

P-68 Nomenclature of organic compounds of the Groups 13, 14, 15, 16, and 17 elements not included in Sections 62-67.

P-68.0 Introduction

P-68.1 Nomenclature of compounds of Group 13

P-68.2 Nomenclature of compounds of Group 14

P-68.3 Nomenclature of compounds of Group 15

P-68.4 Nomenclature of compounds of Group 16

P-68.5 Nomenclature of compounds of Group 17

P-68.0 Introduction

The nomenclature of organic compounds is based on two approaches. General principles, rules and conventions are applicable, with some rare exceptions, to all compounds belonging to Groups 13 through 17. They have been described and illustrated in previous Chapters. Another approach is based on the identical treatment of compounds within one Group. Up until now the nomenclature of compounds of Group 13 was essentially that of boron compounds. The nomenclature of aluminium, gallium, indium and thallium compounds in these recommendations has been modeled on that of boron compounds. It is thus advantageous to describe all compounds of a Group, to clearly identify their similarities and underline exceptions, if any. This way should facilitate the naming of new compounds by comparison with established models.

Another aspect of nomenclature described Group by Group is to easily grasp the general patterns of the different Groups. The nomenclature of Group 15 is diversified. Suffixes are associated with nitrogen; mononuclear and polynuclear acids are the base of many derivatives of phosphorus, arsenic and antimony compounds; bismuth compounds are all named substitutively. In comparison, compounds of Group 14 are essentially named by substitutive nomenclature. Thus, the compound $C_6H_5-PH-OCH_3$ is named as an ester, methyl phenylphosphinate, but the compound, $C_6H_5-SnH(OCH_3)_2$ is named substitutively as dimethoxy(phenyl)stannane or phenylstannanebis(ylum) dimethanolate, in spite of their apparent similarity of structures.

A third purpose is assigned to this Section. Substitutive nomenclature treats equally metal, semi-metals, and non-metals when the central atom is directly linked to carbon. The Group treatment is illustrating many aspects of the nomenclature of organometallic compounds, again facilitating the naming of new compounds by applying the general rules recommended for the nomenclature of organic compounds. This is particularly evident for the nomenclature of compounds of Groups 13 and 14, for which the extensive and well known nomenclature of boron and carbon compounds serves as models to name the other compounds of the Group.

P-68.1 Nomenclature of compounds of Group 13

Except for the polynuclear boron hydrides, boron compounds have traditionally been included in the recommendations for naming inorganic compounds; substitutive nomenclature has been applied on the basis of parent hydrides, substituent groups and appropriate operations to complement the nomenclature of polynuclear compounds, for example names formed by skeletal replacement ('a') nomenclature, multiplicative names, and names derived from functional parent acids. The nomenclature of Al, Ga, In, and Tl compounds, including formal organometallic compounds, is

patterned on boron nomenclature, with the exception of boronic acid, $B(OH)_3$, boronic acid, $HB(OH)_2$, and borinic acid, $H_2B(OH)$ which are retained names of functional parent compounds.

- P-68.1.1 Parent hydrides
- P-68.1.2 Substituent groups derived from parent hydrides
- P-68.1.3 Modification of the degree of hydrogenation
- P-68.1.4 Parent structures
- P-68.1.5 Substitutive nomenclature
- P-68.1.6 Adducts

P-68.1.1 Parent hydrides

- P-68.1.1.1 Mononuclear hydrides
- P-68.1.1.2 Acyclic polynuclear hydrides
- P-68.1.1.3 Cyclic hydrides

P-68.1.1.1 Mononuclear hydrides

The names of the mononuclear hydrides are listed in Table 1.2. The standard bonding number is 3; the λ -convention (see P-14.1) is used to indicate nonstandard bonding numbers. The names of these parent hydrides are preselected names (see P-12.2).

Examples:

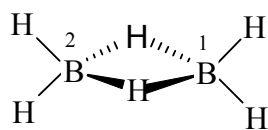
BH_3	BH	AlH_3	InH_3	TlH_3
borane	λ^1 -borane	alumane	indigane	thallane

P-68.1.1.2 Acyclic polynuclear hydrides

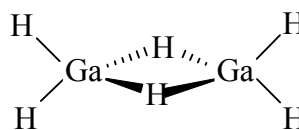
P-68.1.1.2.1 Acyclic di- and polynuclear parent hydrides are named by citing the number of skeletal atoms in the molecule as a multiplying prefix, 'di', 'tri', etc. in front of the name of the mononuclear parent hydride. The number of hydrogen atoms in the molecule is designated by an arabic numeral enclosed in parentheses immediately following the name derived as above. These numbers are omitted when there is no ambiguity or by convention in the names of acyclic polynuclear hydrides. A specific nomenclature is used to name polycyclic polyboranes; these names are described in Chapter I-11 of ref. 14. Parent hydrides are preselected preferred IUPAC names.

Examples:

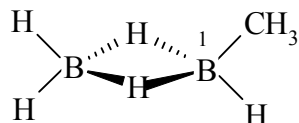
$\overset{2}{H_2}B-\overset{1}{BH_2}$	$\overset{3}{H_2}B-\overset{2}{BH}-\overset{1}{BH_2}$
diborane(4) (preselected name)	triborane(5) (preselected name)



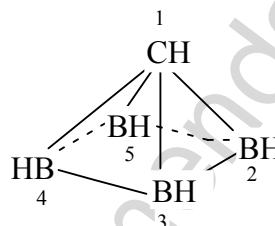
diborane(6) (preselected name)



digallane(6) (preselected name)



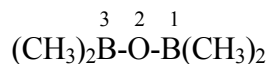
1-methyldiborane(6) (PIN)



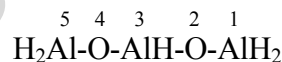
1-carbapentaborane(5) (PIN)

P-68.1.1.2.2 Compounds formed of alternating heteroatoms are considered as nonfunctional parent structures having preselected names.

Examples:



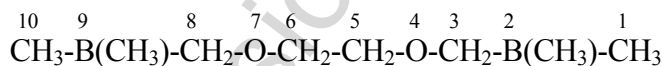
tetramethyldiboroxane (PIN)



trialuminoxane (preselected name)

P-68.1.1.2.3 Compounds named by skeletal replacement ('a') nomenclature

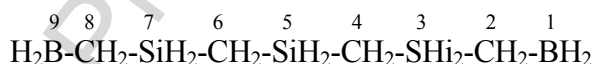
Examples:



2,9-dimethyl-4,7-dioxa-2,9-diboradecane (PIN)

[ethane-1,2-diylbis(oxymethylene)]bis(dimethylborane)

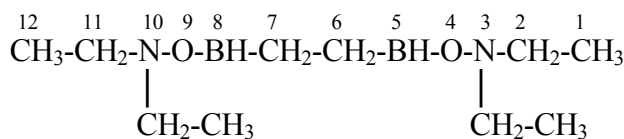
B,B,B',B'-tetramethyl[ethane-1,2-diylbis(oxymethylene)]bis(borane)



3,5,7-trisila-1,9-diboranonane (PIN)

[silanediylbis(methylene)]bis[(boranylmethyl)silane]

Si,Si'-bis(boranylmethyl)[silanediylbis(methylene)]bis(silane)



3,10-diethyl-4,9-dioxa-3,10-diaza-5,8-diboradodecane (PIN)
 O,O'-[(ethane-1,2-diylbis(boranediy))bis(*N,N'*-diethylhydroxylamine)]

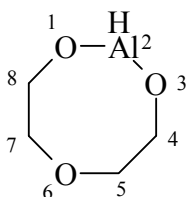
P-68.1.1.3 Cyclic parent hydrides

Nomenclature of polyhedral polyboranes constitute a rich and diversified system characterized by specific prefixes. It has been described and illustrated in the Section I-11.2 (ref. 14)(Red Book); it is not reproduced in these recommendations.

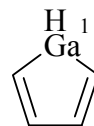
Cyclic parent hydrides containing Group 13 atom(s) belong to all the different classes of rings and ring systems described in Chapter 2. Preferred names are selected according to the general rules given for each class.

P-68.1.1.3.1 Hantzsch-Widman names (see P-22.2.2) are preferred for monocyclic rings with three through ten ring members. Names formed by skeletal replacement ('a') nomenclature are not recommended.

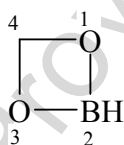
Examples:



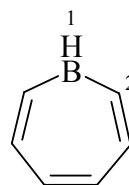
1,3,6,2-trioxaaluminocane (PIN)



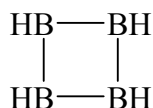
1*H*-gallole (PIN)



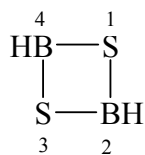
1,3,2-dioxaboretane (PIN)



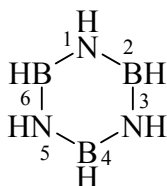
1*H*-borepine (PIN)



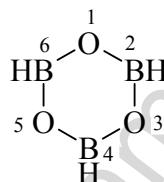
tetraboretane (preselected name; see P-12; P-22.2.4)
 cyclotetraborane(4)



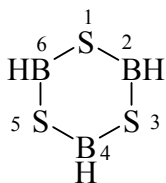
1,3,2,4-dithiadiboretane (preselected name; see P-12, P-22.2.5)
 cyclodiborathiane



1,3,5,2,4,6-triazatriborinane
 (preselected name)
 borazine
 cyclotriborazane



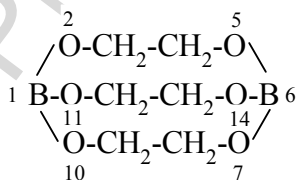
1,3,5,2,4,6-trioxatriborinane
 (preselected name)
 boroxin
 cyclotriboroxane



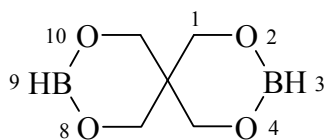
1,3,5,2,4,6-trithiatriborinane (preselected name)
 borthiin
 cyclotriborathiane

P-68.1.1.3.2 von Baeyer and spiro compounds

Examples:



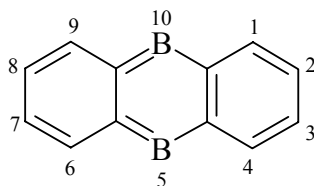
2,5,7,10,11,14-hexaoxa-1,6-diborabicyclo[4.4.4]tetradecane (PIN)



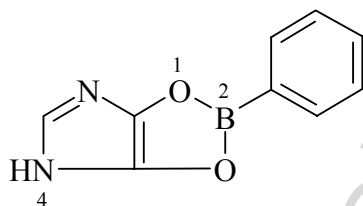
2,4,8,10-tetraoxa-3,9-diborospiro[5.5]undecane (PIN)

P-68.1.1.3.3 Fused ring systems

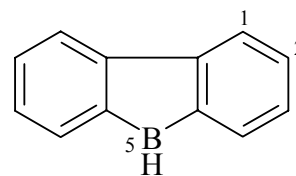
Examples:



boranthrene (PIN)



2-phenyl-4*H*-[1,3,2]dioxaborolo[4,5-*d*]imidazole (PIN)



5*H*-dibenzoborole (PIN)

P-68.1.2 Names of substituent groups derived from parent hydrides

Names of substituent groups -BH_2 and =BH derived from borane are formed by the method described in P-29.2.2; these are preselected preferred IUPAC names.

Examples:



boranyl (preselected name)
 (not boryl)



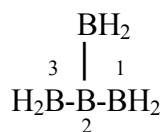
boranylidene (preselected name)
 (not borylidene)



boranediyl (preselected name)
 (not borylidene)
 (not borylene)



boranetriyl (preselected name)
 (not borylidyne)



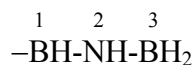
2-boranyltriborane(5) (preselected name)



triboran(5)-1-yl (preselected name)



diboroxanyl (preselected name)



diborazan-1-yl (preselected name)



alumanyl (preselected name)



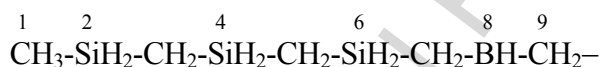
indiganyl (preselected name)



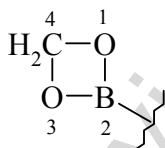
gallanyl (preselected name)



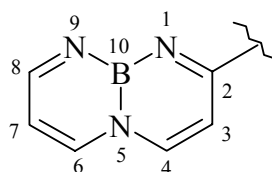
thallanyl (preselected name)



2,4,6-trisila-8-boranonan-9-yl (PIN)



1,3,2-dioxaboretan-2-yl
 (preselected name)

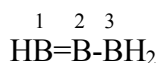


[1,3,2]-diazaborino[1,2-*a*][1,3,2]-diazaborin-2-yl (PIN)

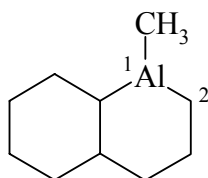
P-68.1.3 Modification of the degree of hydrogenation

Double bonds are denoted by the 'ene' ending, as described in Section P-31.1, and 'hydro' prefixes as indicated in P-33.2.

Example:



triborene(5) (preselected name)



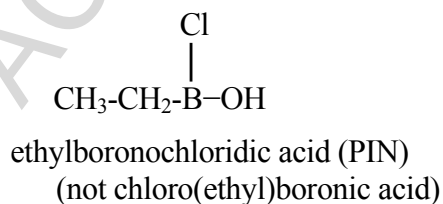
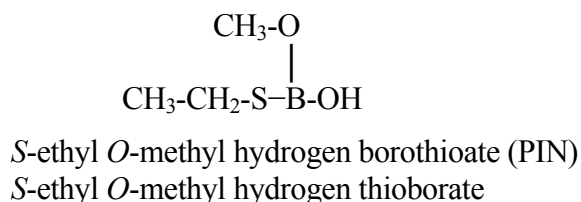
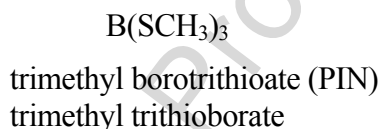
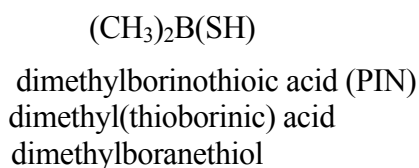
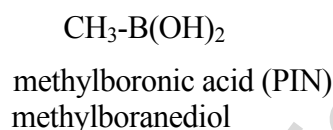
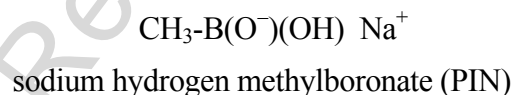
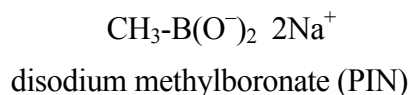
1-methyldecahydro-1-benzaluminine (PIN)

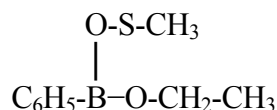
P-68.1.4 Functional parents

P-68.1.4.1 The names boric acid, boronic acid, and borinic acid are preselected retained names denoting the compounds $B(OH)_3$, $HB(OH)_2$, and $H_2B(OH)$, respectively (see P-67.1.1). They are used as preferred IUPAC names to form the names of the corresponding salts, esters, or anhydrides; or when substituted, for example methylboronic acid for $CH_3-B(OH)_2$. Chalcogen analogues are named using infixes to denote functional replacement of oxygen by S, Se, and Te.

Acid names such as these are not used for other elements of Group 13, which are named using substitutive nomenclature based on the appropriate parent hydride. For names such as methaneboronic acid vs. methylboronic acid for $CH_3-B(OH)_2$, see P-67.1.2.4.1.

Examples:

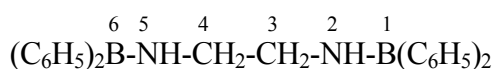




O-ethyl *OS*-methyl phenylborono(thioperoxoate) (PIN)
O-ethyl *OS*-methyl phenyl(thioperoxy)boronate



sodium dimethylalumanolate (PIN)

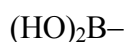


N,N-ethane-1,2-diylbis(diphenylborinic amide) (PIN)
 (not *N,N'*-bis(diphenylboryl)ethane-1,2-diamine)
 (not *N,N'*-ethane-1,2-diylbis(diphenylborananine)
 (not 1,1,6,6-tetraphenyl-2,5-diaza-1,6-diborahexane)

P-68.1.4.2 Substituent groups for the boron acids

The general methodology for forming substituent groups derived from boron acids has been described in P-67.1.4.2.1. Their names are formed substitutively on the basis of the parent hydride 'borane', BH₃. The name 'borono', for (HO)₂B⁻, is retained.

Examples:



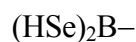
borono (preselected name)
 dihydroxyboranyl



sulfanylboranyl (preselected name)



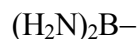
thioborono (preselected name)
 hydroxyl(sulfanyl)boranyl



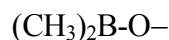
diselenoborono (preselected name)
 bis(selanyl)boranyl



chloroboranyl (preselected name)



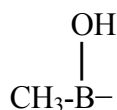
diaminoboranyl (preselected name)



(dimethylboranyl)oxy (PIN)



(methylboranyl)amino (PIN)



methyl(hydroxy)boranyl (PIN)

P-68.1.5 Substitutive nomenclature

Derivatives of borane, BH_3 , are named as substitution products, the substituents being denoted by suffixes and prefixes in accordance with the principles, rules and conventions of substitutive nomenclature. The three acids described in P-68.1.4 have retained names that are preferred IUPAC names.

