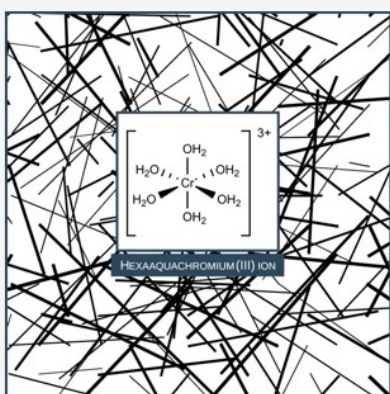


# Peer Instruction ConcepTests

Below are the six ConcepTests employed throughout the PI session. Each ConcepTest was answered twice by students; once independently, and once after PI discussion.

## ConcepTest 1:

When the valence  $d$ -orbitals of an octahedral complex are split in energy in a ligand field, which orbitals are raised highest in energy?



- A.  $d_{xy}$  and  $d_{x^2-y^2}$
- B.  $d_{xy}$ ,  $d_{xz}$  and  $d_{yz}$
- C.  $d_{xz}$ ,  $d_{z^2}$  and  $d_{yz}$
- D.  $d_{x^2-y^2}$  and  $d_{z^2}$

To answer the first ConcepTest correctly, there are three conceptual points which, fundamentally, students must understand:

- i. Firstly, students must recognise how the axial and equatorial aqua ligands are situated around the chromium metal atom.
- ii. Secondly, students must be able to comprehend the shapes and orientations of the five  $d$ -orbitals of the chromium metal atom.
- iii. Lastly, students must be able to comprehend the consequence of ligand and chromium  $d$ -orbital interactions along the three cartesian axis ( $x$ ,  $y$ , and  $z$ ).

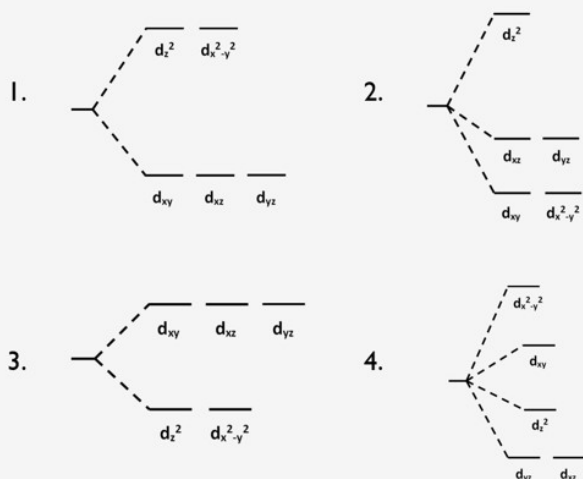
AR technology affords users the ability to instantiate interactable three-dimensional (3D) representations of the octahedral coordination sphere of the chromium complex, in addition to the 5  $d$ -orbitals of the chromium metal atom, to direct peer discussion towards these three conceptual points. The  $d$ -orbitals could be easily toggled through ChemFord's UI. We envisaged that these affordances would support the generation of meaningful dialogues.

### ConcepTest 2:

Which of the following represents the d-orbital splitting diagram for the linear complex  $[\text{AuCl}_2]^-$ ?

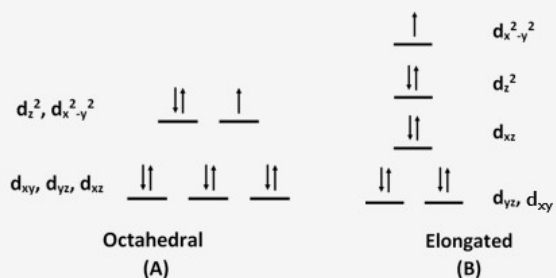
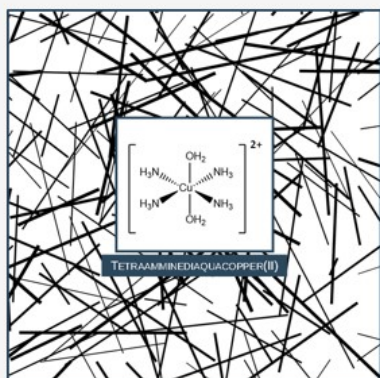


- A. Diagram 1      C. Diagram 3  
B. Diagram 2      D. Diagram 4



### ConcepTest 3:

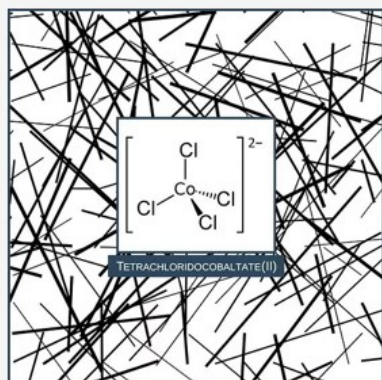
For the ammonia complex of copper(II) in aqueous solution, we would expect splitting diagram A, but splitting diagram B is observed. Why is this the case?



- A. The molecule distorts, stabilising the z-component orbitals  
B. The molecule distorts, restoring the d-orbital degeneracy  
C. The molecule distorts, destabilising the z component orbitals  
D. The molecule distorts, stabilising the x and y component orbitals

#### ConcepTest 4:

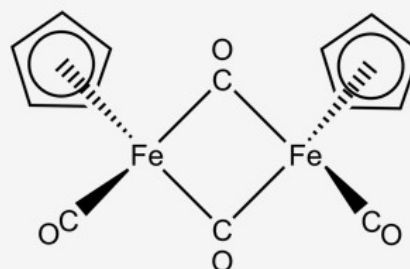
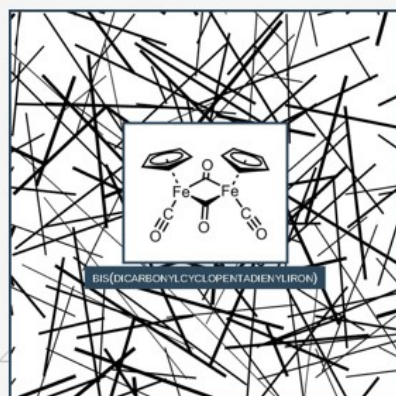
Why are low spin tetrahedral complexes not formed?



- A. For a tetrahedral complex, the splitting energy is lower than the pairing energy
- B. For a tetrahedral complex, the splitting energy is higher than the pairing energy
- C. Electrons do not go to the e orbitals in the case of a tetrahedral complex
- D. Tetrahedral complexes are formed by weak field ligands only

#### ConcepTest 5:

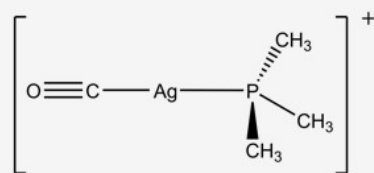
In the following molecule, which of the CO ligands is/are most reactive towards electrophilic attack?



- A. The two terminal CO ligands
- B. The two bridging CO ligands
- C. All CO ligands are equivalent
- D. The bottom bridging CO ligand only

ConcepTest 6:

In the following molecule the CO IR stretching frequency is  $2064\text{ cm}^{-1}$ .



What will happen to the CO IR stretching frequency if all the methyl groups are replaced with fluorine?

- A. The CO IR stretching frequency will increase
- B. The CO IR stretching frequency will decrease
- C. The CO IR stretching frequency will be unaffected
- D. The CO IR stretching frequency will be IR-inactive