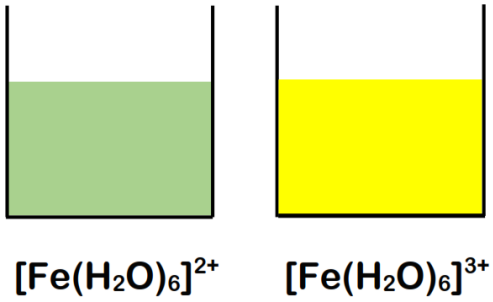
UG PART III

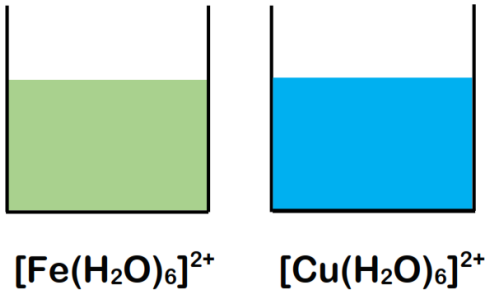
Factors that affect the colour of complex ions

1) Describe and explain the colour changes of the following complex ions:

(i) $[Fe(H_2O)_6]^{2+}$ is pale green, $[Fe(H_2O)_6]^{3+}$ is yellow.



(ii) $[Fe(H_2O)_6]^{2+}$ is pale green, $[Cu(H_2O)_6]^{2+}$ is blue.



Answers:

1) (i)

- In the $[Fe(H_2O)_6]^{2+}$ complex ion, the oxidation number of the iron is +2.
- In the $[Fe(H_2O)_6]^{3+}$ complex ion, the oxidation number of the iron is +3.

- The higher oxidation number increases the splitting of the d orbitals, therefore increases the energy difference between the two sets of d orbitals.
- The bigger the difference in energy between the 2 sets of d orbitals, the more energy is absorbed by the electron as it transitions from the lower to upper set of d orbitals.
- Higher energy = shorter wavelength of light absorbed.
- The complementary colour is transmitted, therefore the colour changes from pale green to yellow.

(ii)

- The identity of the central metal ion changes from Fe^{2+} to Cu^{2+}
- The ligand (H_2O), the oxidation state of the central metal ion (+2) and the shape (octahedral) are the same for each complex ion.
- The change from Fe^{2+} to Cu^{2+} changes the wavelength of light that is absorbed.
- $[Fe(H_2O)_6]^{2+}$ absorbs red light (longer wavelength) and transmits pale green light. $[Cu(H_2O)_6]^{2+}$ absorbs orange light (shorter wavelength) and transmits blue light.
- Therefore, the Cu^{2+} ions produces the biggest splitting of the d orbitals (shorter wavelength =
- The bigger the difference in energy between the 2 sets of d orbitals, the more energy is absorbed by the electron as it transitions from the lower to upper set of d orbitals.
- Higher energy = shorter wavelength of light absorbed
- The complementary colour is transmitted, therefore the colour changes from pale green to blue.