Derivatives are named in accordance with the seniority of classes described by the general rule in Section P-41. Thus, acids having retained names have seniority over other suffixes. Suffixes are used when recommended in substitutive nomenclature, in accordance with the general rule described in Section P-43. In the absence of a suffix that has priority for naming organic compounds, when a choice is possible for selecting the parent hydride, the seniority order is as follows: $\text{N} > \text{P} > \text{As} > \text{Sb} > \text{Bi} > \text{Si} > \text{Ge} > \text{Sn} > \text{Pb} > \text{B} > \text{Al} > \text{Ga} > \text{In} > \text{Tl} > \text{O} > \text{S} > \text{Se} > \text{Te} > \text{C}$ (substituent groups).

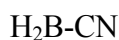
P-69.1.5.1 Suffix nomenclature

P-69.1.5.2 Prefix nomenclature

P-68.1.5.1 Suffix nomenclature

Suffixes, when available, are used to denote characteristic groups; prefixes are not recommended. Suffixes containing a carbon atom generate preferred IUPAC names.

Examples:

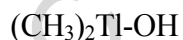


boranecarbonitrile (PIN)



hypodiboric acid (preselected PIN; see P-67)

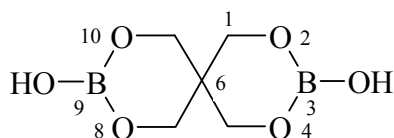
diborane(4)tetrol



dimethylthallanol (PIN)



sodium dimethylthallanolate (PIN)



2,4,8,10-tetraoxa-3,9-diborasp[5.5]undecane-3,9-diol (PIN)

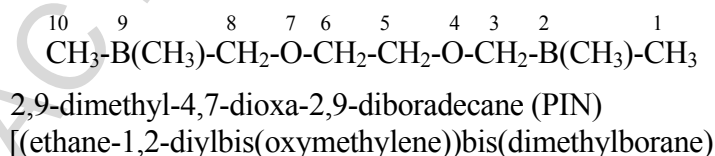
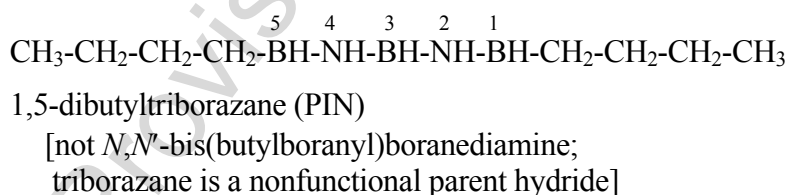
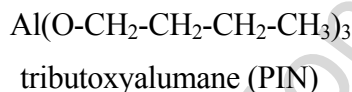
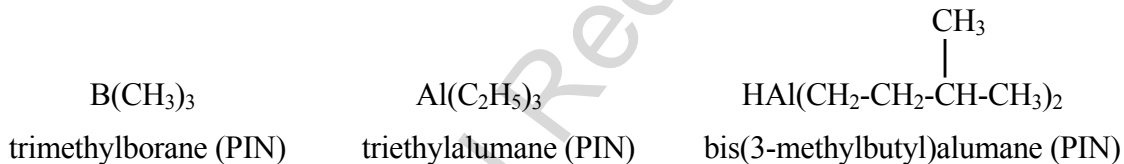
P-68.1.5.2 Prefix nomenclature

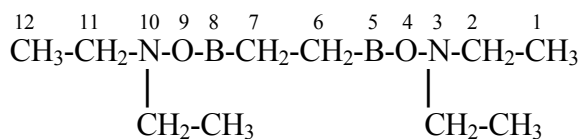
- P-68.1.5.2.1 Substituted parent hydrides;
- P-68.1.5.2.2 Compounds with bridging prefixes
- P-68.1.5.2.3 Compounds with groups of higher seniority.

P-68.1.5.2.1 Substituted parent hydrides

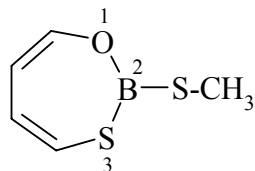
Normal prefix names are used to describe substituents of the B, Al, In, Tl parent hydrides.

Examples:

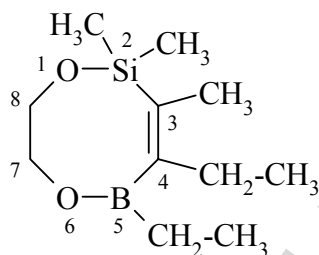




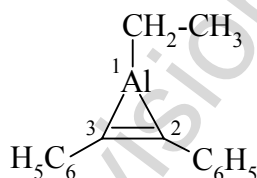
3,10-diethyl-4,9-dioxa-3,10-diaza-5,8-diboradodecane (PIN)
O,O'-[(ethane-1,2-diyl)diboranediy]bis(*N,N*-diethylhydroxylamine)



2-(methylsulfanyl)-1,3,2-oxathiaborepine (PIN)



4,5-diethyl-2,2,3-trimethyl-2,5,7,8-tetrahydro-1,6,2,5-dioxasilaborocine (PIN)



1-ethyl-2,3-diphenylaluminirene (PIN)

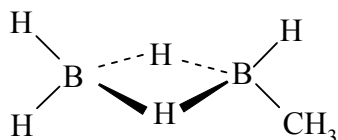
P-68.1.5.2.2 Compounds with bridging atoms or groups

Derivatives of di- and polyheteranes of the Group 13 elements, such as diborane, the polyboranes, and related Al, In, and Tl congeners, are named using substitutive nomenclature. When a nonbridging hydrogen is substituted, locants are used in the customary way. Bridging atoms or groups are indicated as follows:

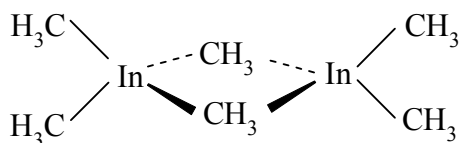
- (a) a bridging substituent is indicated by adding the Greek letter μ (mu) immediately before the name of the substituent and separating its prefix name from that of the rest of the name by hyphens;
- (b) two or more bridging substituents of the same kind are indicated by 'di- μ ' or 'bis- μ ', and so on;

- (c) bridging substituents are listed with the other substituents in alphanumerical order;
- (d) where the same substituent is present as a bridging group and a nonbridging substituent it is cited first as a bridging substituent.

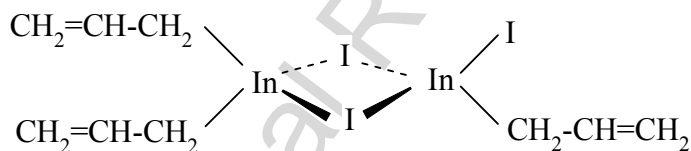
Examples:



methylidiborane(6) (PIN)



di- μ -methyl-tetramethyldiindigane(6) (PIN)



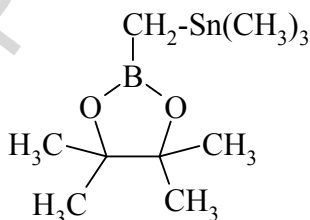
di- μ -iodo-iodotri(prop-2-en-1-yl)diindigane(6) (PIN)

For more examples of the application of the symbol μ , see Rule I-11.4.3.2, ref. 14.

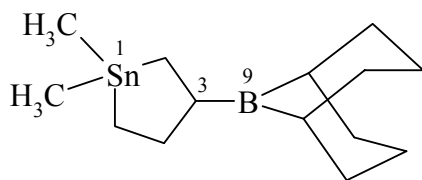
P-68.1.5.2.3 Compounds with groups of higher seniority.

When required, parent structures and prefixes are chosen in accordance with the seniority of classes.

Examples:



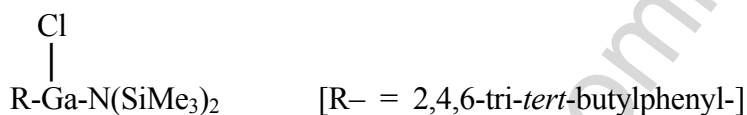
trimethyl[(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)methyl]stannane (PIN)
(Sn is senior to B)



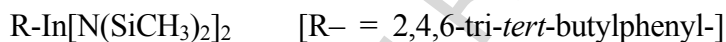
3-(9-borabicyclo[3.3.1]nonan-9-yl)-1,1-dimethylstannolane (PIN)



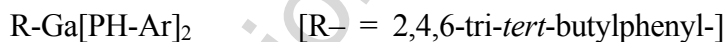
2,2'-boranediylbis(1,1,1,3,3,3-hexamethyldisilazane) (PIN)
 (not *N,N,N',N'*-tetrakis(dimethylsilyl)boranediamine;
 disilazane is a nonfunctional parent hydride; N is senior to B)



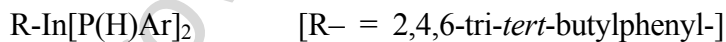
2-[chloro(2,4,6-tri-*tert*-butylphenyl)gallanyl]-1,1,1,3,3,3-hexamethyldisilazane (PIN)
 (disilazane is a nonfunctional parent hydride; N is senior to Ga;)



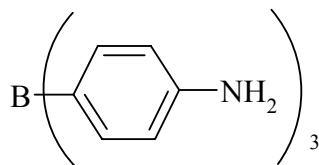
2,2'-[(2,4,6-tri-*tert*-butylphenyl)indigane-diyl]bis(1,1,1,3,3,3-trimethyldisilazane) (PIN)
 (disilazane is a nonfunctional parent hydride; N is senior to In)



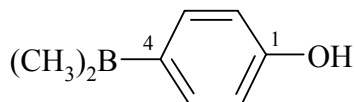
[(2,4,6-tri-*tert*-butylphenyl)gallane-diyl]bis[(2,4,6-tri-*tert*-butylphenyl)phosphane] (PIN)
 (P is senior to In)



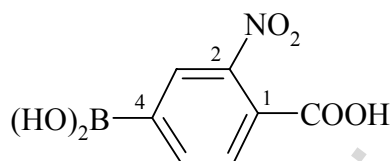
[(2,4,6-tri-*tert*-butylphenyl)indigane-diyl]bis[(2,4,6-tri-*tert*-butylphenyl)phosphane] (PIN)
 (P is senior to In)



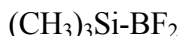
4,4',4''-boranetriyltrianiline (PIN; a multiplicative name)



4-(dimethylboranyl)phenol (PIN)



4-borono-2-nitrobenzoic acid (PIN)



(difluoroboranyl)trimethylsilane (PIN)
(Si is senior to B)
(not (dimethylsilyl)boronic difluoride)



tris(ethyldisulfanyl)gallane (PIN)
tris[ethyl(dithioperoxy)]gallane



alumanetriyl trioctadecanoate (PIN)

P-68.1.6 Adducts

Adducts are chemical species A/B, each molecular entity of which is formed by direct combination (addition) of two molecular entities A and B in such a way that there is change in connectivity, but no loss of atoms within the moieties A and B. Stoichiometries other than 1:1 are also possible, e.g. (2:1), a bis-adduct. An intramolecular adduct is formed when A and B are groups contained within the same molecular entity.

‘Adduct’ is a general term which, whenever appropriate, should be used in preference to the less explicit term ‘complex’. It is also used specifically for products of an addition reaction. Lewis adducts and π -adducts are discussed in this Subsection. Meisenheimer adducts are discussed in Section P-76.2)

P-68.1.6.1 Formulas of Lewis adducts

In the formulas of addition compounds the component molecules are cited in order of increasing number; if they occur in equal numbers, they are cited in alphabetical of the first symbols. Addition compounds containing boron compounds or water are exceptional, in that the water or boron component is cited last. If both are present, the boron compounds precede water. Components are separated by a centered dot.

P-68.1.6.1.1 General method

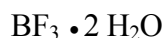
Adducts (addition compounds) between neutral Lewis bases and Lewis acids are named by citing the name of each component in the order given for the structure and connecting the name of each component by a dash (see P-16.2.5). The number of molecules of each component is denoted by two methods:

(1) appropriate multiplying prefixes, except for mono; or,

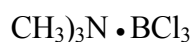
- (2) by indicating the proportions of the species after the name by arabic numbers separated by a solidus (/) and placed in parentheses. A boron component, if present, is cited last in the name; water, if present, is cited last, after any boron component.

Method (1) leads to preferred IUPAC names.

Examples:



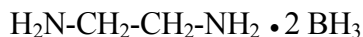
trifluoroborane–water (1/2) (preselected name)
boron trifluoride–bis(water)



N,N-dimethylmethamine–trichloroborane (1/1) (PIN)
N,N-dimethylmethamine–trichloroborane



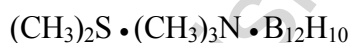
(ethylsulfanyl)ethane–methylborane(1/1) (PIN)
(ethylsulfanyl)ethane–methylborane



ethane-1,2-diamine–borane (1/2) (PIN)
ethane-1,2-diamine–bis(borane)



ethanamine–pentaborane(9) (2/1) (PIN)
bis(ethanamine)–pentaborane(9)



N,N-dimethylmethanamine–(methylsulfanyl)methane–dodecaborane(10) (1/1/1) (PIN)
N,N-dimethylmethanamine–(methylsulfanyl)methane–dodecaborane(10)

When there is more than one possible donor molecule, the points of attachment to the boron component are indicated by italicized atomic symbols joined by a dash (see P-16.2.5), enclosed in parentheses, and cited between the names of each component of the adduct. Each atomic symbol refers to the component nearest to it. The names of components and the atomic symbols are cited in the sequence donor-acceptor. The locant of a component is added before the appropriate atomic symbols, as required.

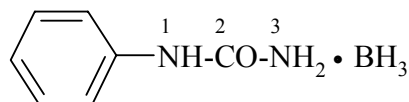
Examples:



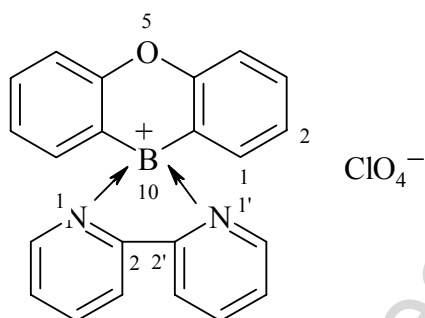
O-methylhydroxylamine(*N-B*)borane (PIN)



N,N-dimethylphosphoramidous difluoride(*P-B*)tetraborane(8) (PIN)



1-phenylurea(3-*N-B*)borane (PIN)

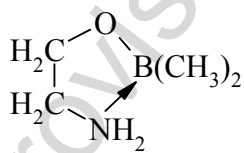


2,2'-bipyridine(*N,N'*-*B*)-10*H*-phenoxaborin-10-ylum perchlorate(1-) (PIN)

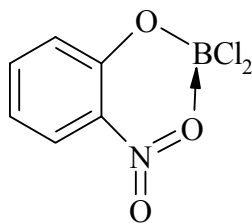
P-68.1.6.1.2 Intramolecular adducts

An intramolecular adduct between a group acting as a Lewis base and another group acting as a Lewis acid in the same molecule is denoted by atomic symbol pairs in the order donor-acceptor as described in Rule P-69.1.1, but cited in front of the complete name of the compound.

