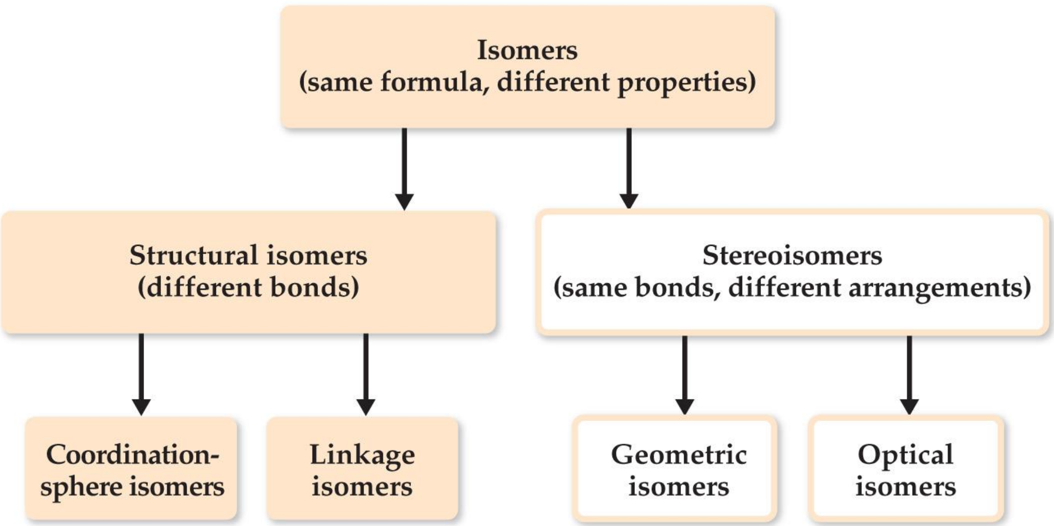
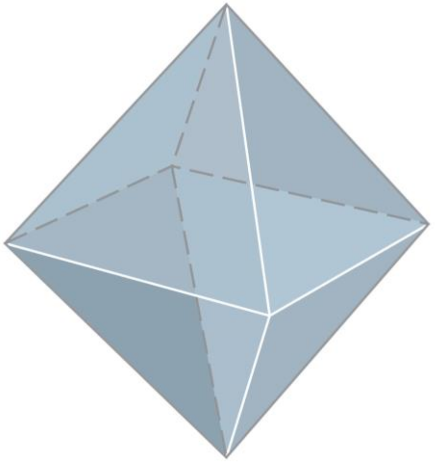
Isomers

Isomers: same molecular formula (composition) but different arrangement of atoms.



