General Chemistry I
Tutorial 09

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Outline

Quiz 11.1

Consider the following C–Cl bond energies in kJ/mol: C_6H_5Cl: 398; CH_3Cl: 327; $C_6H_5CH_2Cl$:300. Explain why the C–Cl bond is stronger in C_6H_5Cl but weaker in $C_6H_5CH_2Cl$, using resonance structures.

Quiz 11.2

How many valence electrons are there at the metal center? Show your calculation.

a) $K_3[Fe(CN)_6]$ Potassium ferricyanide

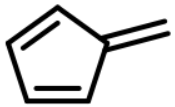
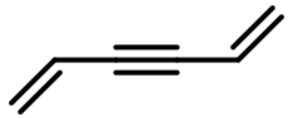
b) $[Co(NH_3)_5Cl]Cl_2$ Pentaaminechlorocobalt(III) chloride

PS 6.1

Acrylic fibers are polymers made from a starting material called acrylonitrile, $H_2C(CH)CN$. In acrylonitrile, a -CN group replaces a hydrogen atom on ethylene. Draw the Lewis diagram for this molecule, give the hybridization of each carbon atom, and describe the π orbitals and the number of electrons that occupy each one. Draw the three-dimensional structure of the molecule, showing all angles.

PS 6.2

Consider the following proposed structures for benzene, each of which is consistent with the molecular formula C_6H_6.

(i)  (ii)  (iii)  (iv)  (v) 

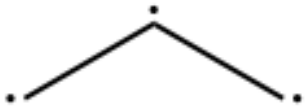
(a) When benzene reacts with chlorine to give C_6H_5Cl, only one isomer of that compound forms. Find out all possible 'chlorobenzene' isomers for each of the five structures. Which of the five proposed structures for benzene is consistent with this observation?
(b) When C_6H_5Cl reacts further with chlorine to give C6H4Cl2, exactly three isomers of the latter compound form. Which of the five proposed structures for benzene is consistent with this observation?

PS 6.3

For each of the following molecules, construct the π MOs from the $2p_z$ atomic orbitals perpendicular to the plane of the carbon atoms.

a) Cyclobutadiene

b) Allyl radical



Indicate which, if any, of these orbitals have identical energies from symmetry considerations. Show the number of electrons occupying each π MO in the ground state.

PS 6.4

Three different compounds are known to have the empirical formula $CrCl_3 \cdot 6\,H_2O$ When exposed to a dehydrating agent, compound 1 (which is dark green) loses 2 mol water per mole of compound, compound 2 (light green) loses 1 mol water, and compound 3 (violet) loses no water. What are the probable structures of these compounds? If an excess of silver nitrate solution is added to 100.0 g of each of these compounds, what mass of silver chloride will precipitate in each case?

Counting electrons

Complex ion $[L_aMX_b]^c$:

Central atom: M, usually metal ions
Ligand (Base on electron configuration): L, X and Z-type
Coordination bond (dative bond, covalent bond or ionic bond): L→M, X→M, or M→Z

L type: **closed-shell**, octet rule satisfied, doubly occupied MO involved in the coordination bond, donate **2e** to the central atom, e.g. OH_2, NH_3
X type: **open-shell**, octet rule unsatisfied, singly occupied MO involved in the coordination bond, donate **1e** to the central atom, e.g. $\cdot OH$, F
Z type: **closed-shell**, octet rule usually unsatisfied, unoccupied MO involved in the coordination bond, donate **0e** to the central atom, e.g. BH_3

Remark 3.1

Suppose that neutral M atom has m electrons initially, the number of electrons M berry in this complex is given by:

$$\# = m + 2a + b - c$$