Examples:

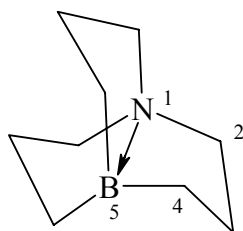


(*N-B*)-2-aminoethyl dimethylborinate (PIN)



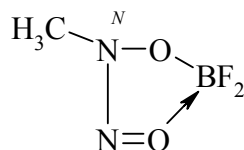
(*O-B*)-2-nitrophenyl borodichloridate (PIN)

(*O-B*)-dichloro(2-nitrophenoxy)borane

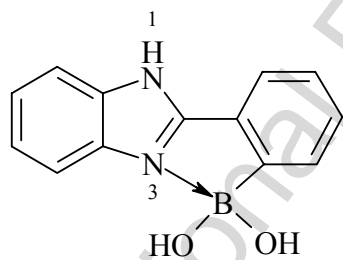


(*N-B*)-1-aza-5-borabicyclo[3.3.3]undecane (PIN)

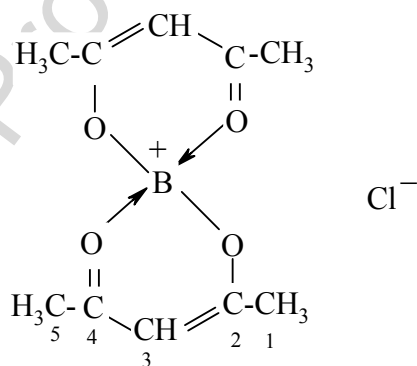
Note: If the structure is shown as a charged system, it is named as a zwitterion
 (see P-74.1.1)



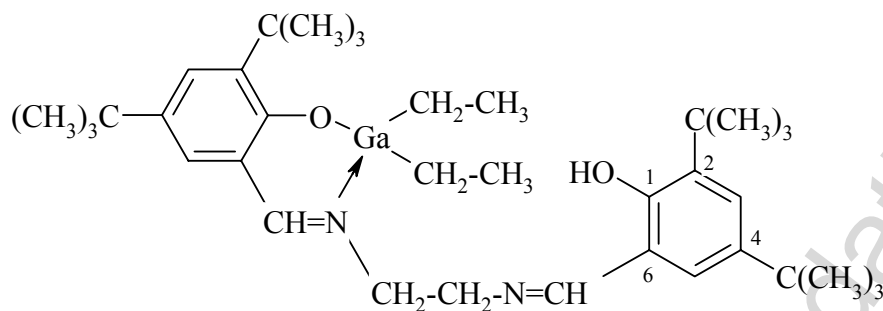
(*O-B*)-*O*-(difluoroboranyl)-*N*-methyl-*N*-nitrosohydroxylamine (PIN)



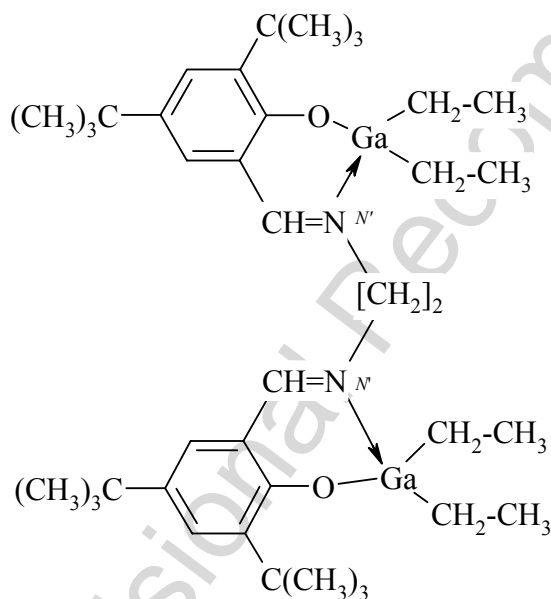
(3-*N-B*)-2-[(1*H*-benzimidazol-2-yl)phenyl]boronic acid (PIN)
 (not (*N*³-*B*)-2-[2-(dihydroxyboranyl)phenyl]benzimidazole)



[2(*O-B*)]-bis[(4-oxopent-2-en-2-yl)oxy]boranylium chloride (PIN)



2,4-di-*tert*-butyl-6-[(2-[(*N*-*B*)-3,5-di-*tert*-butyl-2-[(diethylgallanyl)-oxy]phenyl)methylidene)amino]ethyl]imino)methyl]phenol (PIN)



N,N'-ethane-1,2-diylbis[*N*-*Ga*]{3,5-di-*tert*-butyl-2-[(diethylgallanyl)oxy]phenyl}methanimine] (PIN)

P-68.2 Nomenclature of compounds of Group 14

P-68.2.0 Introduction

The nomenclature of carbon compounds as the basis for organic compounds, has been described in previous chapters. It is not exemplified in this Section, unless comparisons with other compounds are needed.

With the exception of silicic acid, a retained name for $\text{Si}(\text{OH})_4$ (formerly orthosilicic acid), all Si, Ge, Sn, and Pb compounds are named in accordance with the principles, rules and conventions of substitutive nomenclature.

Suffixes and prefixes are used in accordance with the seniority of classes (see P-41). This is a modification to the traditional system that used suffixes and prefixes for silicon compounds, but only prefixes for germanium, tin and lead compounds. Functional class nomenclature is used only to denote esters and anhydrides derived from orthosilicic acid.

- P-68.2.1 Si, Ge, Sn, and Pb parent hydrides
- P-68.2.2 Substituent groups derived from parent hydrides
- P-68.2.3 Modification of the degree of hydrogenation
- P-68.2.4 Silicic acid as parent structure
- P-68.2.5 Substitution compounds denoted by suffixes
- P-68.2.6 Substitution compounds denoted by prefixes

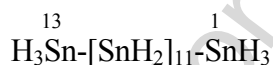
P-68.2.1 Si, Ge, Sn, and Pb parent hydrides

- P-68.2.1.1 Mononuclear and acyclic parent hydrides
- P-68.2.1.2 Cyclic parent hydrides

P-68.2.1.1 Mononuclear and acyclic parent hydrides

Names of acyclic parent hydrides are formed in accordance with the general rules described in Section P-21. They are preselected names.

Examples:



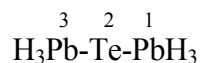
tridecastannane (preselected name)



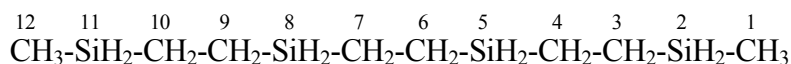
trigermaselenane (preselected name)



docosasiloxane (preselected name)



diplumbatellurane (preselected name)

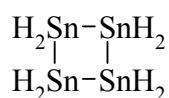


2,5,8,11-tetrasiladodecane (PIN)
 ethylenebis[2-(methylsilyl)ethylsilane]

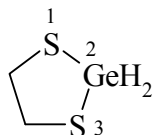
P-68.2.1.2 Cyclic parent hydrides

Names and preferred IUPAC names of cyclic parent hydrides are formed in accordance with the rules described in Sections P-23 to P-29. Those with no carbon atoms have preselected names.

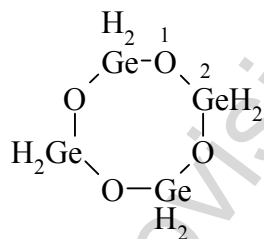
Examples:



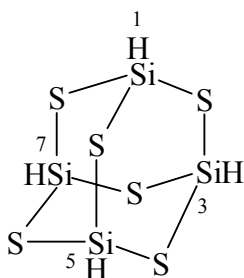
tetrastannetane (preselected name, Hantzsch-Widmann name)
 cyclotetrastannane



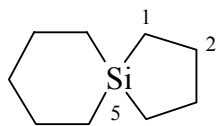
1,3,2-dithiagermolane (PIN)



1,3,5,7,2,4,6,8-tetraoxatetragermocane (preselected name, Hantzsch-Widman name)
 cyclotetragermoxane



2,4,6,8,10-pentathia-1,3,5,7-tetrasiladamantane (preselected name)



5-silaspiro[4.5]decane (PIN)

P-68.2.2 Substituent groups derived from parent hydrides

Names of substituent groups $-XH_3$, $=XH_2$, and $\equiv XH$ derived from mononuclear parent hydrides where X = Si, Ge, Sn, and Pb are formed by the specific method described in P-29.2.1; all other substituent groups are named by using the general method described in P-29.2.2.

Examples:



silyl (preselected name)



germyl (preselected name)



stannyl (preselected name)



plumbyl (preselected name)



silylidene (preselected name)



plumylidene (preselected name)



germylidyne (preselected name)



stannylidyne (preselected name)



silanylylidene (preselected name)



germanediylidene (preselected name)



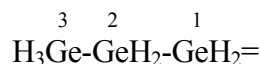
stannanetriyl (preselected name)



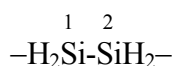
plumbaneterayl (preselected name)



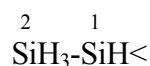
disilanyl (preselected name)
(not disilyl)



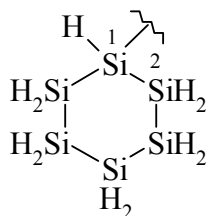
trigerman-1-ylidene (preselected name)



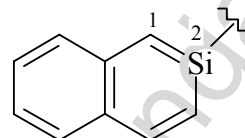
disilane-1,2-diyl (preselected name)



disilane-1,1-diyl (preselected name)



hexasilinanyl (preselected name)
cyclohexasilanyl

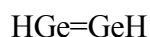


2-benzosilin-2-yl (PIN)

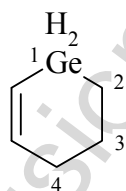
P-68.2.3 Modification of the degree of hydrogenation

Double bonds are denoted by the 'ene' ending, as described in Section P-31.1, and 'hydro' prefixes as indicated in P-33.2.

Examples:



digermene (preselected name)



1,2,3,4-tetrahydrogermine (PIN)

P-68.2.4 Silicic acid as functional parent

The nomenclature of silicic acid (formerly orthosilicic acid) has been discussed in Section P-67.1.2.1. Silicic acid is modified by prefixes only to denote functional replacement by chalcogen atoms. Functional replacement by other atoms or groups is not recommended. Names of salts, esters and anhydrides are derived from the retained name. Names of amides and hydrazides are based on the name 'silicic acid'.

Names of substituent groups derived from silicic acid are formed on the basis of the parent hydride 'silane' (see P-67.1.4.4).

Examples:

$(\text{HO})_3\text{Si}-$
trihydroxysilyl (preselected name)

$(\text{HS})(\text{HO})_2\text{Si}-$
dihydroxy(sulfanyl)silyl (preselected name)

$\text{Si}(\text{NH}_2)_4$
silicic tetramide (preselected name)
(not silanetetramine)

P-68.2.5 Substitutive nomenclature: suffix mode

Traditionally, silicon compounds were denoted suffixes or prefixes; germanium, tin and lead compounds were denoted by prefixes only. Full systematization is recommended to use suffixes, when available, to generate preferred names, in accordance with the seniority order of suffixes, and the seniority of suffixes over prefixes.

Examples:

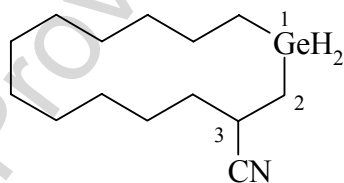
$\text{CH}_3\text{-Si}(\text{NH}_2)_3$
methylsilanetriamine (PIN)

$(\text{CH}_3)_2\text{Si}(\text{OH})_2$
dimethylsilanediol (PIN)

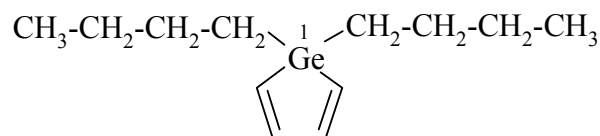
$\text{CH}_3\text{-NH-Si}(\text{OH})_3$
(methylamino)silanetriol (PIN)
N-methylsilicamidic acid

$(\text{CH}_3)_3\text{Si-COOH}$
trimethylsilanecarboxylic acid (PIN)

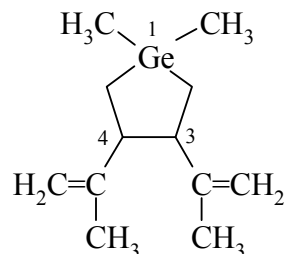
$\text{CH}_3\text{-GeH}_2\text{-SH}$
methylgermanethiol (PIN)



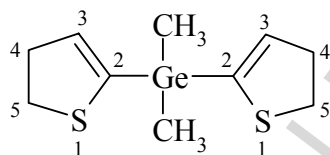
1-germacyclotetradecane-3-carbonitrile (PIN)



1,1-dibutyl-1*H*-germole (PIN)
 (note the indicated hydrogen atom)



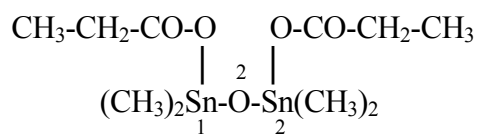
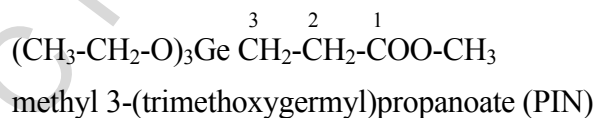
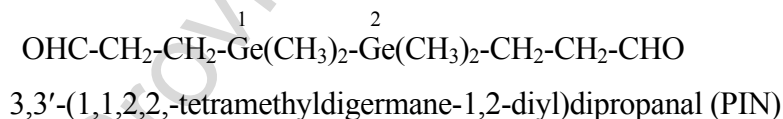
1,1-dimethyl-3,4-di(prop-1-en-2-yl)germolane (PIN)
 1,1-dimethyl-3,4-diisopropenylgermolane



bis(4,5-dihydrothiophen-2-yl)dimethylgermane (PIN)
 (Ge is senior to S)

P-68.2.6.2 Substituent groups derived from parent hydrides

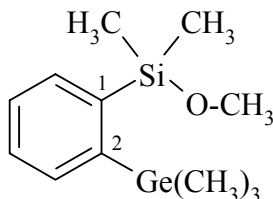
Examples:



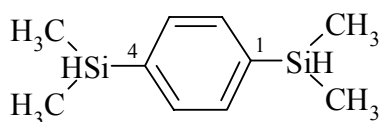
1,1,3,3-tetramethyldistannoxane-1,3-diyl dipropanoate (PIN)



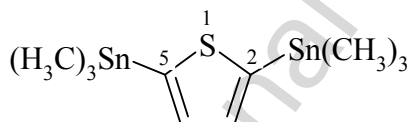
[plumbanediylbis(methylene)]bis(plumbane) (PIN)
bis(plumbylmethyl)plumbane



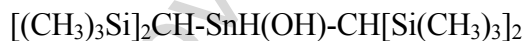
[(2-(trimethylgermyl)phenyl)methoxydimethylsilane] (PIN)
(Si is senior to Ge)



1,4-phenylenebis(dimethylsilane) (PIN)



2,5-bis(trimethylstannyl)thiophene (PIN)
(S preferred to Sn)



[(hydroxystannediyl)dimethanetriyl]tetrakis(trimethylsilane) (PIN)
(Si preferred to Sn)

P-68.3 Nomenclature of compounds of Group 15

P-68.3.0 Introduction.

For the purposes of nomenclature, compounds of Group 15 are divided into three sub-groups:

- Nitrogen compounds, named as amines and imines (see P-62), amides, hydrazides, imides, amidines, amidrazones, hydrazidines, nitriles and cyanides, as described in Section P-66, or substitutively on the basis of parent hydrides, such as hydrazine and triazane or functional parent compounds, such as hydroxylamine. This last aspect is

covered in P-68.3.2. For reasons of similarity, azonic, $\text{HN}(\text{OH})_2$ and azinic acids, $\text{H}_2\text{N}(\text{OH})$, are discussed in Section P-67 along with P, As, and Sb oxoacids.

- (b) Phosphorus, arsenic and antimony compounds are discussed together in P-68.3.3 because of the importance of functional class nomenclature based on acids used as functional parents. Other compounds are named substitutively on the basis of parent hydrides.
- (c) Bismuth compounds are all named by substitution of parent hydrides, such as BiH_3 , in P-68.3.4.

P-68.3.1 Nitrogen compounds

P-68.3.1.0 Introduction

P-68.3.1.1 Hydroxylamines, oximes, nitrolic acids and nitrosolic acids

P-68.3.1.2 Hydrazine compounds

P-68.3.1.3 Diazene compounds

P-68.3.1.4 Polyazane compounds

P-68.3.1.0 Introduction

Many acyclic nitrogen compounds have retained names or functional class names. These names are retained for use in general nomenclature, but for most acyclic nitrogen compounds preferred IUPAC names are formed systematically. Hydroxylamine, urea, guanidine, and formazan are retained as preferred IUPAC names. Other retained names have been inserted into systematic substitutive nomenclature. Oxime is a retained functional class.

P-68.3.1.1 Hydroxylamines, oximes, nitrolic and nitrosolic acids

Several nitrogen compounds having one nitrogen atom belong to the identified classes: hydroxylamines, oximes, nitrolic and nitrosolic acids. The methodology for naming them is illustrated here. Nitro and nitroso compounds, isocyanates and isonitriles were discussed in Section P-61.

The class name 'hydroxylamine', a preselected PIN, is also used as a functional parent and the class name 'oxime' is used as a functional class modifier, respectively. Nitrolic and nitrosolic acids are named as oximes of pseudoketones.

P-68.3.1.1.1 Hydroxylamines

P-68.3.1.1.2 Oximes

P-68.3.1.1.3 Nitrolic and nitrosolic acids

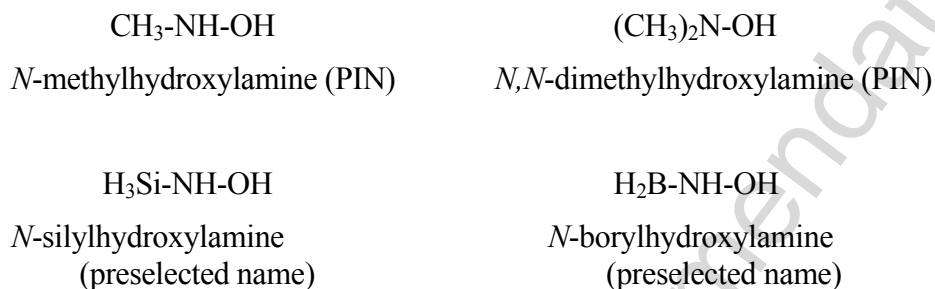
P-68.3.1.1.1 Hydroxylamines

P-68.3.1.1.1.1 Substitution on the nitrogen atom

The retained name 'hydroxylamine' is a preselected PIN and designates the structure $\text{H}_2\text{N}-\text{OH}$. It is a functional parent compound allowing full substitution even, as an exception, on the oxygen atom. Substitution on the nitrogen or the oxygen atom of hydroxylamine may create a function senior to amine, justifying a systematic name based on a higher class to denote this new function.

