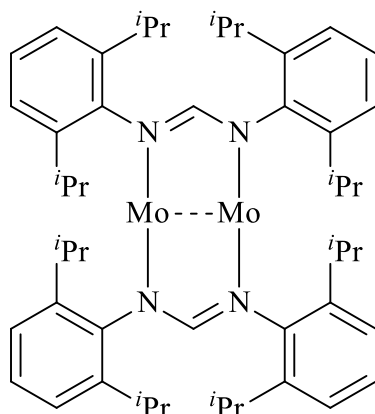


Marks
6

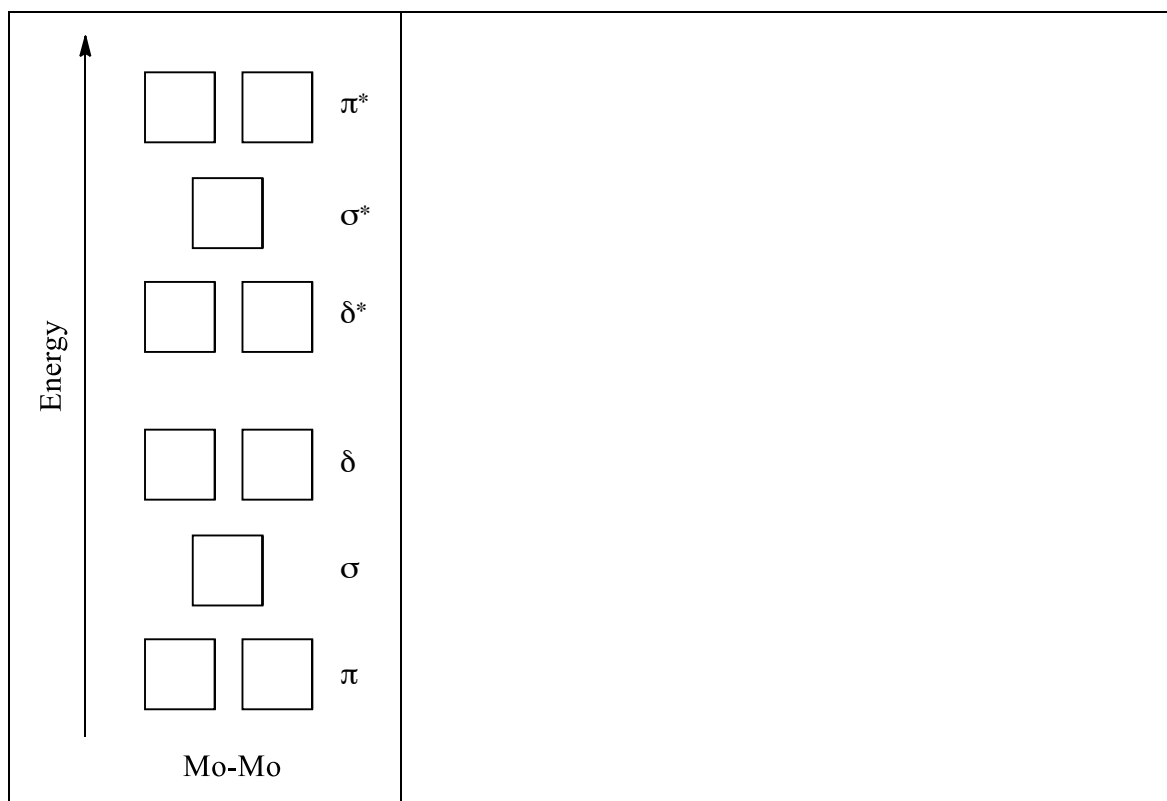
- In 2009, great excitement was generated amongst chemists worldwide with the report of a neutral Mo complex containing two bridging, anionic *N*-donor ligands. The structure of the complex is shown below. $i\text{Pr} = \text{isopropyl} = -\text{CH}(\text{CH}_3)_2$



Name the complex by using standard IUPAC nomenclature. For simplicity, the name of the *N*-donor ligand (in its neutral form) can be shortened to “aminidate”.

