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Exam 4
CEM 151
Wednesday, December 3, 2014

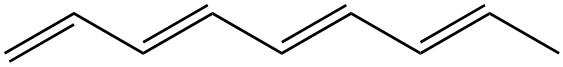
(Multiple choice, 6 points)

1) Order the following molecules by boiling point, with the lowest first and the highest last (*hint,* the dipole moments of H_2S, H_2Se, H_2Te are similar).

H_2O, H_2S, H_2Se, H_2Te

a. H_2O, H_2S, H_2Se, H_2Te
b. H_2Te, H_2Se, H_2S, H_2O
c. H_2O, H_2Te, H_2Se, H_2S
d. H_2Te, H_2Se, H_2O, H_2S
e. H_2Te, H_2S, H_2Se, H_2O
f. H_2S, H_2Se, H_2Te, H_2O

2) How many unhybridized p atomic orbitals (add up the orbitals on all the atoms) are involved in π bonding in 1,3,5,7-nonatetraene (shown below) according to Valence Bond Theory?

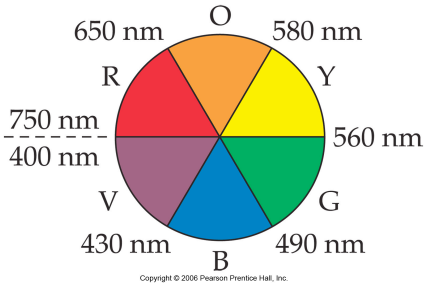


a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8
j. None of the above

3) What is the hybridization for each of the carbons in 1,3,5,7-nonatetraene (in order from left to right in the figure)?

a. sp^3, sp^3, sp^3, sp^3, sp^3, sp^3, sp^3, sp^3, sp^3
b. sp^3, sp^2, sp^3, sp^2, sp^3, sp^2, sp^2, sp^3, sp^3
c. sp^2, sp, sp, sp, sp, sp, sp, sp^2, sp^2
d. sp^3, sp^2, sp^2, sp^2, sp^2, sp^2, sp^3, sp^2, sp^2
e. sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^2
f. sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^2, sp^3

Use the color wheel below to answer the next 3 questions. The letters stand for colors, r, red, o, orange, y, yellow, g, green, b, blue, v, violet.



4) A metal complex that absorbs light at 520 nm will appear _____.

a. red
b. green
c. yellow
d. orange
e. blue
f. violet
g. colorless
h. black
i. white

5) A metal complex absorbs light mainly at 460 nm. What is the color of the complex?

a. green
b. orange
c. red
d. yellow
e. violet
f. black
g. blue
h. colorless
i. black

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Based on the crystal-field strengths $Cl^- < F^- < H_2O < CH_2CN < NH_3 < en < NO_2^- < CN^-$ answer the following questions:

6) The following complexes have the colors: violet, orange and green. Order the three complexes by color, in the same order as the colors above (the violet complex first followed by the orange and ending with the green).

I. $[Co(NH_3]_6]^{3+}$ II. $[CoCl(NH_3)_5]^{2+}$ III. $[CoCl_2(NH_3)_4]^{1+}$

a. I, II, III
b. I, III, II
c. II, I, III
d. II, III, I
e. III, I, II
f. III, II, I

7) Does either or both *cis*- or *trans*- $[Mn(en)_2(NH_3)_2]$ have optical isomers?

a. *cis* only
b. *trans* only
c. both *cis* and *trans*
d. neither *cis* or *trans*
e. It does not exhibit cis-trans isomerism
f. They are all optically active

8) A gaseous substance with only paired electrons is

a. diamagnetic
b. paramagnetic
c. ferromagnetic
d. permanently magnetic.
e. brightly colored.