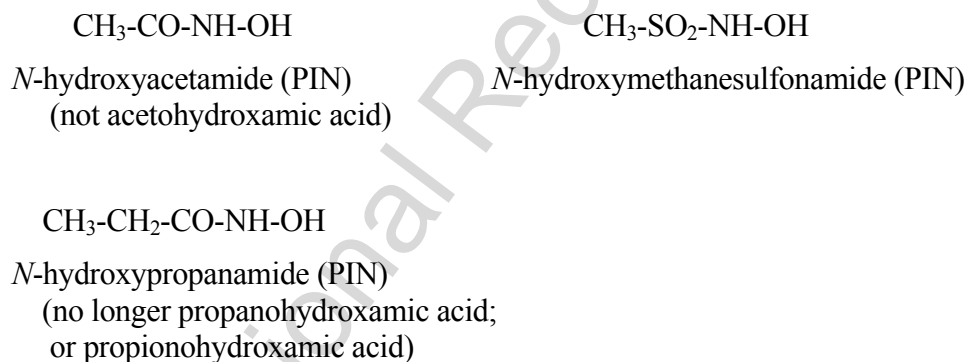
Substituted hydroxylamines of the type R-NH-OH or RR'N-OH are named by prefixing the name(s) of the substituent group(s) together with the locant *N* to the functional parent compound name 'hydroxylamine'.

Examples:



Substitution by acyl groups generate hydroxamic acids that are named as *N*-hydroxyamides (see P-65.1.3.4).

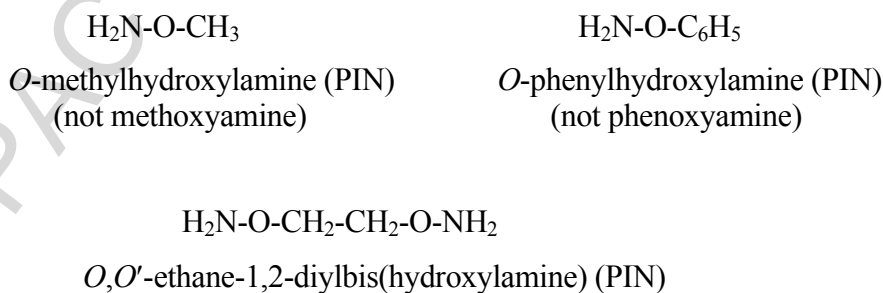
Examples:



P-68.3.1.1.1.2 Substitution on the oxygen atom

Substitution on the oxygen atom by hydrocarbyl groups or acyl groups is expressed as *O*-substitution. Names such as 'alkyloxyamines' are not recommended and the class peroxyamide has never been recognized.

Examples:





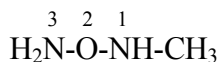
O-benzoylhydroxylamine (PIN)



O-methanesulfinylhydroxylamine (PIN)

O-Substitution by –NHR or –NRR' leads to derivatives of dioxazane (see P-21.2.3.1)

Example:



1-methyldiazoxane (PIN)

P-68.3.1.1.1.3 Substitution on both nitrogen and oxygen atoms

Substitution on both nitrogen and oxygen atom is expressed by:

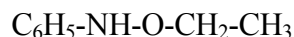
- (1) the corresponding *N*-(hydrocarbyloxy)amines, and
- (2) *N,O*-substituted hydroxylamines.

Method (1) leads to preferred IUPAC names since an amine, expressed by the suffix -amine, is senior to the parent structure 'hydroxylamine' (see P-41).

Examples:



N-methoxymethanamine (PIN)
N,O-dimethylhydroxylamine

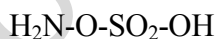


N-ethoxyaniline (PIN)
O-ethyl-*N*-phenylhydroxylamine

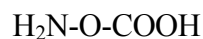
P-68.3.1.1.1.4 Substitution by characteristic groups expressed as suffixes

Hydroxylamine is a functional parent to which suffixes expressing characteristic groups, such as acids, amides, etc., can be attached to the oxygen atom; for exceptional use of suffixes with functional parent compounds see P-46.2.3.1. In names, the locant *O* is placed in front of the suffix. Attachment of characteristic groups to the nitrogen atom generally leads to compounds of higher function.

Examples:



hydroxylamine-*O*-sulfonic acid
(preselected name)



hydroxylamine-*O*-carboxylic acid (PIN)



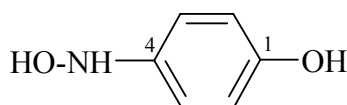
hydroxylamine-*O*-carboxamide (PIN)

P-68.3.1.1.1.5 Hydroxylamine expressed as prefix

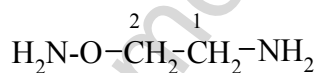
In the presence of a characteristic group having priority for citation as suffix or of a senior parent hydride, the appropriate complex or compound prefixes are used:

$-\text{NH}-\text{OH}$	hydroxyamino- (preselected name)
$-\text{O}-\text{NH}_2$	aminooxy- (preselected name)
	(note that there is no elision of the final letter 'o' in amino)

Examples:



4-(hydroxyamino)phenol (PIN)



2-(aminooxy)ethan-1-amine (PIN)



[(aminooxy)methyl]hydrazine (PIN)

P-68.3.1.1.1.6 Chalcogen analogues of hydroxylamine

Chalcogen analogs of hydroxylamine are denoted by the appropriate functional replacement prefix 'thio', 'seleno' and 'telluro'. Parentheses are sometimes required to avoid the possibility of ambiguity. Substitution follows the principles of hydroxylamine.

Examples:



thiohydroxylamine (preselected name)



N-methyl(thiohydroxylamine)



N-sulfanylacetamide (PIN)



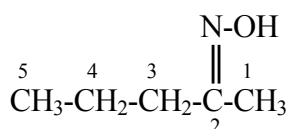
S-methyl(thiohydroxylamine)

P-68.3.1.1.2 Oximes

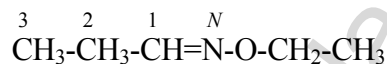
Compounds having the general structure $\text{R}-\text{CH}=\text{N}-\text{OH}$ or $\text{RR}'\text{C}=\text{N}=\text{OH}$ have the class name 'oxime' and have been further classified as 'aldoximes' and 'ketoximes' respectively. For general nomenclature they are named according to the principles of functional class nomenclature by placing the class name 'oxime' as a separate word after the name of the aldehyde or ketone. Preferred IUPAC names are formed substitutively as 'ylidene' derivatives of hydroxylamine. Compounds containing the group $=\text{N}-\text{OR}$ are named substitutively as alkoxy substituted imines. In the presence

of a characteristic group having priority for citation as a suffix, in substitutive nomenclature oximes are designated by the prefix 'hydroxyimino'.

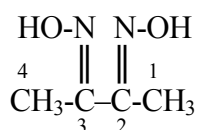
Examples:



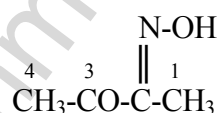
pentan-2-ylidenehydroxylamine (PIN)
 pentan-2-one oxime



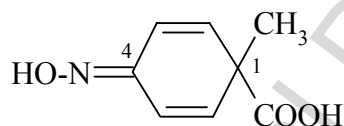
N-ethoxypropan-1-imine (PIN)
 propanal *O*-ethyloxime



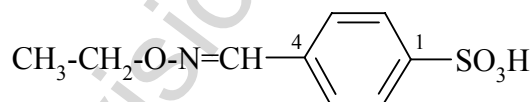
butane-2,3-diylidenebis(hydroxylamine) (PIN)
 butane-2,3-dione dioxime



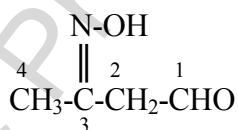
3-(hydroxyimino)butan-2-one (PIN)
 butane-2,3-dione oxime



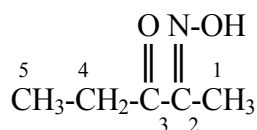
4-(hydroxyimino)-1-methylcyclohexa-2,5-diene-1-carboxylic acid (PIN)



4-[(ethoxyimino)methyl]benzene-1-sulfonic acid (PIN)



3-(hydroxyimino)butanal (PIN)



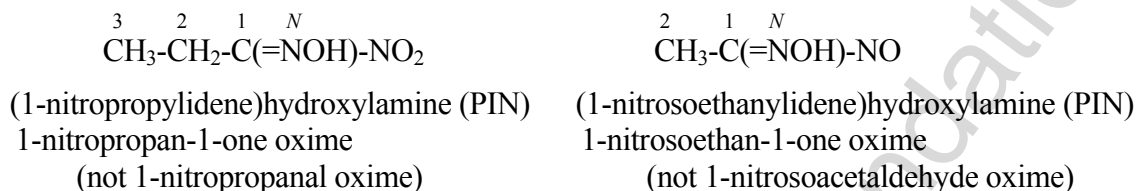
2-(hydroxyimino)pentan-3-one (PIN)
 pentane-2,3-dione 2-oxime

P-68.3.1.1.3 Nitrolic and nitrosolic acids

Compounds having the general structure R-C(=NOH)-NO₂ and R-C(=NOH)-NO are called 'nitrolic acids' and 'nitrosolic acids', respectively. They are named substitutively for general nomenclature as oximes of pseudoketones. Preferred IUPAC names are formed as described above

for 'oximes' (see p-68.3.1.1.3). Traditionally, they were named by functional class nomenclature as oximes of aldehydes substituted in position 1 by a nitro or nitroso group.

Examples



P-68.3.1.2 Hydrazine and related compounds: hydrazones, azines, semicarbazides, semicarbazones, and carbonohydrazides

P-68.3.1.2.1 Hydrazine and derivatives

Hydrazine is a retained name describing the structure $\text{H}_2\text{N}-\text{NH}_2$ that is the preferred IUPAC name; it is preferred to the systematic name 'diazane'.

Substituent groups derived from hydrazine are named systematically:

$\text{H}_2\text{N}-\text{NH}-$	hydrazinyl (preselected PIN) diazanyl (not hydrazino)
$\text{H}_2\text{N}-\text{N}=\text{}$	hydrazinylidene (preselected PIN) diazanylidene (not hydrazono)
$=\text{N}-\text{N}=\text{}$	hydrazinediylidene (preselected PIN) diazanediylidene (not azino)
$-\text{NH}-\text{NH}-$	hydrazine-1,2-diyl (preselected PIN) diazane-1,2-diyl (not hydrazo)

As a parent hydride, hydrazine is numbered by numerical locants, 1 and 2, not *N* and *N'*. Hydrazine is substituted by hydrocarbonyl groups and characteristic groups expressed by suffixes and prefixes.

Examples:



$\text{H}_2\text{N}-\overset{1}{\text{N}}\text{H}-\overset{N}{\text{C}}\text{H}_2-\text{NH}_2$	$\text{H}_2\text{N}-\text{NH}-\text{COOH}$
1-hydrazinylmethanamine (PIN) (see also P-62.2.1.1.2)	hydrazinecarboxylic acid (PIN) (not carbazic acid)
$\text{F}_2\text{N}-\text{NF}_2$	$\text{H}_2\text{N}-\text{NH}-\text{CH}_2-\text{CN}$
tetrafluorohydrazine (preselected name)	hydrazinylacetonitrile (PIN)
$\text{H}_2\text{N}-\text{CO}-\overset{3}{\text{C}}\text{H}_2-\overset{3'}{\text{C}}\text{H}_2-\text{NH}-\text{NH}-\overset{3'}{\text{C}}\text{H}_2-\text{CH}_2-\text{CO}-\text{NH}_2$	
3,3'-(hydrazine-1,2-diyl)dipropanamide (PIN) (not 3,3'-hydrazodipropanamide)	

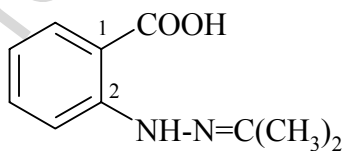
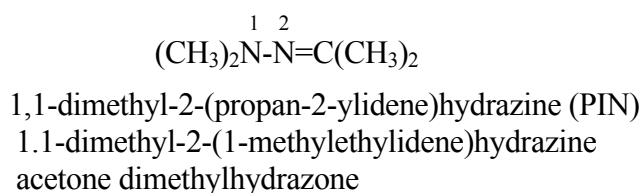
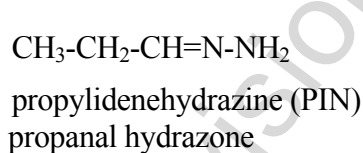
P-68.3.1.2.2 Hydrazones

Compounds having the general structure $\text{RCH}=\text{N}-\text{NH}_2$ or $\text{RR}'\text{C}=\text{N}-\text{NH}_2$ are called 'hydrazones' and are named in two ways.

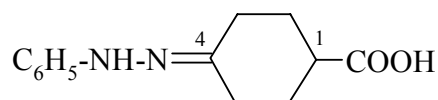
- (1) substitutively as derivatives of the parent hydride 'hydrazine', $\text{H}_2\text{N}-\text{NH}_2$;
- (2) by functional class nomenclature using the class name 'hydrazone'.

Method (1) generates preferred IUPAC names

Examples:



2-[2-(propan-2-ylidene)hydrazinyl]benzoic acid (PIN)
 2-[2-(1-methylethylidene)hydrazinyl]benzoic acid



4-(phenylhydrazinylidene)cyclohexane-1-carboxylic acid (PIN)

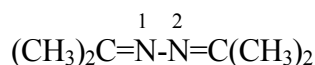
P-68.3.1.2.3 Azines

P-68.3.1.2.3.1 Compounds having the general structure $R-CH=N-N=CH-R$ or $RR'C=N-N=RR'$ are called 'azines' and are named in two ways.

- (1) substitutively, as derivatives of hydrazine;
- (2) by functional class nomenclature using the class name 'azine'.

Method (1) leads to preferred IUPAC names.

Example:



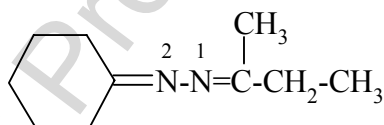
1,2-di(propan-2-ylidene)hydrazine (PIN)
1,2-bis(1-methylethanylidene)hydrazine
acetone azine

P-68.3.1.2.3.2 Azines are symmetrical derivatives of hydrazine. When this condition is not fulfilled, compounds having the structures $R-CH=N-N=CH-R'$ or $RRC=N-N=CR'R'$, are named in two ways.

- (1) as unsymmetrical derivatives of hydrazine;
- (2) as 'ylidenehydrazones' of the preferred ketone or aldehyde

Method (1) generates preferred IUPAC names.

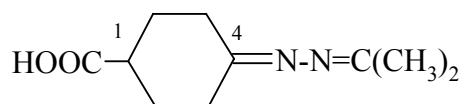
Example:



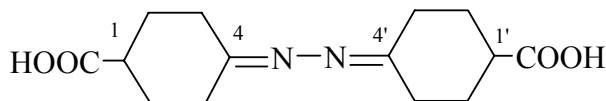
1-(butane-2-ylidene)-2-cyclohexylidenehydrazine (PIN)
2-cyclohexylidene-1-(1-methylpropylidene)hydrazine
cyclohexanone butan-2-ylidenehydrazone

P-68.3.1.2.3.3 In presence of functions having seniority, the prefix 'hydrazinylidene' is used. The prefix 'hydrazinediylidene' is used in multiplicative nomenclature.

Examples:



4-(propan-2-ylidenehydrazinylidene)cyclohexane-1-carboxylic acid (PIN)
 4-[(1-methylethylidene)hydrazinylidene]cyclohexane-1-carboxylic acid



4,4'-hydrazinediylidenedi(cyclohexane-1-carboxylic acid) (PIN)
 4,4'-azinodi(cyclohexane-1-carboxylic acid)

P-68.3.1.2.4 Semicarbazides

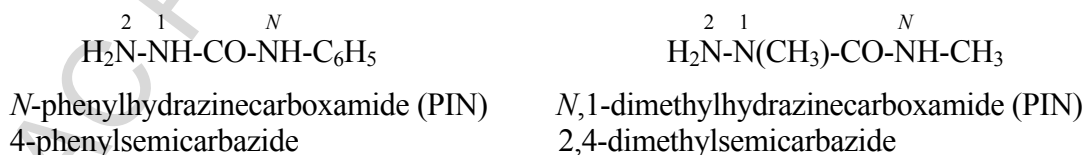
Semicarbazide is the amide of 'hydrazinecarboxylic acid'. As acids and amides expressed by suffixes are senior to acids or amides modified by functional replacement, these names are senior to 'carbonohydrazidic acid' and 'carbonohydrazidic' amide.



Semicarbazide is the traditional name for the compound $\text{H}_2\text{N-NH-CO-NH}_2$, systematically named 'hydrazinecarboxamide'. The systematic name is the preferred IUPAC name. The usual numbering for amides is recommended for the systematic name; special numbering is characteristic for the name semicarbazide.

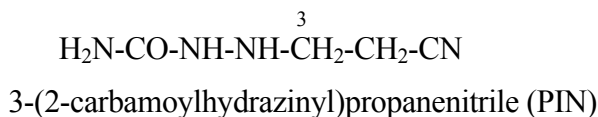


Examples:

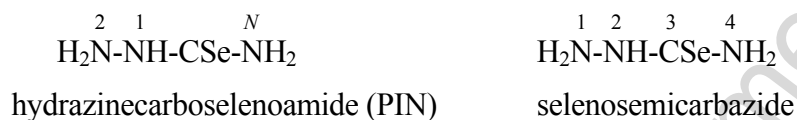


As a prefix, the $-\text{HN-NH-CO-NH}_2$ group is called 'semicarbazido' or '2-carbamoylhydrazin-1-yl' or '2-(aminocarbonyl)hydrazine-1-yl'. The systematic name '2-carbamoylhydrazin-1-yl' is the preferred IUPAC name.

Example:



Chalcogen analogues are named systematically as described for amides or by functional replacement nomenclature using the class term 'semicarbazide' modified by the replacement prefixes 'thio-', 'seleno-', and 'telluro', for example, 'thiosemicarbazide'.



