZnSe} + 3\ O_2 \rightarrow \mathbf{2\ ZnO} + 2\ SeO_2$	(Georgobiani et al., 2005; Wagenknecht and Juza, 1965, p. 1078)	Georgobiani et al., p. 607, the Eq. Wagenknecht and Juza, p. 1078, "*II. ZnSe may be prepare … according to …*"
$ZnS + \mathbf{2\ ZnO} \rightarrow \mathbf{3\ Zn} + SO_2$ $\mathbf{Zn} + 2\ H_2O \rightarrow \mathbf{Zn(OH)_2} + H_2$ $\mathbf{Zn(OH)_2} \rightarrow \mathbf{ZnO} + H_2O$	(Guntz, 1926; Patnaik, 2003, p. 989; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction: $ZnS + 2ZnO = 3Zn + SO_2$*" Philpott et al., p. 4," *In DI water zinc reacts with water to form zinc hydroxide ($Zn + 2\ H_2O \rightarrow Zn(OH)_2 + H_2$).*"

$4\ ZnO + \mathbf{ZnCl_2} + \mathbf{5\ H_2O} \rightarrow$ $\mathbf{Zn_5(OH)_8Cl_2{\cdot}H_2O}$ $\mathbf{Zn_5(OH)_8Cl_2{\cdot}H_2O} + 8\ HCl \rightarrow \mathbf{5\ ZnCl_2} + \mathbf{9\ H_2O}$	(Sminčáková et al., 2017; Tanaka et al., 2007)	Tanaka et al., p. 2062, "*Preparation of ZHC particles was carried out in aqueous media as follows. The synthetic ZnO particles (16.0 mmol) were added into 50 ml of 0-2.0 mol dm3 $ZnCl_2$ solutions in a sealed polypropyrene vessel or a stainless-steel autoclave and they were aged at 6–140 °C for 48 h without stirring*" "*These facts allow us to infer that the ZnO particles are hydrolyzed in $ZnCl_2$ solutions to recrystallize as ZHC by the following reactions:* *$ZnO + H_2O \rightarrow Zn^{2+} + 2OH^-$,* *$5Zn^{2+} + 8OH^- + 2Cl^- + H_2O \rightarrow Zn_5(OH)_8Cl_2{\cdot}H_2O$*" Sminčáková et al., p. 1869, Eq. (2).
$\mathbf{6\ NaAlO_2} + Al_2(SO_4)_3 + 12\ H_2O \rightarrow 3\ Na_2SO_4 + \mathbf{8\ Al(OH)_3}$ $\mathbf{Al(OH)_3} + NaOH \rightarrow \mathbf{NaAlO_2} + 2\ H_2O$	(Patnaik, 2003, p. 869; 万 et al., 2018)	万et al., p. 4842, "*体系中发生的反应方程式如下* *$6NaAlO_2 + Al_2(SO_4)_3 + 12H_2O \rightarrow 3Na_2SO_4 + 8Al(OH)_3$ (拟薄水铝石) (2)*"
$Cu_2S + \mathbf{2\ CuO} \rightarrow SO_2 + \mathbf{4\ Cu}$ $\mathbf{2\ Cu} + 2\ NO \rightarrow N_2 + \mathbf{2\ CuO}$	(Patnaik, 2003, p. 643; 马 et al., 2003, p. 339)	
$\mathbf{AsCl_3} + As_2O_3 \rightarrow \mathbf{3\ AsOCl}$ $\mathbf{AsOCl} + HCl \rightarrow \mathbf{As(OH)Cl_2}$ $\mathbf{As(OH)Cl_2} + HCl \rightarrow \mathbf{AsCl_3} + H_2O$	(Efremov et al., 2002; Wiberg et al., 2001, p. 747)	Wiberg et al., p. 747, "*As_2O_3 and $AsCl_3$ comproportionate to give arsenic oxygen chloride: $As_2O_3 + AsCl_3 \rightarrow 3\ AsOCl$.*" Efremov et al., p. 844, "*… this band can be assigned to predominantly stretching vibrations of the 'isolated' multiple bonds AsO in AsOCl, which forms by the reactions … $As(OH)Cl_2 \rightleftharpoons AsOCl + HCl$*"; p. 843, "*…hydrolysis proceeds according to the scheme: $AsCl_3 + H_2O \rightleftharpoons As(OH)Cl_2 + HCl$*"
$\mathbf{H_2S_2O_7} + H_2O \rightarrow \mathbf{2\ H_2SO_4}$ $\mathbf{H_2SO_4} + SO_3 \rightarrow \mathbf{H_2S_2O_7}$	(马 et al., 2003, pp. 266, 268)	
$\mathbf{H_2Cr_2O_7} + H_2O \rightarrow \mathbf{2\ H_2CrO_4}$ $\mathbf{H_2CrO_4} + CrO_3 \rightarrow \mathbf{H_2Cr_2O_7}$	(马 et al., 2003, p. 427)	
$\mathbf{2\ CoO} + Co(CN)_2 \rightarrow \mathbf{3\ Co} + 2\ CO + N_2$ $\mathbf{Co} + H_2O \rightarrow \mathbf{CoO} + H_2$	(马 et al., 2003, pp. 477, 480)	
$B_4C + \mathbf{BO} \rightarrow \mathbf{5\ B} + CO$ $\mathbf{B} + N_2O \rightarrow \mathbf{BO} + N_2$	(Hanner and Gole, 1980; Yoon and Jha, 1996)	Yoon and Jha, p. 613, Table VI. Hanner and Gole, p. 5027, Eq. (2); p. 5029, FIG. 6.
$\mathbf{B_2O_3} + 2\ KBH_4 \rightarrow \mathbf{4\ B} + 2\ KOH + H_2O + 2\ H_2$ $\mathbf{4\ B} + 3\ O_2 \rightarrow \mathbf{2\ B_2O_3}$	(Wang et al., 2013; 马 et al., 2003, p. 107)	Wang et al., p. 2019, Eq. (2).

$6\ AlN + \mathbf{Al_2(SO_4)_3} + 24\ H_2O \rightarrow \mathbf{8\ Al(OH)_3} + 3\ (NH_4)_2SO_4$ $\mathbf{2\ Al(OH)_3} + 3\ H_2SO_4 \rightarrow \mathbf{Al_2(SO_4)_3} + 6\ H_2O$	(马 et al., 2003, pp. 117, 120)	
$\mathbf{6\ AlN} + Al_2(SO_4)_3 + 24\ H_2O \rightarrow \mathbf{8\ Al(OH)_3} + 3\ (NH_4)_2SO_4$ $\mathbf{2\ Al(OH)_3} \rightarrow \mathbf{Al_2O_3} + 3\ H_2O$ $\mathbf{Al_2O_3} + 3\ C + N_2 \rightarrow \mathbf{2\ AlN} + 3\ CO$	(马 et al., 2003, pp. 117, 118)	
$\mathbf{Al_2(SO_4)_3} + 2\ Na_3AlF_6 \rightarrow \mathbf{4\ AlF_3} + 3\ Na_2SO_4$ $\mathbf{AlF_3} + 3\ H_2O \rightarrow \mathbf{Al(OH)_3} + 3\ HF$ $\mathbf{2\ Al(OH)_3} + 3\ H_2SO_4 \rightarrow \mathbf{Al_2(SO_4)_3} + 6\ H_2O$	(Лидин et al., 2007, p. 19; 马 et al., 2003, p. 120)	
$\mathbf{CO_2} + CS_2 + 4\ Cu \rightarrow \mathbf{2\ CO} + 2\ Cu_2S$ $\mathbf{CO} + FeO \rightarrow Fe + \mathbf{CO_2}$	(Wilson and Bremner, 1948; 马 et al., 2003, p. 142)	Wilson and Bremner, p. 13, Eq. (2).