Draw and Manipulate Octahedron



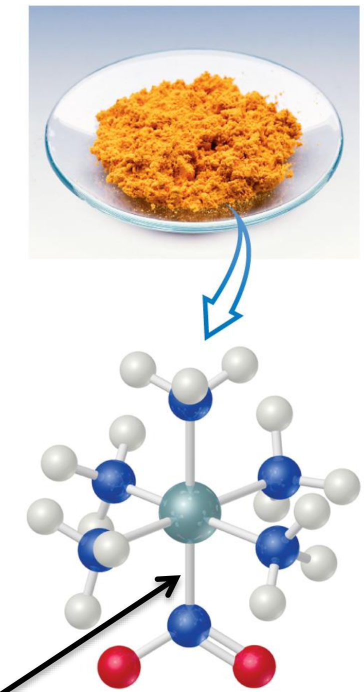
Draw

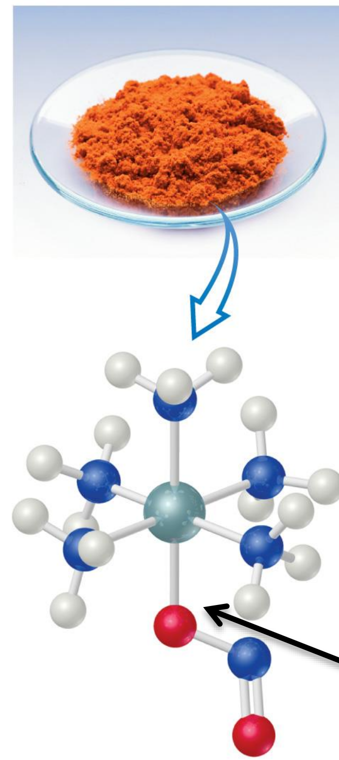
Draw and Manipulate Octahedron

Rotation

Structural Isomers

1) Linkage Isomers E.g. $Co(NH_3)_5NO_2^{2+}$





Co-NO_2 bond

Co-ONO bond

Pentaamminenitrocobalt(III) ion

Pentaamminenitritocobalt(III) ion

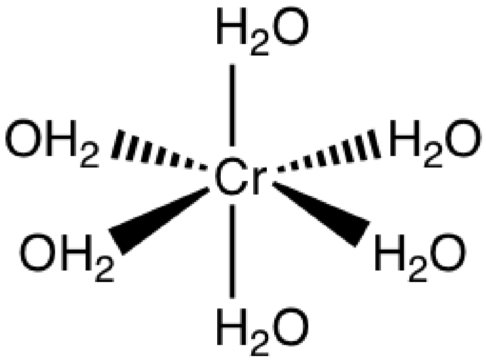
Occurs with NO_2^- and SCN^- groups.

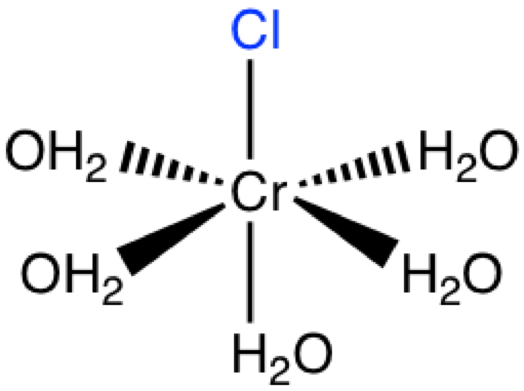
Structural Isomers

2) Coordination Sphere Isomers

Differ in which species are ligands & which are outside coord. sphere

$[Cr(H_2O)_6]Cl_3$ vs. $[Cr(H_2O)_5Cl]\,Cl_2 \cdot H_2O$





Stereoisomers

1) Geometrical Isomers

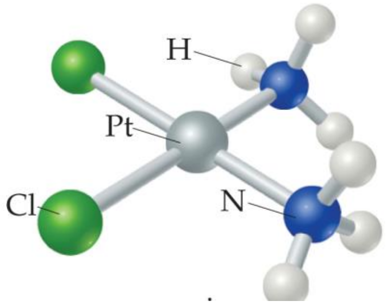
Same bonds - different spatial arrangement

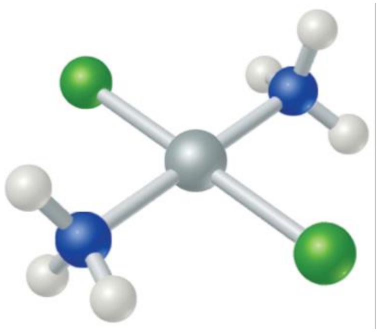
Geometrical isomers have completely different properties