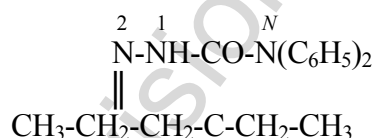
P-68.3.1.2.5 Semicarbazones

Compounds having the structure $\text{R}-\text{CH}=\text{N}-\text{NH}-\text{CO}-\text{NR}'\text{R}''$ or $\text{RR}'\text{C}=\text{N}-\text{NH}-\text{CO}-\text{NR}''\text{R}'''$ are generically called 'semicarbazones'. They are named in two ways.

- (1) substitutively by using the parent hydride 'hydrazinecarboxamide';
- (2) by the class modifier 'semicarbazone' placed after the name of the corresponding aldehyde or ketone.

Method (1) yields preferred IUPAC names.

Examples:

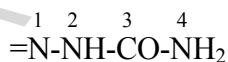


2-(hexan-3-ylidene)-*N,N*-diphenylhydrazinecarboxamide (PIN)

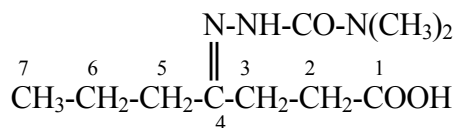
2-(1-ethylbutanylidene)-*N,N*-diphenylhydrazinecarboxamide

hexan-3-one 4,4-diphenylsemicarbazone

The compound prefix '2-carbamoylhydrazinylidene' is used as a prefix in the presence of a characteristic group that is preferred for citation as a suffix. This prefix is preferred to the traditional name 'semicarbazono', whose structure is numbered as follows:

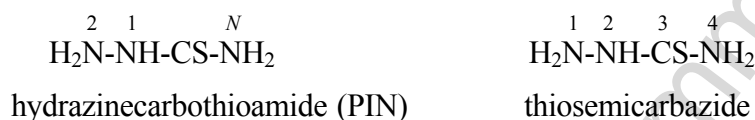


Example:

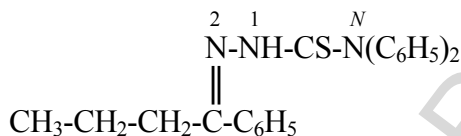


4-[2-(dimethylcarbamoyl)hydrazinylidene]heptanoic acid (PIN)
 4-(4,4-dimethylsemicarbazono)heptanoic acid

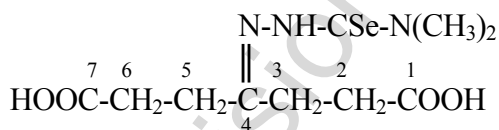
Chalcogen analogues are named systematically as described for amides to give preferred IUPAC names, or by functional replacement nomenclature using the class terms 'semicarbazone' modified by the replacement prefixes 'thio-', 'seleno-', and 'telluro', for example, 'thiosemicarbazone'. The prefix '2-carbamothioylhydrazinylidene' is preferred to the traditional prefix 'thiosemicarbazono'.



Examples:



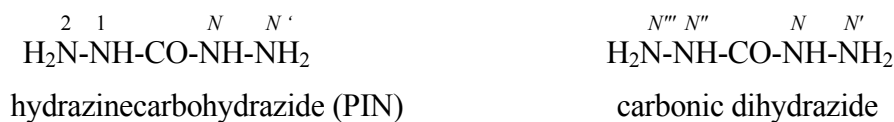
N,N-diphenyl-2-(1-phenylbutylidene)hydrazine-1-carbothioamide (PIN)
 1-phenylbutan-1-one 4,4-diphenylthiosemicarbazone



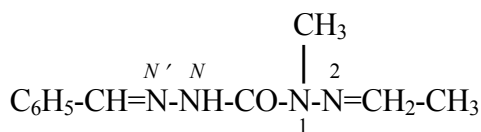
4-[2-(dimethylcarbamosenoyl)hydrazinylidene]heptanedioic acid (PIN)
 4-[4,4-dimethyl(selenosemicarbazono)]heptanedioic acid

P-68.3.1.2.6 Hydrazinecarbohydrazide and derivatives

P-68.3.1.2.6.1 The compound $\text{H}_2\text{N-NH-CO-NH-NH}_2$ is named 'hydrazinecarbohydrazide' systematically; it is the preferred IUPAC name. The name 'carbonic dihydrazide' is also recommended, but for general use only; the names 'carbonohydrazide', 'carbohydrazide', and 'carbazine' are not recommended. Systematic numbering is applied to the systematic name; a special numbering is assigned to the retained name, as follows:



Example:

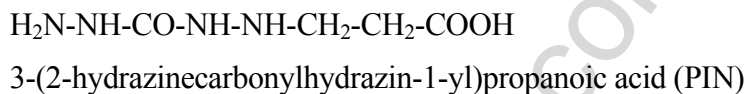


N'-benzylidene-2-ethylidene-1-methylhydrazine-1-carbohydrazide (PIN)
(the twice substituted chain is the principal chain; in alphanumerical order, *N'* is senior to 2)

5-benzyl-1-ethylidene-2-methylcarbonohydrazide
(the set of locants 1,2,5 is lower than 1,4,5)

P-68.3.1.2.6.2 As prefixes, the groups -NH-NH-CO-NH-NH_2 and $=\text{N-NH-CO-NH-NH}_2$ are called '2-hydrazinecarbonylhydrazin-1-yl' and '2-hydrazinecarbonylhydrazinylidene', respectively; these names are preferred IUPAC names.

Example:



P-68.3.1.3 Compounds derived from diazene

P-68.3.1.3.1 Azo compounds ($\text{R-N=N-R}'$)

P-68.3.1.3.2 Azoxy compounds ($\text{R-N=N(O)-R}'$)

P-68.3.1.3.3 Diazenecarbohydrazides (HN=N-CO-NH-NH_2)

P-68.3.1.3.4 Formazan and its derivatives ($\text{H}_2\text{N-N=CH-N=NH}$)

P-68.3.1.3.5 Carbonylbis(diazene) (HN=N-CO-N=NH)

P-68.3.1.3.6 Isodiazenes ($\text{R}_2\text{N}^+=\text{N}^-$)

P-68.3.1.3.1 Azo compounds, $\text{R-N=N-R}'$

Compounds with the general structure $\text{R-N=N-R}'$, where R and R' may be alike or different, are known generically as 'azo compounds'. They are named in two ways:

- (1) substitutively using the parent 'diazene', HN=NH ;
- (2) by using the prefix 'azo' in the traditional manner.

Examples: Method (1) leads to preferred IUPAC names.

Rules for naming azo compounds using the azo prefix were quite complex. Two sets of rules were recommended, the so called 'old method' (Rule C-911) and the Chemical Abstracts Service rules (C-912). The old method must be totally discarded since some examples do not follow the basic rules developed in the 1979 organic nomenclature rules, especially with respect to the treatment of suffixes. In 1993, a new approach was recommended that was based on the use of the parent 'diazene' [Method (1), above]. It brought simplicity and rationalization to the field. It is the method chosen to generate preferred names in these recommendations. The CAS method is given as an acceptable alternative.

Azo compounds are divided into monoazo compounds, having one $-N=N-$ group, bis(azo) compounds, having two $-N=N-$ groups, and so on.

P-68.3.1.3.1.1 Symmetrical monoazo compounds, $R-N=N-R$, are named:

- (1) by substituting the parent diazene, $HN=NH$, by the appropriate substituent groups;
- (2) by adding 'azo' to the name of the parent hydride, RH ; substituents are denoted in the usual way by prefixes, the two RH parents being distinguished by unprimed and primed locants. Attachment of the azo group has priority for lowest available numbers.

Method (1) gives preferred IUPAC names.

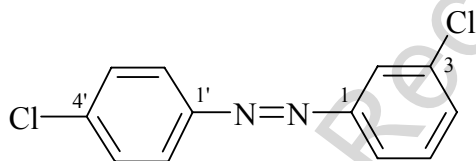
Examples:



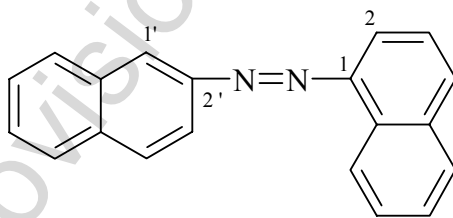
dimethyldiazene (PIN)
azomethane



diphenyldiazene (PIN)
azobenzene



(3-chlorophenyl)(4-chlorophenyl)diazene (PIN)
3,4'-dichloroazobenzene
(numbering shown)



naphthalen-1-yl(naphthalen-2-yl)diazene (PIN)
1,2'-azonaphthalene
(numbering shown)

P-68.3.1.3.1.2 Unsymmetrical monoazo compounds are named in two ways:

- (1) substitutively, by prefixing, in alphabetical order, the names of the appropriate substituent groups before the parent hydride name diazene;
- (2) by inserting 'azo' between the names of the parent hydrides RH and $R'H$; the principal chain or the senior ring or ring system is cited first and is assigned plain locants, the other parent hydride being given primed locants; when locants are required to denote the

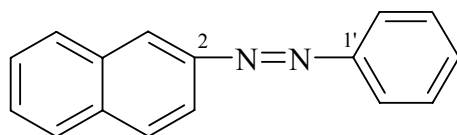
points of attachment of the parent hydrides, they are placed immediately before or after the prefix 'azo', respectively.

Method (1) leads to preferred IUPAC names.

Examples:



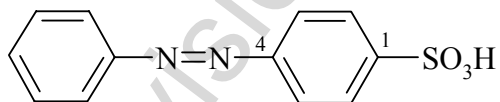
ethenyl(methyl)diazene (PIN)
methyl(vinyl)diazene
etheneazomethane



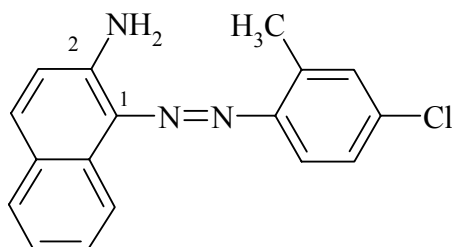
naphthalen-2-yl(phenyl)diazene (PIN)
naphthalene-2-azobenzene
(numbering shown)

Monoazo compounds with the general structure $\text{R}-\text{N}=\text{N}-\text{R}'$ in which R is substituted by a principal characteristic group is named on the basis of the parent hydride, RH, substituted by an organyl diazenyl group, $\text{R}'-\text{N}=\text{N}-$. If both R and R' are substituted by the same number of the principal characteristic group, a multiplicative name is preferred to a substitutive name.

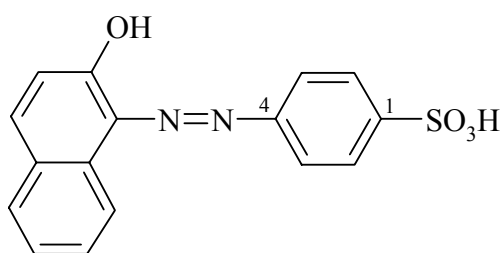
Examples:



4-(phenyldiazenyl)benzene-1-sulfonic acid (PIN)
4-(phenylazo)benzene-1-sulfonic acid



1-[(4-chloro-2-methylphenyl)diazenyl]naphthalen-2-amine (PIN)
[not 2-aminonaphthalene-1-azo-(4'-chloro-2'-methylbenzene) (see C-911.2, ref. 1);
the principal characteristic group, the amine must be denoted by a suffix]



4-[(2-hydroxynaphthalen-1-yl)diazenyl]benzene-1-sulfonic acid (PIN)
4-[(2-hydroxy-1-naphthyl)azo]benzenesulfonic acid)



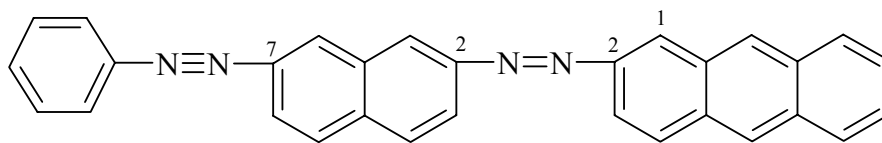
4,4'-diazenediyldibenzoic acid (PIN)
(traditionally 4,4'-azodibenzoic acid)

P-68.3.1.3.1.3 Bis(azo) compounds and more complex analogues, in the absence of a characteristic group having seniority to be cited as suffix, are named:

- (1) on the basis of 'diazene', as described in 68.3.1.3.1.1 above; the first cited substituent being chosen on the basis of the principle of alphanumerical order;
- (2) by using the prefix 'azo', as described in 68.3.1.3.1.1;
- (3) by using the prefix 'azo', after choosing the principal parent hydride and substituting the other components as 'organylazo' groups.

Method (1) generates preferred IUPAC names.

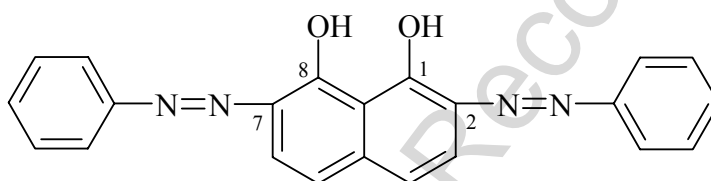
Example:



- (1) anthracen-2-yl[(7-phenyldiazenyl)naphthalen-2-yl]diazene (PIN)
(not [7-(anthracene-2-yl)diazenyl]naphthalen-2-yl]phenyldiazene; in
alphanumerical order 'anthracen-2-yl' precedes 'anthracen-2-yl)diazenyl';
numbering shown)
- (2) anthracene-2-azo-2'-naphthalene-7'-azobenzene)
- (3) 2-{{[7-(phenylazo)naphthalen-2-yl]azo}anthracene

When characteristic groups that have priority for citation as suffixes are present, the usual substitutive operations based on priority of suffixes are carried out. Names based on the prefix 'diazenyl' are preferred to those using 'azo' for generating preferred IUPAC names.

Example:



- 2,7-bis(phenyldiazenyl)naphthalene-1,8-diol (PIN)
2,7-bis(phenylazo)naphthalene-1,8-diol

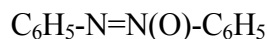
P-68.3.1.3.2 Azoxy compounds, R-N=N(O)-R'

P-68.3.1.3.2.1 *N*-Oxides of azo compounds having the general structure R-N₂(O)-R' (R = R' or R ≠ R') are known generically as 'azoxy compounds'. Their nomenclature was revised in 1993 (ref. 2) and is used in these recommendations. Azoxy compounds are named in two different ways.

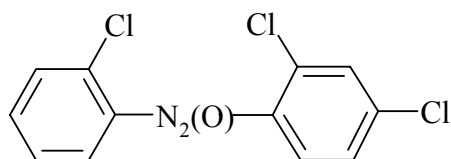
- (1) by adding the term 'oxide' to the name of the corresponding azo compound, preceded by a locant 1 or 2;
- (2) in the traditional way of replacing the prefix 'azo' by 'azoxy' and using the locants *NNO* and *ONN* to indicate the parent hydride associated with the =N→O group. In the general structure R-N(O)N-R', the symbol *NNO* specifies that the oxygen atom is attached to the nitrogen atom next to the R' group. The symbol *ONN* specifies that the oxygen atom is attached to the nitrogen atom next to the R group. When the point of attachment is not known, the symbol *NON* is used.

Method (1) leads to preferred IUPAC names. Azoxy compounds could also be named by using the λ-convention or as zwitterions; these methods are not recommended.

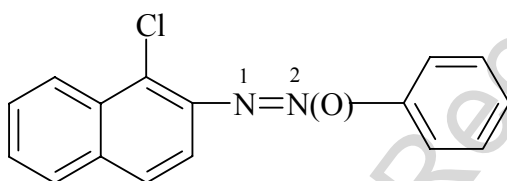
Examples:



- (1) diphenyldiazene oxide (PIN)
- (2) azoxybenzene
[not 1-oxo-1,2-diphenyl-1 λ^5 -diazene]
[not (1,2-diphenyldiazanium-1-yl)oxidanide]



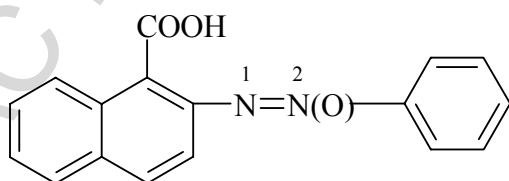
- (2-chlorophenyl)(2,4-dichlorophenyl)diazene oxide (PIN)
- 2,2',4'-trichloroazoxybenzene
(the absence of locants indicates that the points of attachment are not known)



- 1-(1-chloronaphthalen-2-yl)-2-phenyldiazene 2-oxide (PIN)
- 1-chloro-2-(phenyl-*ONN*-azoxy)naphthalene

P-68.3.1.3.2.2 An azoxy compound, according to the general seniority given to zwitterions over suffixes expressing characteristic groups, is preferably named as a derivative of diazene oxide, unless some other priority is given to another radical or ionic group. In general nomenclature, the traditional method for naming azoxy compounds is maintained. An azoxy compound in which the general structure is $\text{R-N=N(O)-R}'$ or $\text{R}'\text{-N=N(O)-R}$, in which R is substituted by a principal characteristic group is named on the basis of the parent hydride, RH, substituted by the R'-azoxy group in which the position of the oxygen atom is denoted by the prefix *NNO*-, *ONN*-, or *NON*-, as appropriate.