$\mathbf{CO} + H_2 + CaCN_2 \rightarrow CaO + \mathbf{2\ HCN}$ $\mathbf{HCN} + H_2O \rightarrow \mathbf{CO} + NH_3$	(Dedman and Owen, 1961; 马 et al., 2003, p. 138)	Dedman and Owen, p. 681, "*…and suggests that hydrogen cyanide is produced by the reaction of carbon monoxide and hydrogen with calcium cyanamide:* *$CO + H_2 + CaCN_2 \rightarrow CaO + 2\ HCN$*"
$\mathbf{PbS} + 3\ PbSO_4 \rightarrow \mathbf{4\ PbO} + 4\ SO_2$ $\mathbf{PbO} + H_2S \rightarrow \mathbf{PbS} + H_2O$	(Sadovnikov et al., 2011; 马 et al., 2003, p. 180)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction $3PbSO_4 + PbS = 4PbO + 4SO_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction $Pb + ½O2 = PbO$.*"
$PbS + \mathbf{3\ PbSO_4} \rightarrow \mathbf{4\ PbO} + 4\ SO_2$ $\mathbf{PbO} + SO_3 \rightarrow \mathbf{PbSO_4}$	(Sadovnikov et al., 2011; 马 et al., 2003, p. 181)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction $3PbSO_4 + PbS = 4PbO + 4SO_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction $Pb + ½O2 = PbO$.*"
$PbS + \mathbf{2\ PbO} \rightarrow \mathbf{3\ Pb} + SO_2$ $\mathbf{2\ Pb} + O_2 \rightarrow \mathbf{2\ PbO}$	(Лидин et al., 2007, p. 448; 马 et al., 2003, p. 176)	
$\mathbf{5\ H_3PO_4} + POCl_3 \rightarrow \mathbf{3\ H_4P_2O_7} + 3\ HCl$ $\mathbf{H_4P_2O_7} + H_2O \rightarrow \mathbf{2\ H_3PO_4}$	(Лидин et al., 2007, p. 436; 马 et al., 2003, p. 217)	

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O_2SCl_2 + **O_2SF_2** → **2 O_2SFCl** **O_2SFCl** + KSO_2F → **O_2SF_2** + KCl + SO_2	(Greenwood and Earnshaw, 1997, p. 694; Schmidt and Siebert, 1973, p. 849; Seel et al., 1967)	Greenwood and Earnshaw, p. 694, "*Fluorination yields $O2_5F_2$ (also prepared by SO_2 + F_2) and comproportionation of this with O_2SCl_2 and O_2SBr_2 yield the corresponding O_2SFX species.*" Seel et al., p. 111, the second equation.
Na_2S + H_2S → **2 NaHS** **NaHS** + NaOH → **Na_2S** + H_2O	(Reátegui-Romero et al., 2019; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5)(7).
Na_2S + **H_2S** → **2 NaHS** **NaHS** + HCl → **H_2S** + NaCl	(Madsen et al., 2014; Reátegui-Romero et al., 2019; Rule, 1911; Siebenthal, 1915, p. 49)	Reátegui-Romero et al., p. 47, Eqs. (5) Rule, p. 560, "*The substance obtained by this method possesses a light buff tint, is extremely deliquescent, and when freshly prepared dissolves in hydrochloric acid to a clear solution with violent evolution of hydrogen sulphide.*"
ZnS + 2 ZnO → **3 Zn** + SO_2 **Zn** + 2 HCl → **$ZnCl_2$** + H_2 **$ZnCl_2$** + H_2S → **ZnS** + 2 HCl	(Guntz, 1926; Patnaik, 2003, p. 994; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction: $ZnS + 2ZnO = 3Zn + SO_2$*" Philpott et al., p. 4,"*... as detailed in the following chemical reactions: $Zn(OH)_2$ + 2 HCl → $ZnCl_2$ + 2 H_2O and Zn + 2 HCl → $ZnCl_2$ + H_2.*" Patnaik, p. 994, "*Also, zinc sulfide may be prepared in the laboratory by passing hydrogen sulfide through an aqueous solution of a soluble zinc salt, such as zinc chloride or zinc nitrate.*"
3 AsS_2^- + AsO_3^{3-} + 6 H^+ → **2 As_2S_3** + 3 H_2O **As_2S_3** + HS^- + NH_3 → **2 AsS_2^-** + NH_4^+	(Rich, 2007, p. 388)	Rich, p. 388, "*The thioarsenites react with acids, forming As2S3: ... 3 AsS_2^- + AsO_3^{3-} + 6 H_3O^+ → 2 As_2S_3 + 9 H_2O*" "*Alkali sulfides dissolve the sulfides, e.g.: As_2S_3 + HS^- + NH_3 → 2 AsS_2^- + NH_4^+*"
$H_2S_2O_7$ + H_2O → **2 H_2SO_4** **H_2SO_4** + SO_3 → **$H_2S_2O_7$**	(马 et al., 2003, pp. 266, 268)	

FeS_2 + **Fe** → **2 FeS** **FeS** + C + CaO → **Fe** + CO + CaS	(曹 and 王, 1982, pp. 324, 334)	
6 AlN + **$Al_2(SO_4)_3$** + 24 H_2O → **8 $Al(OH)_3$** + 3 $(NH_4)_2SO_4$ **2 $Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(马 et al., 2003, pp. 117, 120)	
$Al_2(SO_4)_3$ + 2 Na_3AlF_6 → **4 AlF_3** + 3 Na_2SO_4 **AlF_3** + 3 H_2O → **$Al(OH)_3$** + 3 HF **2 $Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(Лидин et al., 2007, p. 19; 马 et al., 2003, p. 120)	
PbS + 3 $PbSO_4$ → **4 PbO** + 4 SO_2 **PbO** + H_2S → **PbS** + H_2O	(Sadovnikov et al., 2011; 马 et al., 2003, p. 180)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction $3PbSO_4$ + PbS = 4PbO + $4SO_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction Pb + ½O2 = PbO.*"
PbS + **3 $PbSO_4$** → **4 PbO** + 4 SO_2 **PbO** + SO_3 → **$PbSO_4$**	(Sadovnikov et al., 2011; 马 et al., 2003, p. 181)	Sadovnikov et al., p. 1865, "*Systematization of earlier data suggests that the overall reaction of bulk PbS with gaseous oxygen is represented by chemical equation (1) and includes lead sulfate formation via reaction (2), lead sulfate decomposition via reaction (5) and via the overall reaction $3PbSO_4$ + PbS = 4PbO + $4SO_2$, lead metal formation via reactions (5) and (6), and lead oxidation via the reaction Pb + ½O2 = PbO.*"
PbS + 2 PbO → **3 Pb** + SO_2 **Pb** + H_2S → **PbS** + H_2	(Лидин et al., 2007, p. 448; 马 et al., 2003, p. 177)	

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2 ZnO + ZnS + 3 Se → **3 ZnSe** + SO_2 **2 ZnSe** + 3 O_2 → **2 ZnO** + 2 SeO_2	(Georgobiani et al., 2005; Wagenknecht and Juza, 1965, p. 1078)	Georgobiani et al., p. 607, the Eq. Wagenknecht and Juza, p. 1078, "*II. ZnSe may be prepare … according to …*"

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O_2SCl_2 + **O_2SF_2** → **2 O_2SFCl** **O_2SFCl** + KSO_2F → **O_2SF_2** + KCl + SO_2	(Greenwood and Earnshaw, 1997, p. 694; Schmidt and Siebert, 1973, p. 849; Seel et al., 1967)	Greenwood and Earnshaw, p. 694, "*Fluorination yields $O2_sF_2$ (also prepared by SO_2 + F_2) and comproportionation of this with O_2SCl_2 and O_2SBr_2 yield the corresponding O_2SFX species.*" Seel et al., p. 111, the second equation.
$Al_2(SO_4)_3$ + 2 Na_3AlF_6 → **4 AlF_3** + 3 Na_2SO_4 **AlF_3** + 3 H_2O → **$Al(OH)_3$** + 3 HF **2 $Al(OH)_3$** + 3 H_2SO_4 → **$Al_2(SO_4)_3$** + 6 H_2O	(Лидин et al., 2007, p. 19; 马 et al., 2003, p. 120)	
2 HF + SiF_4 → **H_2SiF_6** **H_2SiF_6** + 4 H_2O → **6 HF** + H_4SiO_4	(曹 and 王, 1982, pp. 106, 108)	

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O_2SCl_2 + **O_2SF_2** → **2 O_2SFCl** **O_2SFCl** + KSO_2F → **O_2SF_2** + KCl + SO_2	(Greenwood and Earnshaw, 1997, p. 694; Schmidt and Siebert, 1973, p. 849; Seel et al., 1967)	Greenwood and Earnshaw, p. 694, "*Fluorination yields $O2_SF_2$ (also prepared by SO_2 + F_2) and comproportionation of this with O_2SCl_2 and O_2SBr_2 yield the corresponding O_2SFX species.*" Seel et al., p. 111, the second equation.