Stereoisomers

1) Geometrical Isomers

a) *cis* vs. *trans*





Cis-diamminedichloroplatinum

Adjacent

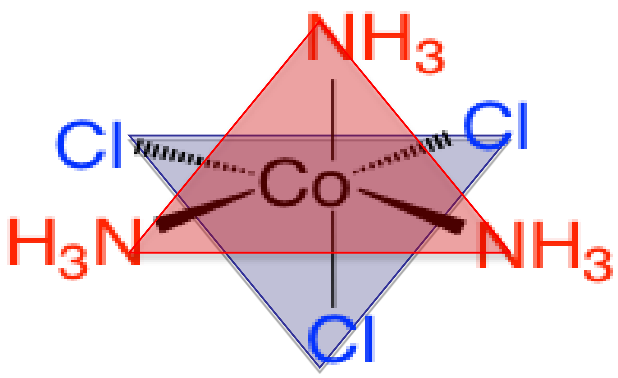
Trans-diamminedichloroplatinum

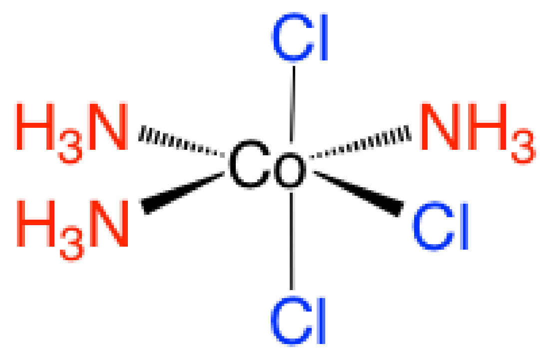
Opposite

Stereoisomers

1) Geometrical Isomers

b) *fac* vs. *mer*

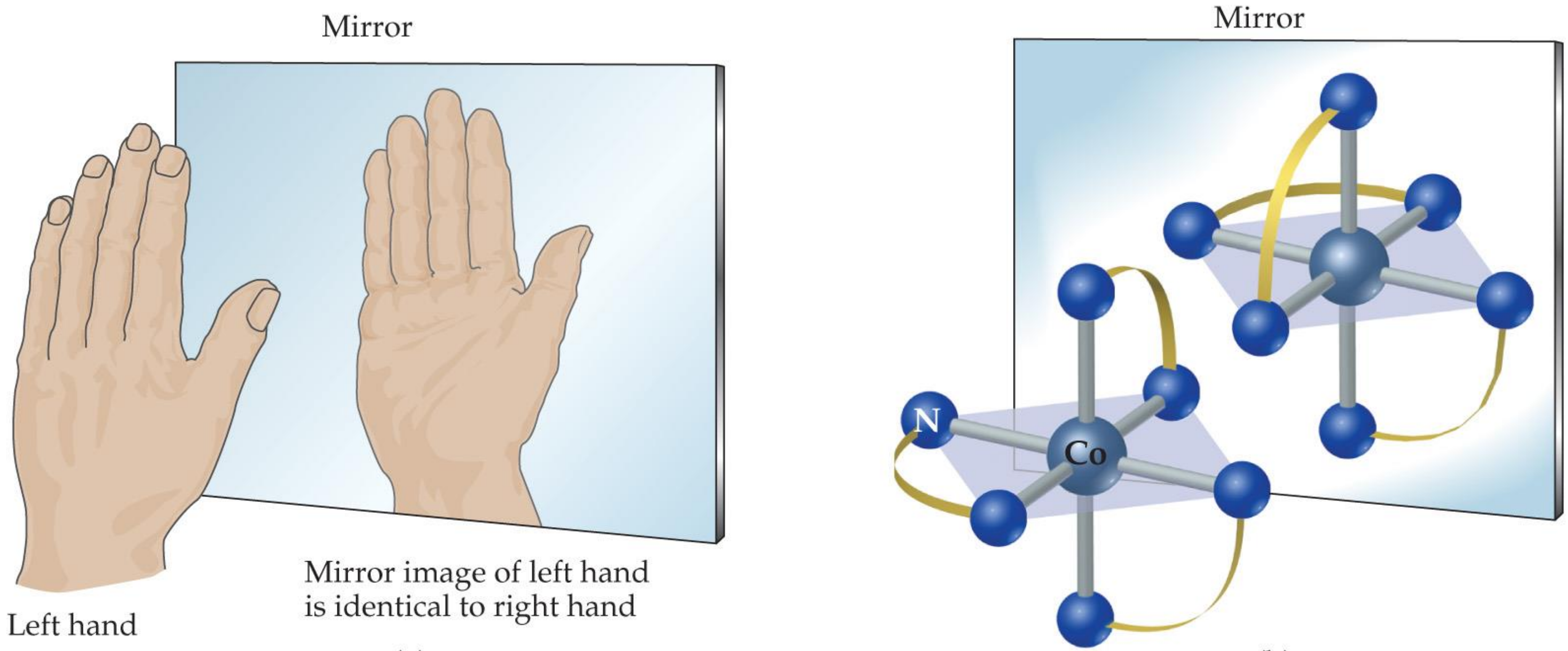




