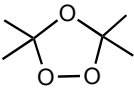


Safety Instruction for Hazardous Materials (Appendix 3-4)

Structures and Generation of Explosives

"Safety Guidance for Chemical Experiments 4th Edition" ed. by The Chemical Society of Japan, Maruzen (1999)

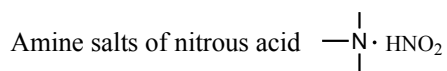
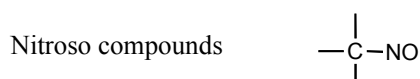
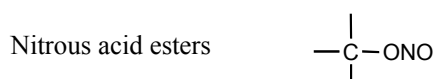
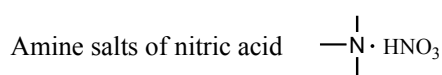
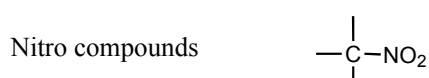
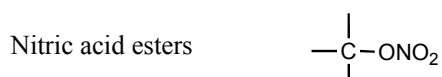
Bond	Explosive compounds	Chemical structures	Generation reaction
O-O	High concentrated hydrogen peroxide	$H_2O_2$	
	Organic peroxides	$R-O-O-R'$	Alcohols + $H_2O_2$ Halides + $H_2O_2$ Aldehydes + $H_2O_2$ Ketones + $H_2O_2$ Carboxylic acids + $H_2O_2$ Ethers + $H_2O_2$
	Ozonides		Unsaturated hydrocarbon + $O_3$
N-O	Nitric acid esters	$\begin{array}{c}   \\ -C-ONO_2 \\   \end{array}$	Alcohols + $HNO_3$ Carbohydrates + $HNO_3$
	Nitrous acid esters	$\begin{array}{c}   \\ -C-ONO \\   \end{array}$	Alcohols + $HNO_2$ Halides + $MNO_2$
	Nitro compounds	$\begin{array}{c}   \\ -C-NO_2 \\   \end{array}$	Halides + $M'NO_2$ Hydrocarbons, others + $HNO_3$
	Amine salts of nitric acid	$\begin{array}{c}   \\ -N \cdot HNO_3 \\   \end{array}$	Amines + $HNO_3$
	Ammonium nitrate	$NH_4NO_3$	$NH_3 + HNO_3$
	Nitramines	$\begin{array}{c}   \quad   \\ -C-N-NO_2 \\   \end{array}$	Dehydration of amino nitrates Amines + $HNO_3$
	Nitroso compounds	$\begin{array}{c}   \\ -C-NO \\   \end{array}$	Phenols + $HNO_2$
	Ketone oximes	$O=C-C=NOH$	
	Hydroxyamine derivatives	$\begin{array}{c} R^1 \\ \diagdown \\ N-OH \\ \diagup \\ R^2 \end{array}$	
	Fulminates	$M'-O-N=C$	Metal nitrates + $HNO_3$ + Alcohols

X-O	Dichlorine Heptoxide	$\text{Cl}_2\text{O}_7$	
	Amine salts of perchloric acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HClO}_4 \\   \end{array}$	
	Perchloric acid esters	$\begin{array}{c}   \\ -\text{C}-\text{OClO}_3 \\   \end{array}$	Alcohols + $\text{HClO}_4$
	Perchloryl compounds	$\begin{array}{c}   \\ -\text{C}-\text{ClO}_3 \\   \end{array}$	$\begin{array}{c}   \\ -\text{C}-\text{H} + \text{FClO}_3 \\   \end{array}$
	Chloric acid	$\text{HClO}_3$	$\text{M}'\text{ClO}_3 + \text{Acids}$
	Chlorine dioxide	$\text{ClO}_2$	$\text{M}'\text{ClO}_2 + \text{Acids}$
	Heavy metal salts of chloric acid	$\text{M}'\text{ClO}_3$	$\text{KClO}_3 + \text{Heavy metal salts, Hg, Ag, Pb}$
	Ammonium chlorate	$\text{NH}_4\text{ClO}_3$	$\text{M}'\text{ClO}_3 + \text{NH}_3$ or Ammonium salts
	Amine salts of chloric acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HClO}_3 \\   \end{array}$	$\text{M}'\text{ClO}_3 + \text{Amine salts}$
	Chloric acid esters	$\begin{array}{c}   \\ -\text{C}-\text{OClO}_2 \\   \end{array}$	
	Chlorous acid	$\text{HClO}_2$	
	Hypochlorous acid	$\text{HClO}$	
	Chlorine monoxide	$\text{Cl}_2\text{O}$	
	Salts of hypochlorous acid	$\text{M}'\text{ClO}$	
	Hypochlorous acid esters	$\begin{array}{c}   \\ -\text{C}-\text{OCl} \\   \end{array}$	
	Amine salts of boromic acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HBrO}_3 \\   \end{array}$	
	Ammonium bromate	$\text{NH}_4\text{BrO}_3$	
	Amine salts of iodic acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HIO}_3 \\   \end{array}$	
	Ammonium iodate	$\text{NH}_4\text{IO}_3$	
	Permanganic acid	$\text{HMnO}_4$	$\text{M}'\text{MnO}_4 + \text{H}_2\text{SO}_4$
	Manganese(VII) oxide (Dimanganese heptoxide)	$\text{Mn}_2\text{O}_7$	$\text{M}'\text{MnO}_4 + \text{H}_2\text{SO}_4$
	Ammonium Permanganate	$\text{NH}_4\text{MnO}_4$	$\text{M}'\text{MnO}_4 + \text{Ammonium salts}$
	Amine salts of permanganic acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HMnO}_4 \\   \end{array}$	
	Ammonium dichromate	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7$	$\text{M}'_2\text{Cr}_2\text{O}_7 + \text{Ammonium salts}$
	Amine salts of dichromic acid	$\left( \begin{array}{c}   \\ -\text{N} \cdot \\   \end{array} \right)_2 \text{H}_2\text{Cr}_2\text{O}_7$	