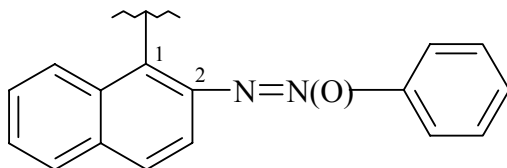
Example:



- 1-(1-carboxynaphthalen-2-yl)-2-phenyldiazene 2-oxide (PIN)
- 2-(phenyl-*ONN*-azoxy)naphthalene-1-carboxylic acid
(not 2-(phenyl-*ONN*-azoxy)-1-naphthoic acid; no substitution allowed on naphthoic acid)

When the azoxy compound has to be expressed by a prefix, substitutive nomenclature using the λ -convention is preferred (see Section 74.1.1).

Example:



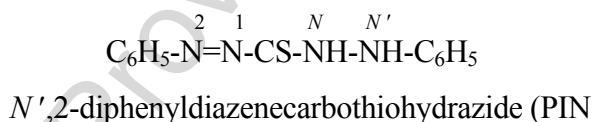
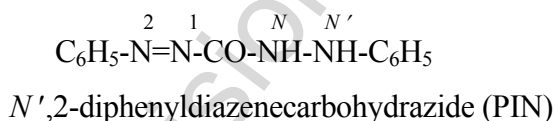
(1-phenyl-1-oxo-1 λ^5 -diazen-2-yl)naphthalen-1-yl (PIN)
 2-(2-oxido-2-phenyldiazen-2-ium-1-yl)naphthalen-1-yl

P-68.3.1.3.3 Derivatives of diazenecarbohydrazide, $\text{HN}=\text{N}-\text{CO}-\text{NH}-\text{NH}_2$

The hydrazide of 'diazenecarboxylic acid, $\text{HN}=\text{N}-\text{CO}-\text{NH}-\text{NH}_2$, is named systematically diazenecarbohydrazide; it is the preferred IUPAC name. The name 'carbazone' is not recommended. Chalcogen analogues are named by using the infixes and the prefixes 'thio', 'seleno' and 'telluro'.



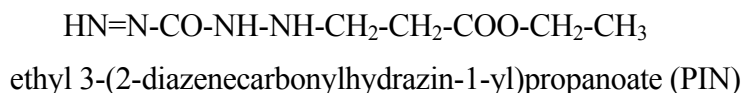
Examples:



As a prefix, the group $-\text{HN}-\text{NH}-\text{CO}-\text{N}=\text{NH}$ is named '2-diazenecarbonylhydrazin-1-yl' or 'diazenecarbohydrazido'; the preferred IUPAC name is '2-diazenecarbonylhydrazin-1-yl'. The name 'carbazono' is not recommended.

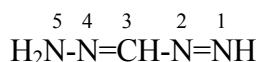
The group $\text{H}_2\text{N}-\text{NH}-\text{CO}-\text{N}=\text{NH}-$ is named '2-hydrazinecarbonyldiazen-1-yl'.

Example:

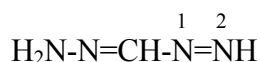


P-68.3.1.3.4 Formazan, $\text{H}_2\text{N}-\text{N}=\text{CH}-\text{N}=\text{NH}$, and its derivatives

The hydrazone of diazenecarbaldehyde, $\text{H}_2\text{N}-\text{N}=\text{CH}-\text{N}=\text{NH}$, has the preferred IUPAC retained name 'formazan'; it is numbered in a special manner. It can also be named substitutively as a derivative of the parent hydride 'diazene'; its derivatives are named accordingly.



formazan (PIN)

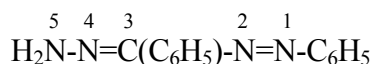


(hydrazinylidenemethyl)diazene

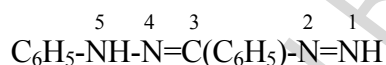
P-68.3.1.3.4.1 Derivatives of formazan

Preferred names are constructed systematically as derivatives of formazan or by using parent names denoting characteristic groups expressed as suffix.

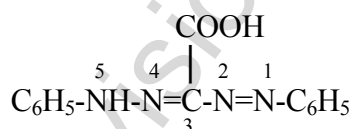
Examples:



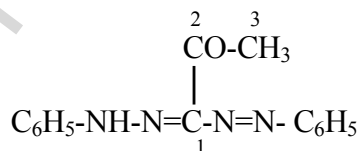
1,3-diphenylformazan (PIN)
 [hydrazinylidene(phenyl)methyl]phenyldiazene



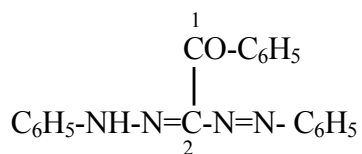
3,5-diphenylformazan (PIN)
 [phenyl(phenylhydrazinylidene)methyl]diazene



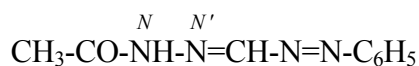
1,5-diphenylformazan-3-carboxylic acid (PIN)
 (phenyldiazenyl)(phenylhydrazinylidene)acetic acid



1-(phenyldiazenyl)-1-(phenylhydrazinylidene)propan-2-one (PIN)
 3-acetyl-1,5-diphenylformazan



1-phenyl-2-(phenyldiazenyl)-2-(phenylhydrazinylidene)ethan-1-one (PIN)
 3-benzoyl-1,5-diphenylformazan

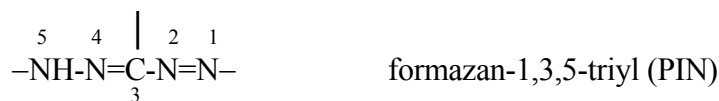


N'-[(phenyldiazenyl)methylidene]acetohydrazide (PIN)

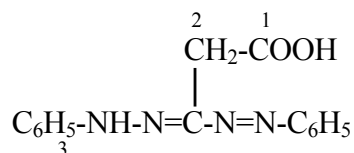
P-68.3.1.3.4.2 Prefixes derived from formazan for substitutive nomenclature

Substituent groups derived from formazan are as follows; retained names lead to preferred IUPAC names.

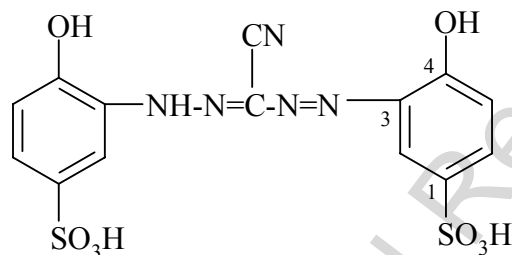
	Retained name	Systematic name
$\begin{array}{c} 5 \quad 4 \quad 3 \quad 2 \quad 1 \\ \text{H}_2\text{N-N}=\text{CH-N}=\text{N}- \end{array}$	formazan-1-yl (PIN)	(hydrazinylidenemethyl)diazenyl
$\begin{array}{c} 1 \quad 2 \quad 3 \quad 4 \quad 5 \\ \text{HN}=\text{N}-\text{CH}=\text{N}-\text{NH}- \end{array}$	formazan-5-yl (PIN)	(diazenylmethylidene)hydrazinyl
$\begin{array}{c} 5 \quad 4 \quad \quad 2 \quad 1 \\ \text{H}_2\text{N-N}=\text{C}-\text{N}=\text{NH} \\ 3 \end{array}$	formazan-3-yl (PIN)	diazenyl(hydrazinylidene)methyl
$\begin{array}{c} 5 \quad 4 \quad 3 \quad 2 \quad 1 \\ -\text{HN-N}=\text{CH-N}=\text{N}- \end{array}$	formazan-1,5-diyl (PIN)	
$\begin{array}{c} 1 \quad 2 \quad \quad 4 \quad 5 \\ \text{HN}=\text{N}-\text{C}=\text{N}-\text{NH}- \\ 3 \end{array}$	formazan-3,5-diyl (PIN)	
$\begin{array}{c} 5 \quad 4 \quad 3 \quad 2 \quad 1 \\ =\text{N-N}=\text{CH-N}=\text{N}- \end{array}$	formazan-1-yl-5-ylidene (PIN)	
$\begin{array}{c} 5 \quad 4 \quad \quad 2 \quad 1 \\ =\text{N-NH}-\text{CH}-\text{N}=\text{NH} \\ 3 \end{array}$	formazan-3-yl-5-ylidene (PIN)	



Examples:



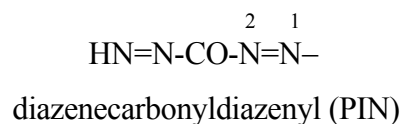
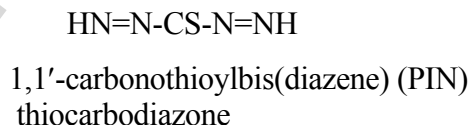
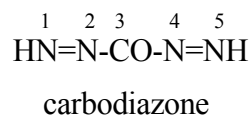
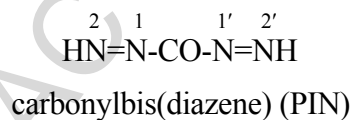
3-(phenyldiazenyl)-3-(phenylhydrazinylidene)propanoic acid (PIN;
 propanoic acid preferred to acetic acid)
 (1,5-diphenylformazan-3-yl)acetic acid



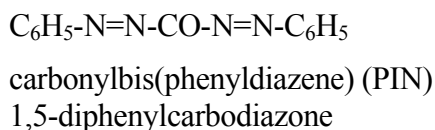
(3-cyanoformazan-1,5-diyl)bis(4-hydroxybenzene-1-sulfonic acid) (PIN)
 3-({cyano[(2-hydroxy-5-sulfonophenyl)hydrazinyl]methyl}diazenyl)-4-hydroxy-
 benzenesulfonic acid

P-68.3.1.3.5 1,1'-carbonylbis(diazene), HN=N-CO-N=NH

The compound HN=N-CO-N=NH is named 1,1'-carbonylbis(diazene); its hydrocarbyl derivatives are named substitutively. Such names are preferred IUPAC names over those denoted by the retained name 'carbodiazone', which can be used in general nomenclature with full substitution according to a special numbering. Chalcogen analogues are named by using the infixes and the prefixes 'thio', 'seleno' and 'telluro' for naming the chalcogen analogs of the hydrazide and the carbazone. The corresponding prefix is named systematically.



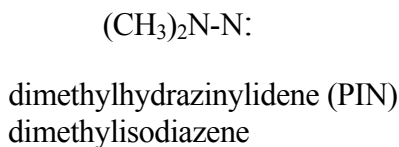
Example:



P-68.3.1.3.6 Isodiazenes, $\text{R}_2\text{N}^+=\text{N}^-$

Compounds with the general structure $\text{R}_2\text{N-N:} \leftrightarrow \text{R}_2\text{N}^+=\text{N}^-$ are generically called 'isodiazenes' and named substitutively on the basis of the parent radical 'hydrazinylidene, $\text{H}_2\text{N-N:}$ '. This method leads to preferred IUPAC names rather than the parent hydride name 'isodiazone'.

Example:



P-68.3.1.4 Polyazanes

P-68.3.1.4.1 Acyclic polyazanes are saturated chains composed of nitrogen atoms; hydrazine is the IUPAC preferred retained name for diazane, $\text{H}_2\text{N-NH}_2$. Names are formed by prefixing the mononuclear parent hydride name 'azane' with an appropriate numerical prefix and numbered in the same way as hydrocarbons. The parent hydrides are preselected IUPAC names (see P-12)

Examples:



1-methyltriazane. (PIN)



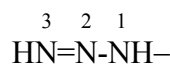
1,2-dimethyltetraazane (PIN)

The corresponding prefixes are named according to the general method described in P-29. The traditional names 'triazano' and 'triazeno' are names of bridges in bridged fused ring names and must not be used as substituent groups.

Examples:

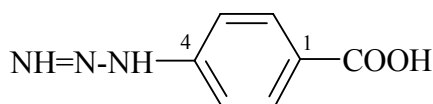


triazan-1-yl- (preselected name)
(not triazano)



triaz-2-en-1-yl- (preselected name)
(not 2-triazeno)

Examples:



4-(triaz-2-en-1-yl)benzoic acid (PIN)
(not 4-triazobenzoic acid)

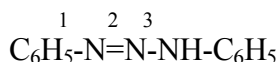


ethyl (tetrazan-1-yl)acetate (PIN)
(not ethyl tetrazanoacetate)

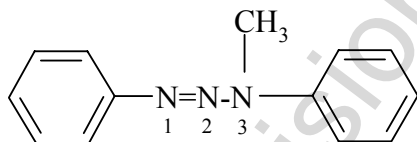
P-68.3.1.4.2 Diazoamino compounds

Compounds having the structure $\text{R}-\text{N}=\text{N}-\text{NR}_2$ are classified as 'diazoamino compounds', when the same substituent group is located at each end of the chain. They are named substitutively, on the basis of parent hydride name 'triazene'. The prefix 'diazoamino' is no longer recommended.

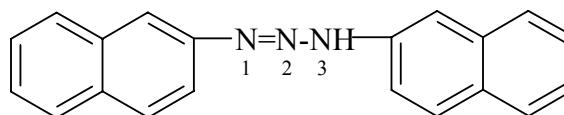
Examples:



1,3-diphenyltriaz-1-ene (PIN)
(formerly diazoaminobenzene)



3-methyl-1,3-diphenyltriaz-1-ene (PIN)
(formerly *N*-methyl diazoaminobenzene)



1,3-di(naphthalen-2-yl)triaz-1-ene (PIN)
(formerly 2,2'-diazoaminonaphthalene)

P-68.3.2 Phosphorus, arsenic and antimony compounds

P-68.3.2.1 General methodology

Preferred names of acyclic phosphorus, arsenic and antimony compounds are functional class names (see P-67) derived from mononuclear and polynuclear acids, such as phosphoric acid, H_3PO_4 , arsonous acid, $\text{HAS}(\text{OH})_2$, stibinic acid, $\text{H}_2\text{Sb}(\text{O})(\text{OH})$, diphosphonic acid, $\text{HO}-\text{HP}(\text{O})-\text{O}-\text{P}(\text{O})\text{H}-\text{OH}$, rather than substitutive names based on parent hydrides.

Other preferred names of acyclic and cyclic compounds are substitutive names, in accordance with the seniority of classes (see P-41).

This subsection includes the description of functional class nomenclature and substitutive nomenclature.

P-68.3.2.2 Parent hydrides

P-68.3.2.3 Substitutive nomenclature

P-68.3.2.2 Parent hydrides

Parent hydrides are formed by the methods described in Chapter 2. They are mononuclear and acyclic polynuclear and cyclic and are preselected names (see P-12). The λ -convention is used to denote pentavalent phosphorus and arsenic atoms. Retained names for use only in general nomenclature are phosphine, phosphorane, arsine, arsorane, stibine, stiborane, and bismuthine.

Preferred names are selected as indicated in Chapter 2.

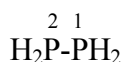
Examples:



phosphane (preselected name)
 phosphine



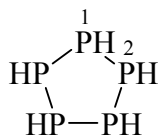
λ^5 -arsane (preselected name)
 arsorane



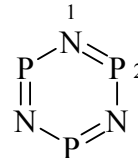
diphosphane (preselected name)
 diphosphine



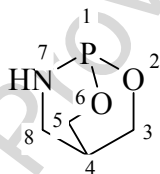
pentaarsane (preselected name)



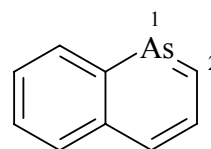
pentaphospholane (preselected name)
 cyclopentaphosphane



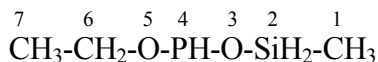
1,3,5,2,4,6-triazatriphosphinine (preselected name)
 cyclotriphosphazene



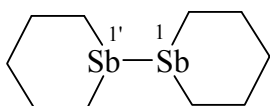
2,6-dioxa-7-aza-1-phosphabicyclo[2.2.2]octane (PIN)



arsinoline (PIN)



3,5-dioxa-4-phospha-2-silaheptane (PIN)



1,1'-bistibinane (PIN)

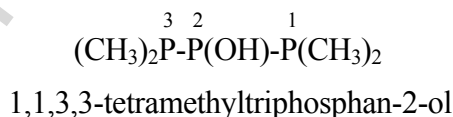
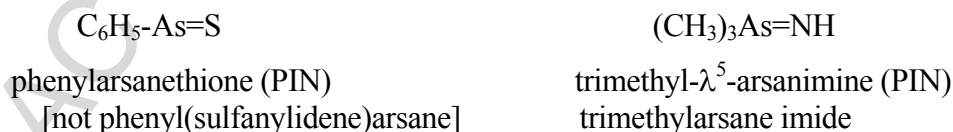
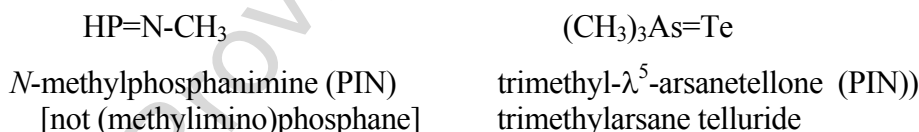
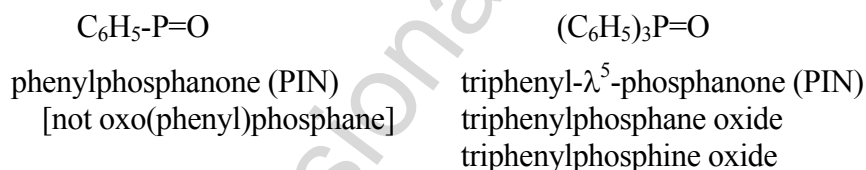
P-68.3.2.3 Substitutive nomenclature

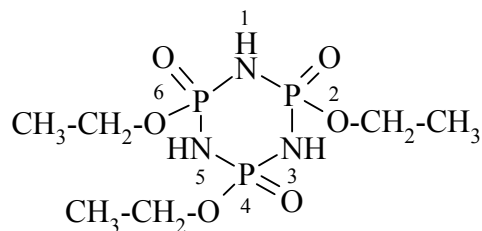
Compounds not named in accordance with the previous section, P-68.3.2.3, are named substitutively on the basis of acyclic and cyclic parent hydrides, using suffixes and prefixes to designate characteristic groups.

P-68.3.2.3.1 Substitutive nomenclature, suffix mode

Suffixes are used to denote characteristic groups present as principal groups, with the exception of acids having retained names and their derivatives, as described in P-68.3.2.3. This method produces preferred IUPAC names over those formed by functional class nomenclature where =O, =S, =Se, =Te, =NH are denoted by the class names oxide, sulfide, selenide, telluride, and imide added to the name of the parent hydride.

Examples:





2,4,6-triethoxy-1,3,5-triaza-2 λ^5 ,4 λ^5 ,6 λ^5 -triphosphinane-2,4,6-trione (PIN)

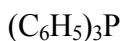
P-68.3.2.3.2 Substitutive nomenclature, prefix mode

The seniority of classes must be applied in the following order: classes expressed by suffixes, then classes in order of the senior class, in the order N > P > As > Sb > Bi > Si > Ge > Sn > Pb > B > Al > Ga > In > Tl > O > S > Se > Te, and C.

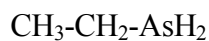
P-68.3.2.4.2.1 Substitution of phosphanes, arsanes and stibanes by organyl groups

Alkyl, aryl, etc. groups and groups derived from parent hydrides containing O, S, Se, and Te atoms are always denoted by prefixes. Halides and pseudohalides are not expressed by prefixes when attached directly to a P, As or Sb atom, because functional replacement of parent acids having retained names is senior for naming them as acid halides and pseudohalides (see P-67).

Examples:



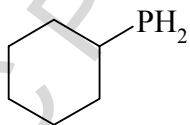
triphenylphosphane (PIN)
triphenylphosphine



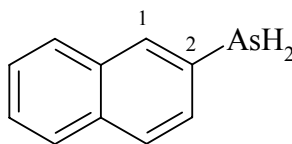
ethylarsane (PIN)
ethylarsine



pentamethoxy- λ^5 -phosphane (PIN)
(formerly pentamethyl holophosphate)



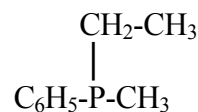
cyclohexylphosphane (PIN)
cyclohexylphosphine



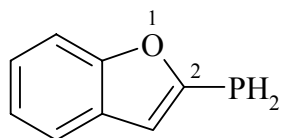
naphthalen-2-ylarsane (PIN)
naphthalen-2-ylarsine
2-naphthylarsane



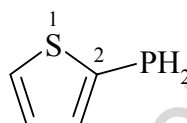
(1-chloroethyl)(2-chloroethyl)arsane (PIN)
 (1-chloroethyl)(2-chloroethyl)arsine



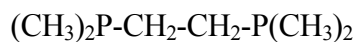
ethyl(methyl)phenylphosphane (PIN)
 ethyl(methyl)phenylphosphine



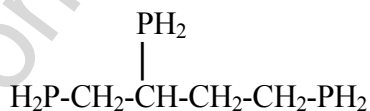
1-benzofuran-2-ylphosphane (PIN)
 1-benzofuran-2-ylphosphine



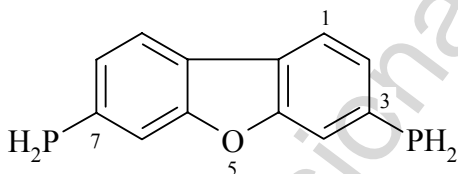
thiophen-2-ylphosphane (PIN)
 thiophen-2-ylphosphine



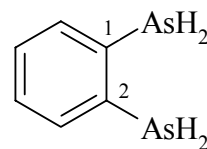
ethane-1,2-diylbis(dimethylphosphane) (PIN)
 ethane-1,2-diylbis(dimethylphosphine)



butane-1,2,4-triyltris(phosphane) (PIN)
 butane-1,2,4-triyltris(phosphine)



dibenzofuran-3,7-diylbis(phosphane) (PIN)
 dibenzofuran-3,7-diylbis(phosphine)



1,2-phenylenebis(arsane) (PIN)
 1,2-phenylenebis(arsine)

P-68.3.2.4.2.2 Phosphanes, arsanes and stibanes expressed as substituent groups

Substituent groups are formed by the general method described in Section P-29, by adding the suffixes 'yl', 'ylidene' and 'ylydyne' to the name of the parent hydride with elision of the final letter 'e'. When required, the order of classes is applied, as indicated in Section P-41. The traditional names phosphino, arsino and stibino are no longer recommended.



phosphanyl (preselected name)
 (not phosphino)



arsanylylidene (preselected name)

$-\text{H}_2\text{P}-\text{PH}_2-$
 phosphane-1,2-diyl (preselected name)

$-\text{As}<$
 arsane-triyl (preselected name)

AsH_2
 arsanyl (preselected name)
 (not arsino)

$-\text{SbH}_2$
 stibanyl (preselected name)
 (not stibino)

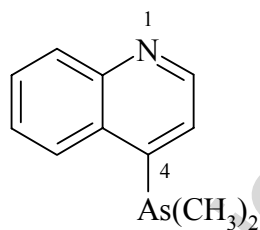
$-\text{PH}_4$
 λ^4 -phosphanyl (preselected name)
 phosphoranyl

$-\text{SbH}-\text{SbH}_2$
 distibanyl (preselected name)

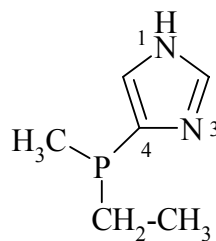
Examples:

$\text{H}_2\text{P}-\overset{2}{\text{CH}_2}-\overset{1}{\text{CH}_2}-\text{NH}_2$
 2-phosphanylethanamine (PIN)

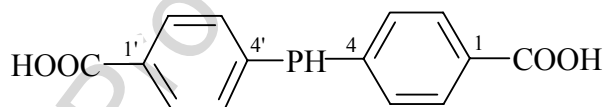
$\text{H}_2\text{As}-\text{CH}_2-\text{P}(\text{C}_6\text{H}_5)_2$
 (arsanylmethyl)diphenylphosphane (PIN)



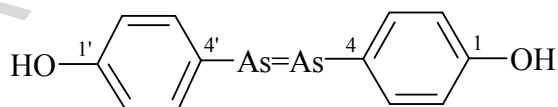
4-(dimethylarsanyl)quinoline (PIN)



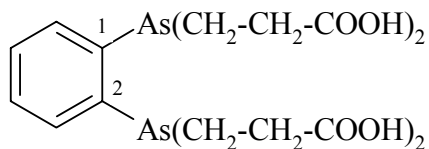
4-[ethyl(methyl)phosphanyl]imidazole (PIN)



4,4'-phosphanediyl dibenzoic acid (PIN)

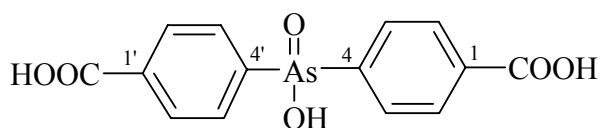


4,4'-diarsenediyl diphenol (PIN)

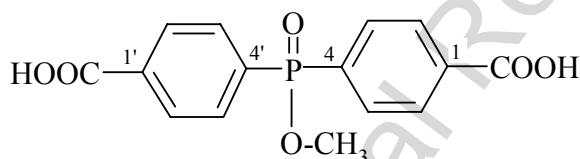


3,3',3'',3'''-[1,2-phenylenebis(arsanetriyl)]tetrapropanoic acid (PIN)

$(\text{HO})_2\text{As}(\text{O})\text{-CH}_2\text{-COOH}$
arsonoacetic acid (PIN)



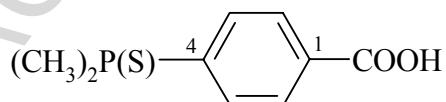
4,4'-(hydroxyarsoryl)dibenzoic acid (PIN)
4,4'-arsinicodibenzoic acid



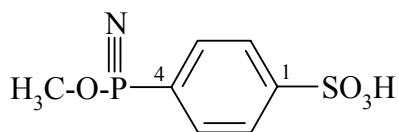
4,4'-(methoxyphosphoryl)dibenzoic acid (PIN)

$\text{Cl}_2\text{P}(\text{O})\text{-CH}_2\text{-CO-Cl}$
phosphorodichloridoacetyl chloride (PIN)
(dichlorophosphoryl)acetyl chloride

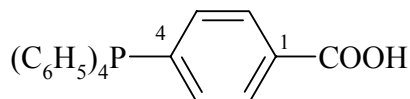
$(\text{CH}_3\text{O})_2\text{P}(=\text{NH})\text{-CH}_2\text{-CO-O-CH}_3$
methyl (dimethoxyphosphorimidoyl)acetate (PIN)



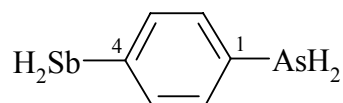
4-(dimethylphosphinothioyl)benzoic acid (PIN)



4-(methoxyphosphoronitrido)benzene-1-sulfonic acid (PIN)



4-(tetraphenyl- λ^5 -phosphanyl)benzoic acid (PIN)
 4-(tetraphenylphosphoranyl)benzoic acid



(4-stibanylphenyl)arsane (PIN)

P-68.3.3 Bismuth compounds

Bismuth compounds are named substitutively on the basis of parent hydrides named in accordance with the rules described in Chapter 2. Suffixes and prefixes are used as indicated for substitutive nomenclature. There are no acids having retained names subject to functional class nomenclature. Substitutive nomenclature is preferred to functional nomenclature to designate oxides, sulfides, selenides, tellurides, and imides. Preferred and preselected names are chosen as for P, As and Sb parents and prefixes.

Examples:

BiH_3
 bismuthane (preselected name)
 bismuthine

BiH_5
 λ^5 -bismuthane (preselected name)
 bismuthorane

$\text{H}_2\text{Bi}-\text{BiH}_2$
 dibismuthane (preselected name)

$\text{H}_2\text{Bi}-$
 bismuthanyl (preselected name)
 (not bismuthino)

$\text{H}_3\text{Bi}=\text{}$
 λ^5 -bismuthanylidene (preselected name)

$-\text{HBi}-\text{BiH}-$
 dibismuthane-1,2-diyl (preselected name)

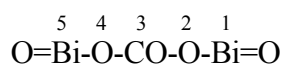
Examples:

$\text{Bi}(\text{CH}=\text{CH}_2)_3$
 triethenylstibane (PIN)
 trivinylstibane

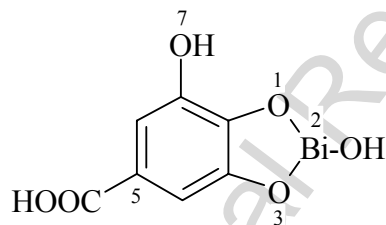
$\text{Bi}(\text{CH}_3)_3$
 trimethylbismuthane (PIN)

$(\text{C}_6\text{H}_5)_3\text{Bi}=\text{O}$
 triphenyl- λ^5 -bismuthanone (PIN)
 triphenylbismuthane oxide

$(\text{C}_6\text{H}_5)_3\text{Bi}=\text{NH}$
 triphenyl- λ^5 -bismuthanimine (PIN)
 triphenylbismuthane imide

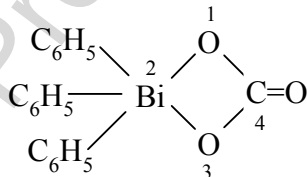


2,4-dioxa-1,5-dibismapentane-1,3,5-trione (PIN)

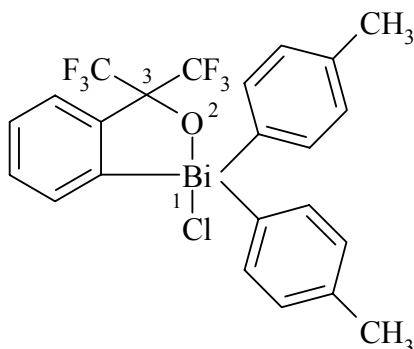


2,7-dihydroxy-2*H*-1,3,2-benzodioxabismole-5-carboxylic acid (PIN)

$(\text{C}_6\text{H}_5)_3\text{BiCl}_2$
 dichloro(triphenyl)- λ^5 -bismuthane (PIN)
 dichloro(triphenyl)- λ^5 -bismuthorane



2,2,2-triphenyl-1,3,2- λ^5 -dioxabismetan-4-one (PIN)



1-chloro-1,1-bis(4-methylphenyl)-3,3-bis(trifluoromethyl)-1,3-dihydro-2,1 λ^5 -benzoxabismole (PIN)

P-68.4 Nomenclature of elements of Group 16

P-68.4.0 Introduction

P-68.4.1 Compounds with three or more homogeneous contiguous chalcogen atoms

P-68.4.2 Compounds with three or more heterogeneous contiguous chalcogen atoms

P-68.4.3 Compounds with contiguous chalcogen atoms terminated by hydrogen atoms

P-68.4.4 Chalcogen atoms with bonding numbers other than standard bonding numbers

P-68.4.0 Introduction

The nomenclature of compounds containing chalcogen atoms depends on the number and kind of chalcogen atoms present. When one or two contiguous chalcogen atoms are present, chalcogen atoms are not used as parent hydrides unless there is no other alternative. To the contrary, when three or more contiguous identical chalcogen atoms are present these chalcogen atoms are treated as parent hydrides in the normal way.

Compounds having one or two contiguous chalcogen atoms have been described in previous sections. They are briefly recalled in this introduction, for comparison purposes with compounds having three or more contiguous chalcogen atoms. See P-63.1 for hydroxy compounds, P-63.4 for hydroperoxy compounds, P-63.2 for ethers and P-63.3 for peroxy compounds, and chalcogen analogues. Sulfoxides and sulfones are also included in this type of nomenclature (see P-63.6).

P-68.4.1 Compounds with three or more contiguous chalcogen atoms.

P-68.4.1.1 Compounds with three or more contiguous identical chalcogen atoms are treated as parent hydrides in substitutive nomenclature.

Examples:

HO-O-OH
trioxidane (preselected name)

CH₃-S-S-SH
methyltrisulfane (PIN)

CH₃-O-O-O-CH₃
dimethyltrioxidane (PIN)

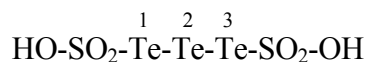
CH₃-S-S-S-CH₃
dimethyltrisulfane (PIN)



1-methyl-3-phenyltriselenane (PIN)
methyl(phenyl)triselenane



1,3-diphenyltriselenane (PIN)
(not triselenanediyl dibenzene)



tritellanedisulfonic acid (PIN)
tritelluropentathionic acid
(traditional name)



trisulfanedisulfonic acid (PIN)
pentathionic acid
(traditional name)



methyltriselenane-*OS*-thioperoxol (PIN)



tritellane(diselenoperoxol) (PIN)



phenyltrisulfanol (PIN)



methyltetratellane-thiol (PIN)

P-68.4.1.2 Multiplicative nomenclature is used if conditions are fulfilled. Central substituent groups are derived from the general method for generating divalent substituent groups.



trioxidanediyl (preselected name)

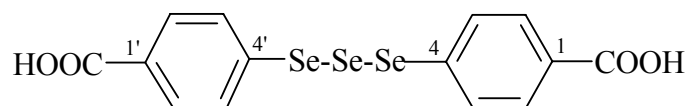


tetrasulfanediyyl (preselected name)

Examples:



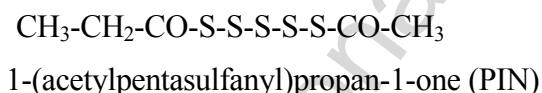
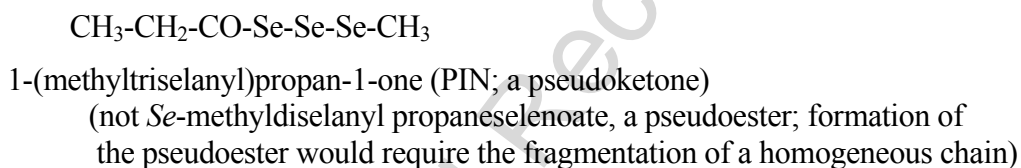
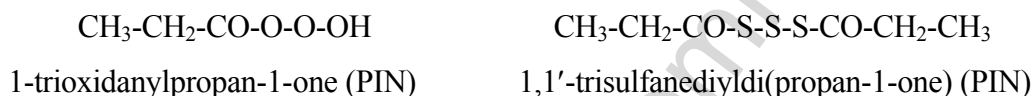
methylenebis(trisulfane) (PIN)



4,4'-triselanedyldibenzoic acid (PIN)

P-68.4.1.3 If the chain of identical chalcogen atoms is terminated by one or two acyl groups the compound is named as a pseudoketone on the basis of the preferred carbonyl component. Multiplicative nomenclature is used if the principles for its use are met. When there is a choice between names of a pseudoketone and of a pseudoester, the compound is named as a pseudoketone and not as a pseudoester if that leads to fragmenting the homogeneous chain.

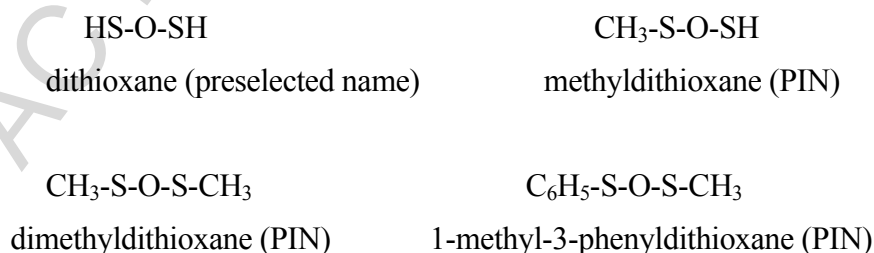
Examples:



P-68.4.2 Compounds with three heterogeneous contiguous chalcogen atoms

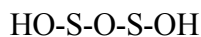
P-68.4.2.1 Compounds of the type $\text{a}(\text{ba})_x$ are parent hydrides; they are discussed in P-21.2.3.1. Other compounds containing three or more heterogeneous contiguous chalcogen atoms are named on the basis of appropriate mononuclear, dinuclear and polynuclear, as appropriate, chalcogen parent hydrides with the exception of oxidane..

Examples:

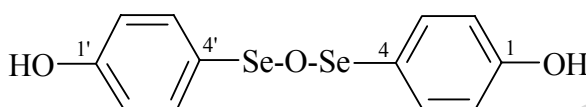




dithioxanol (preselected name)
(sulfanyloxy)sulfanol
(not hydroxysulfane-*OS*-peroxol)



dithioxanediol (preselected name)
(not oxydisulfanol)



4,4'-diselenoxaneyldiphenol (PIN)

P-68.4.2.2 Mono, di and polynuclear parent hydride names, except for oxidane, itself, are used for compounds with contiguous chalcogen atoms terminated by hydrogen atoms.

Examples:



sulfanol (preselected name)
(not oxidanethiol)



sulfanediol (preselected name)
(not oxidane-*OS*-peroxol)



tellanediselenol (preselected name)
(not sellane-*TeSe*-selenotelluroperoxol)



(hydroperoxy)sulfanol (preselected name)
(not dioxidane-*SO*-peroxol)

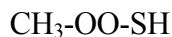


disulfaneperoxol (preselected name)
[(not dioxidane(dithioperoxol))]

P-68.4.2.3 Compounds with an organic group at one or both ends of a heterogeneous chalcogen chain of atoms are named substitutively on the basis of the preferred organic group.

Substituting groups may be made up of individual units or formed by functional replacement nomenclature based on tri or tetraoxide, etc., substituting groups. The latter method is not used if the compound is a pseudoketone or a pseudoester. Multiplicative or skeletal replacement ('a') nomenclature is used if the requirements for either are met.

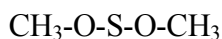
Examples:



(sulfanylperoxy)methane (PIN)
 (SOO-thiohydrotrioxy)methane
 (not methyl dioxidanethiol)



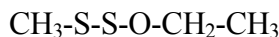
(hydroxydisulfanyl)methane (PIN)
 (OSS-dithiohydrotrioxy)methane
 (not methyl disulfanol)



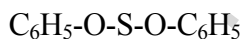
[(methoxysulfanyl)oxy]methane (PIN)
 (methyl-OSO-thiotrioxo)methane
 dimethoxysulfane



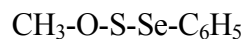
[(methylperoxy)sulfanyl]methane (PIN)
 methyl(methylsulfanyl)dioxidane
 (methyl-OOS-thiotrioxo)methane
 (methyl-SSO-dithiotrioxo)ethane



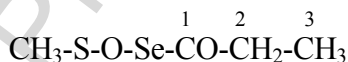
[(methyl disulfanyl)oxy]ethane (PIN)
 [methyl(dithiohydroperoxy)oxy]ethane
 ethoxy(methyl)disulfane



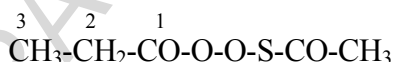
[sulfanediy]bis(oxy)dibenzene (PIN)
 OSO-thiotrioxo dibenzene



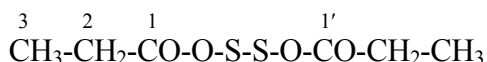
[(methoxysulfanyl)selanyl]benzene (PIN)
 methyl-OSSe-selenothiotrioxo benzene



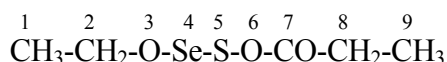
1-[[methylsulfanyl]oxy]selanyl}propan-1-one (PIN)



[(acetylsulfanyl)peroxy]propan-1-one (PIN)



1,1'-[disulfanediy]bis(oxy)dipropan-1-one (PIN)
 1,1'-[dithiohydroperoxy]bis(oxy)dipropan-1-one



3,6-dioxa-5-thia-4-selenanonan-7-one (PIN)

P-68.4.3 Chalcogen parent compounds with bonding numbers other the standard bonding number.

Many chalcogen compounds are designated by class names that were used as parent structures to name their derivatives. In these recommendations, in conformity with the principle that substitutive names are preferred, derivatives named on the basis of class names are retained for general use only.

P-68.4.3.1 Sulfanes and similar chalcogen compounds;

P-68.4.3.2 Sulfones and sulfoxides, polysulfones, polysulfoxides, and similar chalcogen compounds: R-EO₂-R', R-EO-R', R-EO₂-EO₂-R', etc. (E = S, Se, and Te).

P-68.4.3.3 Sulfimides, H₂E=NH (E = S), and similar chalcogen compounds (E = Se, Te):

P-68.4.3.4 Sulfinylamines, RN=E=O (E = S), and sulfonylamines, RN=E(=O)₂ (E = S), and similar chalcogen compounds: (E = Se, Te).

P-68.4.3.5 Sulfonediimines, RE(=NH)₂R' (E = S), and similar chalcogen compounds. (E = Se, Te).

P-68.4.3.6 Sulfoximides, R₂E(=O)=NR' (E = S), and similar chalcogen compounds (E = Se, Te)

P-68.4.3.7 Sulfur dimides, HN=E=NH (E = S), and similar chalcogen compounds (E = Se, Te)

P-68.4.3.8 Sulfur triimides, E(=NH)₃ (E = S), and similar chalcogen compounds (E = Se, Te)

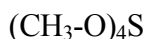
P-68.4.3.1 Sulfanes, selanes, and tellanes.

Sulfanes, selanes, and tellanes, that have a nonstandard bonding number are named on the basis of parent hydrides such as λ⁴-sulfane, λ⁶-sulfane, and λ⁴-selane, according to the λ-convention.

Example:



dimethyl(methylidene)-λ⁴-sulfane (PIN)

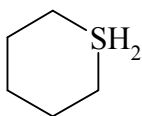


tetramethoxy-λ⁴-sulfane (PIN)

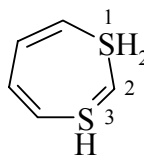
(trimethoxy-λ⁴-sulfanyl)methane

(formerly tetramethyl orthosulfurite)

(formerly dimethyl sulfoxylate)



λ^4 -thiane (PIN)



1H-1 λ^4 ,3 λ^4 -dithiepine (PIN)

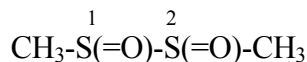
P-68.4.3.2 Di- and polysulfoxides, polysulfones, and selenium and tellurium analogues

Compounds with the general structures R-[SO]_n-R' and R-[SO₂]_n-R', in which $n \geq 2$, have the class name 'disulfoxides', 'trisulfoxides', 'disulfones', etc. They are named in two ways. Selenium and tellurium analogues are named in the same manner.

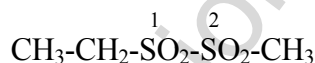
- (1) substitutively by adding the suffix 'one' to the name of the appropriate parent hydride, λ^4 or λ^6 disulfane, diselane, ditellane, etc.;
- (2) by functional class nomenclature, using class names such as 'disulfoxide', 'disulfone', 'diselenoxide', 'diselenone', etc.

Method (1) generates preferred IUPAC names and is also used to name mixed sulfoxide-sulfones.

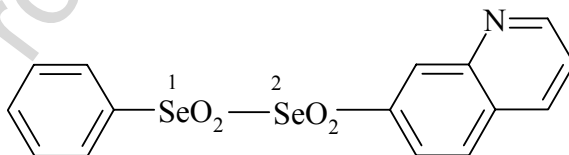
Examples:



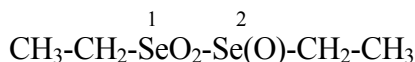
dimethyl-1 λ^4 ,2 λ^4 -disulfane-1,2-dione (PIN)
 dimethyl disulfoxide



ethyl(methyl)-1 λ^6 ,2 λ^6 -disulfane-1,1,2,2-tetrone (PIN)
 ethyl methyl disulfone



1-phenyl-2-(quinolin-7-yl)-1 λ^6 ,2 λ^6 -diselane-1,1,2,2-tetrone (PIN)
 phenyl quinolin-7-yl diselenone



diethyl-1 λ^6 ,2 λ^4 -diselane-1,1,2-trione (PIN)

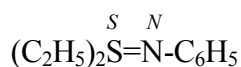
P-68.4.3.3 Sulfinimides, $\text{H}_2\text{E}=\text{NH}$ ($\text{E} = \text{S}$), and chalcogen compounds where $\text{E} = \text{Se}, \text{Te}$.

Compounds with the general structures, $\text{H}_2\text{S}=\text{NH}$, have the class name 'sulfinimides' (CAS calls them sulfilimines). They are named in two ways.

- (1) substitutively by adding the suffix 'imine' to the name of the parent hydride such as, λ^4 -sulfane;
- (2) by functional class nomenclature, using the class name 'sulfinimide'.

Method (1) generates preferred IUPAC names.

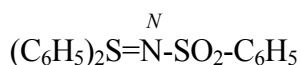
Example:



S,S-diethyl-*N*-phenyl- λ^4 -sulfanimine (PIN)
S,S-diethyl-*N*-phenylsulfinimide

N and/or *S* substitution by groups that are not hydrocarbyl groups, may create senior parent structures that become the basis for the name.

Example:



N-(diphenyl- λ^4 -sulfanylidene)benzenesulfonamide (PIN)
S,S-diphenyl-*N*-benzenesulfonylsulfinimide

P-68.4.3.4 Sulfinylamines, $\text{RN}=\text{E}=\text{O}$, ($\text{E} = \text{S}$), sulfonylamines, $\text{RN}=\text{E}(=\text{O})_2$ ($\text{E} = \text{S}$), and chalcogen analogues where $\text{E} = \text{Se}, \text{Te}$.

Compounds with the general structures, $\text{R}-\text{N}=\text{S}=\text{O}$ and $\text{R}-\text{N}=\text{S}(=\text{O})_2$, have the class names 'sulfinylamines' and 'sulfonylamines', respectively. They are named substitutively on the basis of the parent hydrides λ^4 -sulfane or λ^6 -sulfane.

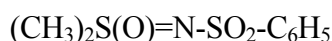
Examples:



(phenylimino)- λ^4 -sulfanone (PIN)
(not *N*-sulfinylaniline)



(methylimino)- λ^6 -sulfanedione (PIN)
(not *N*-sulfonylmethanamine)

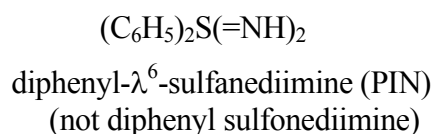


(benzenesulfonylimino)dimethyl- λ^6 -sulfanone (PIN)

P-68.4.3.5 Sulfonediimines, $RE(=NH)_2R'$ ($E = S$), and chalcogen analogues where $E = Se, Te$.

Compounds with the general structures, $RE(=NH)_2R'$, have the class name 'sulfonediimines'. Preferred IUPAC names are formed substitutively on the basis of the parent hydride λ^6 -sulfane. Names based on the the class name 'sulfonediimine' are not recommended.

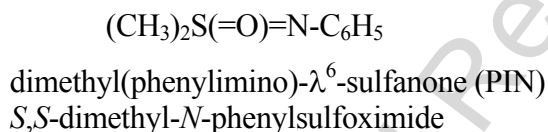
Example:



P-68.4.3.6 Sulfoximides, $R_2E(=O)=NR'$ ($E = S$), and chalcogen analogues where ($E = Se, Te$).

Compounds with the general structure, $R_2E(=O)=NR'$, have the class name 'sulfoximides' (CAS calls them sulfoximines). Preferred IUPAC names are formed substitutively on the basis of the parent hydride λ^6 -sulfane. Functional class names are based on the class name 'sulfoximide'.

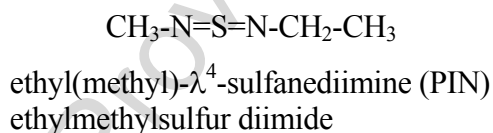
Example:



P-68.4.3.7 Sulfur diimides, $HN=E=NH$ ($E = S$), and chalcogen analogues where $E = Se, Te$.

Compounds with the general structure, $HN=S=NH$, have the class name 'sulfur diimides'. Preferred IUPAC names are formed substitutively on the basis of the parent hydride λ^4 -sulfane. Functional class names are based on the class name 'sulfur diimide'.

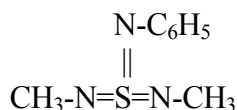
Example:



P-68.4.3.8 Sulfur triimides, $E(=NH)_3$ ($E = S$), and chalcogen analogues where $E = Se, Te$.

Compounds with the general structure, $S(=NH)_3$, have the class name 'sulfur triimides'. Preferred IUPAC names are formed substitutively on the basis of the parent hydride λ^6 -sulfane. Functional class names are based on the class name 'sulfur triimide'.

Example:



dimethyl(phenyl)- λ^6 -sulfanetriimine (PIN)
dimethylphenylsulfur triimide

P-68.5 Nomenclature of compounds of Group 17

P-68.5.0 Substitutive nomenclature

In substitutive nomenclature, halogen atoms are denoted only by specific prefixes (see P-61.3), by their class names in functional class nomenclature (see P-65.3) and by prefixes and infixes in functional replacement nomenclature (see P-35).

Examples:

$\text{CH}_3\text{-Cl}$
chloromethane (PIN)

$\text{CH}_3\text{-CH}_2\text{-NH-Cl}$
N-chloroethanamine (PIN)

$\text{C}_6\text{H}_5\text{-ClO}$
chlorosylbenzene (PIN)

$\text{CH}_3\text{-CH}_2\text{-CO-Br}$
propanoyl bromide (PIN)

$\text{CH}_3\text{-CH}_2\text{-SO}_2\text{-Cl}$
ethanesulfonyl chloride (PIN)

$\text{C}_6\text{H}_5\text{-P(O)Cl}_2$
phenylphosphonic dichloride (PIN)

$\text{CH}_3\text{-BCl}_2$
dichloro(methyl)borane (PIN)

$\text{CH}_3\text{P(Cl)(S-C}_2\text{H}_5)$
ethyl methylphosphonochloridothioite (PIN)
(not ethyl methanephosphonochloridothioite)

P-68.5.1 Nomenclature based on halogen parent hydrides

For cyclic and acyclic parent hydrides the lambda convention is used to indicate nonstandard bonding numbers.

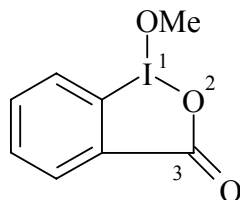
Examples:

$\text{C}_6\text{H}_5\text{-I(OH)}_2$
phenyl- λ^5 -iodanediol (PIN)

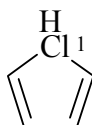
$\text{CH}_3\text{-ICl}_2$
dichloro(methyl)- λ^3 -iodane (PIN)

$(\text{CH}_3\text{-CO})_2\text{I-}$ bis(acetyloxy)- λ^3 -iodanyl
(not diacetoxyiodo)

$(\text{HO})_2\text{I-}$ dihydroxy- λ^3 -iodanyl
(not dihydroxyiodo)



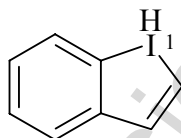
1-methoxy-1 λ^3 ,2-benziodoxol-3(1*H*)-one (PIN)



1 λ^3 -chlorole (PIN)



1 λ^3 -bromirane (PIN)



1 λ^3 -benziodole (PIN)

P-68.5.2 Nomenclature of halogen acids

The halogen acids HO-Cl, hypochlorous acid, HO-ClO, chlorous acid, HO-ClO₂, chloric acid, and HO-ClO₃, perchloric acid, and similar acids where Br, F, and I take the place of Cl, are discussed in P-67.1.1. They form esters (see P-67.1.3.1), such as ‘methyl chlorite’, CH₃-O-ClO, and anhydrides (see P-67.1.3.2), such as ‘benzoic hypochlorous anhydride’, C₆H₅-CO-O-Cl.

Substituent groups derived from the halogen acids, such as chlorosyl, -ClO, bromyl, -BrO₂, and periodyl, -IO₃, are discussed in P-67.1.4.5 and exemplified in P-61.3.2.