ZnS + 2 ZnO → **3 Zn** + SO_2 **Zn** + 2 HCl → **$ZnCl_2$** + H_2 **$ZnCl_2$** + H_2S → **ZnS** + 2 HCl	(Guntz, 1926; Patnaik, 2003, p. 994; Philpott et al., 2022)	Guntz, p. 196, "*L'élimination de l'oxyde se fait par la réaction:* *ZnS + 2ZnO = 3Zn + SO_2*" Philpott et al., p. 4,"*... as detailed in the following chemical reactions: $Zn(OH)_2$ + 2 HCl → $ZnCl_2$ + 2 H_2O and Zn + 2 HCl → $ZnCl_2$ + H_2.*" Patnaik, p. 994, "*Also, zinc sulfide may be prepared in the laboratory by passing hydrogen sulfide through an aqueous solution of a soluble zinc salt, such as zinc chloride or zinc nitrate.*"
4 ZnO + **$ZnCl_2$** + **5 H_2O** → **$Zn_5(OH)_8Cl_2·H_2O$** **$Zn_5(OH)_8Cl_2·H_2O$** + 8 HCl → **5 $ZnCl_2$** + **9 H_2O**	(Sminčáková et al., 2017; Tanaka et al., 2007)	Tanaka et al., p. 2062, "*Preparation of ZHC particles was carried out in aqueous media as follows. The synthetic ZnO particles (16.0 mmol) were added into 50 ml of 0-2.0 mol dm3 $ZnCl_2$ solutions in a sealed polypropyrene vessel or a stainless-steel autoclave and they were aged at 6–140 ℃ for 48 h without stirring*" "*These facts allow us to infer that the ZnO particles are hydrolyzed in $ZnCl_2$ solutions to recrystallize as ZHC by the following reactions:* *$ZnO + H_2O → Zn^{2+} + 2OH^-$,* *$5Zn^{2+} + 8OH^- + 2Cl^- + H_2O → Zn_5(OH)_8Cl_2·H_2O$*" Sminčáková et al., p. 1869, Eq. (2).
$AsCl_3$ + As_2O_3 → **3 AsOCl** **AsOCl** + HCl → **$As(OH)Cl_2$** **$As(OH)Cl_2$** + HCl → **$AsCl_3$** + H_2O	(Efremov et al., 2002; Wiberg et al., 2001, p. 747)	Wiberg et al., p. 747, "*As_2O_3 and $AsCl_3$ comproportionate to give arsenic oxygen chloride: As_2O_3 + $AsCl_3$ → 3 AsOCl.*" Efremov et al., p. 844, "*... this band can be assigned to predominantly stretching vibrations of the 'isolated' multiple bonds AsO in AsOCl, which forms by the reactions ... $As(OH)Cl_2$ ⇌ AsOCl + HCl*"; p. 843, "*…hydrolysis proceeds according to the scheme: $AsCl_3$ + H_2O ⇌ $As(OH)Cl_2$ + HCl*"
$AlCl_3$ + 3 $LiAlH_4$ → **4 AlH_3** + 3 LiCl **2 AlH_3** + 2 BCl_3 → **2 $AlCl_3$** + B_2H_6	(Zuckerman and Hagen, 1991, p. 14; 듀 et al., 2003, p. 122)	Zuckerman and Hagen, p. 14, Eq. (a).

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5 B_2H_6 + 2 BBr_3 → **6 B_2H_5Br** **B_2H_5Br** + $(CH_3)_2SbH$ → **B_2H_6** + $(CH_3)_2SbBr$	(Burg and Grant, 1959; Schlesinger and Burg, 1931)	Schlesinger and Burg, p. 4322, "*A similar experiment …*" Burg and Grant, p.3, "*Its vapor density …*"