SEE DETAILED ANSWER KEY POSTED ON WEBSITE FOR ANSWERS TO PROBLEMS NOT WORKED THROUGH BELOW

Chem E-1a
Friday Review Problems
Chapter 20: Coordination Compounds

Cl^- COUNTER ION

$[Co(NH_3)_2(H_2O)_2ClBr]^+$

LIGANDS −2 CHARGE

1. Consider the coordination compound $[Co(NH_3)_2(H_2O)_2ClBr]Cl$
   a) Write the correct name of this compound.

$\boxed{\text{TRANSITION METAL: } Co^{+3}}$

SO Co^{3+}

LIGANDS: 2 NH_3 = AMMINE
2 H_2O = AQUA
1 Cl^- = CHLORO
1 Br^- = BROMO

$\boxed{\text{DIAMMINEDIAQUABROMOCHLOROCOBALT (III) CHLORIDE}}$

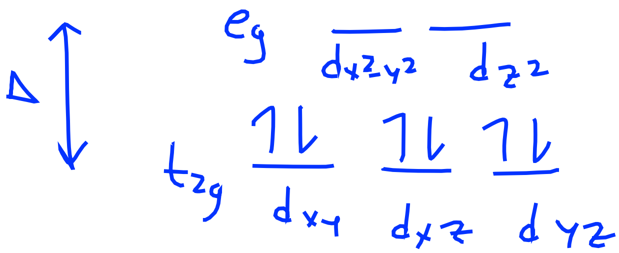
   b) Determine the oxidation state of cobalt in this compound.

+3

   c) Determine the number of *d* electrons on cobalt.

6 d ELECTRONS (d^6)

   d) This complex is low-spin. Draw an energy level diagram for the *d* orbitals of Co in this compound.



   e) Determine the number of unpaired electrons in this compound.

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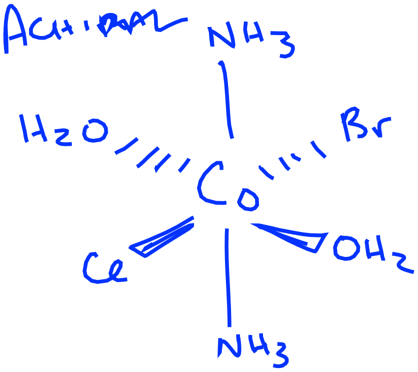
1. (cont.)

f) Draw all unique geometric and optical isomers of the complex $[Co(NH_3)_2(H_2O)_2ClBr]^+$

ACHIRAL



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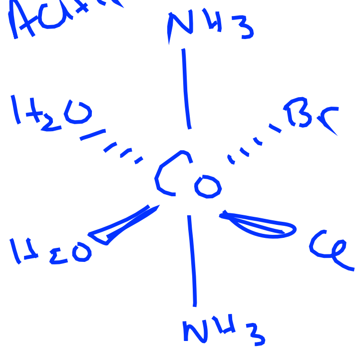

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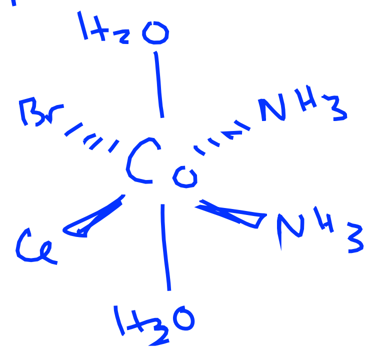


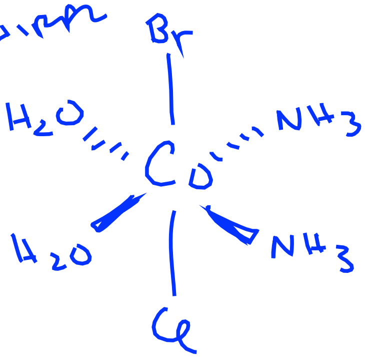
TRANS:

$NH_3 - NH_3$
$H_2O - H_2O$
$Cl - Br$

$NH_3 - NH_3$
$H_2O - Cl$
$H_2O - Br$

$H_2O - H_2O$
$Cl - NH_3$
$Br - NH_3$

ACHIRAL



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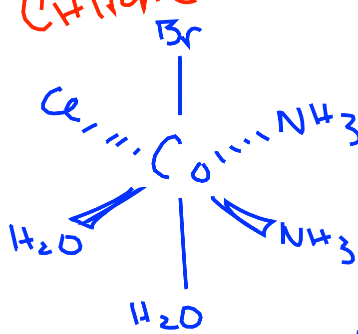

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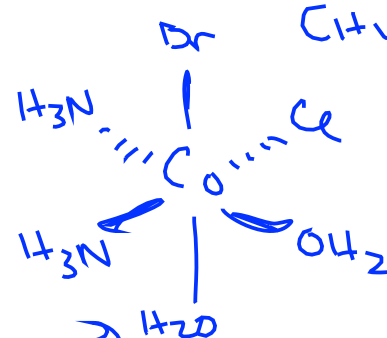