9) Based on electron configuration, and assuming no charge transfer absorption, which is most likely colorless?

a. $[Sc(H_2O)_6]^{3+}$
b. $[Au(NH_3)_4]^{3+}$
c. $[Cr(NH_3)_5Cl]^{2+}$
d. $[Co(NH_3)_6]^{2+}$
e. $[Ni(NH_3)_6]^{2+}$
f. They are all colored

10) A complex is written (incorrectly) as $FeCl_3 \cdot 3NH_3$. What is the oxidation state of the metal in this complex?

a. +1
b. +2
c. +3
d. +4
e. +5
f. +6
g. -1
h. -2
i. -3
j. None of the above

11) Indicate the coordination number of the metal and the oxidation number of the metal for $Na[Cr(NH_3)_3(CN)_3]$ (coordination number, oxidation number)

a. 6, +6
b. 6, +4
c. 6, +3
d. 6, +2
e. 4, +4
f. 4, +3
g. 4, +2
h. 2, +4
i. 2, +3
j. 2, +2

Directions for the next 3 problems. Give the number of unpaired electrons for the following compounds:

12) $[Fe(H_2O)_3Cl_3]$ (high spin)

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. Can't tell
j. None of the above

13) $Na_4[NiCl_6]$

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. Can't tell
j. None of the above

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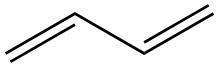
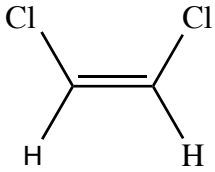
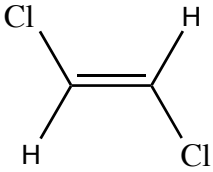
14) $K_3[Ru(CN)_6]$ (low spin)

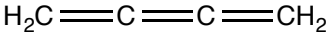
a. 0	c. 2	e. 4	g. 6	i. Can't tell
b. 1	d. 3	f. 5	h. 7	j. None of the above

15) Of the following molecules which are completely planar (all of the atoms in the molecule are located in the same plane, all the time)?

I. 

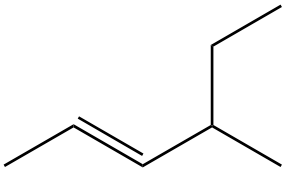
III. 

II. 

IV. 

a. I	c. III	**e. II, III, and IV**	g. I and IV	i. all of the above
b. II	d. II and III	f. I, II and III	h. I, II and III	j. None of the above.

16) Name the following compound.



a. *trans*-2-ethyl- 3-pentene	d. ***trans*-4-methyl-2-hexene**	g. *cis*-3-ethyl- 2- pentene
b. *trans*-3-ethyl- 2- pentene	e. *trans*-2-octene	h. *cis*-3-methyl- 4-hexene
c. *trans*-3-methyl- 4-hexene	f. *cis*-2-ethyl- 3- pentene	i. *cis*-2-octene

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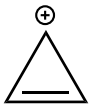
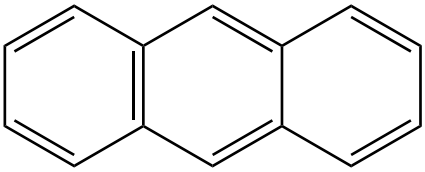
17) Which of the following are aromatic?

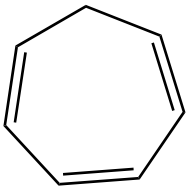
a.



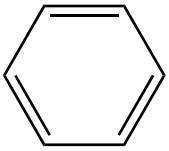
c.



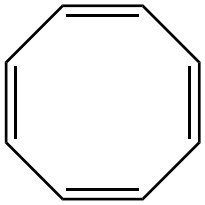
b.



d.



e.



f. a, b, c, d
g. c and d
h. a, c and d
i. a, b, c, d, e
j. None of the above

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(essay/short answer)

18) (10 points) Draw the molecular orbitals for N_2 in order of energy and fill them with the appropriate number of electrons. What is the bond order for N_2 according to your diagram? Is N_2 diamagnetic or paramagnetic? Explain using your diagram. Which do you predict would be more stable N_2 or F_2 and why? (you don't need more than 10 words to answer).

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19) (12 points) Sketch all possible isomers of the following. If an isomer has an enantiomer, simply write "plus enantiomer" after it:

(a) Square planar $[Pt(H_2O)_2Cl_2]$

(b) C_5H_{12}

(c) Tetrahedral $[Fe(NH_3)(CN)BrF]$

20. (6 points) Draw the appropriate arrows to complete the following mechanism: