

## 2023 Fall Chemistry 2

### Assignment 4 (Atkins, Focus 9 & 10)

(Total 150 pt; Due 2023/12/6 Class)

1. The complex ion  $[\text{Ni}(\text{NH}_3)_6]^{2+}$  forms in a solution containing  $0.16 \text{ mol}\cdot\text{L}^{-1} \text{ NH}_3$  (aq) and  $0.015 \text{ mol}\cdot\text{L}^{-1} \text{ Ni}^{2+}$  (aq). If the formation constant of  $[\text{Ni}(\text{NH}_3)_6]^{2+}$  is  $1.0 \times 10^9$ , what are the equilibrium molar concentrations. [15 pt]
2. Draw the structures of all possible isomeric forms of  $\text{CrBrCl}(\text{NH}_3)_3$ . Which isomers are chiral? [20 pt]
3. A hexagonal planar structure was once proposed for the  $\text{CrCl}_3(\text{NH}_3)_3$  complex. Propose possible isomer structures. [15 pt]
4. Nickel(II) complexes with weak-field ligands such as the bromide ion have been found to be octahedral, but nickel(II) complexes with strong-field ligands have been found to be square planar. Explain these findings. (See Exercise 9.13.) [15 pt]
5. Is there a correlation between the ligand field strength of the halide ions  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ , and  $\text{I}_2$  and the electronegativity of the halogen? If so, can this correlation be explained by ligand field theory? Justify your answer. [20 pt]
6. *cis*-Platin is an anticancer drug with a three-dimensional structure that can be viewed on the Internet. (a) What are the formula and systematic name for the compound *cis*-platin? (b) Draw any isomers that are possible for this compound. Label any isomers that are optically active. (c) What is the coordination geometry of the platinum atom. [15 pt]
7. State whether the following statements are true or false. If false, explain why. (a) Fissile nuclei can undergo fission when struck with slow neutrons, whereas fast neutrons are required to split fissionable nuclei. (b) For fusion to occur, the colliding particles must have high relative kinetic energy. (c) The larger the binding energy per nucleon, the more stable is the nucleus. [10 pt]
8. A radioactive sample contains  $^{32}\text{P}$  (half-life, 14.28 d),  $^{33}\text{S}$  (half-life, 87.2 d), and  $^{59}\text{Fe}$  (half-life, 44.6 d). After 90 d, a sample that originally weighed 8.00 g contains 0.0254 g of  $^{32}\text{P}$ , 1.466 g of  $^{33}\text{S}$ , and 0.744 g of  $^{59}\text{Fe}$ . What was the percentage composition (by mass) of the original sample? [15 pt]
9. Actinium-225 decays by successive emission of three  $\alpha$  particles. (a) Write the nuclear equations for the three decay processes. (b) Compare the neutron-to-proton ratio of the final daughter product with that of actinium-225. Which is closer to the band of stability? [10 pt]
10. Suppose a planet on which life is based on silicon instead of carbon has been discovered. However, a meteor strike destroyed most of the life on the planet. To determine how long ago the meteor strike occurred, the activity of silicon-32, which has a half-life of  $1.6 \times 10^2$  a (note that the SI symbol for 1 year is 1 a), was measured in samples from the fossil

remains of life forms killed in the meteor strike and in existing life forms. Activity in the fossil samples was found to be 0.015% of the activity in the living samples. How long ago did the meteor strike occur? [15 pt]