Stereoisomers

2) Optical Isomers (enantiomers)

non-superimposable mirror images of one another



(a) (b)

Stereoisomers

2) Optical Isomers (enantiomers)

Enantiomers are said to be **chiral**

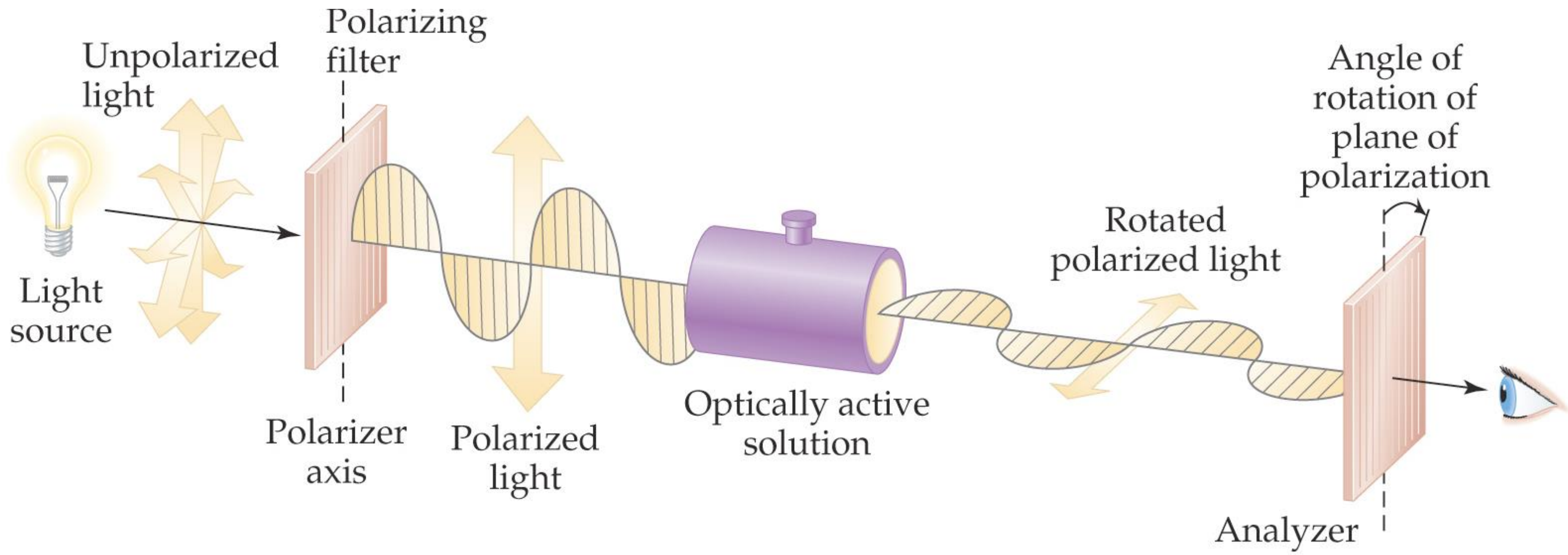
Prop. differ ONLY in a chiral environment
(such as in biological systems)

