Exam 4

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. Which one the following objects is chiral?
   1. A bottle
   2. A chair
   3. A glass
   4. A glove
   5. all of the above
2. What hybridization scheme is used for Ni in the square planar complex of [Ni(CN)4]2-?
   1. sp2
   2. sp3
   3. dsp2
   4. dsp3
   5. d2sp3
3. The compounds [Cr(H2O)6]Cl3 and [CrCl3(H2O)3]∙3H2O are examples of
   1. Diastereomers
   2. Enantiomers
   3. Coordination isomers
   4. Linkage isomers
   5. Structural isomers
4. A few sheets of ordinary paper can form an effective shield against what type of radiation?
   1. Alpha particles
   2. Beta particle
   3. Gamma rays
   4. Positrons
   5. Neutrons
5. The effects of ionizing radiation depend on
   1. length of exposure to radiation.
   2. location of source (external or internal).
   3. type and energy of radiation
   4. all of the above
   5. none of the above
6. Which of the following elements would be expected to be particularly stable?
7. The most important characteristic of carbon atoms for forming organic molecules is the
   1. ability to bond together to form long chains.
   2. ability to form multiple covalent bonds.
   3. use of hybrid orbitals
   4. a and b
   5. none of the above
8. What is the hybridization of the starred carbon in (CH3)2C\*=CHCN?
   1. sp
   2. sp2
   3. sp3
   4. dsp3
   5. d2sp3
9. Which of the following statements is false regarding functional groups?
   1. The chemical properties of the functional groups dictate the chemistry of the larger molecule.
   2. Each functional group has a characteristic chemical behavior.
   3. A functional group consists of an atom or a group of atoms that is part of a larger molecule.
   4. A functional group consists of only carbon and hydrogen atoms.
   5. none of the above
10. When in lab you are
11. the experimenter.
12. expected to wear safety goggle or glasses whenever anyone is using chemicals or flames.
13. not required to clean up the common areas.
14. a and b
15. all of the above

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. Answer the following for the weak field complex [MnI6]4-, and the strong field complex [Mn(CN)6]4- (12 points)
   1. Name the complexes.

[MnI6]4- hexaiodomanganate(II) ion and [Mn(CN)6]4- hexacyanomanganate(II) ion

* 1. Sketch the orbital energy level diagrams.

Mn: [Ar] 4s2 3d5

Mn2+: [Ar] 3d5

\_\_ \_\_

↑ ↑

↑ ↑ ↑ ↑↓ ↑↓ ↑

[MnI6]4- [Mn(CN)6]4-

* 1. Are the complex ions paramagnetic or diamagnetic?

Both are paramagnetic.

* 1. Which complex transmits the longer wavelengths of incident electromagnetic radiation? Explain your reasoning.

Strong field ligands absorb shorter wavelength light, therefore [Mn(CN)6]4- transmits longer wavelengths.

1. The hexachlorochromate(III) ion, [CrCl6]3-, has a maximum in its absorption spectrum at 735 nm. Calculate the crystal field splitting energy (in kJ/mol) for this ion (6 points).

1. The table here contains data from reactions of solutions of a series of octahedral platinum(IV) complexes with AgNO3 (aq). The compounds have the general formula Pt(NH3)xCl4, where x is 6, 5, 4, 3, or 2. Write formulas for each compound (6 points).

|  |  |  |
| --- | --- | --- |
| Composition of Complex | Number of Moles of AgCl Produced per Mole of Complex Added. | Formula |
| Pt(NH3)6Cl4 | 4 | [Pt(NH3)6]Cl4 |
| Pt(NH3)5Cl4 | 3 | [Pt(NH3)5Cl]Cl3 |
| Pt(NH3)4Cl4 | 2 | [Pt(NH3)4Cl2]Cl2 |
| Pt(NH3)3Cl4 | 1 | [Pt(NH3)3Cl3]Cl |
| Pt(NH3)2Cl4 | 0 | [Pt(NH3)2Cl4] |

Each reactant (i.e. formula) will be reacted with silver nitrate to produce the number of moles of silver chloride per mole of complex added as follows:

1. What do the prefixes cis- and trans- mean in the context of an octahedral complex ion (3 points)?

For an octahedral geometry, cis- means that two ligands are side by side and have a 90° bond angle between them. Ligands that are trans- to each other have a 180° bond angle between them.

1. List alpha particles, beta particles, positrons, and gamma rays in order of each of the following (6 points):
   1. Increasing ionizing power

gamma rays < beta particles ~ positrons < alpha particles

* 1. Increasing penetrating power

alpha particles < beta particles ~ positrons < gamma rays

1. What is radioactivity (3 points)?

Radioactivity is the emission of subatomic particles or high-energy electromagnetic radiation by the nuclei of certain atoms.

1. When uranium-235 nuclei are bombarded with neutrons (1.0087 amu), they can split apart in a variety of ways, like glass balls that shatter into pieces of different sizes. In one process, uranium-235 (235.04 amu) forms barium-142 (141.92 amu) and krpton-92 (91.92 amu) (12 points).
   1. Write the balanced nuclear fission equation
   2. Calculate the energy (in joules) released when 1.0 g of uranium-235 undergoes this fission reaction (1 amu = 1.6605 x 10-27 kg).

Δm = mproducts – mreactants

Δm = (141.92 amu + 91.92 amu + 2(1.0087 amu)) – (235.04 amu + 1.0087 amu)

Δm = 235.8674 amu – 236.0487 amu

1. Write nuclear equations for the following processes (4 points):
   1. Oxygen-17 produced by α-particle bombardment of nitrogen-14
   2. Americium-240 produced by neutron bombardment of plutomium-239.
2. Complete the following nuclear equations (6 points):
3. Whereas the solubility of both compounds in water is about 8 grams per 100 mL, the boiling point of 1-butanol is 117 °C, but that of diethyl ether is 35 °C. Account for these observations (4 points).

1-butanol can hydrogen bond with itself but diethyl ether cannot, so 1-butanol molecules are held together more strongly in the liquid, thereby resulting in the higher boiling point.

1. Pheromones are commonly called sex attractants, although they have more complex signaling functions. The structure of a pheromone in the queen bee is (6 points):

trans-CH3CO(CH2)5CH=CHCOOH

* 1. Write the structural formula of the pheromone.



* 1. Identify and name the functional groups in the molecule.



1. Benzaldehyde is responsible for the odor of almonds and cherries (12 points).
2. Draw the structure of benzaldehyde.



1. It has a normal boiling point of 179.0 °C. Calculate the boiling point of benzaldehyde at the summit of Pikes Peak, Colorado, if the atmospheric pressure is 447 torr. ΔHvap for benzaldehyde is 4.88 kJ/mol.