The Mo complex above possesses an extremely short Mo–Mo bond (202 pm), much shorter than the bonding distance between Mo atoms in Mo metal (273 pm)!

- Propose a reasonable explanation for the very short Mo–Mo bond length in the complex by adding *d*-electrons into the (*partial*) MO scheme shown below.
- Determine the bond order for the metal-metal bond and re-draw the structure of the complex shown above indicating the actual bonding between the two Mo atoms.



THIS QUESTION CONTINUES ON THE NEXT PAGE.

Oxidation of the Mo complex by **two** electrons gives rise to a paramagnetic species in which the Mo–Mo distance increases significantly. Give a reasonable hypothesis for the bond-lengthening phenomenon.

Marks
2

Determine the number of unpaired electrons in the oxidised Mo complex.

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

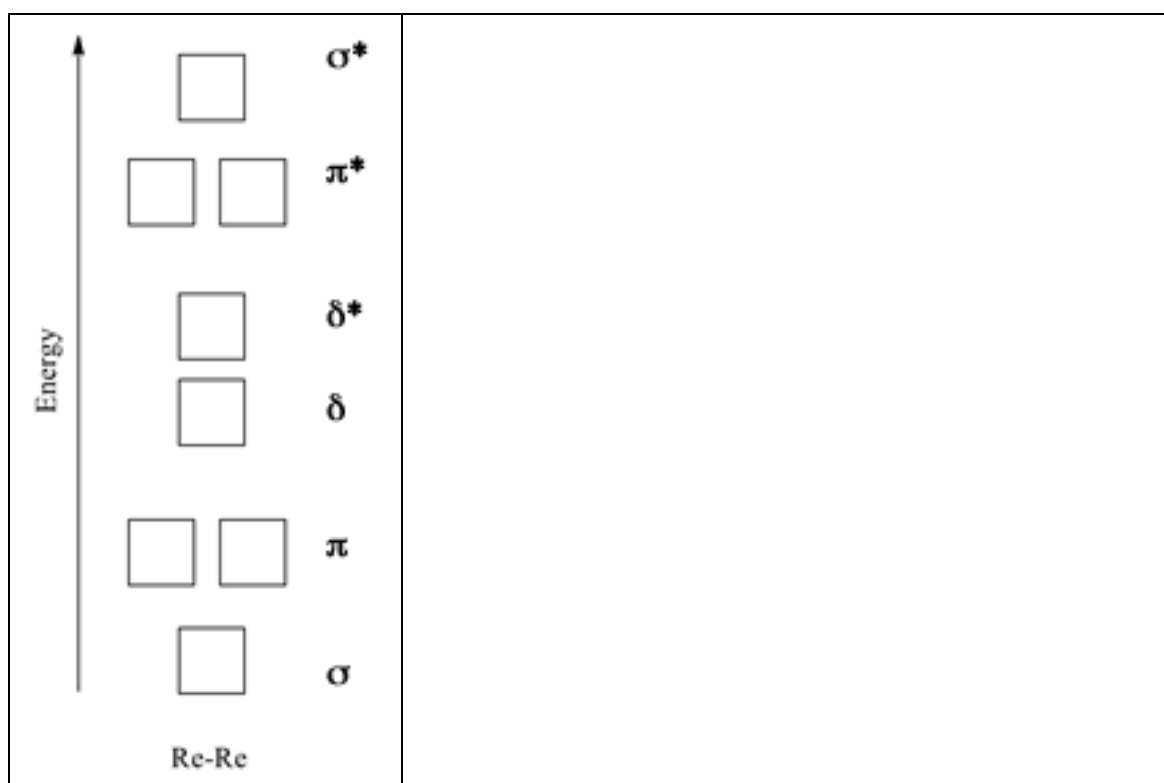
- $K_2[Re_2Cl_8] \cdot 2H_2O$ is an historically important example of a metal-metal bonded complex. Name the complex by using standard IUPAC nomenclature.