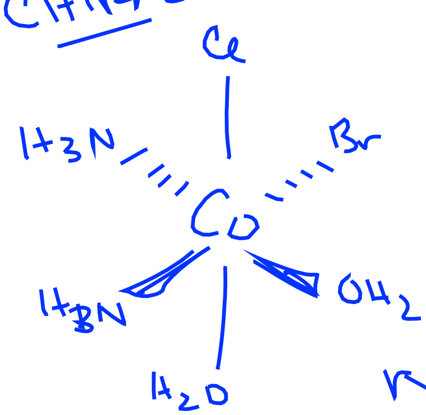
ENANTIOMERS

$Br - Cl$
$H_2O - NH_3$
$H_2O - NH_3$

MATCHING PAIR ⇒ ACHIRAL

$Br - H_2O$
$Cl - NH_3$
$H_2O - NH_3$

CHIRAL



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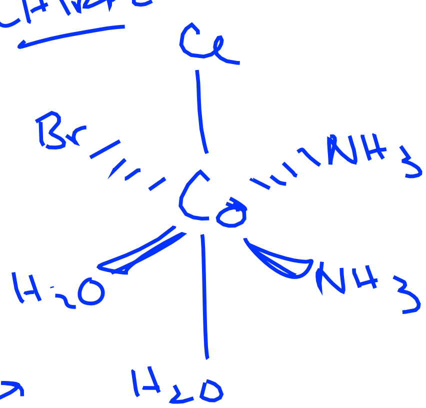


ENANTIOMER

$Br - NH_3$
$Cl - H_2O$
$H_2O - NH_3$

2. You have three solutions each containing one of the following complex ions:

$[Ni(H_2O)_6]^{2+}$ $[Ni(NH_3)_6]^{2+}$ $[Ni(en)_3]^{2+}$

One solution is blue, one is green, and one is violet (though not necessarily in that order).

a) Match the color of each solution with the nickel complex it contains.

LOW ENERGY
SMALL Δ $\longrightarrow$ HIGH ENERGY
LARGE Δ

ABSORBS: R O Y G B V

APPEARS: G B V R O Y

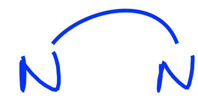
$[Ni(H_2O)_6]^{2+}$ → G

$[Ni(NH_3)_6]^{2+}$ → B

$[Ni(en)_3]^{2+}$ → V

b) All of these nickel complexes have the same *d*-orbital electron configurations. Show a diagram of the *d*-orbital energies with the correct number and configuration of electrons.

c) Will these complexes be paramagnetic or diamagnetic?

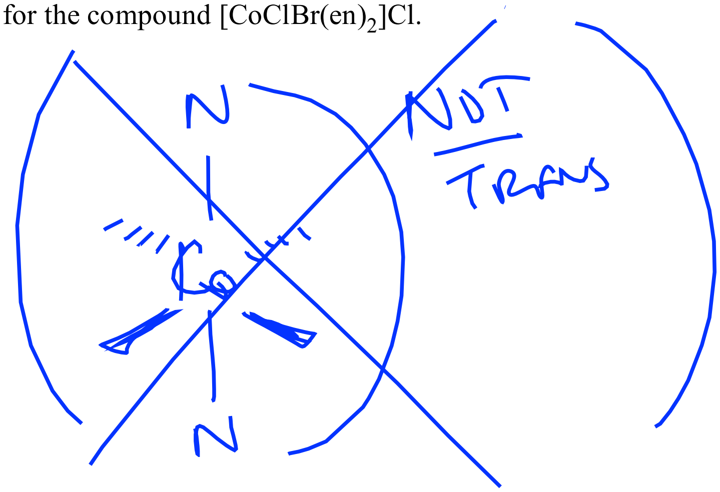


BIDENTATE LIGAND

3. Consider the octahedral complex $[CoClBr(en)_2]^+$
where en = ethylenediammine ($H_2NCH_2CH_2NH_2$)

a) Provide the correct systematic name for the compound $[CoClBr(en)_2]Cl$.

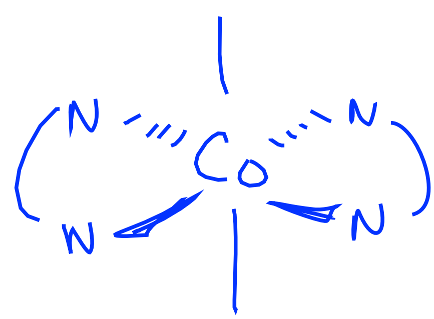
en CAN BIND AT ANY 2 CIS POSITIONS



b) Draw all the unique geometric and optical isomers of this complex. Indicate whether each isomer is chiral or achiral.

2 en LIGANDS: 2 POSSIBILITIES (ONE IS CHIRAL SO THERE WILL BE 3 DIF. ISOMERS!)

CHIRAL



ACHIRAL

(SPECIAL CASE - DON'T FOLLOW NORMAL CHIRALITY RULES FOR "TRANS" LIGANDS!)

3. (cont.)

c) This cobalt complex, $[CoClBr(en)_2]^+$, is known to be diamagnetic. The cobalt complex $[CoF_6]^{3-}$, however, is paramagnetic. Explain why these two species exhibit different magnetic behavior.

d) The $[CoF_6]^{3-}$ complex appears blue. Would you expect the $[CoClBr(en)_2]^+$ complex to absorb light of a higher energy or lower energy? Name one color that $[CoClBr(en)_2]^+$ could *not* be.