Distinquished from one another by
interaction with plane-polarized light

Stereoisomers

2) Optical Isomers (enantiomers)

If polarized light passed through a solution of an optical isomer the plane of polarization is rotated right (clockwise) or left (counterclockwise)



Stereoisomers

2) Optical Isomers (enantiomers)

Dextrorotatory (right) – "*d* " isomer

Levorotatory (left) – "*l* " isomer

Enantiomers rotate pp-light in diff. directions

Chiral molecules are optically active

Determining optical isomers

Tetrahedron

Determining optical isomers

Ex: Octahedron – $MA_2B_2C_2$ (C- trans)

Determining optical isomers

Ex: Draw the structure for $MA_2B_2C_2$ in which like ligands are cis to each other. Is it optically active?

Determining optical isomers

Ex: Draw all the stereoisomers of $Co(en)_2Cl_2^{4+}$.

Which are optical & geometrical isomers?

Potential stereoisomers

Shape	Geometric Isomer	Optical Isomer
Tetrahedron MA_4, MA_3B, MA_2BC		
Tetrahedron MABCD		
Square Planar MA_4, MA_3B		

Potential stereoisomers

Shape	Geometric Isomer	Optical Isomer
Square Planar MA_2B_2		
Square Planar MABCD		
Octahedron		

Ex: How many stereoisomers are there for an octahedral complex with a formula $[MA_4B_2]$?

Ex: How many stereoisomers are there for an octahedral complex with a formula $[MA_3B_3]$?

Ex: How many stereoisomers are there for an octahedral complex with a formula $[M(en)_3]$?

Ex: How are $[Ag(SCN)_2]^-$ and $[Ag(NCS)_2]^-$ related to each other:

Color & Magnetism

- What is the origin of colors and magnetism in inorganic complexes?

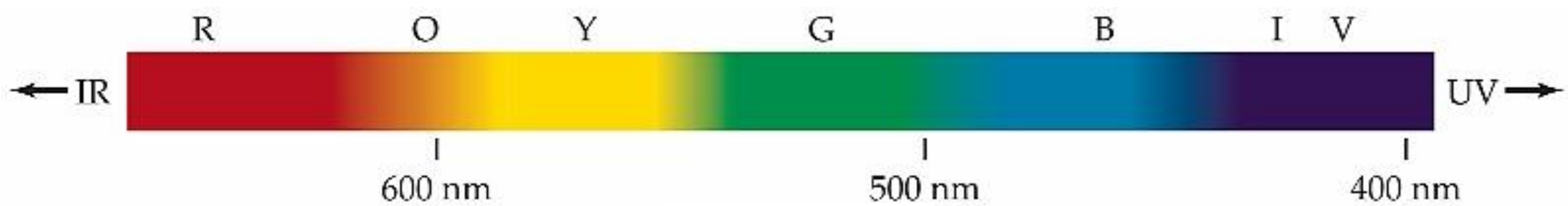
- CoF_6^{3-} = 4 unpaired e^- = paramagnetic (attracted to a magnetic field)
- $Co(CN)_6^{3-}$ = no unpaired e^- = diamagnetic (repels electric field)

Both properties can be explained by understanding the electronic configuration. We have two theories;

1) Crystal Field Theory 2) Molecular Orbital Theory

Colored Compounds

- compounds must absorb visible light (λ ~ 400 to ~750 nm) if they are colored
  - *particular energy of radiation* ***absorbed*** *dictates the color of the compound – see complementary colors*



Wavelength ←

Energy →

Frequency →

$$E = \frac{hc}{\lambda} = h\upsilon$$

Wavelength Absorbed *vs.* Color Observed

- colors of solids we see = sum of *remaining colors* in spectra that are *reflected* or *transmitted*
  - **all** visible light absorbed = **black**
  - **no** visible light absorbed = white
- what about something that looks *red*-*violet*?
  - Transmitted Light = Absorbed Light =