Marks
8

What is the oxidation state of Re in this complex?

How many *d*-electrons are on each Re atom in this complex?

$K_2[Re_2Cl_8] \cdot 2H_2O$ possesses an extremely short Re–Re bond (224 pm), much shorter than the bonding distance between Re atoms in Re metal (274 pm)! Propose a reasonable explanation for the very short Re–Re bond length in the complex by adding *d*-electrons into the (*partial*) MO scheme shown below. Determine the bond order for the metal-metal bond and draw a structure for the complex.

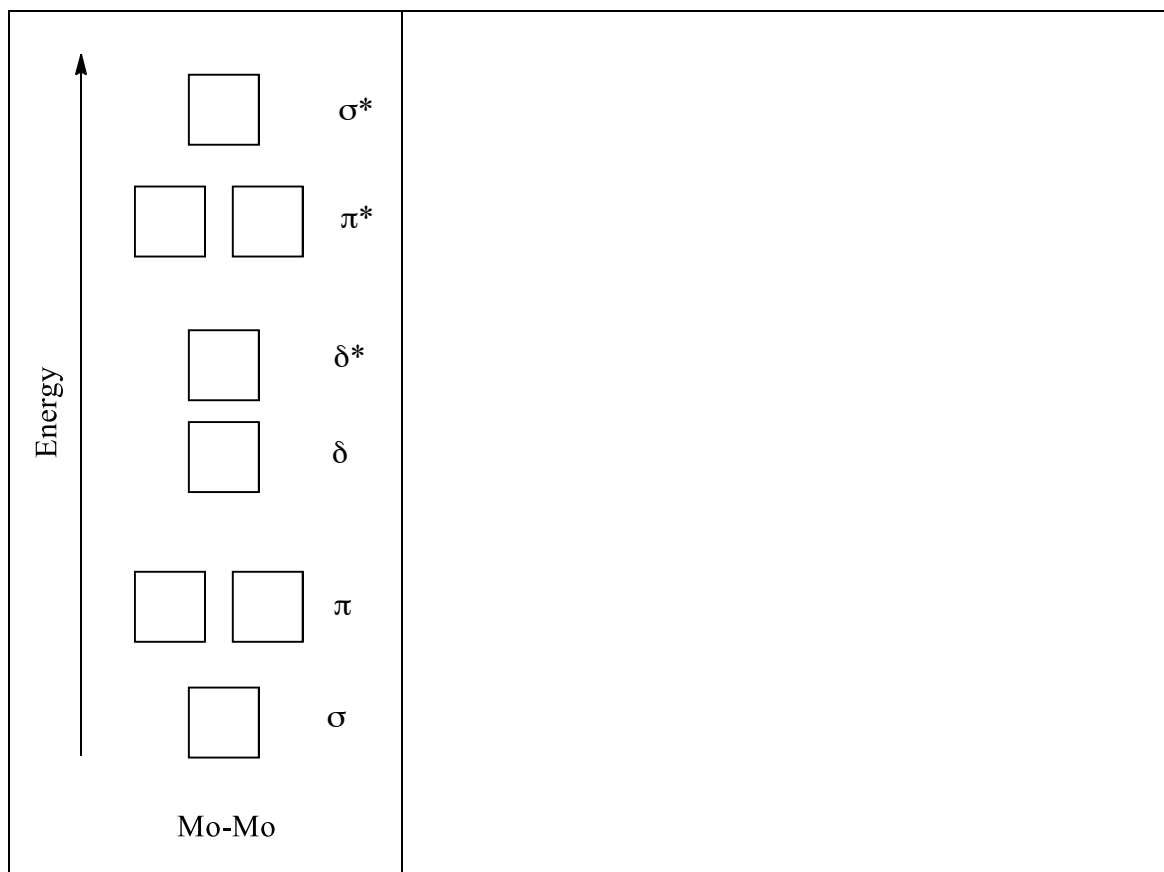


Reduction of the Re complex by **one** electron gives rise to a paramagnetic species in which the Re–Re distance increases significantly. Propose a reasonable hypothesis for the bond-lengthening phenomenon.

