

Advanced Inorganic Chemistry - part Inorganic Molecules

Exercise 1 (electronic and molecular structure, building reaction, and chemical and physical properties of inorganic molecules and ions)

Of the 5 molecules and/or ions each listed below, give the oxidation numbers of the non-ligand atoms, draw a suitable Lewis structure with the formal charges (if necessary) by using lines for bonds and free electron pairs and dots for single electrons, the ψ -type AL_mE_n (m = number of ligands, n = number of free electron pairs or single electrons), the resulting ψ -polyhedron, the gas phase structure/shape and the symmetry of the molecule (in form of the point group symbol), and mark those with a star which have no resonance structures (no other electronic structures).

Give the result in form of a table as given below.

Formula	Ox. no.	Lewis structure	ψ -type	ψ -polyhedron	Mol. Struct.	Sym.
NF ₃	3+	draw it	AL ₃ E	tetrahedron	trig. pyr.	C _{3v}

Molecules/ions to be treated in exercise 1.

Afzal	Faria	AsX ₃	ClF ₅	N ₂	OX ₂	S ₂
Ateacha	Derick	AsX ₄ ⁺	CO ₂	N ₂ O	P ₂ O ₆ ⁴⁻	S ₂ Cl ₂
Chen	Yizhou	BeCl ₂	CO ₃ ²⁻	N ₂ O ₂ ²⁻	P ₂ O ₇ ⁴⁺	S ₂ F ₁₀
Dörbaum	Nils	BeX ₄ ²⁻	CX ₄	N ₂ O ₃	P ₂ Se ₅	S ₂ F ₂
Haas	Simon	BrF ₃	AlI ₃	N ₂ O ₄	P ₄ (NR) ₆	S ₂ O ₃ ²⁻
Kiefer	Konrad	BrF ₄ ⁻	GeX ₄	N ₂ O ₅	P ₄ O ₁₀	S ₂ O ₄ ²⁻
Kirsch	Christoph	BrF ₅	H ₂ PO ₂ ⁻	NO	P ₄ O ₆	SiX ₄
Krüger	Sascha	S ₂ O ₆ ²⁻	SnCl ₂	BX ₃	HgX ₂	NO ⁺
Liedke	André	P ₄ S ₆	SbCl ₅	SO ₂	BX ₄ ⁻	HPO ₃ ²⁻
Mutengwa	Archford	NO ₂	PCl ₃ F ₂	SbF ₅	SO ₃	[(CH ₃) ₂ PN]
Najm-ul	Hassan	I ₂ Cl ₆	NO ₂ ⁻	PCl ₅	SbX ₃	SO ₃ ²⁻
Peram	Pardha Saradhi	[(CH ₃) ₂ SiO] ₃	I ₃ ⁻	NO ₂ ⁺	PCl ₆ ⁻	SCL ₂
Tambe	Suparna	SO ₄ ²⁻	[Cl ₂ PN] ₃	ICl ₂ ⁻	NO ₃ ⁻	PF ₅
Wael	Ali	SCL ₄	SX ₂	[Cl ₂ PN] ₄	ICl ₄ ⁻	NX ₃
Weimer	Christian	PF ₆ ⁻	Se ₂ F ₁₀	Te(OH) ₆	CdX ₂	IF ₅
Xin	Bo	NX ₄ ⁺	PO ₄ ³⁻	SeF ₄	TeF ₄	ClF ₃
Ye	Shite	IF ₇	OH ₃ ⁺	PX ₃	SeF ₆	TeF ₆

* X = F, Cl, Br, and/or I

Every student has to treat the 5 molecules/ions given in the table.

For help, information, and further exercise, refer to the given textbook(s) of inorganic chemistry and our corresponding website <http://www.uni-siegen.de/fb8/ac/be/lehre/inorganicmolekules.html?lang=de> and <http://anorganik.chemie.uni-siegen.de>, respectively.

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Exercise 2 (electronic and molecular structure, building reaction, and chemical and physical properties of inorganic molecules and ions)

Of the 5 molecules and/or ions each listed below, give the formula, the names, a suitable building reaction, the reactivity, the color, the state of matter under normal conditions (if possible), and the magnetic properties (d for dia- and p for paramagnetic). As far as possible, give the results in form of a table.

Molecules/ions to be treated in exercise 2.