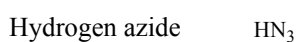
N-N	Amine salts of nitrous acid	$\begin{array}{c}   \\ -\text{N} \cdot \text{HNO}_2 \\   \end{array}$	Amines + $\text{HNO}_2$
	Ammonium nitrite	$\text{NH}_4\text{NO}_2$	$\text{M}'\text{NO}_2 + \text{NH}_4\text{X}$
	Nitrosoamines	$\begin{array}{c}   \quad   \\ -\text{C}-\text{N}-\text{NO} \\   \end{array}$	$\begin{array}{c}   \quad   \\ -\text{C}-\text{N} \\   \quad   \\ \text{H} \end{array} + \text{HNO}_2$
	Diazonium salts	$\begin{array}{c}   \\ -\text{C}-\overset{+}{\text{N}}\equiv\text{N} \\   \\ \text{X}^- \end{array}$	Amines + $\text{HNO}_2 + \text{HX}$
	Diazo oxides	$\text{N}_2=\overset{ }{\text{C}}-\cdots-\overset{ }{\text{C}}=\text{O}$	$\begin{array}{c}   \quad   \\ \text{H}_2\text{N}-\text{C}-\cdots-\text{C}-\text{OH} \\   \quad   \end{array} + \text{HNO}_2 + \text{HX}$
	Hydrazine derivatives	$\begin{array}{c}   \quad   \\ -\text{N}-\text{N}- \\   \quad   \end{array}$	
	Hydrogen azide	$\text{HN}_3$	Metal azides + acids
	Heavy metal azides	$\text{M}'\text{N}_3$	$\begin{array}{cc} \text{NaNH}_3 & \text{N}_2\text{H}_4 \\ + & + \\ \text{N}_2\text{O} & \text{NaNO}_2 \\ \downarrow & + \\ & \text{RONO} \\ \leftarrow & \text{NaN}_3 + \text{Heavy meal salts} \end{array}$
	Halogen azides	$\text{XN}_3$	$\text{NaN}_3 + \text{Halogen or hypohalogenous acid salts}$
	Organic azides	$\begin{array}{c}   \\ -\text{C}-\text{N}_3 \\   \end{array}$	Halides + $\text{NaN}_3$
	Isotetracene derivatives		
	Nitrogen long chain compounds		
N-M	Nitriles	$\text{M}'_3\text{N}$	
	Imides	$\text{M}'_2\text{NH}$	
	Amides	$\text{M}'\text{NH}_2$	
	Amine metal complexes		$\text{MX} + n\text{NH}_3$
N-X	Nitrogen halides	$\text{NX}_3$	$\text{X}_2$ or $\text{M}'\text{XO} + \text{NH}_3$ or Ammonium salts
	Nitrogen sulfide	$\text{N}_4\text{S}_4$	$\text{SCl}_2$ or $\text{S}_2\text{Cl}_2 + \text{NH}_3$

C-C	Acetylene	$\text{HC}\equiv\text{CH}$	$\text{CaC}_2 + \text{H}_2\text{O}$
	Heavy metal acetylide	$\text{M}'\text{C}\equiv\text{CM}'$	Heavy metal salts + $\text{C}_2\text{H}_2$
	Acetylene halides	$\text{X}-\text{C}\equiv\text{C}-\text{X}$	
	Polyacetylenes, acetylene derivatives etc. and their halogen or heavy metal derivatives		
	Heavy metal salts of oxalic acid	$\begin{array}{c} \text{COOM}' \\   \\ \text{COOM}' \end{array}$	$\begin{array}{c} \text{COOH} \\   \\ \text{COOH} \end{array} + \text{Heavy metal salts}$
	Ethylene oxide	$\begin{array}{c} \text{CH}_2 \\   \\ \text{CH}_2 \end{array} \text{O}$	

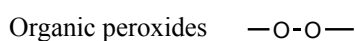
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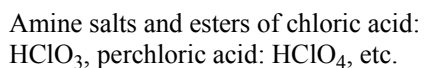
Compounds with a N-N bond:



Compounds with an O-O bond:



Compounds with an O-halogen bond:



Others:

