5.111 Principles of Chemical Science

Fall 2008

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Selected biology-related questions from problem sets for lectures 27-36

Transition Metals

A.
Cisplatinum [$Pt(NH_3)_2Cl_2$] is a potent anticancer drug. ***(a)*** *Draw the structure of this square planar molecule and the structure of its isomer transplatinum.* ***(b)*** *What are the angles for a square planar molecule?* ***(c)*** *What is the CN?* ***(d)*** *Draw the crystal field energy-level diagram for cisplatinum, labeling the d-orbitals.* ***(e)*** *Predict whether cisplatinum is diamagnetic or paramagnetic? Explain your answer.*

B.
Octahedral platinum(IV) complexes are used in protein crystallography to help determine three-dimensional protein structures. If the octahedral crystal field splitting energy (Δ_o) is large for these complexes, ***(a)*** *predict whether they are diamagnetic or paramagnetic, and* ***(b)*** *write the expected d^n electron configuration.*

Rate laws and enzyme kinetics

C.
The element techneticum has never been found in nature. It can be obtained readily as a product of uranium fission in nuclear power plants, however, and is produced in quantities of many kilograms per year. MIT Chemistry Professor Alan Davison pioneered the use of Techneticum in the diagnosis of heart disease. Calculate the total activity (in disintegrations per second) caused by the decay of 0.5 microgram of ^{99m}Tc (an excited nuclear state of ^{99}Tc), which has a half-life of 6.0 hours.

D.
Consider the formation of a DNA double helix from strands A and B to form an unstable helix (UH) and a stable helix (SH).

Step 1: $A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} UH$

Step 2: $UH \xrightarrow{k_2} SH$

(a) What is the molecularity of each step?
Step 1 is bimolecular and step 2 is unimolecular.

(*b) Write the rate law for the formation of the stable helix (SH) using the steady-state approximation. Be sure to eliminate intermediates from the rate expression.*