Afzal	Faria	AsX ₃	ClF ₅	N ₂	OX ₂	S ₂
Ateacha	Derick	AsX ₄ ⁺	CO ₂	N ₂ O	P ₂ O ₆ ⁴⁻	S ₂ Cl ₂
Chen	Yizhou	BeCl ₂	CO ₃ ²⁻	N ₂ O ₂ ²⁻	P ₂ O ₇ ⁴⁻	S ₂ F ₁₀
Dörbaum	Nils	BeX ₄ ²⁻	CX ₄	N ₂ O ₃	P ₂ Se ₅	S ₂ F ₂
Haas	Simon	BrF ₃	GaI ₃	N ₂ O ₄	P ₄ (NR) ₆	S ₂ O ₃ ²⁻
Kiefer	Konrad	BrF ₄ ⁻	GeX ₄	N ₂ O ₅	P ₄ O ₁₀	S ₂ O ₄ ²⁻
Kirsch	Christoph	BrF ₅	H ₂ PO ₂ ⁻	NO	P ₄ O ₆	SiX ₄
Krüger	Sascha	S ₂ O ₆ ²⁻	SnCl ₂	BX ₃	HgX ₂	NO ⁺
Liedke	André	P ₄ S ₆	SbCl ₅	SO ₂	BX ₄ ⁻	HPO ₃ ²⁻
Mutengwa	Archford	NO ₂	PCl ₃ F ₂	SbF ₅	SO ₃	[(CH ₃) ₂ PN]
Najm-ul	Hassan	I ₂ Cl ₆	NO ₂ ⁻	PCl ₅	SbX ₃	SO ₃ ²⁻
Peram	Pardha Saradhi	[(CH ₃) ₂ SiO] ₃	I ₃ ⁻	NO ₂ ⁺	PCl ₆ ⁻	SCl ₂
Tambe	Suparna	SO ₄ ²⁻	[Cl ₂ PN] ₃	ICl ₂ ⁻	NO ₃ ⁻	PF ₅
Wael	Ali	SCl ₄	SX ₂	[Cl ₂ PN] ₄	ICl ₄ ⁻	NX ₃
Weimer	Christian	PF ₆ ⁻	Se ₂ F ₁₀	Te(OH) ₆	CdX ₂	IF ₅
Xin	Bo	NX ₄ ⁺	PO ₄ ³⁻	SeF ₄	TeF ₄	ClF ₃
Ye	Shite	IF ₇	OH ₃ ⁺	PX ₃	SeF ₆	TeF ₆

* X = F, Cl, Br, and/or I

Exercise 3

Name the number of covalent bonds, the elements P, S, and Cl can build.

Exercise 4

Explain why the compounds or ions SiF₆²⁻, PF₅, SF₆ do exist and CF₆²⁻, NF₅, OF₆ do not.

Exercise 5

Sketch the Lewis structures of N₂, NH₃, and S₂ and explain why these molecules do not have different resonance structures.

Exercise 6

Explain why P₄O₆, and P₄O₁₀ are built instead of P₂O₃ and P₂O₅, respectively.

Exercise 7

(Cl₂PN)₃ was found to have symmetry D_{3h}. Please explain why it is not aromatic.

Advanced Inorganic Chemistry - part Inorganic Molecules

Exercise 8

Sketch the molecular and Lewis structures and give the symmetry groups of "P₂O₃", P₂O₅", and P₄S₆. Write a reasonable Lewis structure of (Cl₂PN)₃ and explain whether and why it is aromatic or not.

Exercise 9

Sketch the Lewis structures and the expected and found molecular structures and give the names and the symmetry groups (Schönflies or Hermann/Mauguin) of "P₂O₅" P₂O₆⁴⁻, (Cl₂PN)₃, P₄S₆, and P₂Se₅.

Exercise 10

Sketch and explain the MO's of N₂ and HF.

Exercise 11

Name and describe structurally (coordination, molecular structure, differences/relations of bond lengths and angles, structure type, crystal system) the main group IV, V, and VI elements.

Exercise 12

Name and describe structurally (coordination, molecular structure, differences/relations of bond lengths and angles, structure type, crystal system) the thermodynamically stable forms of the main group IV, V, and VI elements.

Exercise 13

Sketch the Lewis structures and the expected and found molecular structures and give the names and the symmetry groups (Schönflies or Hermann/Mauguin) of the oxides and oxoions of C, N, P, and S.

Exercise 14

Give the ranges of energies and wavelengths of X-ray, UV/Vis, and IR radiation. Name and describe the structure determination methods based on these radiations and explain the respective physical processes.

Exercise 15

Sketch the principle parts of an IR spectrometer and a X-ray diffraction device and describe the main differences between IR spectroscopy and X-ray diffraction concerning the principle processes, selection rules, changes of energy etc., and their meaning for the structure determination of inorganic molecules.

Exercise 16

Sketch the principle parts of an IR and a Raman spectrometer and describe the main differences between IR and Raman spectroscopy concerning the principle processes, selection rules, and their meaning for the structure determination of inorganic molecules.

Exercise 17

Name two common structure determination methods based on different types of electromagnetic radiation with their ranges of energies and wavelengths each and the respective physical processes.

Exercise 18

Name and specify the factors and forces affecting the crystal structures of molecular solids.

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