- The red species $\text{K}_4[\text{Mo}_2\text{Cl}_8]$ is an historically important example of a metal-metal bonded complex. Use standard nomenclature to name the complex salt.

Marks
6

$\text{K}_4[\text{Mo}_2\text{Cl}_8]$ possesses an extremely short Mo–Mo bond (214 pm), much shorter than the bonding distance between Mo atoms in Mo metal (273 pm)! Propose a reasonable explanation for the very short Mo–Mo bond length in the complex by adding *d*-electrons into the (partial) MO scheme shown below. Draw a structure for the complex that is consistent with the completed MO scheme and your explanation.



Oxidation of the complex by one electron gives rise to a paramagnetic species in which the Mo-Mo distance increases significantly. Propose a reasonable hypothesis for the bond lengthening phenomenon.

Marks
7

- The species $[\text{Cr}(\text{en})_3][\text{FeCl}_4]_3$ is an example of a salt in which both the anion and cation are comprised of coordination complexes. Name the complex using standard IUPAC nomenclature (en = ethane-1,2-diamine).

Draw the structure of the cation. Is this complex chiral? Briefly explain your reasoning.

If the salt is dissolved in water and a saturated solution of KCl is added to the solution, different coloured complexes can be crystallised from the solution. Write the formulae for two of these complexes.

Marks
6

• When cobalt(II) chloride is reacted with ethane-1,2-diamine (en) and the product is oxidised in the air, a purple compound with the empirical formula $\text{CoCl}_3 \cdot 2\text{en}$ is obtained. When reacted with silver nitrate only one chloride ion is released. The compound can be resolved into its enantiomeric forms.

Give the structural formula of the compound.

Give the name of the compound.

Draw the structure of the metal complex component of the compound.

What is the *d* electron configuration of the Co in this complex?

What types of isomers can be formed by a compound with this empirical formula?

Which of the possible isomers has formed? Explain the logic you have used in determining this.

Marks
5

- Alfred Werner, one of the founders of the field of coordination chemistry, prepared a series of platinum complexes that contained ammonia and chloride ions. One of these had the empirical formula $\text{PtCl}_4 \cdot 4\text{NH}_3$ and when reacted with silver nitrate released two chloride ions per formula unit. Write the structural formula of this compound and write the name of this compound.

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Draw the possible structures of the metal complex.

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What types of isomers can be formed by a compound with this empirical formula?

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What is the *d* electron configuration of the Pt in this complex?

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Marks
6

- Alfred Werner, one of the founders of the field of coordination chemistry, made extensive studies of the metal complex $[\text{PtCl}_2(\text{NH}_3)_2]$. He showed that it existed in two isomeric forms and used this information to predict that the compound had a square-planar molecular geometry. What other molecular geometry would need to be considered for such a complex and on what basis did Werner reject this alternative geometry?

Draw and name the two isomers.

Why does platinum(II) form square-planar complexes?

Which one of the isomers is biologically active? What is its activity? Describe two features of the complex that play important roles in this biological activity.

Marks
4

- Consider the complex $[\text{CoCl}_2(\text{NH}_3)_4]\text{Cl}\cdot 2\text{H}_2\text{O}$.

Write the systematic name of this complex.

What type(s) of isomerism is/are possible for this complex?

How many *d* electrons are there in the cobalt in this complex?

What oxidation state of platinum has the same number of valence shell *d* electrons as the cobalt in this complex?

- Complete the following table.

Formula	Oxidation state of transition metal	Coordination number of transition metal	Number of <i>d</i> -electrons in metal in complex ion	Species formed upon dissolving in water
$K_2[Ni(CN)_4]$				
$[Cr(NH_3)_5Cl]Cl_2$				
$[Co(en)_3]Br_3$				

en = ethylenediamine = $NH_2CH_2CH_2NH_2$

